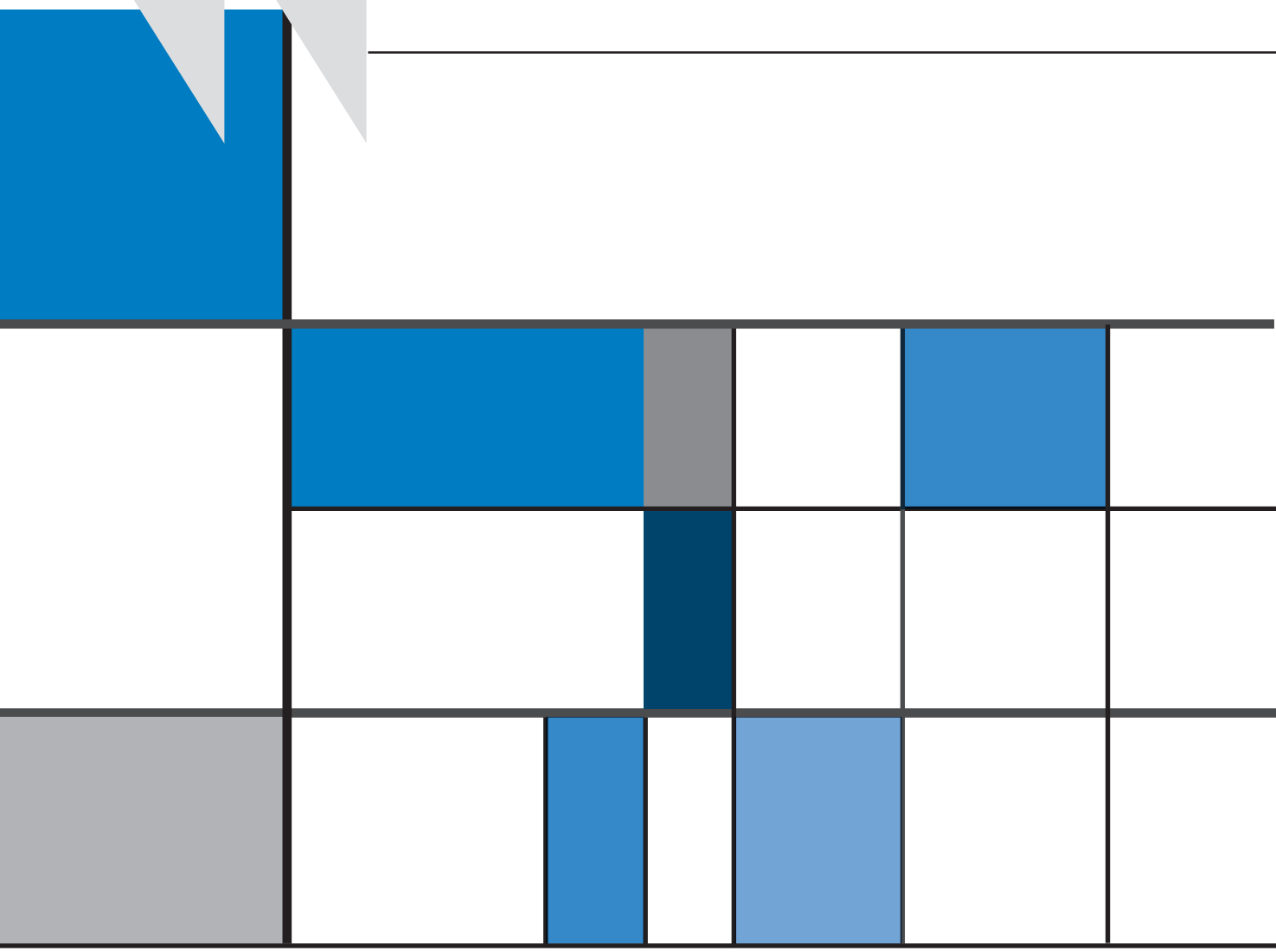
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Volume 2008

OECD Journal: Economic Studies

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Foreword

OECD Journal: Economic Studies *publishes articles in the area of economic policy analysis, applied economics and statistical analysis, generally with an international or cross-country dimension. While it draws significantly on economic papers produced by the Economics Department and other parts of the OECD Secretariat for the Organisation's intergovernmental committees, the submission of articles produced by non-OECD authors is encouraged.*

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Table of Contents

Publicly Provided Services and the Distribution of Households' Economic Resources . . . 9

by François Marical, Marco Mira d'Ercole, Maria Vaalavuo *and* Gerlinde Verbist

Conventional income distribution statistics subtract taxes from household income but do not take into account the distributional effects of the services financed through these taxes. As many of the functions of government are available to the population free of charge or at a subsidised rate, this means that income distribution figures exaggerate the degree of inequality in the distribution of resources. This article examines the extent to which this is the case, and assesses whether statements about the relative inequality prevailing in different countries are reliable. Estimates of the impact of government services on the static distribution of household income, based on two different approaches, show that publicly-provided goods and services significantly narrow the dispersion of income inequality across countries with only small changes in the ranking of individual countries, and that the effects are larger when looking at the extremes of the distributions.

Improving the Efficiency of Health Care Spending: What Can be Learnt from Partial and Selected Analyses of Hospital Performance? 49

by Espen Erlandsen

There are no ready-made data on hospital outputs and inputs which would allow comprehensive international comparisons of hospital efficiency to be carried out. This paper, therefore, relies on selected evidence to compare hospital efficiency in a sub-set of OECD countries, based on three different approaches relying on, respectively: i) *unit costs for standard hospital treatments;* ii) *overall efficiency levels in a set of paired countries;* iii) *within-country dispersion in individual hospital efficiency. The analysis suggests substantial cross-country differences in hospital performance. Although country coverage varies between the different approaches, making it difficult to assess the extent to which comparisons provide a consistent picture of national efficiency levels, cross-checks between the different indicator sets tend to support the robustness of the country rankings.*

Globalisation and Employment in the OECD 83

by Margit Molnar, Nigel Pain *and* Daria Taglioni

This article reviews some of the possible changes that may occur in the national labour markets of many OECD countries as a result of the internationalisation of production by multinational companies, with a particular focus on the impact of outward foreign direct investment (FDI) from OECD countries on employment in the home country of the investing firms. Existing studies suggest that the overall impact of trade and the internationalisation of production on aggregate labour market outcomes has been comparatively small, although particular skill and occupational groups have been affected more strongly. The empirical findings in the paper suggest that the aggregate employment impact of outward FDI varies across industries and countries. For manufacturing

industries with strong commercial links with the non-OECD economies, there is evidence that domestic employment has become more sensitive to movements in domestic labour costs. At the country level, the growth of outward investment is found to have a significant positive effect on domestic employment growth in the United States. In contrast, there is a negative association in Japan, especially from outward investment in China.

Globalisation and OECD Consumer Price Inflation 117

by Nigel Pain, Isabell Koske *and* Marte Sollie

Over the past 25 years inflation has moderated considerably in all OECD economies. At the same time, the production of many goods and services has become increasingly internationalised and the level of trade between the OECD and non-OECD economies has risen markedly. This paper investigates the extent to which the observed changes in the inflation process can be attributed to the increasing integration of non-OECD economies into the global economy. The results of the analysis show that i) import prices have become a more important driver of domestic consumer prices since the mid-1990s; ii) the sensitivity of inflation to domestic economic conditions has declined whereas the sensitivity to foreign economic conditions has risen, working through import prices; and iii) the strong GDP growth in the non-OECD economies over the past five years has contributed to the growth of real oil and metals prices. A scenario analysis shows that globalisation has put upward pressure on inflation via higher commodity prices and downward pressure via lower non-commodity import prices with the latter effect having dominated in most OECD economies.

The Macroeconomic Policy Challenges of Continued Globalisation 149

by Karine Hervé, Isabell Koske, Nigel Pain, *and* Franck Sédillot

This article investigates the macroeconomic policy challenges associated with a prospective continuation of international trade and financial integration over the next two decades, making use of a global macroeconomic model newly developed by the OECD. The analysis has several important policy implications. First, with the shares of non-OECD economies in world output, trade, and capital markets rising substantially, global economic developments would become much more dependent on developments in these economies than they used to be. Second, the sustainability of existing global current account imbalances will depend in part on the future build-up and composition of international assets and liabilities. While the imbalances could be sustainable for some time if economic integration continues at its current pace, a slowdown of the globalisation process would raise the likelihood of a disruptive adjustment in financial markets. Third, the increase in trade and financial linkages implies that macroeconomic shocks in a given country or region have a larger impact on other economies in the future than they do today. Policymakers in the OECD may have to act more promptly and more vigorously to economic "shocks" in the non-OECD economies in order to limit the impact on OECD economies.

Economic Resilience to Shocks: The Role of Structural Policies 201

by Romain Duval *and* Lukas Vogel

Cyclical fluctuations in economic activity have moderated over time but the extent and dynamics of volatility remain different across OECD countries. A reason behind this heterogeneity is that countries exhibit different degrees of resilience in the face of common shocks. This paper traces divergences in resilience back to different policy settings and institutions in labour, product and financial markets. Using pooled regression analysis across 20 OECD countries over the

period 1982-2003, the paper identifies the impact of policy settings on two dimensions of resilience: the impact effect of a shock and its subsequent persistence. Policies and institutions associated with rigidities in labour and product markets are found to dampen the initial impact of shocks but to make their effects more persistent, while policies allowing for deep mortgage markets lower persistence and thereby improve resilience. Combining these two dimensions of resilience, the paper then uses the estimated equations to derive indicators of resilience for the OECD countries concerned, based on their current or recent policy settings. Three groups of countries emerge. In English-speaking countries, simulations suggest shocks have a significant initial effect on activity but this impact then dies out relatively quickly. By contrast, in many continental European countries the initial impact of shocks is cushioned but their effect linger for longer, with the cumulated output loss tending to be larger than in English-speaking countries. Finally a few, mostly small, European countries combine cushioning of the initial shock with a fairly quick return to baseline.

The Incidence of Carbon Pricing: Norway, Russia and the Middle East 239

by Philip Bagnoli, Jean Château *and* Yong Gun Kim

Russia, Norway and the Middle East are three regions that have distinct histories in energy policies. Current situations will make it more challenging for Russia and the Middle East to implement greenhouse gas abatement than it will be for Norway, even though all three are major energy producers. Relative to the world as a whole, Russia is most heavily impacted, with the Middle East less so but still significantly affected. Norway's potential economic loss is only a little larger than the world average. This asymmetry implies that if the differences in impacts are not broadly understood, then international negotiations may be subjected to bargaining under asymmetric information. If so, they may not be able to reach agreement. The result reported here is thus a step in overcoming information asymmetries and facilitating successful negotiation. The results also have clear implications for the speed at which Russia undertakes energy market reforms, and for the manner in which Middle Eastern countries implement diversification of their economies.

Fiscal Equalisation 265

by Hansjörg Blöchliger *and* Claire Charbit

Fiscal equalisation is a transfer of fiscal resources across jurisdictions to offset disparities in revenue raising capacity or public service cost. It covers on average 2.5% of GDP or 5% of total government expenditure across OECD countries. Equalisation reduces fiscal disparities by two-thirds on average and in some countries levels them virtually out. Strong equalisation comes at a price: on average, around 70% of a jurisdiction's additional tax income must be dedicated to an equalisation fund. The equalisation rate is generally higher for jurisdictions with low fiscal capacity, reducing their tax effort and likely to slow down regional economic convergence. Cost equalisation is larger than revenue equalisation in terms of GDP despite smaller cost disparities, pointing at inefficiencies in the distribution formulae. Fiscal equalisation can be pro-cyclical but most countries succeed in reducing fluctuations of entitlements, sometimes at the cost of sub-central budget needs. Fiscal equalisation is very country specific, and data and analysis must be taken with care.

The Contribution of Economic Geography to GDP per Capita 287

by Hervé Boulhol, Alain de Serres *and* Margit Molnar

This article examines how much of the dispersion in economic performance across OECD countries can be accounted for by the proximity to areas of dense economic activity. To do so, various indicators

of distance to markets and transportation costs are added as determinants in an augmented Solow model, which serves as a benchmark. Measures of distance to markets are found to have a statistically significant effect on GDP per capita. And the estimated economic impact is far from negligible. The reduced access to markets relative to the OECD average could contribute negatively to GDP per capita by as much as 11% in Australia and New Zealand. Conversely, a favourable impact of around 6-7% of GDP is found in the case of two centrally-located countries: Belgium and the Netherlands. The paper provides also some tentative evidence that spending on R&D and human capital might have a stronger effect on GDP per capita in countries with a higher degree of urban concentration.

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Publicly Provided Services and the Distribution of Households' Economic Resources

by

François Marical, Marco Mira d'Ercole, Maria Vaalavuo and Gerlinde Verbist

Introduction 10
Findings from previous research 13
Health care 13
Education 16
Social housing 18
New empirical evidence 19
Size and composition of public services to households 19
Estimates based on individual records 20
Estimates based on grouped data 27
Conclusions 32
Notes 33
Bibliography 36
Annex Table A.1. Main findings from selected studies on the distributive impact of public services 40

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Introduction

Most studies on income inequalities, within a country or internationally, are based on the concept of household monetary income. This choice is not without consequences. The fact is that many factors other than income contribute to individuals' well-being and, by leaving them out, conventional income measures may give a biased impression of both the average level of well-being and its distribution. This article focuses on one of these factors, *i.e.* those government-provided services to households that confer a personal benefit to users. Households pay taxes to finance these public services; but while (part of) these taxes are deducted from their income, the services provided in return do not affect traditional income measures.[1] A more accurate table of inequalities and standards of living should, in principle, include the value of the public services from which households benefit.

The omission of this category of resources is due both to the difficulty of measuring it and to more profound conceptual questions, evoked in Box 1. While there are no simple answers to many of these questions, excluding such services from the analysis of how households economic resources are distributed is unfortunate since, in the majority of OECD countries, their budgetary cost is comparable to that of cash transfers. Consequently, and despite the conceptual problems referred to, a long tradition of analysis in certain OECD countries (United Kingdom, United States and Australia in particular) has addressed the effect of public services on distribution.[2]

Box 1. **Conceptual and methodological issues**

Considering the influence of government services on the distribution of economic resources available to households requires broadening the definition of resources, from the more narrow concept of disposable income – *i.e.* the sum of market income (earnings, rents, dividends, etc.) and cash transfers (from both public and private sources) that households receive, less the direct taxes and social security contributions they pay – to one that includes additional non-market elements, such as government-provided services, that are usually omitted from conventional statistics. Shifting from household income towards a broader concept of economic resources raises a range of questions: some are conceptual, and mainly relate to the valuation of these services and to their distribution across individual beneficiaries; others are methodological – and probably less controversial – but can crucially affect numerical results.

- *What services should be included?* The boundaries of what can be included under the heading of "public services" to households are ill defined. Major items of public expenditure such as education and health are certainly included, but *a priori* any public expenditure – either directly or indirectly – benefits households, from spending on military equipment to operating costs of institutions. One can, however, categorise these different types of expenditure. Some services provided by government benefit households individually, as in the case of health, education and social housing. Others,

Box 1. **Conceptual and methodological issues** *(cont.)*

conversely, benefit the whole population more or less indivisibly, for example infrastructure or security. A few studies have sought to allocate all public expenditure to households, from agricultural subsidies to construction of motorways (*e.g.* Ruggles *et al.,* 1981). Others have relied on a more precise classification of public services according to their impact on households (*e.g.* Wolff *et al.,* 2004).[1] In practice, most studies have focussed on more limited sectors of activity – notably education, health and certain other items of social expenditure – where services provided confer a personal benefit upon users.

- *How to value government services to households?* Public services are typically provided outside market settings. Because of the lack of market prices, these services are generally valued, in the national accounts system, at their production cost – which, in most cases, is further limited to labour costs, *i.e.* excluding costs for the use of capital equipment. This is a controversial choice when the objective is to value the well-being of individuals and households. An alternative to production costs would be to value these services by what an individual would have spent if similar services had been bought on the market or on the willingness of individuals to pay for them, but the information requirements of these approaches are demanding – and government services may have characteristics that differ from those purchased on the market. Despite these problems, the valuation of government output has a critical importance for all analyses of its distributive impact – underlining the importance of the ongoing discussion within the national accounts community of how best to measure government output (Atkinson, 2005). Most studies on the distributive impacts of government services value these at their production costs (*e.g.* Aaberge *et al.,* 2006 ; Ruggles *et al.,* 1981 ; Smeeding *et al.,* 1993), thus neglecting differences across countries in the efficiency of service provision.[2]
- *How to distribute the aggregate value of government services among individuals?* The household surveys that are typically used to assess income distribution often provide only limited information on the actual use of different government services by each individual and household. This implies that most attempts to "individualise" these benefits rely on imputation techniques, and are therefore exposed to errors.[3] While for some services this individualisation is relatively straightforward (*e.g.* use of public education is limited to those households with a child of the relevant school-age), for other types it requires more detailed information (*e.g.* on the number of medical and hospital visits in the case of public health). Most studies of the distributive impact of public health care services base the distribution of their aggregate value across individuals not on their actual use, but rather on the characteristics of individuals (*e.g.* age, gender, education or income) and households (*e.g.* presence of children, work status of other adults in the family) – *i.e.* on the assumption that the probability that a person will access these services is the same as that prevailing for other individuals with the same characteristics.[4]
- *Should the value of government services be attributed to individuals or to the household in which they live?* This methodological question is important for interpreting the results of different studies. Most studies of income distribution use the household (or, more rarely, the family) as the unit within which resources are pooled and (equally) shared by individuals (*i.e.* individuals are attributed the income of the household where they live, after an adjustment for different needs across households of different size, Canberra Group 2001). This approach raises, however, specific problems in the case of government

Box 1. **Conceptual and methodological issues** *(cont.)*

- services, *i.e.* whether their benefits accrue to the individual user (for example, those who are attending university education) or extend to other household members (*i.e.* parents who may bear the costs of their children's university studies).[5] While this second approach is the one used by most studies, its application raises specific problems in the case of students in tertiary education, many of whom may be counted as being part of an independent household with low reported income. While some studies try to overcome this problem by attaching students to their family of origin, this is not always feasible.
- *Redistribution over what period?* The benefits of government services to individual users may not be limited to the moment in which they are consumed but extend to the long term (*e.g.* education services enhance the future earnings of students). Accounting for these long-term benefits, however, requires life-cycle models whose assumptions (in terms of preferences and risk aversion) are often *ad hoc*. Because of these difficulties, most studies in this field take a more limited, but also less arbitrary, *static* view of these benefits.

Answers to many of the questions above are inevitably controversial. Some observers will question the possibility of assessing households' well-being by "adding" cash components that can be used by recipients to meet all their needs of daily living – and whose value is known with certainty – to other components that can only be used to meet some of these needs – and whose valuation is inevitably controversial. Even when accepting the usefulness of a broader concept than household income, the partial nature of this extension (*e.g.* including in-kind public services but excluding other components such as imputed rents or capital gains) can improve the ranking of some individuals (*e.g.* families with children) while an extension to all components could have the opposite effect (Verger, 2005). In other words, each additional item has the potential to affect the overall assessment of well-being and inequality.[6] These considerations have obvious implications for the interpretation of results in this report.

1. Wolff *et al.* (2004) use a classification for the United States based on the national accounts nomenclature, which includes all services that directly benefit households but excludes general administration, national defence, justice and prisons.
2. Smeeding (1977), however, values government services based on how much households would have spent for a private service with similar characteristics, *i.e.* their cash-equivalent value. Because of differences in the characteristics of households who purchase public and private services, Smeeding relies on econometric methods (applied to households buying private services on the market) to estimate the price that households who use public services would have been ready to pay.
3. In addition, the benefits from these services may not be limited to the individual user but extend to society as a whole (*i.e.* each person may benefit from living in a community where the levels of education and heath are high). However, accounting for these externalities is difficult: as a result, they are generally ignored by most empirical analysis.
4. This assumption effectively implies that all individuals derive a benefit from knowing that, in case of need, they would have access to these services.
5. In one approach, the equivalised income of the beneficiary is increased by the non-equivalised value of government services; while in the second, the non-equivalised income of the household is first raised by the amount of government services and then equivalised.
6. Both the size and the distributive effects of various income components will depend on the valuation used. For example, Mattila-Wiro (2004) estimates that household production (*i.e.* the production by household members of goods and services for their own use that could have been delegated to individuals outside the household), when valued at the earnings of a non-skilled worker, would lower the Gini coefficient of income inequality in Finland by around 30% and the headcount poverty rate by close to 60% in 1999-2000.

This article takes stock of the evidence and compares the methodologies adopted to take account of the distributive impacts of public services to households. The analysis ignores however other potentially important effects – such as those on labour supply and poverty – as well as those public services that cannot be attributed to individual users (*e.g.* transport infrastructure, police, defence). The next section summarises the main results of previous studies on this subject while the one that follows presents the results of a quantitative evaluation. This evaluation is based on two different approaches. The first approach relies on the micro-records from household surveys for 18 OECD countries and considers the impact on the distribution of households' economic resources of public health care, education and social housing. The second approach is based on grouped income data by deciles from the OECD questionnaire on income distribution and provides estimates for 26 OECD countries and for all spending categories included in the OECD Social Expenditure Database. The final section summarises the evidence and concludes.

Findings from previous research

Several studies have looked at the distributive implications of publicly provided services. This section summarises some of the main findings from this research in the fields of health care, education and social housing. Key results from these studies are summarised in Annex Table A.1. Results are however difficult to compare directly across studies, because of differences in the programmes covered and in the methodology used.

Health care

Research on the distributive effects of health care services has pursued two main approaches: the first considers the monetary value of public health care services as *adding* to household income; the second focuses on how individuals' out-of-pocket health care costs *lower* their economic resources.

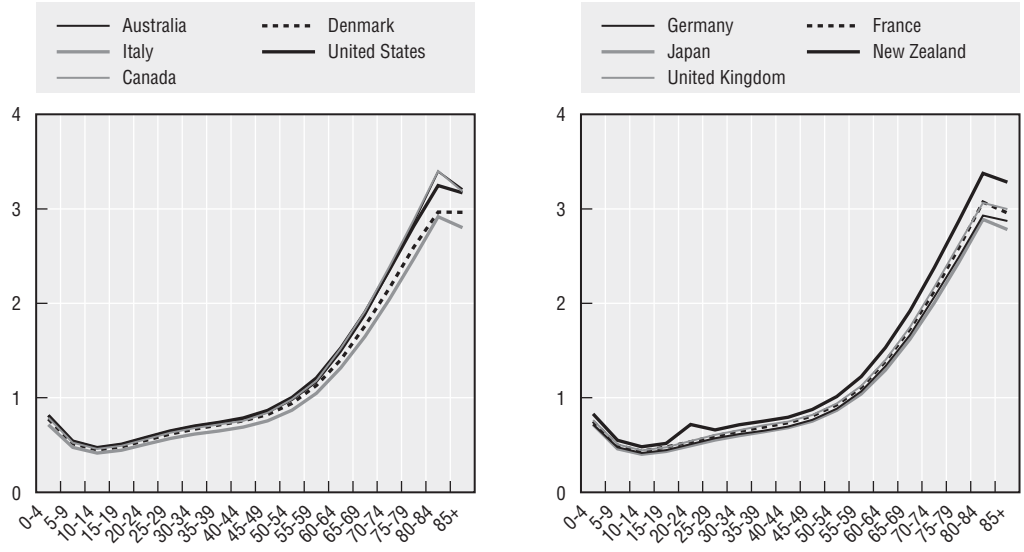
Approaches based on adding public outlays to household income

Studies on the impact of public health care expenditure on overall household resources have relied on two main approaches in attributing to individuals the benefits from these services. The first is based on the notion that each individual has the same probability of benefiting from these programmes as other people with similar characteristics (*insurance value*); the second is based on the *actual use* of these services. The first approach is by far the most dominant, and is the one that will be used for the empirical analysis presented in the next section. The dominance of this approach partly reflects the high concentration of health spending on the elderly. Indeed, the profile of public health expenditure by age is remarkably similar across OECD countries: following a slight fall after an early age, use of health care services remains broadly flat until the age of 40-44 before increasing exponentially in old age, and then declining marginally after age 85 (Figure 1).

Research that bases the imputation of public health care expenditure on people's age (extended, more rarely, to other characteristics) reports a significant effect in reducing inequality in the distribution of economic resources. This effect reflects two elements.

- The first is the heavy concentration of health spending on the elderly mentioned above, combined with the fact that most elderly, having withdrawn from the labour market, have low money income – which implies a strong redistributive effect in terms of the

Figure 1. **Public health care expenditures per capita for each age group, as a proportion of total per capita health expenditure**



Note: Values above 1 indicate that the per capita spending of a given age group is above the one for the population as a whole (*e.g.* health care spending going to people aged 80 and over is around three times higher than the average).

Source: Calculations based on OECD (2006), "Projecting OECD Health and Long-Term care Expenditures: What are the Main Drivers", *OECD Economics Department Working Papers*, No. 477, OECD, Paris.

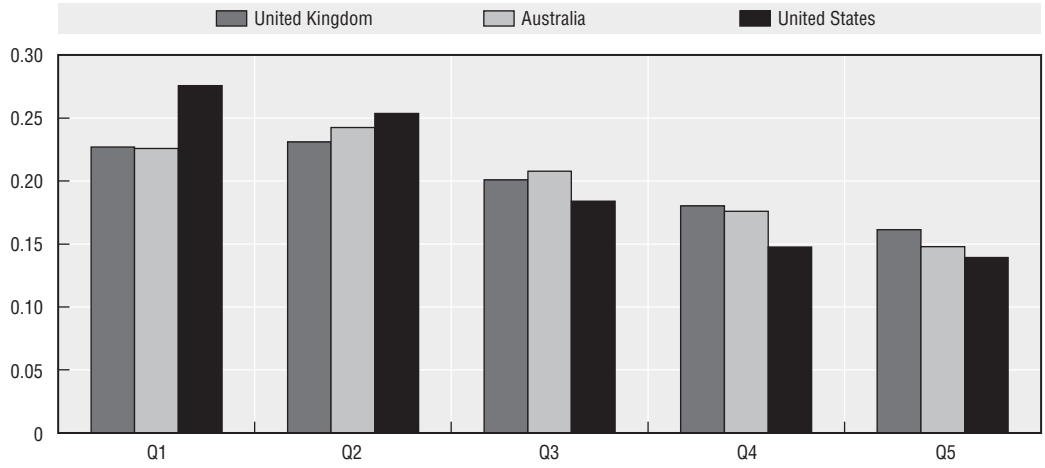
annual accounting period used here. Indeed, according to Gardiner *et al.* (1995), the greater concentration of health care spending in the lower quintiles mainly reflects the low income of most elderly people.

- The second is the amplification of this age-related redistributive impact by an additional equalising impact from the distribution of public health care spending within age groups.[3] This reflects both the greater importance of health care services for those at the bottom of the income distribution, even when the absolute amount provided is the same for all individuals, and – in some countries – the higher value of the health care services provided to people in the lower quintiles of the income distribution.

These patterns hold both in countries with a universal health care system (*e.g.* the United Kingdom), and, to an even greater extent, in those where access to some public health care services is limited to elderly people or to those with fewer resources (*e.g.* the United States). Estimates from national studies of the distribution of public health care expenditure across income quintiles show that the decline is both steeper and more progressive in the United States, while in both the United Kingdom and Australia those in the second quintile receive the largest share (Figure 2). Indeed, according to Lakin (2004), the distribution of public health care spending in the United Kingdom is relatively uniform for non-retired households, while it favours those in the lower part of the distribution when the analysis is extended to all households.

Other studies have relied on *actual* consumption to assess the distributive effects of public health care. For example, both Evandrou *et al.* (1993) and Sefton (2002), who rely on detailed data on the effective use of health care services by individuals in the United Kingdom, conclude that public health care expenditure lowers inequality – with an even larger share of public health care spending accruing to people in the second quintile and a steeper fall in its distribution, relative to studies based on insurance values. Estimates

Figure 2. **Distribution of public health care expenditure across income quintiles, early 2000s**



Note: Estimates for the United States assume that outlays for public health and hospitals are available to all individuals (*i.e.* they are distributed on a per capita basis) while those for Medicare and Medicaid are only available to specific segments of the population. For each country, the five bars in the chart sum to unity.

Source: Harding *et al.* (2004) for Australia, Lakin (2004) for the United Kingdom, and Wolff (2004) for the United States.

based on actual health care use, however, are not immune to criticism. In effect, this approach implies that, for a given money income, sick people are better off than others simply because they receive more health-related services (Aaberge *et al.,* 2006). In addition, many health care interventions are both very costly and concentrated over a limited period of time: as a consequence, re-ranking individuals on the basis of "final" income (*i.e.* after allowing for the effect of the public health-care benefits received) may push those people who benefit more from these services into higher income groups, thus dampening the measured effect of health care services in equalising the income distribution.

Addressing these criticisms requires considering both the greater use of health care services by people affected by health problems and their greater health needs. Research on the links between individuals' income and health status suggests that poorer people have worse health conditions than others, and, as a consequence, greater needs for health care (Hernández-Quevedo *et al.*, 2006 ; Humphries *et al.*, 2000; Caussat *et al.,* 2005). Studies that try to control for both needs and use of health care services (based on respondents' self-assessment of their health status and their use of various types of health care services) suggests that most OECD countries have achieved "equity" in terms of number of physician visits and hospital nights across different income groups, while dental health services are invariably pro-rich (Van Doorslaer *et al.,* 2004).[4] This conclusion is further strengthened when considering that poor people may opt to forgo health care as part of the coping strategies they adopt when confronted with illness.

Approaches based on deducting out-of-pocket costs

Cross-country differences in the organisation of health care services have implications for income distribution that go beyond those implicit in the size of public expenditures. To address these, Gardiner *et al.* (1995) propose an alternative approach: rather than adding public health expenditures to personal income, their approach deducts from disposable income the out-of-pocket costs (including the costs of private health insurance) incurred by households.[5] The importance of out-of-pocket health care

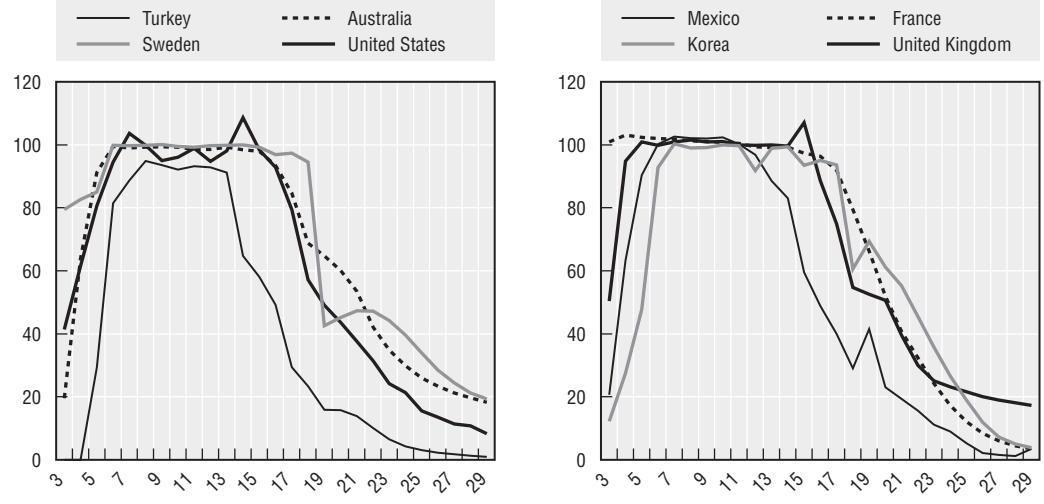
outlays for cross-country comparisons of income inequality is highlighted by the large differences across countries in both their average size and their distribution among income deciles (Gardiner *et al.*, 1995).

Out-of-pocket health care expenditures are a special concern in countries, such as the United States, without a universal health care system.[6] Merlis (2002) observes that these payments are a major reason for income insecurity for people without health insurance in the United States (around 16% of the total population, De Navas-Walt *et al.*, 2006): and that out-of-pocket health care payments account for more than 5% of income for 16% of all US households, and for 23% for those below the official poverty line. Also, these out-of-pocket payments are especially large for households headed by an elderly or disabled person, because of a combination of greater needs, lower income and lower coverage by employer-based health insurance. Out-of-pocket payments are also important in other countries, especially when households confront "catastrophic" events.[7] Overall, evidence suggests that out-of-pocket payments most affect the poorest families with the most serious health problems.[8]

Education

The utilisation of public education services varies from one individual to another, which *a priori* means significant distributive effects. An individual's age – at least up to upper secondary education – is the chief factor which determines the probability that any individual will benefit from such services (Figure 3). Indeed, the majority of studies of the distributive effects of public expenditure on education approach these services globally and base the imputation to individuals on the criterion of age (*e.g.* Garfinkel *et al.*, 2004), although others use information on actual participation in different types of educational institutions.

Figure 3. **School enrolment by age in selected OECD countries, 2003**



Note: Participation in public and private education both on a full- and part-time basis. In some countries, the rate of participation is higher than 100% because the estimates of the number of students and the number of people in each age group are based on different data sources.

Source: OECD (2005b).

However, individuals' age is not the only factor which affects the utilisation of public education services. Other factors, such as individuals' social background and income, are

also important. The role of these factors depends considerably on the category of education concerned. In this regard, the fundamental distinction is between compulsory education and non-compulsory education.

Compulsory education

Compulsory education, which includes primary and lower secondary education, accounts for between 30% and 60% of public education expenditure depending on the country. In principle, all individuals of school age benefit from this, although some households choose private education.[9] While a small minority of children (most of them from poor backgrounds) do not attend school at this age,[10] the allocation of public expenditure for compulsory education based solely on age seems *a priori* justifiable.

Studies adopting this approach to compulsory education have generally found evidence of significant reductions in inequalities in the distribution of economic resources. For example, in Greece primary and secondary education mainly benefit the three lowest quintiles of the distribution, the inclusion of each of these two categories of public spending leading to a one point reduction in the Gini coefficient (Antoninis *et al.,* 2001). Greater equality generally results from the combined effect of a higher value of universal services as a proportion of income for households at the bottom of the income scale, and from the concentration of children in lower income families (in some countries). In some countries, households in the bottom deciles of the income distribution also appear to receive a higher absolute amount (*e.g.* public spending for primary and secondary education in Norway, Steckmest, 1996).

Non-compulsory education

Social background is much more significant for attendance at other levels of education. This is the case of pre-primary education, where the probability of access is higher for children from households where both parents are in paid employment and who, as a consequence, are more likely to be in the highest deciles of the distribution (CERC, 2003; Hugounenq, 1998). This phenomenon is even more apparent at post-compulsory education levels (upper secondary school and university) which, in addition, account for a much higher share of public expenditure on education.[11]

In all the OECD countries, attendance of tertiary education is associated with a more unequal distribution of resources, not least because it depends on parents' socio-economic characteristics.[12] Various factors combine to cause this.

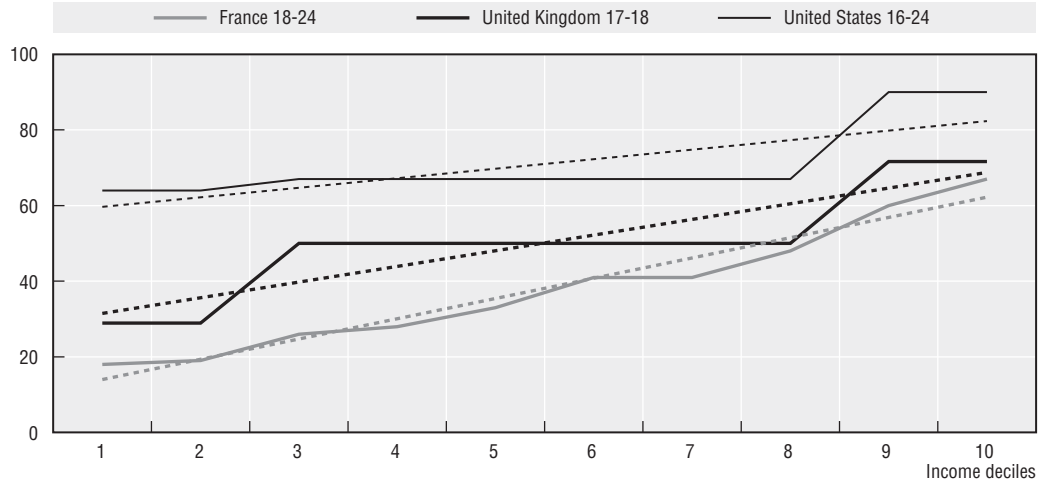
- One factor relates to the parents' age. Parents of children aged 18 to 25 are generally at the time of their life where their salaries are highest, which helps to place them most often in the highest quintiles of the income distribution (Sefton 2002). By contrast, older people, whose incomes are generally lower than the population average, benefit less from this expenditure because fewer of them have children of that age.[13]
- A second factor relates to family incomes. Evaluating this factor, however, raises specific problems. A large proportion of students in tertiary education live away from their family of origin and could, based on conventional definitions of household income, be considered as having low income. To take account of this factor, individuals must be grouped in their households of origin. While only a few studies appear to have used such an approach, they do highlight clear inequalities in attendance. Thus, in France, individuals aged between 18 and 24 from households in the highest quintile of the

income distribution have a probability of access to university which is three times higher than that of the lowest quintile. (Albouy *et al.*, 2002). These inequalities are also evident in the United Kingdom (Evandrou *et al.,* 1993; Sefton, 2002) and, to a lesser extent, in the United States. Among these three countries, inequalities of access are greater in those where the enrolment rate in higher education is lower (Figure 4).[14]

Both of these elements make public expenditure for tertiary education regressive, *i.e.* most of their benefits accrue to individuals coming from richer families.

Figure 4. **Participation in tertiary education by income deciles of family of origin**

Share of individuals in each decile



Note: The rate of participation in higher education is the proportion of individuals of a given age who are students. The differences observed between countries partly reflect differences in age groups considered. The dotted lines represent linear interpolations obtained from these curves. For the United States, the data only cover young people aged 16 to 24 years who have completed their secondary education.

Source: Albouy *et al.* (2002) and Blanden *et al.* (2002).

Social housing

Housing costs are the largest item in the household budget, especially for households at the bottom of the income distribution (Ditch *et al.,* 2001). The institutional arrangements whereby governments help the poorest to meet housing expenditure vary from one country to another (Gardiner *et al.*, 1995). While housing aid in cash is generally included in household money income, this is not the case for social housing, even if households benefiting from this often pay a rent that is below market rates.[15] The scale of social housing varies considerably from country to country. Thus, the proportion of households in social housing ranges from 6% or less in Australia, Canada, New Zealand and Sweden, up to around 20% or more in France (18%), the United Kingdom (22%) and the Netherlands (36%, Ditch *et al.,* 2001).

The impacts of social housing on income inequality depend on the characteristics of renters and on the size of the "implicit subsidy" provided. With respect to the first element, conditions of access to social housing vary considerably from one country to another. In Great Britain, the Netherlands, New Zealand and Sweden, access to social housing is not explicitly linked to individuals' resources, while such means-testing does exist in the other six countries considered by Ditch *et al.* (2001). In France, social housing primarily benefit families on low or modest incomes, even if the majority of them are not poor.[16]

While comparative evidence of the impacts of social housing on income inequality is rare, more evidence is available from national studies.[17] Both Sefton (2002) and Lakin (2004) argue that people in the two bottom quintiles of the income distribution in the United Kingdom benefit most (receiving 36% and 34%, respectively, of the total benefits associated with social housing). Other studies, which "augment" household income for *both* the implicit subsidy provided by social housing and for the imputed rent of owner occupation, show that the effects of these two factors on income inequality offset each other. For example, Saunders *et al.* (2005) conclude that the overall effect of rental income (for all types of tenure) is a small decline of income inequality in Australia;[18] while Gardiner *et al.* (1995) report that allowing for housing subsidies and imputed rents slightly reduces income inequality and poverty in the United Kingdom and France. Overall, these studies suggest that social housing is probably the category of government services that benefit the poor most. However, its overall impact on income inequality is smaller than for health care and education because of the lower amounts of spending.

New empirical evidence

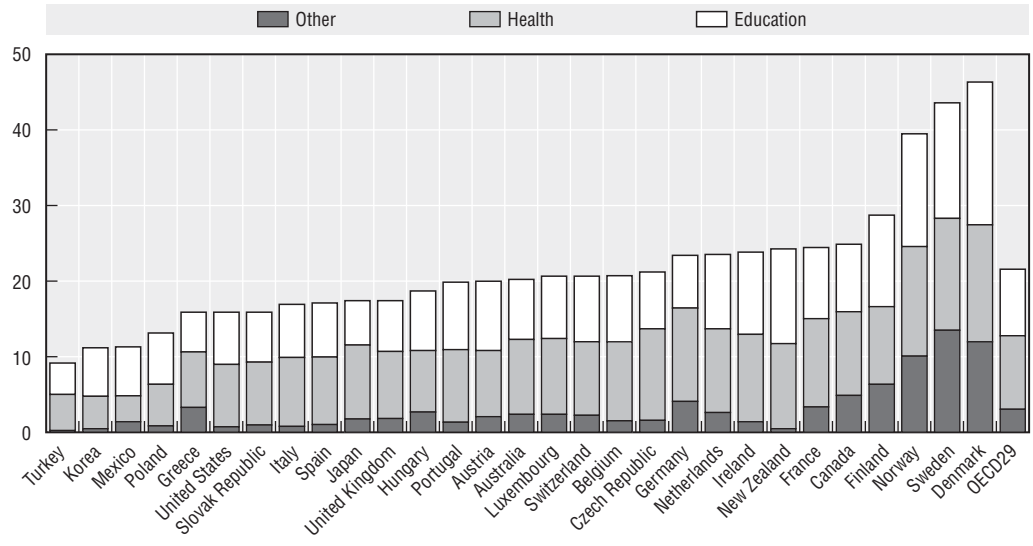
This section first describes the size of public spending on services to households, and then presents estimates of its impact on the *static* distribution of household income. These estimates are based on two different approaches, which use different methodologies to impute these expenditures to individual beneficiaries. The first approach – which is limited to a more narrow range of countries and social programmes – is based on individual records from household surveys: in this approach, household income is increased by the value of the public services received by individual beneficiaries and inequality measures allow for possible moves of individuals in the distribution (*i.e.* for "re-ranking" of individuals). The second approach – which is applied to 26 OECD countries and covers all public expenditures for the provision of social services to households – is based on income data grouped by deciles, as available from the OECD questionnaires on income distributions. In this approach, the average income of each decile is increased by the average value of services received by people in that decile, without "re-ranking" of individuals. Both sets of estimates rely on the concept of "equivalised" household disposable income based on an arbitrary (but commonly used) assumption of how household needs change with household size (the square root elasticity).[19] The description of results presented in this section is mainly based on the inter-quintile share ratio (Q5/Q1) and refers to a single point in time, typically around 2000.

Size and composition of public services to households

Public expenditure for the provision of services that can be attributed to individual households is considerable (Figure 5).[20] At a minimum, these publicly provided services include health care and education, as well as spending for the provision of what are labelled as "other social services" in the OECD Social Expenditure Database.[21] On average, this expenditure represents 21% of household disposable income (according to national accounts data), with large disparities from one country to another (from less than 10% of household income in Mexico to over 40% in the Nordic countries). Health care is the biggest item (on average, 45% of total public expenditure on individualised services), closely followed by education (41%) while other social services account for 14% of the total. Within the latter category, the biggest item is services to families (34% of all "other social services") followed by services to the elderly and disabled persons (28 and 21% respectively). Even

Figure 5. **Public expenditure for in-kind services in OECD countries in 2000**

Percentage of household disposable income



Note: The category "other social expenditure" includes services to the elderly, survivors, disabled persons, families and unemployed, as well as those related to housing, social assistance, and active labour-market policies.

Source: Data are taken from the OECD database on social expenditure for the "health" and "other social expenditure" categories, and from the UNESCO-OECD-Eurostat database for education expenditure. For Turkey, data refer to 1999. Household disposable income is taken from the national accounts for all the countries considered except Ireland and Luxembourg (where no national accounts data for the household sector exist), where data are drawn from the OECD questionnaire on income distribution.

these amounts under-estimate the size of public services to households; in particular, public spending for housing services only include quasi-cash rental-assistance programmes, while excluding both the investment for the building of social housing and the "implicit subsidies" to households renting social housing at a below market rate.[22]

On average, publicly-provided services to individual households represent an amount comparable to public cash transfers (which are included in household disposable income) and a larger amount in 11 OECD countries. In general, however, countries that spend a larger absolute amount on cash transfers also spend a larger amount on in-kind services to households (*e.g.* the Nordic countries).

Estimates based on individual records

Estimates based on individual records from household surveys cover several European countries (based on the 2001 wave of the *European Community Household Panel*, ECHP) as well as the United States, Canada and Australia (based on national surveys).[23] All these surveys provide data on the income of private households as well as information on their socio-economic characteristics that can be used to impute public services to individuals. The analysis covers health and education services, using data on public expenditures from the OECD Social Expenditure database (SOCX) and from the UNESCO-OECD-EUROSTAT data collection on education statistics. In addition, this section provides estimates of the distributive impact of social housing, relying on simple multivariate estimates of the implicit subsidy that is associated with the provision of social housing at below-market rents. For education and social housing, the imputation of public services to individuals is based on actual use and relies on either direct information from surveys or on

"imputations" that attribute public spending to individuals based on those characteristics that most influence their use (*e.g.* age); for health care, it is based on the average costs of the services provided to individuals according to their age. For all categories of expenditures, changes in inequality relative to those based on the distribution of money disposable income depend on both the aggregate size of public expenditures and on the distribution of these services according to the income of the individuals receiving them. Estimates of the equalising impact of these services – expressed as point differences in the inter-quintile share ratio – are summarised in Table 1.

Table 1. **Inter-quintile share ratio before and after inclusion of all types of public services to households**

Estimates based on individual records, around 2000

	Money income	Income plus health		Income plus education		Income plus social housing		Income plus all public services	
	A.	B.	Difference (A-B)	C	Difference (A-C)	D	Difference (A-D)	E	Difference (A-E)
Denmark	3.1	2.5	0.6	2.9	0.2	3.1	0.0	2.4	0.7
Finland	3.6	3.1	0.5	3.5	0.1	3.5	0.0	2.9	0.6
Sweden	3.6	3.1	0.5	3.1	0.5	…	…	2.6	0.9
Austria	3.6	3.1	0.5	3.3	0.4	3.6	0.0	2.8	0.9
Germany	3.7	3.1	0.6	3.4	0.3	3.7	0.0	2.9	0.8
Netherlands	3.7	3.3	0.5	3.2	0.5	3.7	0.0	2.8	0.9
Luxembourg	3.8	3.2	0.5	…	…	…	…	3.2	0.5
France	4.1	3.3	0.7	3.6	0.4	4.0	0.0	3.0	1.1
Belgium	4.1	3.4	0.7	4.0	0.2	4.1	0.1	3.2	0.9
Italy	4.9	3.8	1.0	3.9	0.9	4.8	0.0	3.2	1.7
Canada	4.9	4.2	0.7	4.2	0.6	…	…	3.7	1.2
Ireland	4.9	3.9	1.0	4.4	0.5	4.7	0.2	3.4	1.4
United Kingdom	5.0	4.1	0.9	4.3	0.7	4.8	0.2	3.5	1.6
Australia	5.2	4.1	1.1	4.7	0.5			3.7	1.5
Greece	5.7	4.4	1.3	5.2	0.4	…	…	4.1	1.6
Spain	6.0	4.8	1.2	5.0	1.0	6.0	0.0	4.1	1.9
Portugal	6.5	4.8	1.7	5.1	1.3	6.4	0.1	4.0	2.5
United States	7.1	5.5	1.6	5.6	1.5	…	…	4.6	2.6
Average	*4.6*	*3.8*	*0.9*	*4.1*	*0.6*	*4.4*	*0.1*	*3.3*	*1.3*

Note: The first column presents the inter-quintile share ratio (Q5/Q1) for the conventional measure of money (disposable) income, *e.g.* in Denmark, the fifth quintile receives a money income which is 3.1 times higher than that of the first quintile; in the second column, the same mesure is applied to an income concept "augmented" for the value of public services: and, the third column presents the difference between the two, *i.e.* the *change* in the income distribution which follows from the consideration of publicly-provided services. Countries are ranked, from top to bottom, in increasing order of the inter-quintile ratio (Q5/Q1) for money income. Estimates for health care expenditure are based on insurance values; those for pre-primary education are based only on the age of the child. Data for Luxembourg exclude both education and social housing; those for Australia, Canada, the United States, Greece, Spain and Sweden exclude social housing.

Source: Authors' calculations based on ECHP for European countries and national survey data for non-European ones.

Health care

Estimates of the redistributive effects of health care are based on the insurance-value approach. This is based on the notion that what government provides is equivalent to funding an insurance policy where the value of the premium is the same for everybody sharing the same characteristics, such as age. In this section, these insurance values have been calculated on the basis of the distribution of public health care expenditures across the detailed age groups that underlie the latest set of OECD expenditure projections for health and long-term care (OECD, 2006) shown in Figure 1.[24] In practice, this approach

implies attributing to each individual of a given age the average per capita spending amount accruing to the corresponding age group. These per capita amounts are "added" to the household disposable income of the household to which the individual belongs, and then equivalised.[25]

Based on this approach, the inter-quintile ratio declines, on average, by 0.9 points (from 4.6 for money disposable income to 3.8 after allowing for public health services, Table 1, second set of columns). The reduction affects all countries and ranges between over 1 point in Southern European countries, Australia and the United States to around 0.5 points in Sweden, Finland and the Netherlands.[26] In general, public health care services are distributed rather uniformly across quintiles (*i.e.* each quintile gets around 20% of public health care services), with marginally higher shares going to people in the lowest quintiles in Denmark, Greece and Belgium.[27] Estimates based on actual use – as available for a smaller number of countries – point to a more limited distributive impact of public health care spending (Box 2).

Box 2. **Redistributive effects of health care based on actual use**

The approach based on *actual* use of health care services can only be applied to a limited number of European countries. Several questions in ECHP relate to the use of health care services by individuals aged 15 or more (without distinguishing, however, between use of public and private facilities): questions relate to visits to a general practitioner, to a specialist and to a dentist in the year preceding the questionnaire, as well as to the number of nights spent in hospital. These data – available for eight European countries (France was excluded because of a low response rate) – have been combined with data on public health care expenditures grouped in two broad categories: hospital care, and consultations and medical examinations outside hospitals.[1]

Based on this approach, the distributive effect of health care expenditures is, on average, significantly lower than for the insurance-value approach (an average reduction of 0.2 points, as compared with one of 0.8 based on insurance value for the same countries). Results vary considerably among countries. In Denmark, inequality *rises*, and the same occurs, to a smaller extent, in Italy, Finland and the Netherlands. Conversely, public health care reduces inequality in Spain, the United Kingdom, Austria and Ireland. In those countries where inequality rises, this reflects the effect of health care services provided inside a hospital (in five of the eight countries these services widen inequalities) while health care services outside hospitals have an equalising effect in all countries.

These opposite effects reflect the large differences in how inside and outside hospital care expenditures are distributed among individuals in different income quintiles. While both inside and outside hospital expenditures tend to benefit more the lowest quintiles (based on money income), the profile is especially steep for hospital care. For example, in Denmark, 35% of hospital care expenditures go to the lowest quintile. While this may seem surprising – in the light of evidence in the table below – the result that in-hospital expenditures *increases* inequality in several countries reflects the effect of "re-ranking" individuals: as in-hospital expenditures are concentrated among a small number of individuals[2] they lead more easily to re-ranking individual beneficiaries, which dampen (or even reverses) the equalising effects of these health services. These results underline the limits (described earlier) of this approach.

Box 2. **Redistributive effects of health care based on actual use** *(cont.)*

Inter-quintile share ratio before and after inclusion of public health expenditures based on actual use

Estimates based on individual data, around 2000

	A. Money income	Total expenditure		In-hospital expenditures		Out-of-hospital expenditures	
		B. Income plus health care (consumption)	C. Difference (A-B)	B1. Income plus in-hospital health care	C1. Difference (A-B1)	B2. Income plus out-of-hospital health care	C2. Difference (A-B2)
Denmark	3.1	3.3	–0.2	3.4	–0.3	2.9	0.2
Finland	3.6	3.6	0.0	3.8	–0.2	3.4	0.2
Austria	3.6	3.4	0.3	3.6	0.1	3.4	0.3
Netherlands	3.7	3.8	0.0	4.0	–0.3	3.5	0.3
Italy	4.9	4.9	0.0	5.4	–0.6	4.3	0.6
Ireland	4.9	4.7	0.2	5.0	–0.1	4.5	0.4
United Kingdom	5.0	4.4	0.7	5.0	0.1	4.4	0.7
Spain	6.0	5.2	0.7	5.9	0.1	5.2	0.8
Average	4.3	4.1	0.2	4.5	–0.2	3.9	0.4
Memorandum item:							
Average for the same countries based on insurance approach	4.3	3.5	0.8	..	..	..	..

Note: Countries are ranked, from first to last, in increasing order of the inter-quintile share ratio for money income.
Source: Authors' calculations based on ECHP for European countries.

1. This breakdown of health care expenditures does not correspond exactly to the one used in ECHP (*e.g.* OECD data provide information on public health care expenditures for medical visits, without distinguishing – for most countries – between general practitioners and specialists). Imputations of in-hospital care expenditures to an individual *j* (DSH_j) are based on the number of nights spent in hospital (n_j):

$$DS^H{}_j = n_j \times \frac{DS^H}{N \times \sum_{i \in N} n_j}$$

where *N* indicates the population (*i.e.* those older than 15) in the sample. For expenditures outside hospital (DS^{OH}_j) the criterion used is based on the number of visits to a general practitioner (v_j), *i.e.*:

$$DS^{OH}{}_j = v_j \times \frac{(DS - DS^H)}{N \times \sum_{i \in N} v_j}$$

2. In the survey data used here, around 5% of the population accounted for more than 90% of the nights spent in hospital; conversely, more than 50% of the population accounted for 90% of all medical visits.

Education

Imputation of public educational expenditures to individuals based on actual use requires, first, determining whether or not an individual is participating in different levels of the education system; and second, increasing the income of the households where they live by the average public spending per student at the relevant educational level.[28] The methodology followed for determining participation applies two different approaches for individuals aged below and those aged 16 and over.

- For children aged 16 and over, the survey data provide information on education participation for each individual filling out the questionnaire, although without distinguishing between public and private institutions.[29]
- For children younger than 16, the surveys provide no information on education attended. For this age-group, the probability of participating in a specific education level

relies on data on net enrolment rates[30] by single year of age (*i.e.* the probability of attending school is assumed to be the same for each individual of that age in the survey, irrespectively of their household income).

Public educational expenditure refers to total direct government expenditures for educational institutions per education level, converted to a per student' basis through data on the number of students in each level.[31] Overall, the combined effect of public spending on all categories of education is a reduction in the inter-quintile share ratio of 0.6 points on average (Table 1, third set of columns). The reduction is stronger (1 point or more) in Spain, Portugal and the United States, while it is low (less than 0.2 points) in Finland, Denmark and Belgium.

The impact of public services in education on income inequality depends crucially on the level considered.

- *Pre-primary education* generally narrows inequalities. The effect is small because of the modest amount of expenditures for pre-primary education (in all countries below 2% of household disposable income). Different assumptions for imputing participation rates have only small effects. When the imputation is based only on the age of the child (Table 2, left-hand panel) the average reduction in the quintile-share ratio is 0.1 point

Table 2. **Inter-quintile share ratio before and after inclusion of pre-primary education expenditures**

Estimates based on individual data, around 2000

	A. Money income	Imputation based on the age of the child		Imputation based on the age of the child and the employment status of parents	
		B1. Income plus pre-primary education	Difference (A-B1)	B2. Income plus pre-primary education	Difference (A-B2)
Denmark	3.1	3.1	0.0	3.1	0.0
Finland	3.6	3.5	0.0	3.5	0.0
Sweden	3.6	3.5	0.1	3.5	0.1
Austria	3.6	3.5	0.1	3.6	0.1
Germany	3.7	3.7	0.0	3.7	0.0
Netherlands	3.7	3.7	0.1	3.7	0.1
France	4.1	4.0	0.1	..	..
Belgium	4.1	4.1	0.1	..	..
Italy	4.9	4.7	0.2	..	..
United Kingdom	5.0	4.9	0.1	4.9	0.1
Australia	5.2	5.2	0.0	..	..
Greece	5.7	5.6	0.0	5.6	0.0
Spain	6.0	5.9	0.1	..	..
Portugal	6.5	6.2	0.2	6.1	0.3
United States	7.1	6.9	0.2	..	..
Average	*4.7*	*4.6*	*0.1*	..	..
Average across the countries included in right-hand panel	*4.3*	*4.2*	*0.1*	*4.2*	*0.1*

Note: Countries are ranked, from top to bottom, in increasing order of the Q5/Q1 ratio for money income. Ireland is excluded because of the very small number of children aged 3 to 6 in pre-primary education in the survey. Estimates in the left-hand panel assume that the probability of attending pre-primary education is the same for each child, and independent of household income. Estimates on the right-hand panel assume, for countries where the participation rate of children in this age group is *below* the share of children in households where both parents work, that all children belonging to this household type have the same probability of attending and that all other children are not attending; and, for countries where the participation rate is *above* the share of children in households where both parents work, that all children in this household type are in pre-primary and that all other children have the same probability of attending. Estimates on the right-hand panel have been limited to countries where participation in pre-primary education is 80% or less in the age groups under consideration.

Source: Authors' calculations based on ECHP for European countries and national survey data for non-European ones.

(but twice as high in Portugal and the United States); when the imputation is based on both the age of the child and the employment status of the parents (*i.e.* allowing for the possibility that households where both parents work make more use of pre-primary education) the fall in inequality is marginally smaller.

- For *primary and secondary education,* public expenditures have a stronger effect in reducing inequalities, with an average decline of around 0.5 points (Table 3, middle panel).[32] The decline of the inter-quintile share ratio is largest in the countries with the most unequal distribution of money income (Spain, Portugal and the United States) while it is negligible in Denmark and Finland. The first outcome mainly reflects the size of public expenditures for this level of education: in most countries, primary and secondary education make-up about 10% of household disposable income. On average, the distribution of this category of public expenditure is uniform across quintiles, with a marginally lower share for people in the upper part of the distribution. The share of public expenditure for primary and secondary education going to people in the bottom quintile is low in Finland and Denmark, reflecting the greater concentration of children in the middle of the income distribution in these countries.[33]
- For *tertiary education,* patterns are radically different – on average, the decline in the inter-quintile share ratio is negligible. In around one-third of the countries included in Table 3 (right panel) this ratio increases slightly, a pattern suggesting that students in higher education predominantly live in better-off households. Even for countries where tertiary education lowers inequalities, such as Denmark and Sweden, this effect may predominantly reflect the large proportion of tertiary students living away from the

Table 3. **Inter-quintile share ratio before and after inclusion of public expenditures on primary, secondary and tertiary education**

Estimates based on individual data, around 2000

	A. Money income	Primary and secondary education		Tertiary education	
		B1. Income plus primary and secondary education	Difference (A-B1)	B2. Income plus tertiary education	Difference (A-B2)
Denmark	3.1	3.1	0.0	2.9	0.2
Finland	3.6	3.6	–0.1	3.5	0.1
Sweden	3.6	3.4	0.2	3.4	0.2
Austria	3.6	3.4	0.3	3.7	0.0
Germany	3.7	3.5	0.2	3.7	0.0
Netherlands	3.7	3.3	0.4	3.7	0.0
France	4.1	3.8	0.3	4.0	0.1
Belgium	4.1	4.0	0.2	4.2	–0.1
Italy	4.9	4.1	0.7	4.8	0.1
Canada	4.9	4.3	0.6	4.8	0.1
Ireland	4.9	4.2	0.7	5.1	–0.2
United Kingdom	5.0	4.4	0.6	5.0	0.1
Australia	5.2	4.8	0.4	5.1	0.1
Greece	5.7	5.3	0.4	5.6	0.0
Spain	6.0	5.0	1.0	6.1	–0.1
Portugal	6.5	5.2	1.3	6.5	–0.1
United States	7.1	5.8	1.3	7.0	0.1
Average	*4.7*	*4.2*	*0.5*	*4.7*	*0.0*

Note: Countries are ranked, from top to bottom, in increasing order of the Q5/Q1 ratio for money income.
Source: Authors' calculations based on ECHP for European countries and national survey data for non-European ones.

parental home, who are classified by surveys as separate households with low reported income. Because of the earnings premium of higher education, many of these individuals will be high-income earners in the future. The share of public expenditure in tertiary education accruing to people in the top quintile of the distribution is close to 30% on average, and above 40% in Belgium, Spain and Portugal (Marical *et al.*, 2006).

Social housing

Estimating the distributive effect of social housing is more difficult than for other social services, as it requires quantifying the aggregate size of the implicit benefits provided. This section presents estimates for some European countries based on information on housing tenure (*i.e.* whether different households own or rent their residence, and whether they rent from the public or private sector)[34] as well as on their actual rents.

OECD countries differ not only with respect to the relative importance of various types of housing, but also in how their prevalence varies with household income. The share of individuals who are renting their main residence is close to 40% in the lowest quintile and only 13% in the top one (Marical *et al.*, 2006), with the exceptions only of Greece and Austria, where the share of renters is rather uniform across quintiles. The importance of public sector rentals also declines when moving up the income distribution.[35] Overall, the share of renters living in social housing is low in Greece and Spain (less than 10%) but more important in Ireland, the Netherlands and the United Kingdom.

To evaluate the implicit subsidy associated with the provision of social housing at below market rents, each beneficiary is attributed an amount equal to the difference between the rent effectively paid and the one they would have paid on the market for a dwelling with similar characteristics (Box 3). The distributive effects of social housing are in general quite limited (Table 1, fourth set of columns). This small equalising effect reflects the small size of the aggregate subsidy implicit in the provision of social housing (0.6% of household disposable income, on average), even though – when compared with health and education – it mainly benefits individuals in the lowest quintiles of the distribution.

Summing up

When considering the combined effect of the three categories of public services discussed above, the inter-quintile share ratio falls, on average, by around 1.3 points (*i.e.* from 4.6 for money disposable income to 3.3), with a reduction that is largest in the United States and Portugal (almost twice the average) and smallest in Finland and Denmark (Table 1, rightmost columns).[36] In general, patterns are little affected by the specific inequality measure used. Figure 6, which presents estimates of the effects of government services for both the inter-quintile share ratio and the Gini coefficient, suggests that:

- Both the Gini coefficient and the inter-quintile share ratio decline significantly when the income concept is broadened to include all public services considered here.
- With both measures, the ranking of countries does not change significantly when moving from money (disposable) income to a measure that includes public services (the rank correlation coefficients for both the Gini and the inter-quintile share ratio, among the 17 countries considered, is above 0.95).

Box 3. **Estimates of the implicit subsidy provided to renters in the public sector**

Estimates are based on a simple model, which is applied separately to renters in the public and in the private sectors:

$$\text{rent} = \alpha \times \text{rooms} + \beta \times \text{income} + c.$$

where *rent* is the monthly rent paid by households, *rooms* the number of rooms in the dwelling, and *income* is the (non equivalised) household income – a variable used to capture the neighbourhood in which households live, as individuals with the same income tend to cluster in areas with similar house prices. Coefficients (shown below) have the expected sign and are statistically significant (*i.e.* private rents are higher for households with higher income and for accommodations with a higher number of rooms), although there are exceptions and a significant fraction of the variance remains unexplained. The coefficients for private rentals are used to calculate, for households renting in the public sector, what they would have paid on the market for an accommodation with similar characteristics.

Estimates from a linear model for private rents

	Private rentals				Private rentals		
	Income	Rooms	Adjusted R^2		Income	Rooms	Adjusted R^2
Denmark	0.0040 *	337.3 *	0.21	Portugal	0.0024 *	2 229.8 *	0.10
	7.55	6.53			12.37	5.47	
Netherlands	0.0058 *	19.3 *	0.22	Austria	0.0002	671.2 *	0.04
	9.54	2.08			0.28	6.12	
Belgium	0.0036 *	1 136.7 *	0.21	Finland	0.0041 *	565.5 *	0.27
	10.38	6.68			4.33	8.79	
France	0.0093 *	–13.2 *	0.39	Germany	0.0049 *	120.8 *	0.34
	31.27	–0.51			22.56	22.82	
Ireland	0.0099 *	38.3 *	0.32	United Kingdom	0.0048 *	14.1 *	0.09
	7.27	2.34			6.62	2.34	
Italy	0.0055 *	66.5 *	0.22				
	18.77	9.20					

Note: T statistics are reported below the estimated coefficients.
* denotes significance at the 5% level.

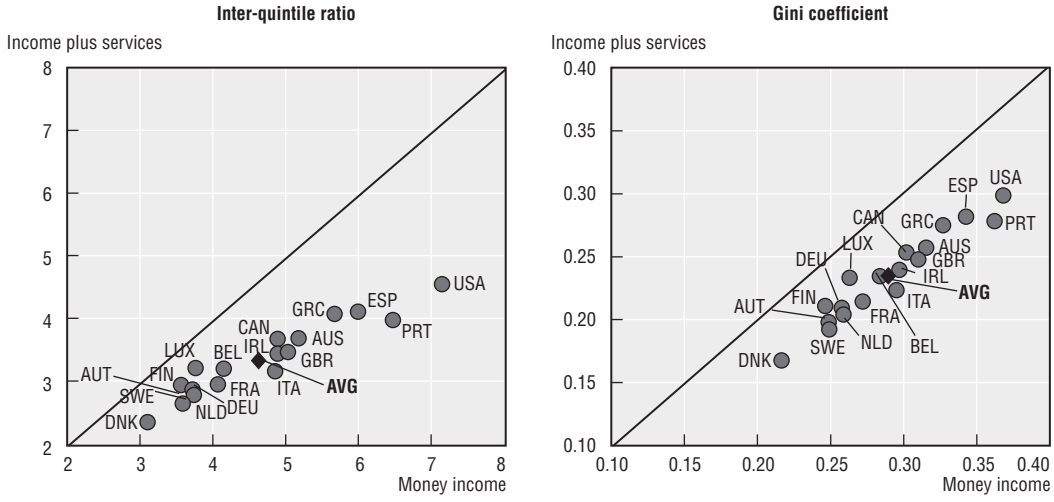
- There are significant differences across countries in the size of the reduction in inequality depending on the measure used. Based on the inter-quintile share ratio, the (point) reduction is larger for countries with higher inequality in money income (United States, Portugal and Spain); conversely, declines are more uniform for the Gini coefficient, with a smaller change in the dispersion across countries.[37]

Estimates based on grouped data

The analysis of the distributive effects of government services based on individual records can be complemented by estimates based on income data for different deciles of the distribution. This grouped-data approach rests on attributing to different income deciles the monetary value of public expenditure for the provision of different types of social services, and on comparing various inequality measures before and after this imputation (*i.e.* with no re-ranking of individuals).[38] This approach is less accurate than

Figure 6. **Income inequality before and after inclusion of expenditures on public services in OECD countries**

Estimates based on individual data, around 2000



Source: Authors' calculations based on ECHP for European countries and national survey data for non-European ones.

that based on individual records, but allows the analysis to be extended to a broader range of OECD countries and public services.

The imputation of the value of the different public services to each decile of the income distribution relies on information about the average equivalised disposable income of each decile and the distribution of (nine) age groups across them.[39] The imputation of government expenditures for these services to different income deciles relies on different rules according to the type of service considered:

- *Health care*. The imputation is based on the age of individuals and on the distribution of different age groups across income deciles. Information on the latter is drawn from OECD questionnaires on income distribution. The data on the distribution of public health expenditures by age of recipients are those shown in Figure 1. For most countries, these age-expenditure profiles are based on national data; for countries where no national data are available,[40] the imputation relies on the "average" profile prevailing in other OECD countries.
- *Education*. The imputation of education expenditure is based on individuals' age and the distribution of different age groups across income deciles. The procedure involves three steps. The first requires determining the enrolment rates of individuals of a given age (from 3 to 29 years) in different levels of education and grouping them into the three age groups available in the OECD income distribution questionnaire (0-17, 18-25 and 26-40);[41] the second step involves calculating total education expenditure by age group; and the last step computes education spending in each decile based on the educational expenditure for each age group and the distribution of each age group across deciles. Expenditure data refer to the direct educational outlays of the general government, *i.e.* excluding cash transfers to private entities such as student grants and loans.[42]
- *Other social services*. This category of spending includes (in the SOCX classification) a heterogeneous set of programmes. Because of their diversity, the individualization of public spending is based on the assumption that these services are distributed across

income deciles in the same way as the corresponding cash transfers (based on information included in the OECD questionnaire on income distribution). This assumption reflects the notion that, for each type of programme, services and cash transfers typically complement each other.

While less accurate than the estimates based on individual records described above, this approach can be applied to 26 countries included in the OECD database on income distribution and to the full range of public services to households included in OECD data on social expenditure. These results can be considered as providing a "first-order" approximation of the distributive effects of public services for countries where micro records are not available.

Distributive effects, based on this approach, vary with the category of services considered:

- *Health care*. Health expenditure reduces inequalities in all the 26 OECD countries considered (by 1.1 point, on average, Table 4, second set of columns). Changes in country-rankings are, however, small: the Nordic countries and the Czech Republic are the most egalitarian countries both before and after taking health services into account.

Table 4. **Inter-quintile share ratio before and after inclusion of expenditure on all public services**

Estimates based on grouped data, around 2000

	Money income A.	Income plus health		Income plus education		Income plus other social services		Income plus all public services	
		B.	Difference (A-B)	C.	Difference (A-C)	D.	Difference (A-D)	E.	Difference (A-E)
Denmark	3.1	2.5	0.6	2.7	0.4	2.5	0.7	1.9	1.2
Sweden	3.4	2.7	0.8	2.9	0.5	2.7	0.8	2.0	1.4
Netherlands	3.6	3.1	0.5	3.1	0.5	3.4	0.2	2.6	0.9
Czech Republic	3.6	2.9	0.7	3.0	0.6	3.3	0.3	2.4	1.2
Luxembourg	3.7	3.1	0.5	3.1	0.6	3.4	0.3	2.6	1.1
Finland	3.7	3.1	0.7	3.2	0.6	3.2	0.5	2.5	1.2
Norway	3.7	2.9	0.9	3.2	0.5	3.0	0.8	2.2	1.5
Austria	3.9	3.3	0.6	3.1	0.8	3.8	0.1	2.7	1.2
Switzerland	3.9	3.2	0.7	3.4	0.6	3.7	0.2	2.8	1.1
France	4.0	3.2	0.9	3.3	0.8	3.7	0.4	2.6	1.4
Germany	4.3	3.3	1.0	3.6	0.6	3.9	0.3	2.8	1.4
Hungary	4.4	3.5	0.9	3.7	0.7	4.1	0.3	2.9	1.5
Canada	4.8	3.9	0.9	3.9	0.9	4.4	0.4	3.2	1.6
Australia	4.9	3.5	1.4	4.1	0.7	4.1	0.7	2.8	2.0
Ireland	5.0	3.7	1.3	4.3	0.7	4.7	0.4	3.2	1.8
United Kingdom	5.2	4.1	1.0	4.3	0.8	4.8	0.4	3.4	1.7
New Zealand	5.4	4.2	1.2	4.1	1.3	5.1	0.2	3.3	2.0
Spain	5.6	4.3	1.3	4.4	1.2	5.4	0.2	3.6	2.0
Japan	5.7	4.3	1.4	4.8	0.9	5.4	0.3	3.7	2.0
Greece	6.0	4.8	1.2	5.3	0.7	5.7	0.3	4.2	1.8
Poland	6.1	5.2	0.9	4.7	1.3	5.8	0.3	4.1	2.0
Italy	6.2	4.5	1.7	4.8	1.4	6.0	0.1	3.7	2.4
Portugal	6.2	4.4	1.8	4.9	1.3	6.0	0.2	3.7	2.5
United States	6.9	5.1	1.7	5.1	1.8	6.4	0.5	4.0	2.9
Turkey	9.3	7.8	1.5	7.4	1.9	9.3	0.0	6.5	2.8
Mexico	12.6	10.9	1.7	9.9	2.7	12.3	0.3	8.8	3.8
Average	*5.2*	4.1	1.1	4.2	1.0	4.8	0.3	3.4	1.8

Source: Authors' calculation based on OECD data.

The greatest changes in the inter-quintile ratio affect countries such as Portugal, the United States and Mexico, where the distribution of disposable income is the most unequal. Hence, overall there is a convergence of income inequalities among countries (as measured by the range of variation).[43]

- *Education*. The redistributive impact of public expenditure on education is only marginally smaller than that for health (the average inter-quintile ratio falls from 5.2, for money disposable income, to 4.2 after taking education services into account, Table 4, third set of columns). In general, education expenditure especially benefits the three lowest quintiles of the income distribution, even if the differences between countries are considerable. Sensitivity analysis shows that inequalities in attendance to education across income deciles have a fairly marginal impact on the results and are limited to the 18-25 age group (Marical *et al.*, 2007).[44]
- *Other social services*. While often significant, the effects of these services in narrowing income inequality (a decline of the inter-quintile share ratio of 0.3 points, on average, Table 4, fourth set of columns) are significantly lower than those associated with health and education, as the effect of their more targeted nature is offset by the lower amount of expenditure.

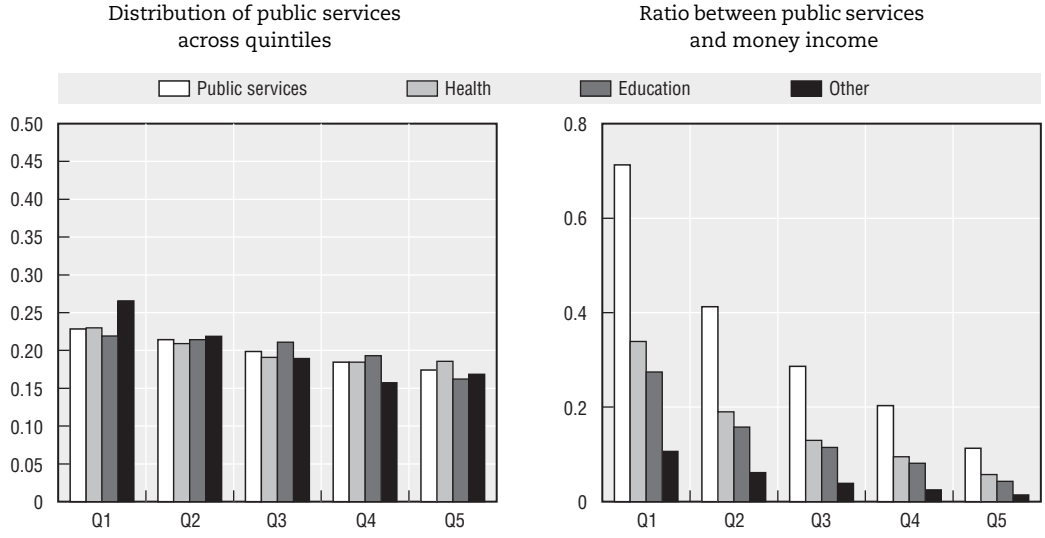
Overall, the effects of all public services on income inequalities are considerable in most countries. Thus the inter-quintile ratio falls on average from 5.2, on a cash basis, to 3.4 after taking public services into account – a fall of 1.8 points (Table 4, rightmost columns). The differences between countries in the size of this fall are marked, with a largest (point) fall in countries where the inequalities in the distribution of disposable income are greatest.[45] The reduction in the disparities between countries narrows without fundamentally altering their ranking, even though some countries improve their position (*e.g.* France and Australia), while that of others worsens (especially the Netherlands, Austria and Greece).

Not surprisingly, the approach based on grouped-data lead, in general, to different numerical estimates of the reduction in inequality due to public services than those based on individual records. A comparison of these estimates – across the countries and programmes (education and health) that are covered by both approaches – shows the fall in inequality based on grouped data exceeds that based on individual records (as the first approach does not allow for individuals' re-ranking), although the difference is much lower for the Gini coefficient that for the inter-decile ratio; further the reduction in inequality based on the two approaches are highly correlated with each other (above 0.90) across countries, and this for both inequality measures.

This analysis also suggests that public services are distributed quite uniformly among the different quintiles and, in consequence, in a less inegalitarian way than money incomes. Figure 7 shows this result for the average of OECD countries. For all public services to households, the lowest quintile receives a share of 23% and the highest quintile 17% (left-hand panel). Similar values are recorded for health services and education, while the share of the lowest quintile is the highest for "other" public services. However, due to the different levels of cash income in the different quintiles, public services represent a much larger share of the income of those at the bottom of the distribution (around 70% of disposable income on average) than for those at the top of the distribution (11%, right-hand panel).[46] These patterns mirror closely those obtained based on individual records.

Figure 7. **Importance of public services in household income across the distribution, OECD average**

Estimates based on grouped data, around 2000

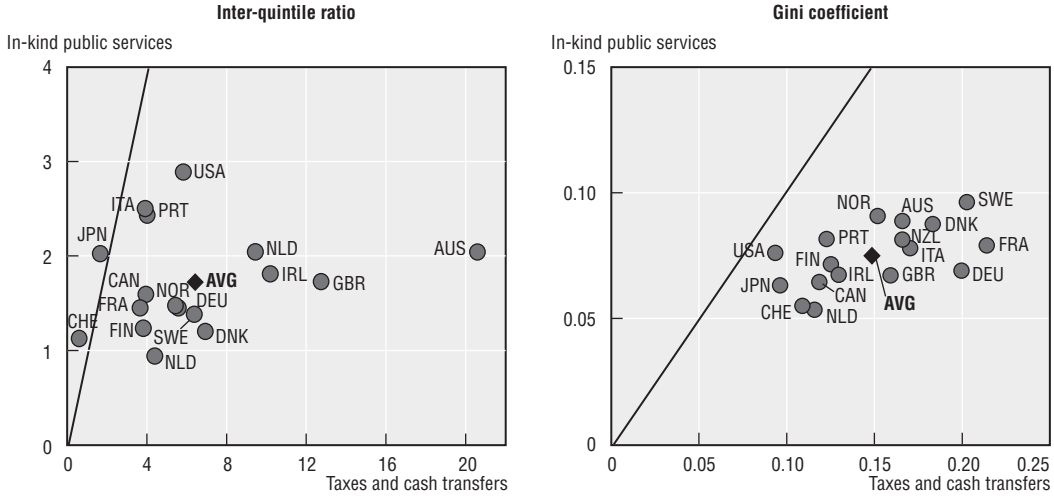


Source: Authors' computation based on different OECD databases.

A further issue is how the redistributive effect of in-kind government services compares with that of household taxes and public cash transfers. Figure 8 shows the point reduction of both the inter-quintile share ratio and the Gini coefficient achieved by in-kind

Figure 8. **Redistributive impact of in-kind public services compared with that of household taxes and cash benefits**

Point differences in the inter-quintile ratio and Gini coefficient, estimates based on grouped data, around 2000



Note: The reduction in inequality due to in-kind public transfers (on the vertical axis) is measured as the absolute difference between the inequality measures (the inter-quintile ratio, in the left-hand panel; the Gini coefficient in the right-hand panel) for disposable household income and that for income plus in-kind public services. The reduction in inequality due to household taxes and public cash transfers is the absolute difference between the inequality measures for market income and for disposable income. Points below the line denote countries where the reduction in inequality due to household taxes and public cash benefits exceeds that due to in-kind public services.

Source: Authors' computation based on different OECD databases.

government services (on the vertical axis) and by household taxes and public cash benefit (on the horizontal axis).[47] Three patterns stand out.

- First, the equalising impact of public in-kind services is, on average, around ¼ of that achieved by household taxes and cash transfers when looking at the inter-quintile share ratio, and around ½ in the case of the Gini coefficient – although, for some countries, the reduction in inequality achieved through the two sets of policies is broadly similar.[48]
- Second, the redistributive effect of household taxes and government cash transfers varies much more across countries than that of public services in-kind – around 50% more when looking at the coefficient of variation, for both inequality measures used.
- Finally, countries with a lower inequality of money disposable income also record a lower inequality after including in-kind public services (with a correlation above 95% for both inequality measures); there is conversely no correlation across countries when considering the (absolute) redistribution achieved by the two policy levers.

Conclusions

Overall, both the approach based on individual records and that based on grouped data highlight some consistent patterns that mirror, with few exceptions, those identified by previous research on the subject.

- Public expenditure for the provision of social services to households significantly narrows income inequality, although for some countries – when the imputation is based on individual data – this effect is negligible for non-compulsory education. The overall effect of publicly-provided in-kind services in narrowing inequalities in the distribution of households' economic resources results mainly from a relatively uniform distribution of these services across income quintiles, which translates into a larger increase in the income share at the bottom of the distribution than at the top.
- Changes in inequality measures prompted by the consideration of public services do not lead to major changes in country rankings. The dispersion of inequality across countries narrows considerably for the inter-quintile share ratio but by much less in terms of the Gini coefficient.
- The inequality reduction due to government in-kind services is, on average, lower than that achieved by the combined effect of household taxes and public cash transfers, although this is not true in all countries.

The way various government services are distributed among the population has some important policy implications. First, because of the significant effect of the publicly-provided services considered in this chapter on the distribution of economic resources among households and individuals, it is important to take account of this redistributive impact when making policy choices about these programmes. Second, and despite economists' presumption in favour of cast transfers, provision of public services may be justified on a variety of reasons (e.g. when the consumption choices of the parents do not take into full account the utility of their children, to improve the targeting of programmes, to increase investment is people's health and skills – and hence productivity in the long run, Currie and Gahvari, 2007); this raises the question of how best to mix cash transfers and in-kind public services to meet any particular redistributive goal. Finally, public services may also effect the labour-supply decisions of beneficiaries, in particular for those at the bottom of the distribution; it follows that reform should consider how provision of

in-kind services (e.g. childcare) might augment the labour supply and thus ease the trade-off between equity and efficiency goals. These considerations underscore the importance of accounting more systematically for the contribution of government services to household well-being and its distribution.

Notes

1. For example, households with children in state schools benefit from a tax-financed service that improves their well-being compared with those who have to buy the same service in the market. It should be noted, in this respect, that the OECD national accounts combine information on both the goods and services bought by households on the market and those are provided by governments free of charge or at subsidised prices within the concept of the "actual" consumption of households.
2. For example, every year the UK national statistical office publishes a report on the distribution of household income which also considers the effect of public spending in health and education (*e.g.* Jones, 2006); and similar reports exist for Australia (ABS, 2001). While most of studies have a national focus, a few provide information extending to several countries – and their number has increased following the availability of the Luxembourg Income Study, a database providing access (within a uniform data environment) to the micro-records of household income surveys for several OECD countries (*e.g.* Brady, 2004; Garfinkel *et al.*, 2004; Smeeding, 2002; Smeeding and Rainwater, 2002; Steckmest, 1996).
3. Differences in the use of health care services according to individuals' income and socio-economic status are reported even in countries with universal health care systems (*e.g.* Goddard *et al.*, 2001, for the United Kingdom).
4. Exceptions include the United States, Portugal and Finland, in the case of consultations with doctors; and Mexico in the case of hospital nights.
5. Both approaches will lead to the same quantitative results when considering two countries with identical (pre-tax) money income and health care needs, and where these needs are met, in one country, through tax-financed public health care and, in the other, through private out-of-pocket health expenditures.
6. The Committee on National Statistics of the US National Academy of Sciences recommended that, for the purpose of measuring poverty, "family resources" should exclude both out-of-pocket medical care expenditures and health insurance premiums (Citro and Michael, 1995). Weinberg (2006) underscores the importance of employer-provided health insurance for a better measure of household income.
7. According to Xu *et al.* (2003), the share of households with out-of-pocket payment exceeding 40% of their income is almost nil in France but close to 3% in Portugal. This proportion tends to be higher in low- and middle-income countries, as well as in economies in transition.
8. Private out-of-pocket costs are only one among the different sources of health care financing. Some studies have focused on the distributive implications of all types of health care financing, *i.e.* taxes, contributions and out-of-pocket costs. In general, these effects will depend on the relative importance of each source, on their "progressivity" (*i.e.* the extent to which they weigh more heavily on higher income groups) and on various factors that shape horizontal equity (*e.g.* differences in contribution rates across insurance funds or in health-related tax rates across municipalities, Wagstaff *et al.*, 1999). De Graeve *et al.* (2003), who examine the impact of different financing sources on income distribution in 23 European countries, find that direct taxes are progressive in all countries, and indirect taxes and out-of-pocket payments regressive, while there are more differences in results for contributions to social security and private insurance. Similar results are reported by van Doorslaer *et al.* (1999) for 12 OECD countries including the United States. Klavus *et al.* (1998), who apply a similar methodology for Finland, argue that reforms to health care financing introduced following the recession of the early 1990s have moderately reduced the progressivity of the overall system without compromising its equity features, mainly because of the continuous importance of direct income taxes.
9. Private expenditure on education in OECD countries accounts on average for 18% of total expenditure at the pre-primary stage and 22% in tertiary education, but only 7% in primary and secondary education (OECD, 2005b).

10. The proportion of young people aged 20 to 24 years who, in 2001, had not completed lower secondary school was less than 5% in 14 OECD countries, but highest in New Zealand (16%), Portugal (29%), Mexico (33%) and Turkey (47%).

11. Public expenditure on higher education accounts, on average, for almost half of educational spending (48%) while the share of pre-primary education is only 7%.

12. For example, the probability of access to tertiary education is three times higher for young people whose parents have a university degree than for those from less well-educated households (Machin, 2006). Differences in access to university education are also evident with regard to ethnic background. Thus, in the United States, the percentage of white students who, upon finishing high school, enrol in university is 10 points higher than for young people of Hispanic origin and 20 points higher than for young blacks, even though these differences have declined since 1994.

13. This phenomenon is well documented by Evandrou (1993) for the United Kingdom. This study shows that the distribution of public expenditure on tertiary education is more unequal when pensioners' households are included, as compared to results obtained when limiting the analyses to households of non-pensioners.

14. Inequalities in the distribution of expenditure on tertiary education reflect note only differences in access but also differences in costs per student depending on the subject chosen. Thus, in France, students from the wealthiest families choose more expensive course (Albouy and Wanecq, 2003).

15. Governments also intervene through rent controls applied to private housing: these measures are not covered in this article.

16. Access to social housing generally means less expenditure on housing for the households concerned. In France, tenants in private accommodation pay 22% of their income on housing, compared with 18% for tenants of public housing. These differences may under-estimate the benefit, if people who live in social housing can afford a bigger or more comfortable home than if they rented in the private sector; but they may also over-estimate them, if social housing units are mainly located in disadvantaged neighbourhoods.

17. The approach used in the majority of the studies that focused on the distributive effects of social housing is to "gross up" the households' cash income by an amount equal to the difference between the market rent for a home with the same characteristic as the one occupied and the rent actually paid for it.

18. The same pattern is reported by Harding *et al.* (2004), who argue that social housing accounts for 13% of the disposable income of people in the first quintile of the income distribution in Australia, as compared to 3% for those in the second.

19. The "square root elasticity" implies that the needs of a household composed of four people are twice as large as those of a single (1.4 and 1.7 times those of a single in the case of a childless couple and of a couple with one child).

20. These data – as well as the estimates presented later – refer to public expenditures in 2001 (despite availability of more recent data) as the latest information on the distribution of household disposable income available at the time of writing referred to the early 2000s.

21. The category "other social expenditure" (in the SOCX nomenclature) includes services to the elderly, survivors, disabled persons, families and unemployed, as well as those related to housing, social assistance, and active labour market policies.

22. As some of these quasi-cash housing benefits may be included in household income as measured in surveys, the estimates based on "grouped" income data in this article may imply some double counting.

23. The 2001 wave of ECHP provides information on income earned in 2000. Data for non-European countries are based on the *Household Income and Labour Dynamics* for Australia (HILDA); the *Survey of Income and Labour Dynamics* (SLID) for Canada, and the *Annual Social and Economic Supplement* (ASEC) to the *Current Population Survey* for the United States. For Canada and the United States, data are drawn from the Luxembourg Income Study database and refer to income earned in 2000. Data for Australia refer to 2004: computations were provided courtesy of Mark Pearson.

24. These projections refer to per-capita amounts of public health care services for 5-year age groups in 2003. This age-profile has been applied to public expenditure data referring to 2001.

25. In most countries, public health care services make up a considerable share of disposable household income (around 13% on average), ranging between 11% (in Finland, the United Kingdom and the United States) and 16% (in Germany and Italy).

26. The larger absolute fall in the inter-quintile share ratio in countries with a wider distribution of money income implies much smaller cross-country differences in terms of percentage reduction (*e.g.* from 19% in Denmark to 23% in the United States).

27. In theory, the approach used here, which accounts only for differences in use by age, may underestimate the equalising effect of public health care services in countries where these are targeted to low-income households (*e.g.* Medicaid in the United States). In practice, estimates of the equalising impact of Medicaid and Medicare from the US Census Bureau point to a reduction of the inter-quintile share ratio and of the Gini coefficient (for non-equivalised household income) of, respectively, 0.75 and 0.15 points (Cleveland 2005), as compared with a decline of 1.63 and 0.37 points, respectively, reported by Marical *et al.* (2006).

28. The expenditures on education attributed to individual j attending education level c (DE_j^c) are determined on the basis of whether or not they are attending these institution (t_j^c = 1 if an individual follows education in category c, otherwise it is zero) based on the following identity:

$$DE_j^c = t_j^c \times \frac{DE^c}{N^c}$$

where N^c denotes the number of students enrolled in that education category and DE^c the public expenditures on education for that education level.

29. Enrolment in private schools will affect results if these students are mainly from better-off families and if public subsidies to private schools are lower than the costs of public schools; in these conditions, the approach used here will underestimate the distributive effect of public education services. As the survey data for European countries distinguish among four levels of education (tertiary, upper secondary, lower secondary, and less than lower secondary), data for other countries have been re-coded to these four levels. The survey data used for various countries differ in the information they provide on school attendance for individuals of different ages (*e.g.* for the United States and Canada, this information refers to all individuals aged 15 or older; for European countries, this refers to people aged 17 or older).

30. Data on net enrolment by single year of age, from OECD (2005b), refer to 2003 and to individuals aged 3 to 29. For Canada, where data on enrolment by age are not available, all individuals aged between 6 and 15 are assumed to be in school (in line with the enrolment rates prevailing in other OECD countries); children aged 3 to 5 are assumed not to attend education (as no data on public expenditure on pre-primary education are available for Canada).

31. Because of lack of data, Luxembourg is not included in the analysis.

32. Primary and lower secondary education are grouped together as, for all countries considered here, they correspond to "compulsory education"; upper secondary education is also combined with these two categories as, in several countries, compulsory education, or at least part of it, extends to this level .

33. These results overestimate the equalising effect of primary and secondary education as they do not allow for the possibility that most school drop-outs are concentrated in the lower end of the income distribution; this may affect cross-country comparisons, when drop out rates differ across countries.

34. The definition of social housing used in the ECHP includes all accommodations provided by central and local public administrations, as well as those provided by voluntary and non-profit agencies.

35. There are, however, some exceptions. In half of the countries, the proportion of renters in the public sector is higher for the second quintile than in the first; while in Austria and the Netherlands the share of renters from the public sector is relatively uniform across quintiles.

36. The lowest reduction is recorded by Luxembourg, but for this country results only refer to health care.

37. The larger reduction in the inter-quintile share ratio – an inequality measure that is more sensitive to what happens at the two extremes of the distribution – than for the Gini coefficient – a measure that is more sensitive to changes around its middle – suggests that accounting for public services is likely to have major impacts on estimates of relative-income poverty.

38. The consequences of this assumption are especially important for services whose unit costs are large and actual use is concentrated over a short time-span (*e.g.* health-care). In these circumstances, not allowing individuals to change their rank position will increase the equalising effect of government services relative to approaches that allow for such re-ranking (Atkinson, 1980; Plotnick, 1981).

39. The values of equivalised income by deciles are converted into a non-equivalised equivalent based on estimates of the average household size for the entire population.

40. These countries are the Czech Republic, Hungary, Iceland, Japan, Korea, Mexico, New Zealand, Norway, Poland, the Slovak Republic, Switzerland and Turkey.

41. Data on school enrolment by single year of age were not available for some types of educational institutions in the case of Canada, Japan and Luxembourg. For these countries, the distribution of students aged above 17 between the aged groups 18-25 and 26-29 is based on the share of the two age groups prevailing in the United States.

42. To test the sensitivity of the results to the assumption of equal access to education, an alternative scenario (presented in Marical *et al.*, 2006) assumes that enrolment rates for poorer people are lower than those for better-off people, based on an arbitrary inequality coefficient that is common across countries.

43. For example, the gap in the inter-quintile ratio between Denmark and the United States falls from 3.8, based on money income, to 2.6 after taking health services into account.

44. Marical *et al.* (2006) show estimates of the equalising impact of education based on estimates of enrolment rates by income deciles; these are based on country-specific enrolment rates by age and common coefficients for inequality in attendance (implying that disparities in attendance by household income will be higher the lower the average enrolment for educational level).

45. Thus the inter-quintile ratio falls from 6.9 to 4.0 in the United States, from 12.6 to 8.8 in Mexico and from 9.3 to 6.5 in Turkey, while it falls from 3.1 to 2.0 in Denmark.

46. A comparison of results for the inter-quintile ratio and the Gini coefficient highlights patterns that mirror quite closely those described in Figure 5, based on individual data, for a smaller number of OECD countries and social programmes. Both inequality measures decline after considering public spending for social services; the decline in the inter-quintile share ratio is larger for countries with more unequal distribution of disposable income but broadly similar across countries for the Gini coefficient.

47. The comparison is made with the *combined* effect of the taxes paid by households and the cash public transfers they receive, as the information available on Gini coefficients does not allow separating the effects of the two components of disposable income.

48. The larger equalising effect of household taxes and public cash transfers, relative to that achieved by public in-kind services, reflects both differences in their distributive profile and in their size (the three items accounting for 29%, 20% and 27%, respectively, of household disposable income among the countries included in Figure 7).

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Annex Table A.1. **Main findings from selected studies on the distributive impact of public services**

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
		Comparative studies		
Gardiner *et al.*, 1995	France and United Kingdom. Micro data from Family Budget Survey and Family Expenditure Survey referring to the 1980s.	**Health social housing**	*How benefits are attributed to individuals?* Health: Both insurance values (based on income for the United Kingdom) and deduction of out-of-pocket costs Housing: Actual use (difference between actual and market rents) *Other income flows considered?* Housing: Rental and capital values for owner-occupied housing	• Health and housing services lower poverty rates (from 17% to 12% in the United Kingdom; from 12% to 9% in France). • Health services lower the number of individuals with low incomes (especially in the United Kingdom) because of their higher use of these services. • The distributive effects of imputed rents and subsidised housing offset each other (while slightly reducing the number of poor in both countries).
Garfinkel, 2004	Australia, United Kingdom, Canada, United States, Finland, France, Sweden, Belgium, Germany. LIS and OECD data (most recent data refer to 2004).	**Education** (excl. tertiary) **Health**	*How benefits are attributed to individuals?* Education: Actual use Health: Insurance principle (except the US) *Other income flows considered?* Indirect taxes, employer provided health benefits	• Net social expenditure has a pro-poor bias in all countries, with differences in degree. • Changes in the 10/50th per centile ratios are largest in English-speaking countries. • In-kind services increase the most the income of people in the bottom quintile (primarily of elderly and single mothers); people in the middle quintile are net gainers in all countries. • Families with children are net payers in France and Belgium, net gainers in Finland, United Kingdom and United States; the elderly are net beneficiaries in all countries (especially in France).
Garfinkel *et al.*, 2006	Australia, Canada, United Kingdom, United States, France, Belgium, Germany, Netherlands, Finland, Sweden. LIS data for 2002 (or earlier).	**Education** (excl. tertiary) **Health**	*How benefits are attributed to individuals?* Education: Actual use Health: Insurance principle *Other income flows considered?* Direct and indirect taxes.	• The mix between cash transfers and services varies across countries. • Health and education services substitute cash transfers in English-speaking countries. • Countries with larger welfare states rely more heavily on indirect taxes and taxes on cash benefits.

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
Harding *et al.,* 2006	Australia and the United Kingdom National survey data for 2001-2002	**Education** **Health** **Social housing** **Indirect taxes**	*How benefits are attributed to individuals?* Education: Actual use Social Housing: actual use Health: Insurance principle	• Public in-kind services are larger in Australia than in the United Kingdom (23% and 17% of average disposable income, respectively). • These In-kind services benefit most lower-income households, though by less than in the case of cash-transfers. • Consideration of in-kind services lowers the inter quintile share ratio from 5.8 to 3.8 in the United Kingdom; and from 6.0 to 2.3 in Australia. • Indirect taxes are regressive (accounting for 23% and 12% of disposable income of the bottom and top quintiles in Australia; and for 22% and 9% in the United Kingdom).
O'Donoghue, 2003	EU15 except Sweden. ECHP for 1994-98.	**Education** (incl. tertiary)	*How benefits are attributed to individuals?* Education: Actual use (without relating students with their parental family)	• While less targeted, the redistributive effect of education services exceeds that of most cash transfer programmes due to their large size. • Education spending does not eliminate intergenerational inequality (students from richer families are more likely to attend university). • Expected lifetime earnings for men with upper secondary and university education are 50% higher than for less educated men.

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
Smeeding *et al.*, 1993	Australia, Canada, Netherlands, Sweden, United Kingdom, United states, West Germany. LIS data referring to the beginning of the 1980s.	**Education** (excl. tertiary) **Health**	*How benefits are attributed to individuals?* Education: Actual use Health: Insurance principle *Other income flows considered?* Housing: Rental value for owner-occupiers	• Non-cash income reinforces the redistributive effect of cash transfers. • Little change in country rankings for poverty and income inequality when non-cash income is included. • Non-cash income is largest for single parents, families with children and the elderly, smaller for young families without children and those approaching retirement. • The distribution of housing benefits is very different from the distribution of the other types of benefits.
Steckmest, 1996	Norway, Sweden, United Kingdom and United States LIS data referring to 1986/1987.	**Education** (excl. tertiary) **Health**	*How benefits are attributed to individuals?* Education: All school aged children in primary and secondary education (no difference made between these two) Health: insurance approach	• Health and education services equalise income distribution; effect largest in Sweden and United States, smallest in Norway and United Kingdom. • In-kind services increase household income the most in Nordic countries. • Families with children received the largest benefits. • Use of health services is highest for middle deciles.
Whiteford and Kennedy (1995)	Australia, Canada, West Germany, Netherlands, Sweden, United Kingdom, United States LIS data for the mid-1980s	**Education** (incl. tertiary) **Health** **Social housing** **Employer-provided health care (United States)** **Imputed income from owner-occupied housing in 5 countries** **Liquid wealth**	*How benefits are attributed to individuals?* Education: Allocated by presence of children of relevant age (with tertiary education allocated to students in higher education institutions) Health: Insurance premium value Social Housing: Difference between actual and market rents for public housing tenants Imputed income from owner-occupation: imputed income stream from net housing equity	• Poverty rates for population between 40 and 70% lower after taking account of health and education expenditures. • Gini coefficients reduced by between 0.04 and 0.07 (*e.g.* from 0.21 to 0.17 for Sweden and from 0.31 to 0.24 for Australia).
		National studies		

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
Aaberge *et al.,* 2006	Norway Various data sources referring to 1998.	**Municipal services:** Education (excl. secondary and tertiary), Health care, Child care, Social services, Care for elderly and disabled, Other services (Infrastructure, administration, culture)	*How benefits are attributed to individuals?* Education: Actual use Health, care for the elderly and disabled: insurance value Child care: Age of child, family type and education of the mother Social services: Based on the distribution of social assistance (cash benefits).	• Municipal services have little effects on inequality. • People in the middle deciles receive the highest amount of municipal services but pay more user fees than others. • Most municipal services benefit the elderly and children (little benefits for people aged 16 to 66). • Small differences in provision across municipalities (after adjusting for differences in unit costs).
Australian Bureau of Statistics, 2001	Australia Data from 1998-99 Household Expenditure Survey (HES). Previous studies based on 1984, 1988-89 and 1993-94 HES.	**Education** (incl. tertiary) **Health** **Social housing** **Child and other social care** **Indirect taxes** About 50% of all government revenues and expenditures are allocated to households.	*How benefits are attributed to individuals?* Education: Allocated by presence of children of relevant age (tertiary education allocated to students in higher education institutions) Health: insurance premium value Housing: Difference between actual and market rents for public housing tenants	• In-kind benefits are spread evenly across quintiles. The receipt of such benefits varies in relation to other household characteristics such as the numbers and ages of household members. • The net effect of benefits and taxes is to increase average income of households in the three lower quintiles and lower that of households in the two higher quintiles. • The share of all income received by households in the lowest quintile was 0.4% for private income and 6.4% for final income, as compared with 51% and 38%, respectively, for those in the highest quintile.
Caussat *et al.,* 2005	France Household surveys and administrative files referring to 2003	**Health** (both public and private spending, net of contributions)	*How benefits are attributed to individuals?* Health: Insurance value	• Health spending, net of contributions, benefit most people with lower income (accounting for around 50% of the income of people in the first decile, as compared with -2% for those in the top one). • Out-of-pocket health expenditures decline with income (from around 5% for people in the first decile to less than 1% for those in the top one). • Redistributive effects of the health system are smaller when controlling for health status (*i.e.* people with lower income have worse health conditions).

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
CERC, 2003	France Household surveys and administrative files referring to 2001	**Education** (incl. tertiary)	*How benefits are attributed to individuals?* Education: Actual use to family of origin	• Access to higher education is highly unequal (less than ¼ of the students in first decile as compared with ½ for the top decile). • Students from richer families concentrate in more costly fields of education.
Evandrou *et al.*, 1993	United Kingdom General household survey referring to 1987.	**Education** (incl. tertiary) **Health** **Social housing**	*How benefits are attributed to individuals?* Education: Actual use; tertiary education allocated to families of origin Health: Actual use Housing: Actual use (*i.e.* difference between actual and market rents)	• In-kind services benefit most the middle quintile and the least the top quintile (in the case of education: The benefits for the top quintile exceed those for the bottom). • Bottom quintile receives around 60% more health services than the top. • In kind services to the non-retired households benefit the poor most; uniform distribution for those to retired households. • Demographic differences between deciles partly explain patterns of receipt of in kind services. • Overall in-kind services lower inequality because of greater amounts received by retired households (mostly at the bottom of the distribution).

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
Harding *et al.,* 2004	Australia. Household expenditure survey for 2001-2002.	**Education** (incl. tertiary) **Health** (incl. tax expenditures for private insurance) **Other social services** **Social housing**	*How benefits are attributed to individuals?* Education: Actual use Health: Insurance value (based on gender, age, income and whether the household has private insurance) Housing: Actual use (difference between actual and market rents) *Other income flows considered?* Direct and indirect taxes.	• Cash transfers are more progressive than in-kind services. • The overall impact of cash transfers and in-kind services is strongly redistributive towards lower income households. • The bottom 60% of Australians are gainers from the tax and benefit programmes, with gains financed by the top 40%. • Final income of bottom quintile is 10 times higher than private income. • The impact of cash and in-kind services varies by household type (older people and sole parents are the biggest gainers). • Housing benefits are the most progressive but spending is much lower than for other services. • The tax system is, overall, pro-poor (regressive impact of indirect taxes partially offsets the progressive direct taxes).
Hugounenq, 1998	France. Family Budget Survey for 1994.	**Education** (incl. tertiary)	*How benefits are attributed to individuals?* Education: Actual use(by family of origin taking also into account the age of household head)	• In the long run, education lowers income inequalities by reducing wage differences and by favouring social mobility and integration. • The progressive character of education is due to primary and secondary education; non-compulsory education benefits most those with higher socio-economic status. • The heterogeneity of the composition of family across deciles partly explain observed differences.

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
James *et al.,* 1987	Japan. Different datasets collected by ministries from the late-1970s.	**Education** (public spending for public and private schools in upper secondary and tertiary education)	*How benefits are attributed to individuals?* Education: Actual use (with deduction for higher taxes paid in the future by more educated people)	• Higher income groups are more likely to attend upper secondary and tertiary education but will also pay higher taxes in the future (implying net payments by the rich). • Similar patterns for public and private schools (with the latter receiving about 30% of government subsidies). • The distribution of students by family income is similar those attending public and private schools (*i.e.* spending to either sector has the same redistributive effect).
Lakin, 2004	United Kingdom. Expenditure and food survey for 2002-03.	**Education** (incl. tertiary) **Health** **Housing subsidy** **Travel subsidies** **School meals and welfare milk**	*How benefits are attributed to individuals?* Health: Insurance value Education: Actual use (family of origin, excl. students not living with their parents) Housing: actual use. *Other income flows considered?* Indirect taxes	• Absolute value of in-kind services declines as income rises; redistributive effects are smaller for non-retired households. • Tax system has a smaller impact in reducing inequality than cash benefits (indirect taxes weight more heavily on people with lower incomes). • Taxes and benefits have different effects on households (partly depending on the number and ages of people within each.
Ruggles and O'Higgins, 1981	United States Household survey for 1970.	**Total public expenditure (**local and federal expenditures including national defence, local administration, highways etc.	*How benefits are attributed to individuals?* Education: Actual use (to students) Health: insurance value Other (non individualised) items: Per capita, by total and capital income	• Total public expenditure redistributes towards the bottom five deciles, and away from the top three (despite higher amounts received by higher deciles). • Benefits rise with household size; households headed by non-whites and women pay more taxes but receive substantially more benefits. • Other household features beyond income (*e.g.* size) help explain the distribution of in-kind services. • Patterns of use for other (non individualised) services depend on rules used to allocate them.

Annex Table A.1. **Main findings from selected studies on the distributive impact of public services** *(cont.)*

Studies	Countries covered and data used	Spending categories considered	Methodological features	Main results
Sefton, 2002	United Kingdom Data from several household surveys referring to 1996-1997 and 2000-2001.	**Education** (incl. tertiary) **Health** **Social housing** **Social care** Excl. spending for central administration: for health and education around 85% of total spending is allocated.	*How benefits are attributed to individuals?* Education: Actual use (with tertiary education allocated to families of origin) Health: Actual use Social care: Insurance principle Housing: Actual use (difference between actual and market rents)	• Significant difference in the use of services across income deciles (the bottom two receive twice as much as the top one), partly explained by demographic factors. • The pro-poor bias of in-kind services has risen over time without preventing higher inequality. • In-kind services benefit most children, the elderly, single parents and renters from the public sector. • Differences in distributive effects among services (social housing favours most the poor, tertiary education the rich).
Wolff *et al.,* 2005	United States Annual Demographic Supplement of the Current Population Survey (1987 and 2000)	**Public consumption expenditure to households** (around ½ of total). Nine main categories (gen. services, defence, public order, economic affairs, housing, health, recreation, education, inc. security)	*How benefits are attributed to individuals?* Education, income security: actual use. Health: Potential use (insurance value) Economic, affairs, housing and community services: Direct use and costs responsibility	• Public consumption narrows inequality (Gini coefficient falls by 0.31 points in 2000). • Mean level of public consumption rises across income deciles, its ratio to income falls steadily (97% for the bottom, 6% for the top decile). • Value of public consumption for education and economic affairs increase with income, while it declines for health and income security.

Note: Articles are listed in alphabetic order within each section.

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Improving the Efficiency of Health Care Spending: What Can be Learnt from Partial and Selected Analyses of Hospital Performance?

by
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Introduction and findings 50
A cross-country comparison of hospital unit costs 51
Comparing hospital efficiency across pairs of countries 58
Comparing differences in efficiency within countries 61
Partial approaches to assessing hospital performance can be cross-checked for consistency 63
Notes 64
Bibliography 67
Technical Annex 69

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Introduction and findings

This study explores the possibility of measuring cross-country differences in health care performance at the hospital sub-sector level. A cross-country comparison of health care performance is relevant for the adoption of best international practice, which is becoming increasingly important for supporting fiscal sustainability in the context of population ageing and the rapid advances in medical technology (allowing for new treatments and changes in clinical practice).[1] The performance of hospitals in providing health care services appears to be an attractive place to start when aiming to assess overall health sector efficiency from an international viewpoint, since it constitutes a large share (typically one-third) of total health expenditure in OECD countries. Partial evidence indicates that the efficiency with which patients are treated can change dramatically over time, for example with respect to average length of stay, suggesting substantial apparent cross-country differences in hospital performance.[2] Finally, the hospital sector has been analysed extensively in the literature, allowing insight into the complexities of measuring hospital performance at the national level, which could provide better knowledge about the factors that are key to reaping efficiency gains.[3]

There are no ready-made data on hospital outputs and inputs which would allow a comprehensive international comparison of hospital efficiency to be carried out (Häkinnen and Joumard, 2007). Preferably, such an analysis should be based on aggregate output measures that are adjusted for the patient case mix. The implementation of the Diagnosis Related Groups (DRG) classification system in a number of OECD countries, which relate patient treatments to the resources consumed, is therefore promising as it allows aggregate output measures to be constructed capturing case severity. But the fact that there remain important differences in the systems actually used reduces cross-country comparability of aggregate output measures based on this concept.

The following analysis presents elected evidence on hospital performance in a number of OECD countries, in particular: Australia, Denmark, Finland, France, Germany, Iceland, Norway, Sweden, the United Kingdom and the United States, based on the three following approaches to international comparison:

- Differences in the *unit costs* of typical, individual clinical interventions based on DRGs.
- Differences in aggregate hospital efficiency *levels* between (mainly) pairs of countries, based on hospital studies that have applied different "matching techniques" so as to improve cross-country comparability of aggregate output measures.
- Differences in the within-country *dispersion* of individual hospital efficiency (a "differences-in-differences" approach), based on a subset of national hospital studies that have applied "similar" modelling assumptions.

The article ends with a discussion of whether the partial approaches, in combination, provide a consistent picture when they are cross-checked against one another. Technical notes are contained in the Annex.

The main findings of the study are as follows:

- Comparisons based on unit costs suggest that, on average for the interventions covered and disregarding potential differences in quality, countries could potentially reduce costs by between 5% and 48% if unit costs were to be reduced to the level of the best performer for each intervention.
- Bilateral comparisons of aggregate efficiency levels indicate substantial cross-country differences in hospital performance, with an input saving potential ranging from on average 6% to 36%. In addition, preliminary results from a four-country comparison of Nordic hospitals show that hospital efficiency appears to vary considerably, even between countries with relatively similar institutional features, with cost-saving potential ranging from, on average, 23% to 44%.
- The evidence on within-country dispersion indicates large cross-country differences. To the extent that higher dispersion indicates a potential for efficiency gains, there could be substantial scope for improvements in several countries by bringing the performance of inefficient hospitals up to best national practice. While possibly reflecting differences in the composition of health-service outputs, the evidence suggests that the scope for improvements could be larger for private hospitals than for public hospitals.
- While country coverage varies from indicator to indicator, making it difficult to assess the extent to which they provide a consistent picture of national efficiency levels, cross-checks between the different indicator sets tend to support the robustness of the country rankings.

It should, however, be acknowledged that the approach followed here is highly exploratory, and that analysing the determinants of the observed cross-country differences in hospital performance is beyond the scope of this study. The different set of country rankings should thus be seen as a starting point for further research, rather than as decisive evidence on cross-country differences in hospital efficiency. The ultimate objective would be to link measures of hospital performance to factors describing the institutional setting under which hospitals operate so as to draw relevant policy conclusions for the adoption of best international practice.

A cross-country comparison of hospital unit costs

One way of assessing cross-country differences in hospital performance, elaborated here, is to compare unit costs for specific interventions.[4] Unit costs for seven hospital interventions for which clinical procedures are fairly standardised across countries are presented for ten countries in Table 1. The specific definitions of the interventions chosen are based on the use of DRGs, which is a system for grouping patient treatments into a restricted set of clinically and economically homogenous groups, according to the resources used (Box 1).[5] In the second part of the table, the unit costs per treatment, as derived from national DRG schedules, have been normalised by adjusting for cross-country differences in the price level of goods and services in general, using economy-wide Purchasing Power Parities (PPPs).[6] Remaining relative price variations will reflect both differences in technical efficiency and differences in the price of hospital services relative to the whole economy (or more likely, a combination of the two).[7]

There appear to be relatively large cross-country variations in unit costs for the specific interventions examined here. In the third part of Table 1, the potential for cost savings is measured by using the unit costs of the best-performing country as a benchmark: the unit cost indicator for under-performing countries is defined as the ratio

Table 1. **Cross-country comparison of hospital unit costs for seven DRGs, 2006**

	AUS[8]	DNK	FIN	FRA[9]	DEU	ISL	NOR	SWE	GBR[11]	USA[12]
	Mapping of interventions (Grouping system)									
	AR-DRG	DkDRG	Nord-DRG	PMSI	G-DRG	Nord-DRG	Nord-DRG	Nord-DRG	HRG	HCFA-DRG
Primary prosthetic operation (S)[1]	I03B, I03C, I04B[10]	0880, 0884, 0896[10]	209A	08C02Z	I03Z, I04Z[10]	209A	209A	209A	H04, H80, H81[10]	209
Laparoscopic cholecystectomy (S)[2]	H04B	0 708	494, 494O	07C04V	H08B	494, 494O[10]	494	494, 494O[10]	G14	494
Inguinal and femoral hernia (S)[3]	G09Z	0 620	162, 162O[10]	06C12V	G09Z	162, 162O[10]	162	162, 162O[10]	F74	
Coronary bypass (S)[4]	F05A	0 507	107C	05C04W	F05Z	107C	107C	107C	E04	
Lens procedures (S)[5]	C08Z	0205, 0206	39A, 39B, 39O, 39P[10]	02C05Z	C08Z	39, 39O[10]	39	39, 39O[10]	B13, B14, B15[10]	
Simple pneumonia and pleurisy (M)[6]		0445, 0446[10]	89	04M05V		89	89	89	D42	89
Vaginal delivery (M)[7]	O60D	1 407	373	14Z02A	O60D	373	373	373	N07	
	Unit costs per intervention, measured in 2006 US$ PPP									
Primary prosthetic operation	13 523	8 730	8 424	12 972	12 379	11 361	14 438	10 099	8 413	11 761
Laparoscopic cholecystectomy	3 346	2 236	2 323	3 760	2 825	3 374	4 941	4 171	2 802	5 971
Inguinal and femoral hernia	2 365	1 736	1 557	2 564	2 655	2 409	1 829	2 910	1 617	
Coronary bypass	23 464	13 948	18 428	20 225	19 782	24 577	15 754	19 911	11 626	
Lens procedures	2 443	971	1 139	2 308	1 417	1 607	1 348	1932	1 161	
Simple pneumonia and pleurisy		2 869	3 324	5 200		4 190	5 134	4 540	5 428	5 934
Vaginal delivery	1934	1 236	1 484	2 363	1 772	2 372	1 604	2 740	1 188	
	Unit cost indicator, with unit costs of the country with lowest unit costs used as a benchmark									
Primary prosthetic operation	0.62	0.96	1.00	0.65	0.68	0.74	0.58	0.83	1.00	0.72
Laparoscopic cholecystectomy	0.67	1.00	0.96	0.59	0.79	0.66	0.45	0.54	0.80	0.37
Inguinal and femoral hernia	0.66	0.90	1.00	0.61	0.65	0.65	0.85	0.54	0.96	
Coronary bypass	0.50	0.83	0.63	0.57	0.59	0.47	0.74	0.58	1.00	
Lens procedures	0.40	1.00	0.85	0.42	0.69	0.60	0.72	0.50	0.84	
Simple pneumonia and pleurisy		1.00	0.86	0.55		0.68	0.56	0.63	0.53	0.48
Vaginal delivery	0.61	0.96	0.80	0.50	0.67	0.50	0.74	0.43	1.00	
Average (unweighted)	0.58	0.95	0.87	0.56	0.68	0.62	0.66	0.58	0.88	0.52
i.e. potential for cost reductions(%)[13]	42	5	13	44	32	38	34	42	12	48

Table 1. **Cross-country comparison of hospital unit costs for seven DRGs, 2006** *(cont.)*

	AUS[8]	DNK	FIN	FRA[9]	DEU	ISL	NOR	SWE	GBR[11]	USA[12]
	Within country variation in unit costs, normalised on the unit costs for primary prosthetic operations									
Primary prosthetic operation	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Laparoscopic cholecystectomy	0.25	0.26	0.28	0.29	0.23	0.30	0.34	0.41	0.33	0.51
Inguinal and femoral hernia	0.17	0.20	0.18	0.20	0.21	0.21	0.13	0.29	0.19	
Coronary bypass	1.74	1.60	2.19	1.56	1.60	2.16	1.09	1.97	1.38	
Lens procedures	0.18	0.11	0.14	0.18	0.11	0.14	0.09	0.19	0.14	
Simple pneumonia and pleurisy		0.33	0.39	0.40		0.37	0.36	0.45	0.65	0.50
Vaginal delivery	0.14	0.14	0.18	0.18	0.14	0.21	0.11	0.27	0.14	

1. Primary prosthetic operation in hip/knee/ankle, lower extremity cases. Available data do not allow for a cross-country consistent split of unit costs for hip, knee and ankle operations.
2. A non-invasive method for removal of gall bladder, non-complicated cases.
3. Hernia procedures, non-complicated cases.
4. Major heart disease, complicated cases.
5. Include mainly cataract treatments.
6. Infection in the lungs, complicated cases.
7. Normal birth, non-complicated cases.
8. New South Wales. Fiscal year 2005/2006.
9. Fiscal year 2005.
10. The reported unit cost figure is derived by averaging over the individual cost weights for these groups.
11. Fiscal year 2006/2007.
12. Fiscal year 2005.
13. Computed as: 1-average unit cost indicator.

Note: M = Medical DRG, S = Surgical DRG.

Source: OECD Secretariat (see the Annex for further details).

Box 1. **Diagnosis Related Groups (DRGs)**

The DRG system is used to describe the patient case-mix in hospital care. It was developed by Professor Robert Fetter and colleagues at Yale University during the 1970s as a new management tool that could improve cost control in hospitals (Fetter and Freeman, 1986). The basic idea was to describe hospital activity by focusing on the total hospital spell as the final product, measured as discharges defined according to the patient's diagnosis (described according to the International Classification of Diseases, or ICD-codes), and reflecting resources used.

Conceptually, the DRG system groups patients by means of specially designed software into a certain number of categories based on their main diagnosis, clinical procedure codes, gender, age, and the presence of complications and bi-diagnosis. The grouping procedure starts out by categorising patients in (typically 23-25) *Major Diagnostic Categories* (MDCs) according to their main diagnosis. Subsequently, separation is made between medical and surgical cases. The resulting DRGs are assumed to be categorised in a way so that each group is homogenous with respect to clinical and economic resource requirements.

The DRG system was first applied in the United States in 1983 as basis for the Prospective Payment System (PPS) introduced in Medicare (and is often termed the HCFA-DRG system, after the Health Care Financing Administration who was responsible for its implementation). Since then, a number of countries have implemented DRG systems in hospital care (see table below). DRGs are used mainly as a basis for hospital financing based on activity (Docteur and Oxley, 2003), but the system has also been used for benchmarking of national hospitals (*e.g.* in Finland since 1994). Currently, DRG systems capture mainly inpatient care activities although some countries have developed DRGs also for outpatient care (*e.g.* day surgery).

Grouping systems used in hospital care

	Type of grouping system	Year introduced in hospital financing schedules	Number of groups, 2006	Share of hospital budget financed by DRG based activity	Share of hospitals using a DRG system
Australia	AR-DRG	1997	657[1]	65%[1]	100%[1]
Austria	LDF	1997	883	50%	100%
Denmark	DkDRG	2000	599	50% by 2007	100%
Finland	NordDRG	2000	914	43-75%	36%
France	PMSI	2004	768	50% by 2007	100%
Germany	G-DRG	2003	914	20%	100%
Hungary	HBC	1993	786	100%	100%
Iceland	NordDRG	..[2]	744	0%	10%
Italy	DRG	1995	506	100%	100%
Netherlands	DBC[3]	2005	..	..[4]	100%
Norway	NordDRG	1999	532	40%	100%
Spain	DRG	1997[5]	..	35%[5]	..
Sweden	NordDRG	1997	696	55%	80-90%
United Kingdom	HRG	2003[6]	600	35-70%	100% by 2008
United States	HCFA-DRG	1983[7]	543[7]	..	100%[7]

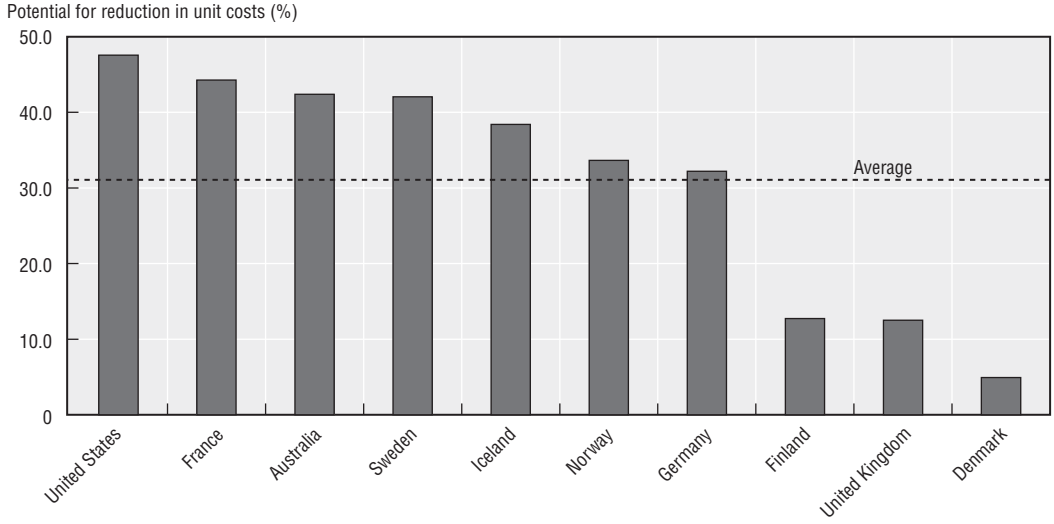
1. New South Wales.
2. Used only for collecting information on provision of hospital care.
3. DBC was introduced in February 2005 for reimbursement of hospital care. However, the DBC system is still under development.
4. In the DBC case-mix system, a distinction is made between DBCs with fixed prices and with negotiable prices.
5. Catalonian region.
6. Only in England.
7. Medicare.

Note: DkDRG = Danish DRG; AR DRG = Australian Refined DRG; HRG = Health Resource Groups; DBC = Diagnose Behandelings Combinaties; PMSI = Programme de médicalisation des systems d'information; LDF = Leistungsbezogene Diagnose-Fallgruppen; NordDRG = Nordic DRG; HBC = Homogén Betegségcsoportok.
Source: OECD Secretariat; Busse *et al.* (2006); The Nordic Case Mix Conference, Copenhagen, 2006; Schreyögg *et al.* (2006).

of the benchmark country's unit costs to their own costs, the potential saving being calculated as the difference between the two.[8] For example, in the case of *laparoscopic cholecystectomy* (a non-invasive method for removal of the gall bladder) the unit cost indicator varies between 0.37 and 0.96 in relation to the benchmark country, Denmark, suggesting a cost-saving potential of around two-thirds for the country having the highest unit costs and less than five per cent for the second most efficient. Likewise, unit costs vary substantially even for a standard clinical intervention like *vaginal delivery* (normal birth without complications), with three countries appearing to have a cost-saving potential of 50% or more.

The potential for reducing unit costs, based on simple averaging over the seven interventions (the lack of data on the number of *e.g.* discharges for each DRG hindered the calculation of a weighted average), appears to be relatively large in Australia, France, Sweden and the United States, while being relatively low in Denmark, Finland and the United Kingdom (Figure 1). Germany, Iceland, and Norway seem to be in intermediate positions. A robustness check of the relative country ranking reported in the Annex shows that using alternative deflators (*i.e.* gross wage earnings and GDP per capita) to economy-wide PPPs does not change relative rankings by very much.

Figure 1. **Cross-country differences in unit costs for seven hospital interventions, 2006**



Source: OECD Secretariat.

In addition, the relative unit costs for the various treatments vary considerably within countries. This is illustrated in the fourth part of Table 1, where unit costs within each country are measured with primary prosthetic operation used as a *numeraire*. For example, unit costs of *vaginal delivery* vary between one-tenth and a quarter of the costs of a primary prosthetic operation, while unit costs of *coronary bypass* vary from being roughly equal to the unit costs for primary prosthetic operation to more than double. Assuming that the DRG-based interventions are indeed consistent across countries, these wide variations in relative unit cost structures are suggestive of considerable scope for efficiency gains.

Although the evidence presented in Table 1 points to areas in which real improvements in unit costs might be achieved, several factors may be behind the substantial variation in

cost performance across countries, reducing cross-country comparability. They include the following:

- First, as countries use different DRG systems, the interventions covered here may not be fully comparable if the diagnosis and clinical procedures reflected in each DRG differ across countries (Box 2).[9] Apparently, there are large variations in the number of groups

Box 2. **Factors affecting the degree of comparability of DRGs across countries**

The fact that no international DRG system has so far been developed[1] – which would permit international comparisons – is due to the following factors (Schreyögg *et al.*, 2006):

- *Differences in the definition of data samples*, *e.g.* in the number of hospitals from which cost data are collected and pooled. The percentage of hospitals that use DRGs varies from less than one per cent of the total data sample (in Italy) to 100% (in the United Kingdom), reflecting differences in the selection criteria. These criteria usually seek to balance the need to ensure high-quality data standards with obtaining a representative sample of hospitals.
- *Differences in the use of trimming methods to detect outlier cases*, *i.e.* treatment episodes which use significantly higher (or lower) resources than the average. Typically, long-stay outliers occur more frequently than short-stay outliers, implying that the average cost per DRG tends to exceed the median, or typical, case. For this purpose, trimming methods that define threshold values (trim-points) are applied but these methods vary across countries.[2]
- *Differences in the methods for calculating individual cost-weights*. Basically, countries apply two different methods to derive reimbursement rates for hospital activity based on DRGs. The first method is based on the concept of individual cost-weights, which define a relationship between the treatment episodes according to the intensity of resources used.[3] However, cost accounting methodology used to establish this relationship varies both within and across countries (see the 2006 August volume of *Health Care Management Science* for details). The second method is based on calculating unit costs (or setting the reimbursement rate) for each group directly. Both methods capture variation in relative resource requirement between different groups of patients, but additional adjustments are typically required to take account of differences in hospital structure and/or regional differences. Countries use different mechanisms for conducting these adjustments.

Another factor which may blur the comparability of unit costs derived from DRG cost-weights is, for example, the frequency at which the weights are updated, implying that the unit costs may reflect cost conditions for different time periods. A further factor is that some countries apply the DRG system uniformly, while others apply different sets of cost-weights, depending on the administrative unit responsible for the provision of hospital care. There is also variation related to hospital ownership, implying that cost-weights may depend on the financing structure of the health care system as a whole. Finally, there is a variation in the type of cost components included in the cost base used to derive national cost-weights (see Annex for details).

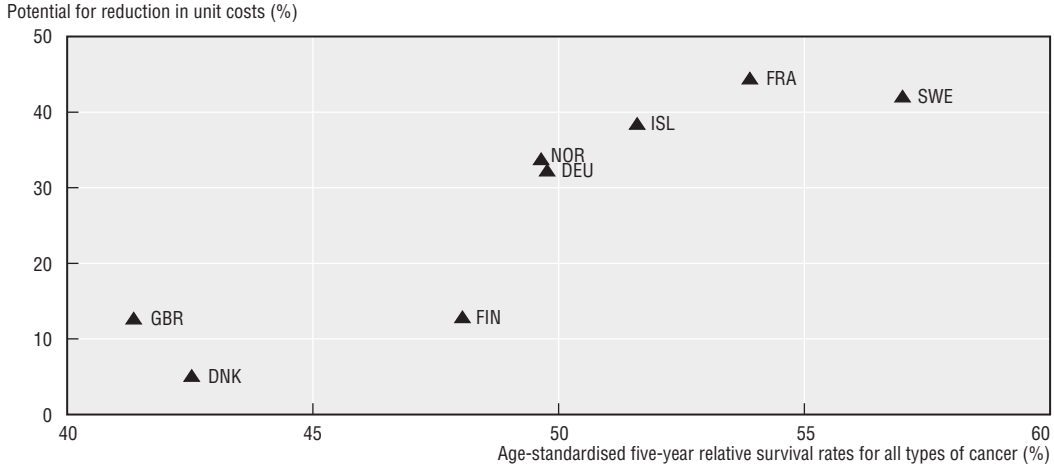
1. The Nordic countries have developed a common DRG system (*i.e.* the common version of the NordDRG system) – which to a large extent is inspired by the US HCFA-DRG system. Although each country uses a national version of the NordDRG in hospital reimbursements, reflecting specific institutional specificities, the common system could be utilised to draw inter-Nordic comparisons (see Linna *et al.*, 2006).
2. Cases of extreme resource use are typically excluded and reimbursed separately. Countries use mainly two types of trimming methods, parametric and non-parametric methods, and some also use additional techniques that may lead to exclusion of certain observations. For short-stay outliers, some countries use lower trim-points, whereas other countries do not use lower thresholds.
3. The advantage with this method is that only the reimbursement rate for the average patient (*i.e.* the DRG with a cost-weight of 1.0) has to be set. The individual rates for all the other groups could then be calculated by multiplying the individual cost-weights with the reimbursement rate for the average patient.

across the different systems in use (from around 500 to more than 900 groups), suggesting that unit costs may better reflect underlying costs for the individual interventions where there are more DRGs (and narrower groupings).

- Second, the methods used to calculate individual cost-weights vary between countries (Box 2 and Schreyögg *et al.*, 2006). Among factors that may reduce comparability of the derived unit cost figures are differences in the type of cost components included in the national cost base used to estimate national cost-weights, differences in trimming methods used to detect outlier cases, differences in the intensity with which care is provided,[10] whether or not a specific intervention is performed as day surgery,[11] and to what extent the cost-weights are representative for the country as a whole.
- Third, countries may attach different weights to the use of medical equipment *versus* the use of labour intensive care. Insofar as the derived figures capture mainly current expenditure, low unit costs may reflect that the country concerned is relatively well-equipped with medical equipment or that such equipment is financed outside the DRG schedule. This could reduce the need for labour-intensive care (which is measured), but would increase capital costs (which are typically not measured). Hence, the presented figures may be biased as indicators of overall, long-term unit costs.[12]
- Fourth, there may be economies of scale, *i.e.* reaping the indicated cost saving potentials might require larger hospitals or higher turnover within hospitals.[13] Although the latter would raise overall spending, even then there would be savings per treatment.

An investigation of the factors behind the cross-country differences in unit costs is beyond the scope of this study, although (unalterable) national characteristics as well as institutional factors are likely to be key determinants.[14] However, to the extent that quality is closely linked to resources consumed, low unit costs could potentially reflect that quality of care is relatively low. In the absence of available indicators on the quality of the specific clinical interventions covered here, Figure 2 illustrates the relationship between the unit cost indicator presented above and 5-year relative survival rates for all types of cancer. The apparent positive correlation between the potential for reduction in unit costs and survival rates is striking (the correlation coefficient is 0.90).[15] This suggests that superior unit cost

Figure 2. **Cross-country variation in hospital unit costs and quality of care**

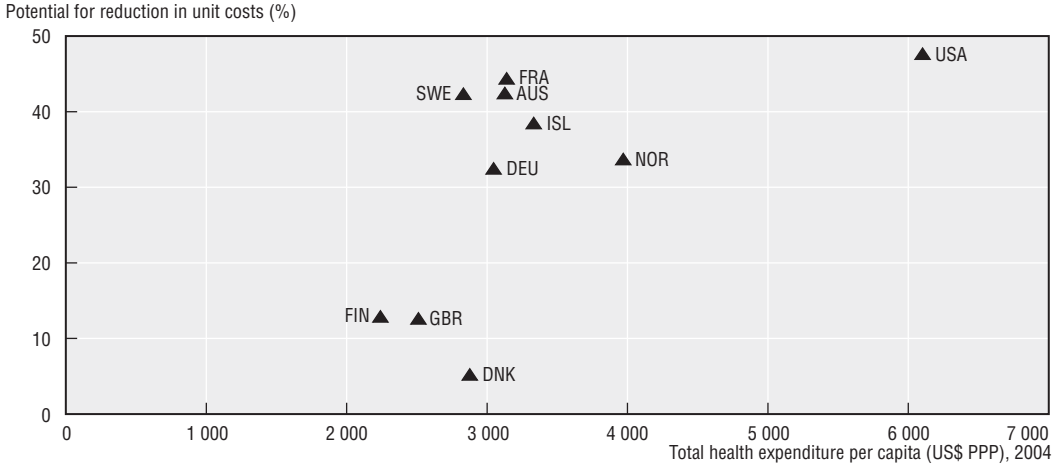


Note: The survival rates for cancer are taken from the Eurocare-3 study, and are based on adults diagnosed 1990-1994.
Source: Sant *et al.* (2003).

performance could come at the cost of low quality services, but the relationship may also reflect differences in priorities. For example, the relatively high survival rates for cancer in France and Sweden could be taken to indicate that more weight is attached to preventive care (*e.g.* screening), implying that patients that are admitted to elective care have a relatively higher case severity (contributing to higher unit costs).

There is also an empirically demonstrated correlation between income and health expenditure, in that countries with higher GDP per capita tend to spend more per capita on health (OECD, 2005). However, high levels of income may lead to failures in providing sufficiently strong incentives to cost containment.[16] A recent report by the McKinsey Global Institute suggests that one of the overriding causes of high health care spending in the United States is the lack of sufficiently strong incentives to promote rational supply of care (McKinsey Global Institute, 2007). Figure 3 is suggestive of a positive relationship between potential cost savings and per capita spending on health (the correlation coefficient is 0.56).

Figure 3. **Cross-country variation in unit costs and spending on health care**



Note: Total health expenditure includes public and private spending.
Source: OECD Health Data 2006.

Comparing hospital efficiency across pairs of countries

Although an international comparison of unit costs for specific clinical interventions could allow for insight into cost performance, the extent to which they are representative for the hospital sub-sector level may be limited insofar as they account for only a small share of total hospital activity. A cross-country comparison of hospital performance should preferably be based on aggregate efficiency measures. Ideally, this would be based on outcome measures that capture value added, *i.e.* the change in a patient's health status with and without the clinical treatment (Jacobs *et al.*, 2006). Since such data rarely exist on an internationally comparable basis, in practice, researchers are usually dependent on hospital outputs.[17] In national studies, typically this has been measured by the (aggregated) number of discharges (or patient days)[18] – a measure equivalent to defining output in the education sector according to the number of students passing through school. There are, however, no ready-made data on hospital discharges which allow comprehensive comparisons of hospital efficiency to be carried out across OECD countries.[19]

Notably, the lack of an international DRG system and an associated weighting set means that comparing aggregate hospital output internationally would be associated with

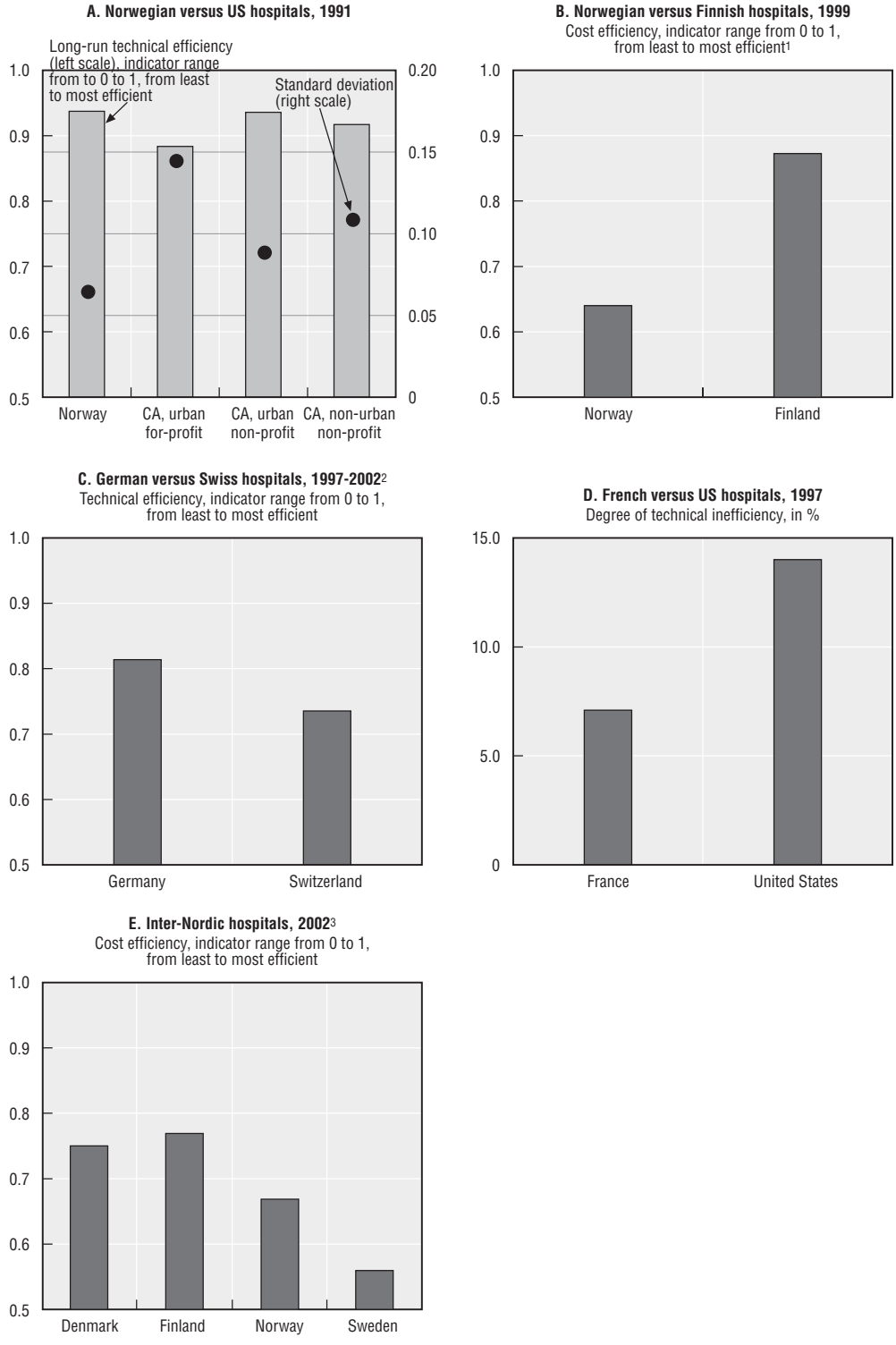
great uncertainties. Thus the limitations of such comparisons are likely to be non-negligible. Aggregate output measures could, in principle, be computed, for example, by multiplying the number of discharges for each group by respective weights adjusted for case severity. But, while many countries have implemented DRG systems in hospital care, there remain important differences between the systems in use (see Box 2). Countries have found it necessary to adapt the detailed design of the DRG system to national circumstances. Cross-country differences with respect to DRG systems concern all levels of its implementation, including grouping logic and the classification system for diseases (*i.e.* the version of the ICD-system) actually used.

A small number of hospital studies have applied different "matching techniques" so as to permit comparisons to be made of efficiency across (mainly) pairs of countries. Two main approaches have been applied in this respect. The first approach is based on matching groups of hospitals according to specific criteria, *e.g.* hospital type, hospital size, length of stay, the number of bed days, etc.[20] The second approach is based on utilising existing DRG systems allowing for international comparisons. Currently, this is possible only for inter-Nordic comparisons.[21]

The results from the international comparisons of hospital efficiency are summarised in Figure 4, panels A-E. Efficiency scores have in all cases been computed on the basis of non-parametric measurement methods (mainly Data Envelopment Analysis, DEA).[22] With the caveat that there may remain some factors reducing cross-country comparability (*e.g.* quality of care), the evidence from these studies points to substantial bilateral differences in hospital efficiency:

- Mobley and Magnussen (1998) compared Norwegian and US (Californian) hospitals based on aggregate output measures adjusted for case severity (partly by using the age distribution of the patients, and partly by using DRGs). In addition, US physician input data were adjusted to better reflect full-time work effort so as to make them more comparable with Norwegian input data. Norwegian and Californian urban non-profit hospitals were found to be the most (technically) efficient, although the differences appear in general as relatively small (Figure 4, panel A).[23] Californian urban for-profit hospitals were found to be most inefficient, reflecting relatively low bed capacity utilisation.
- Another study compared Norwegian and Finnish hospitals based on aggregate output measures adjusted for the patient case-mix (Linna *et al.*, 2006).[24] Norwegian hospitals were found to be less (cost) efficient than Finnish hospitals (Figure 4, panel B).[25] The computed cost-saving potentials are 36% and 13%, respectively.
- Steinmann *et al.* (2004) compared Swiss and German (Saxony) hospitals based on aggregate measures of the number of cases treated. Swiss hospitals were found to be on average 8% less (technically) efficient than German hospitals (Figure 4, panel C).[26]
- Dervaux *et al.* (2004) compared French and US hospitals based on aggregate measures of number of treatments for different categories. US hospitals were found to have a potential for efficiency gains around twice the level in French hospitals (Figure 4, panel D).[27]
- Kittelsen *et al.* (2007) compared hospital efficiency in Denmark, Finland, Norway and Sweden based on aggregate output measures adjusted for case-severity.[28] Preliminary results indicate that cost efficiency is relatively high in Finland and Denmark, while relatively low in Sweden. Norwegian hospitals appear to be in an intermediate position. Computed cost-saving potential range from, on average, 23% to 44% (Figure 4, panel E).[29] These results are roughly in line with those on unit costs reported above.

Figure 4. **International comparisons of hospital efficiency**



Note: CA denotes Californian hospitals.

1. The reported cost efficiency scores for Finland and Norway is the average efficiency score across four different model specifications (all based on a pooled sample).
2. The reported efficiency scores are calculated as the average over the years from 2000 to 2002 for Germany, and as the average over the years from 1997 to 2000 for Switzerland.
3. Preliminary results from Kittelsen *et al.* (2007).

Source: Mobley and Magnussen (1998); Linna *et al.* (2006); Steinmann *et al.* (2004); Dervaux *et al.* (2004); Kittelsen *et al.* (2007).

Comparing differences in efficiency within countries

There is an extensive literature on within-country efficiency measurement in hospital care which could potentially be utilised to calculate cross-country differences in efficiency *levels* based on within-country data (Box 3), if problems of comparability could be

Box 3. **Comparing efficiency in health care across countries based on national studies**

The empirical literature on efficiency measurement in health care is extensive. According to Hollingsworth (2003), up to the end of 2002, 188 journal papers and book chapters had been published on this subject, a large bulk being within-country analyses. Most of these studies have applied non-parametric measurement methods, notably DEA, and more than half of them are conducted in the area of hospital and nursing home care. The majority of the studies are based on US data. Increasingly, analyses of efficiency at the hospital sub-sector level are based on a two-stage approach, where DEA is used to derive efficiency scores while regression methods (*e.g.* TOBIT) are applied to link variation in efficiency to factors describing the institutional setting under which hospitals operate.

According to national studies based on DEA applications, there could be substantial differences in health care efficiency, both across countries as well as between the different areas of the health care sector (see table below). Based on simple averaging across the studies surveyed, Hollingsworth (2003) finds that efficiency seems to be somewhat higher in European countries than in the United States with a measured degree of inefficiency around 17% and 25%, respectively (averaging across all health care sub-sectors). There appear to be considerable differences in efficiency also between the areas of the health care sector, with the largest potential for efficiency gains appearing to be in primary and nursing home care. Although the figures reported below could be seen as a crude illustration of cross-country differences in health care performance, they should not be taken as *prima facie* evidence on differences in efficiency across countries as their comparability may be limited.

Summary statistics on efficiency in health care

Indicator range from 0 to 1, from least to most efficient

	Number of studies	Efficiency[1]		
		Average[2]	Median	Minimum
Hospitals USA	48	0.834	0.860	0.600
Hospitals EU	17	0.892	0.897	0.751
Health districts USA	9	0.742	0.800	0.500
Health districts EU	4	0.839	0.838	0.800
Nursing homes USA	18	0.746	0.806	0.380
Nursing homes EU	4	0.765	0.750	0.700
Primary care USA	4	0.648	0.635	0.427
Primary care EU	5	0.817	0.790	0.675

1. Summary indicators reflect the use of different efficiency concepts (*i.e.* cost efficiency, technical efficiency) as well as differences in the number and type of hospitals that have been analysed, the specification of hospital production in outputs and inputs, assumptions about scale properties, and other technical assumptions.
2. "Average" efficiency shows the average score reported across the number of studies surveyed. For example, the average efficiency of 0.834 for US hospitals is derived by averaging across the 48 hospital studies the average efficiency score reported in each study.

Source: Hollingsworth (2003).

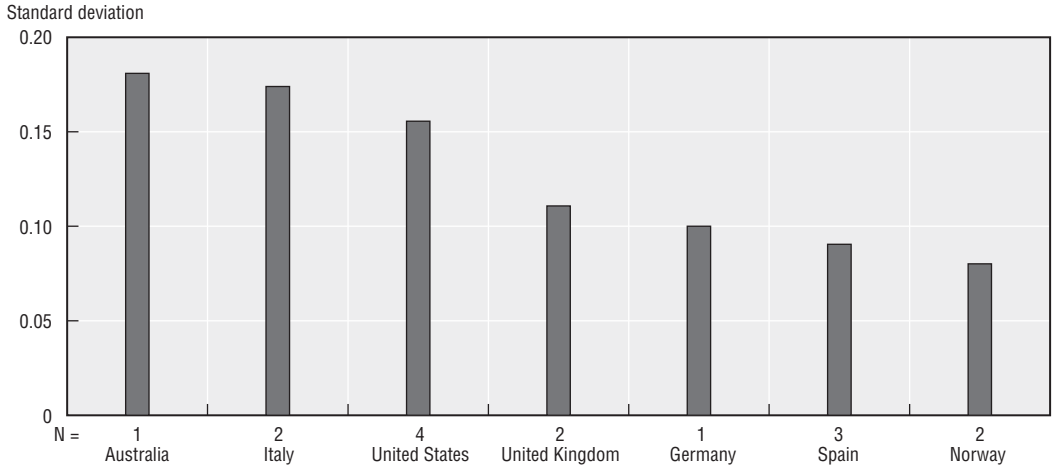
overcome. However, hospital studies suffer from cross-country heterogeneity along several important dimensions, such as the types of hospitals that have been analysed, the specification of hospital production in outputs and inputs, efficiency concepts applied, technical assumptions about scale properties, etc.[30] This avenue of comparison is therefore not followed further in this study. Instead, existing within-country studies of hospital efficiency have been used to draw cross-country comparisons of domestic *dispersion* in hospital performance based on aggregate efficiency measures. Such dispersion in individual hospital efficiency could be taken to indicate that the scope for efficiency gains is relatively large by letting hospitals catch-up to best national practice.[31]

To enhance comparability, this study focuses on a subset of hospital studies matched according to the following criteria: first, only studies based on DEA applications are examined; second, the efficiency concept applied in all studies is technical efficiency; third, only studies that have assumed variable returns to scale production properties are included; fourth, efficiency scores are computed in an input-oriented direction, *i.e.* meaning how much inputs could be reduced for given levels of outputs.[32] Due to these restrictions the subset of empirical studies examined here is confined to 15 national hospital analyses compared with the 68 studies surveyed by Hollingsworth (2003).[33]

This restricted sample of national hospital studies shows that there are substantial differences in the dispersion of hospital performance (Figure 5). Domestic dispersion in aggregate efficiency measures for hospital care appears to be particularly prevalent in Australia and Italy (with the United States close behind), with reported standard deviation figures being around twice the level in Spain and Norway which appears to have the most homogeneously performing hospitals. The United Kingdom and Germany are in intermediate positions. The implication is that there could be considerable scope for improvements in efficiency in the first group of countries by making hospitals operate closer to best national practice.

Although the issue of comparability initially has been addressed by focusing on studies using "similar" modelling assumptions, some heterogeneity is likely to remain which may blur the comparability of domestic dispersion in hospital efficiency, as illustrated in Figure 5. Among factors that could hamper comparability are differences in the type of hospitals (*e.g.* public or private, local or university hospital) analysed, differences in the specification of hospital production into outputs and inputs,[34] and to the extent that the studies examined portray a non-representative picture of national performance. For example, the figure reported for Australia is based on a study of private hospitals, while the figures reported for Italy and the United States are based on a mix of public and private hospitals. In contrast, the figures reported for the other countries capture mainly public or non-profit care providers. Taken together with the cross-country pattern of dispersion in efficiency, this could be taken to indicate that dispersion in performance is larger for private hospitals than for public and non-profit hospitals.[35] However, caution should be taken when drawing comparisons of performance in public *versus* private hospitals as some non-observed factor, such as quality, may vary more across private hospitals, or there may be systematic differences in the composition of health-service outputs between public and private providers.

Figure 5. **Cross-country dispersion in hospital efficiency within countries**



Note: N denotes the number of within-country studies over which the standard deviation estimate for each country is based, *i.e.* for countries where more than one study is available, the reported figure is the average standard deviation across these studies.

Source: See Annex, Table A16.

Partial approaches to assessing hospital performance can be cross-checked for consistency

The partial indicators of hospital performance analysed above can be cross-checked for consistency, to see whether a consistent picture of relative national efficiency levels emerges. Table 2 does indeed suggest such a pattern:

- Countries that perform relatively well with respect to cost performance (as measured by the potential for reduction in unit costs) also appear to do well in comparisons of

Table 2. **Country rankings based on different indicators of hospital performance**

Indicator range from 1 to 10, with 1 as best performance

	Comparison of hospital unit costs	Comparison of between-country differences in efficiency					Comparison of within-country differences
	Unit cost indicator for seven interventions	Norway *vs.* United States	Norway *vs.* Finland	Germany *vs.* Switzerland	France *vs.* United States	Nordic comparison[1]	Domestic dispersion in aggregate efficiency
Australia	8						7
Denmark	1					2	
Finland	3		1			1	
France	9				1		
Germany	4			1			3
Iceland	6						
Italy							6
Norway	5	1	2			3	1
Spain							2
Sweden	7					4	
Switzerland				2			
United Kingdom	2						4
United States	10	2			2		5

1. Ranking based on preliminary results from Kittelsen *et al.* (2007).

Source: See Figures 1, 4 and 5.

aggregate efficiency levels between countries or sets of countries (*e.g.* Denmark, Finland).

- Countries that have a relatively large cost-saving potential according to unit cost comparisons also appear to be relatively inefficient according to comparisons based on either aggregate efficiency levels (*e.g.* Sweden) or within-country dispersion (*e.g.* Australia and the United States).
- In contrast, there are countries for which a consistent picture does not emerge from the various comparisons of efficiency (*e.g.* the United Kingdom).

Overall, and taken together, the partial indicators presented here are suggestive of substantial differences in hospital cost performance across OECD countries. The discussion of factors that may explain this variation, as well as appropriate policies to address any associated inefficiencies, is, however, beyond the scope of this study.

Notes

1. OECD projections suggest that the average public spending share on health could almost double by 2050, from around 6% to nearly 10% of GDP, assuming no policy change action to break with past trends (OECD, 2006).
2. The number of acute care hospital beds per capita decreased significantly in a number of OECD countries from 1990 to 2002, at the same time as hospital discharge rates escalated (OECD, 2005). Average length of hospital stay dropped markedly in the same period for almost all OECD countries.
3. See the survey by Hollingsworth (2003), and the references therein.
4. The HealthBASKET project, funded by the European Commission, aims at developing a more general methodology allowing comparisons to be drawn between differences in costs of treatment across and within EU member States, using a selection of "case-vignettes" for both inpatient and outpatient care (*www.ehma.org/projects/default.asp?NCID=112*).
5. A number of countries have implemented DRG systems in hospital care, but comparing unit costs across countries based on DRGs requires a mapping of clinical interventions so as to ensure a match of similar treatments. The mapping in this paper has been conducted at the DRG level, *i.e.* by comparing DRGs which either have the same number or equivalent labels. Medical experts have been consulted in this process. To ensure an accurate match of diagnosis and clinical procedures, the mapping would preferably have been conducted at the patient level, but individual data needed for this have not been available.
6. The figures are derived from national DRG schedules used in the reimbursement of hospital activity (see further details in the Annex). These schedules have been utilised in the following way: unit costs for each clinical intervention have been derived by multiplying the relevant cost-weight with the national reference price (*i.e.* the reimbursement rate for the average patient), or by taking the unit cost (or reimbursement rate) for each intervention directly. Thus, the derived unit costs are taken to reflect the average input costs at the national level required to treat the median, or typical, case.
7. In the case where the price level for hospital services does not differ from the price level for goods and services in general, cross-country differences in unit costs will reflect pure differences in efficiency, *i.e.* higher use of inputs for a given level of treatment. Conversely, if unit costs were measured by deflating national figures by health-specific PPPs, remaining cross-country differences in unit costs would then purely reflect differences in efficiency (Huber, 2006; Triplett, 2003). However, using those health-specific PPPs that are available to normalise unit costs denominated in national currencies is problematic as they are currently derived from the input side and thus disregard cross-country differences in efficiency among producers.
8. The potential for reduction in unit costs is defined as: (1 – unit cost indicator)*100%. Cost-savings could be achieved by reducing wage costs or other inputs used in the hospital sector (relative to other sectors), or by increasing technical efficiency by changing the way that physical inputs are transformed into outputs.
9. See endnote 5.

10. Implicitly, the comparison of unit costs reported here assumes that the intensity of treatment is constant across countries (see endnote 6). To the extent that it varies, the quality of each DRG category may be affected.

11. For the *lens procedures, inguinal* and *femorial hernia,* and *laparoscopic cholecystectomy* interventions, there are variations across countries to the extent that they are performed as outpatient activities (*i.e.* day surgery). Kittelsen *et al.* (2007) finds, for example, that Swedish hospitals use outpatient care less extensively than other Nordic countries.

12. A simple cross-country comparison shows, however, no clear correlation between investment in medical facilities and unit cost performance (see Annex for details), although there are recognised difficulties in measuring capital spending: hospitals may apply different principles for determining whether medical equipment should be regarded as operational expenditure and for assessing depreciation.

13. In OECD work on the linkages between performance and institutions in the primary and secondary education sector it was found that size of a school was a strong indicator of higher efficiency (Sutherland and Price, 2007).

14. Among the factors that may influence unit cost performance are market imperfections (*e.g.* low unit costs could reflect that hospitals have monopsony power in the market for health personnel) and organisational features (*e.g.* high unit costs may reflect that rehabilitation is conducted "in-house", whereas low unit costs reflect that post-surgical care is undertaken by other care providers).

15. However, a caveat should be entered about the robustness of this quality indicator. Huber (2006) finds that different indicators of quality of care tend to be weakly correlated.

16. Empirical evidence on efficiency in local public service provision indicates that high levels of local revenue are associated with low efficiency (Borge and Naper, 2006). The underlying argument is that the service producing agencies are able to take advantage of a rich sponsor to increase budgetary slack.

17. Empirical evidence indicates, however, that medical care may account for only a small proportion of improvements in health outcomes. For example, estimates by Bunker *et al.* (1994) suggest that medical care may account for only 17-18% of the improvement in life expectancy in the United States and the United Kingdom over the past century. In the same vein, Or (2000) finds that far more important for explaining differences in health outcomes in OECD countries than health care inputs are occupational status and the level of income.

18. See Worthington (2004) for a review of output specifications that have been adopted in empirical studies.

19. See Häkkinen and Joumard (2007) for a fuller discussion of appropriate data needed for carrying out international comparisons of hospital performance based on aggregate efficiency measures. An alternative indicator that may be utilised for cross-country comparisons is average length of hospital stay. Countries characterised by relatively short length of stay would typically be taken as relatively efficient, while countries with long length of stay would be taken as inefficient. However, several factors impede cross-country comparisons based on this indicator: first, length of stay is typically sensitive to how the treatment process is organised (*e.g.* whether or not post-surgical care is conducted "in-house" or by other care institutions, see Ham *et al.*, 2003; and Riksrevisjonen, 2003); second, length of stay may be difficult to interpret. For example, is long length of stay due to inefficiency or does it simply reflect the lack of effective co-ordination between care providers?

20. Mobley and Magnussen (1998) compared Norwegian and US (Californian) hospitals by matching four groups of hospitals according to type, hospital size and average length of stay. In addition, hospitals with outlier observations for the specified variables were excluded. Steinmann *et al.* (2004) compared Swiss and German (Saxony) hospitals by matching groups of hospitals according to type, number of beds, and number of cases treated per physician. Dervaux *et al.* (2004) compared France and US hospitals by matching groups of hospitals according to type and number of beds.

21. Linna *et al.* (2006) compared Norwegian and Finnish hospitals by utilising the common version of the NordDRG system, allowing a more accurate match of patient treatments across countries. Kittelsen *et al.* (2007) compared Danish, Finnish, Norwegian and Swedish hospitals based on the national versions of the NordDRG system, but where additional adjustments were made so as to ensure a common set of DRGs for all the four countries.

22. Non-parametric measurement methods imply constructing an efficiency frontier based on output and input data from a set of production units (*e.g.* hospitals or countries). In essence, the frontier is constructed from the production units that envelop the remaining observations and thus

provides a benchmark by which the others can be judged (Sutherland *et al*., 2007). DEA is a frequently applied non-parametric measurement method, reflecting that it is relatively flexible (*e.g.* allowing for multiple outputs and inputs), but the method also has some drawbacks such as being sensitive to measurement errors. Given that competing methods (*e.g.* stochastic frontier analysis) also suffer from flaws, there is currently no consensus in the literature on the "best method" for deriving best practice production frontiers (Jacobs *et al*., 2006).

23. Efficiency scores were derived separately for each group of hospitals.

24. For both countries, aggregate output measures were constructed by weighting discharges for each DRG with Finnish cost-weights. See also endnote 21.

25. Efficiency scores were derived from a pooled sample of observations. In addition, efficiency was measured separately, showing similar efficiency scores for Finnish hospitals as in the pooled sample, while somewhat higher efficiency scores for Norwegian hospitals.

26. Efficiency scores were derived from a pooled sample of observations. In addition, efficiency scores were derived on a pooled subset of observations (considered to be better comparable), showing similar efficiency scores on average for German hospitals, while somewhat lower for Swiss hospitals on average.

27. Efficiency scores were derived separately for each group of hospitals.

28. The following specifications were applied: output was measured by three types of discharges for inpatient care (medical, surgical and other), and two types of day care patients (medical and surgical), weighted with respective DRG cost-weights (based on a set of inter-Nordic weights). In addition outpatient visits were included as a measure of hospital output. Hospital current expenditure was used as a measure of input.

29. These preliminary figures are based on data that may be adjusted in the ongoing work.

30. As noted by Sutherland *et al*. (2007), a potential drawback with non-parametric approaches such as the DEA method is the so-called "curse of dimensionality", *i.e.* efficiency scores may be biased due to small samples and relatively large numbers of inputs and/or outputs. DEA is under such circumstances likely to produce less dispersion in efficiency scores, as more units will by construction be deemed efficient due to having a non-comparable input-output mix. In addition, the measured degree of inefficiency for each country (based on within-country analyses) will also be susceptible to the number of studies that the estimate is based on.

31. Assuming that all providers should perform more homogeneously might be too static an efficiency perspective. If innovation is important for longer term efficiency, then variation is not necessarily negative. In a number of countries, private hospitals as providers of publicly funded services could help stimulate innovation, which may increase variation as a prelude to spreading best-practice. In the study by Linna *et al*. (2006) quoted above, domestic dispersion in cost efficiency was found to be larger for Finnish hospitals than for Norwegian hospitals even though efficiency levels were higher. This evidence could be taken to indicate that despite being relatively efficient (on average) compared with Norwegian hospitals, some Finnish hospitals could become much more efficient by catching up to best performance.

32. Under the assumption of variable returns to scale production properties, the direction in which efficiency scores are computed (*i.e.* input-oriented or output-oriented) matters for the results. In contrast, this is not the case when assuming constant returns to scale (compare the corresponding discussion in the paper on public spending efficiency in primary and secondary education by Sutherland *et al*., 2007).

33. Another factor which has reduced the sample size is the fact that many studies have not reported standard deviation figures.

34. Empirical evidence indicates that individual efficiency measures are sensitive to the output specification (Magnussen, 1996), which may also potentially change the measured coefficient of variation in aggregate efficiency measures.

35. Similarly, Mobley and Magnussen (1998) found that Californian for-profit-hospitals are relatively more heterogeneous in their performance than Norwegian public hospitals and Californian non-profit hospitals.

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Technical Annex

The Technical Annex contains source descriptions as well as more detailed material on some of the issues raised in the paper, and is presented in four sections showing: *i)* national DRG schedules used to calculate unit costs; *ii)* illustrations of the relationship between unit cost performance and investment in health care; *iii)* tests of the robustness of the relative country ranking with respect to unit cost performance, using alternative deflators to economy-wide Purchasing Power Parities (PPPs); and iv) within-country analyses utilised to calculate measures of domestic dispersion in individual hospital efficiency.

National sources utilised in calculating unit costs for seven DRGs

Tables A1-A10 describe the national sources used to derive unit costs for the seven DRGs covered in this paper. For all countries, the PPPs are taken from the OECD Analytical Database.

Table A1. **Australia (New South Wales)**

National source	"NSW Costs of Care Standards 2005/2006", published by the Department of Health, New South Wales. Cover public acute care hospitals, including district level and large (*e.g.* specialised) hospitals.
Reference price, national currency	ASD 3 584 (including all cost groups, *i.e.* including care undertaken in emergency department and including intensive care cost groups). For the fiscal year 2005/2006.
Cost elements included	Operational costs. Cost-weights are derived on the basis of cost data for the fiscal year 2003/2004. Cost data were collected from a sample of 84 hospitals.
Is outpatient care included in the DRG schedule?	No. Separate schedules.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	I03B, I03C, I04B	5.21[1]
Laparoscopic cholecystectomy	H04B	1.29
Inguinal and femoral hernia	G09Z	0.91
Coronary bypass	F05A	9.04
Lens procedures	C08Z	0.94
Simple pneumonia and pleurisy	..	..
Vaginal delivery	O60D	0.75

1. Calculated as the unweighted average of the individual cost-weights for each of the three groups.

Table A2. **Denmark**

National source	"Takstsystem 2006 – en vejledning", published by Sundhedsstyrelsen.
Reference price, national currency	DKK 25 135.
Cost elements included	Operational costs, excluding pension payments, rate of return and depreciation. Cost-weights are derived on the basis of cost data for 2004. Cost data were collected from a sample of 43 public hospitals, representing 81% of annual discharges.
Is outpatient care included in the DRG schedule?	Yes, 75 day surgery groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	0880, 0884, 0896	2.97[1]
Laparoscopic cholecystectomy	0 708	0.76
Inguinal and femoral hernia	0 620	0.59
Coronary bypass	0 507	4.74
Lens procedures	0205, 0206	DKK 8 293[2]
Simple pneumonia and pleurisy	0445, 0446	0.98[3]
Vaginal delivery	1 407	0.42

1. Calculated as the unweighted average of the individual cost-weights for each of the three groups.
2. Calculated as the unweighted average of the individual reimbursement rates for each of the two groups.
3. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A3. **Finland**

National source	"NordDRG-O-kustannuspainot 1-7/2006", published by the Association for Finnish municipalities on www.kunnat.net.
Reference price, national currency	EUR 531.
Cost elements included	Operational and capital costs, net of patient payments. Cost-weights are derived on the basis of cost data, collected from 7 hospitals in one (out of 21) hospital districts.
Is outpatient care included in the DRG schedule?	Yes, some day surgery groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	14.84
Laparoscopic cholecystectomy	494, 494O	4.09[1]
Inguinal and femoral hernia	162, 162O	2.74[1]
Coronary bypass	107C	32.46
Lens procedures	039A, 039B, 039O, 039P	2.01[2]
Simple pneumonia and pleurisy	089	5.86
Vaginal delivery	373	2.61

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.
2. Calculated as the unweighted average of the individual cost-weights for each of the four groups.

Table A4. **France**

National source	"Echelle nationale de coûts '2005' (données 2002-2003)", published by the Agence Technique de l'Information sur l'Hopitalisation (ATIH). Cover public hospitals.
Reference price, national currency	Unit costs are calculated for each group directly. Figures are for the year 2005.
Cost elements included	Operational costs. Cost-weights are derived from cost data collected from hospitals, representing 10-15% of annual discharges.
Is outpatient care included in the DRG schedule?	..

Interventions examined:	Group number	Unit costs, EUR
Primary prosthetic operation	08C02Z	11 697
Laparoscopic cholecystectomy	07C04V	3 390
Inguinal and femoral hernia	06C12V	2 312
Coronary bypass	05C04W	18 237
Lens procedures	02C05Z	2 081
Simple pneumonia and pleurisy	04M05W	4 689
Vaginal delivery	14Z02A	2 131

Table A5. **Germany**

National source	"Fallpauschalen-Katalog G-DRG version 2001, Anlage 1", published by the Institut für das Entgeltsystem im Krankenhaus (InEK GmbH) on *www.g-drg.de.*
Reference price, national currency	The reference price (base rate) for 2005 was EUR 2 785 (national average), according to the article "Cost accounting to determine prices: How well do prices reflect costs in the German DRG-system?", by Schreyögg *et al.* (2006), published in the Health Care Management Science 2006 (9). The base rate for 2006 is calculated by extrapolating the 2005 base rate with the increase in the base rate from 2004 to 2005 (7.4% according to Schreyögg *et al.*). The national average base rate (reference price) for 2006 is thus calculated to EUR 2 991.
Cost elements included	Operational costs. Cost-weights are derived on the basis of 2004 cost data, collected from 284 (out of 1 800) hospitals.
Is outpatient care included in the DRG schedule?	Day cases are reimbursed separately.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	I03Z, I04Z	3.87[1]
Laparoscopic cholecystectomy	H08B	0.88
Inguinal and femoral hernia	G09Z	0.83
Coronary bypass	F05Z	6.18
Lens procedures	C08Z	0.44
Simple pneumonia and pleurisy	..	..
Vaginal delivery	060D	0.55

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A6. **Iceland**

National source	"DRG prizelist 2006 for patients within the Icelandic Social Security System", provided by Landspitali University Hospital.
Reference price, national currency	ISK 356 728.
Cost elements included	Operational costs. Currently, Swedish cost-weights (mainly for Vestra Gotaland) are applied.
Is outpatient care included in the DRG schedule?	Yes, 139 day surgery groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	2.92
Laparoscopic cholecystectomy	494, 494O	0.87[1]
Inguinal and femoral hernia	162, 162O	0.62[1]
Coronary bypass	107C	6.32
Lens procedures	039, 039O	0.41[1]
Simple pneumonia and pleurisy	089	1.08
Vaginal delivery	373	0.61

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A7. **Norway**

National source	"Innsatsstyrt finansiering 2006", published by the Norwegian Ministry of Health
Reference price, national currency	NOK 31 614.
Cost elements included	Operational costs. Cost-weights are derived on the basis of 2004 cost data, collected from a sample of 21 hospitals.
Is outpatient care included in the DRG schedule?	Yes, 155 day surgery groups and 12 medical day care groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	4.50
Laparoscopic cholecystectomy	494	1.54
Inguinal and femoral hernia	162	0.57
Coronary bypass	107C	4.91
Lens procedures	039	0.42
Simple pneumonia and pleurisy	089	1.60
Vaginal delivery	373	0.50

Table A8. **Sweden**

National source	"The NordDRG Full 2006", published by Centrum för Patientklassificering.
Reference price, national currency	SEK 44 300 for 2005, according to Centrum för Patientklassificering. For 2006, the reference price is calculated by extrapolating the 2005 reference price with the annual increase in the reference price over the period 2002-2005 (3.6%). Hence, for 2006 the reference price is calculated to SEK 45 895.
Cost elements included	Operational and capital costs.
Is outpatient care included in the DRG schedule?	Yes, some day surgery groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	2.06
Laparoscopic cholecystectomy	494, 494O	0.85[1]
Inguinal and femoral hernia	162, 162O	0.59[1]
Coronary bypass	107C	4.05
Lens procedures	039, 039O	0.39[1]
Simple pneumonia and pleurisy	089	0.92
Vaginal delivery	373	0.56

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A9. **United Kingdom**

National source	Payment by Results in 2006/07, published by the UK Department of Health. For England.
Reference price, national currency	Reimbursement tariffs are calculated for each group directly. Figures are for the fiscal year 2006/2007.
Cost elements included	Operational costs and rents, excluding teaching. Tariffs are derived on the basis of cost data, collected from all NHS hospitals in England.
Is outpatient care included in the DRG schedule?	Yes.

Interventions examined:	Group number	Tariffs, £
Primary prosthetic operation	H04, H80, H81	5 206[1]
Laparoscopic cholecystectomy	G14	1 734
Inguinal and femoral hernia	F74	1 001
Coronary bypass	E04	7 195
Lens procedures	B13, B14, B15	719[1]
Simple pneumonia and pleurisy	D42	3 359
Vaginal delivery	N07	735

1. Calculated as the unweighted average of the individual cost-weights for each of the three groups.

Table A10. **United States**

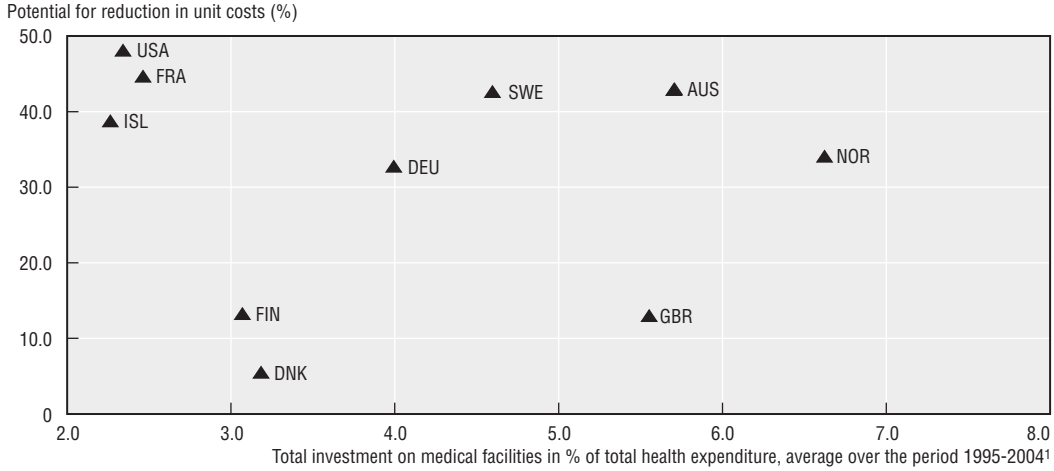
National source	"Top 30 Elective Inpatient Hospitals DRGs", published by the US Center for Medicare and Medicaid Services.
Reference price, national currency	National average Medicare payments.
Cost elements included	The sum of Medicare payments for the DRG, including teaching, disproportionate share, capital, and outlier payments for all cases. Also included in Medicare payments are co-payments and deductibles paid by patients.
Is outpatient care included in the DRG schedule?	..

Interventions examined:	Group number	National average payments, USD
Primary prosthetic operation	209	11 761
Laparoscopic cholecystectomy	494	5 971
Inguinal and femoral hernia		
Coronary bypass		
Lens procedures		
Simple pneumonia and pleurisy	089	5 934
Vaginal delivery		

Cross-country variation in unit costs and investment in medical facilities

Figures A1-A.3 illustrate the relationship between unit costs and different measures of investment in medical facilities, showing that there seems to be no apparent correlation.

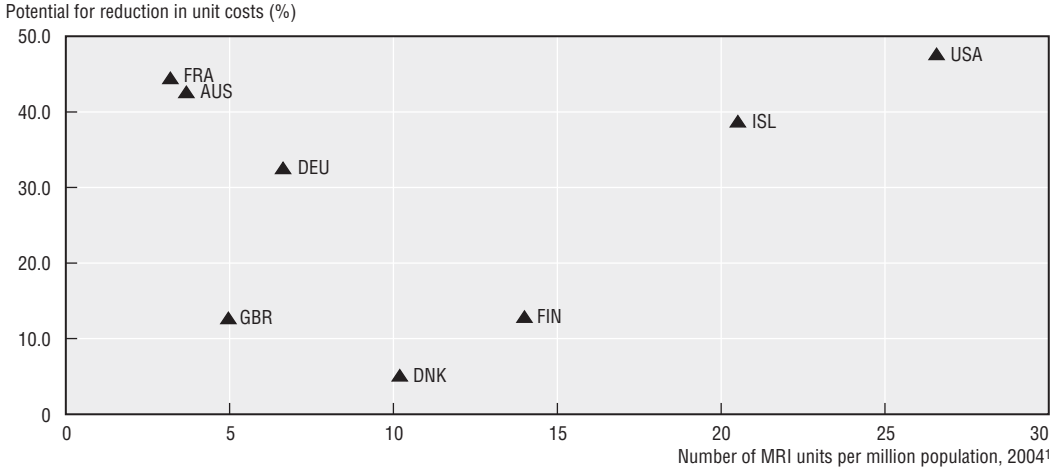
Figure A1. **Cross-country variation in hospital unit costs and investment in medical facilities**



1. Total investment on medical facilities comprises gross capital formation of domestic (public and private) health care provider institutions, excluding those engaged in the retail sale of medical goods and other providers of medical goods. Public investment on health includes publicly financed gross capital formation in health facilities plus capital transfers to the private sector for hospital construction and equipment. Private investment on health comprises private gross capital formation in health care provider industries (excluding retail sale of medical goods.) It excludes capital transfers received from the public sector. Investment in medical facilities does not include depreciation.

Source: OECD Health Data 2006.

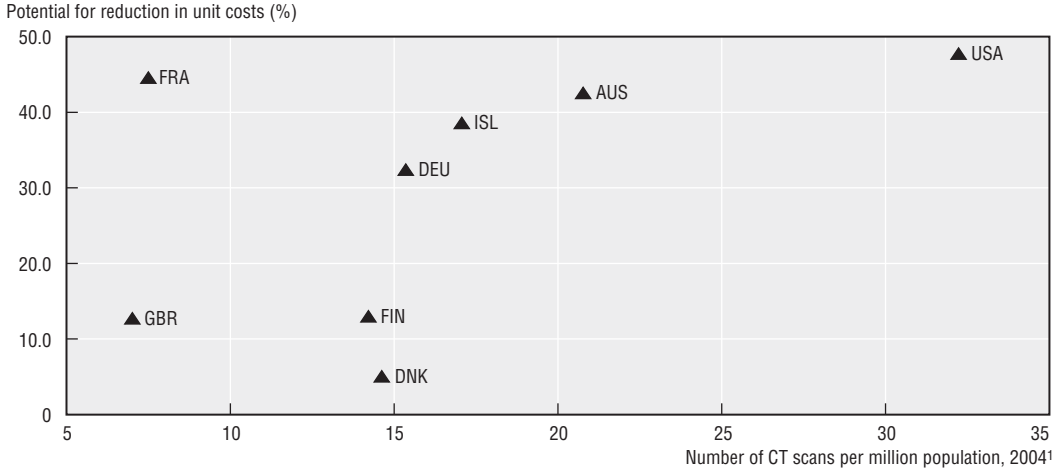
Figure A2. **Cross-country variation in hospital unit costs and MRI units**[1]



1. Number of magnetic resonance imaging (MRI) units per million population. MRI refers to a diagnostic modality in which the magnetic nuclei (especially protons) of a patient are aligned in a strong, uniform magnetic field, absorb energy from tuned radio frequency pulses, and emit radio frequency signals as their excitation decays. These signals, which vary in intensity according to nuclear abundance and molecular chemical environment, are converted into sets of tomographic images by using field gradients in the magnetic field, which permit 3-D localization of the point sources of the signals. Unlike conventional radiography or CT, MRI does not expose patients to ionizing radiation.

Source: OECD Health Data 2006.

Figure A3. **Cross-country variation in hospital unit costs and CT units**[1]



1. Number of computed tomography (CT) scanners, also known as "CAT" scans for computed axial tomography. CT scanners image anatomical information from a cross sectional plane of the body. Each image is generated by a computer synthesis of x-ray transmission data obtained in many different directions in a given plane.

Source: OECD Health Data 2006.

Testing the robustness of country ranking on cost performance by using alternative deflators

The comparisons of unit costs for specific hospital interventions are based on deflating unit costs denominated in national currency by economy-wide PPPs. To test the robustness of the resulting country ranking, two alternative deflators have been applied, gross wage earnings* and GDP per capita measured in basic prices excluding FISIM.

Using gross wage earnings to deflate national unit costs

Table A.11 displays unit costs for each of the seven hospital interventions covered measured relative to gross wage earnings. Data on wages are taken from the *OECD Taxing Wages 2004-2005* publication (Table I.6). As 2005 is the latest year for which data are available, they have been extrapolated to 2006 levels with the projected wage growth rate from 2005 to 2006 taken from the OECD Analytical Database.

Table A11. **Unit costs for seven hospital interventions measured relative to gross wage earnings, 2006**

	Gross wage earnings, national currency	Unit costs, national currency	Unit costs in % of gross wage earnings
		Primary prosthetic operation	
Australia	54 197	18 667	34.4
Denmark	339 355	74 567	22.0
Finland	33 557	7 879	23.5
France	31 140	11 697	37.6
Germany	41 339	11 576	28.0
Iceland	3 182 911	1 042 110	32.7
Norway	395 245	142 263	36.0
Sweden	318 868	94 387	29.6
United Kingdom	29 598	5 206	17.6
United States	33 914	11 761	34.7

* Average gross wage earnings of adult, full-time workers covering industry sectors C-K inclusive in the ISIC Rev.3 classification, *i.e.* total economy excluding agriculture, fishing and the public sector.

Table A11. **Unit costs for seven hospital interventions measured relative to gross wage earnings, 2006** *(cont.)*

	Gross wage earnings, national currency	Unit costs, national currency	Unit costs in % of gross wage earnings
		Laparoscopic cholecystectomy	
Australia	54 197	4 618	8.5
Denmark	339 355	19 103	5.6
Finland	33 557	2 173	6.5
France	31 140	3 390	10.9
Germany	41 339	2 641	6.4
Iceland	3 182 911	309 497	9.7
Norway	395 245	48 686	12.3
Sweden	318 868	38 983	12.2
United Kingdom	29 598	1 734	5.9
United States	33 914	5 971	17.6
		Inguinal and femoral hernia	
Australia	54 197	3 265	6.0
Denmark	339 355	14 830	4.4
Finland	33 557	1 456	4.3
France	31 140	2 312	7.4
Germany	41 339	2 483	6.0
Iceland	3 182 911	220 939	6.9
Norway	395 245	18 020	4.6
Sweden	318 868	27 193	8.5
United Kingdom	29 598	1 001	3.4
United States	33 914	..	**5.7**[1]
		Coronary bypass	
Australia	54 197	32 389	59.8
Denmark	339 355	119 140	35.1
Finland	33 557	17 235	51.4
France	31 140	18 237	58.6
Germany	41 339	18 497	44.7
Iceland	3 182 911	2 254 378	70.8
Norway	395 245	155 225	39.3
Sweden	318 868	186 090	58.4
United Kingdom	29 598	7 195	24.3
United States	33 914	..	**49.1**[1]
		Lens procedures	
Australia	54 197	3 373	6.2
Denmark	339 355	8 293	2.4
Finland	33 557	1 065	3.2
France	31 140	2 081	6.7
Germany	41 339	1 325	3.2
Iceland	3 182 911	147 382	4.6
Norway	395 245	13 278	3.4
Sweden	318 868	18 057	5.7
United Kingdom	29 598	719	2.4
United States	33 914	..	**4.2**[1]

Table A11. **Unit costs for seven hospital interventions measured relative to gross wage earnings, 2006** *(cont.)*

	Gross wage earnings, national currency	Unit costs, national currency	Unit costs in % of gross wage earnings
		Simple pneumonia and pleurisy	
Australia	54 197	..	**13.0**[1]
Denmark	339 355	24 507	7.2
Finland	33 557	3 109	9.3
France	31 140	4 689	15.1
Germany	41 339	..	**13.0**[1]
Iceland	3 182 911	384 303	12.1
Norway	395 245	50 582	12.8
Sweden	318 868	42 430	13.3
United Kingdom	29 598	3 359	11.3
United States	33 914	5 934	22.9
		Vaginal delivery	
Australia	54 197	2 669	4.9
Denmark	339 355	10 557	3.1
Finland	33 557	1 388	4.1
France	31 140	2 131	6.8
Germany	41 339	1 657	4.0
Iceland	3 182 911	217 604	6.8
Norway	395 245	15 807	4.0
Sweden	318 868	25 605	8.0
United Kingdom	29 598	735	2.5
United States	33 914	..	**4.9**[1]

1. Figures in bold indicate that the average value has been set in.
Source: OECD Taxing Wages 2004-2005.

Table A12 shows the resulting country ranking when averaging across the seven interventions.

Table A12. **Country ranking when unit costs are measured relative to gross wage earnings**

Indicator range from 1 to 10, with 1 as best performance

	Unit costs in % of gross wage earnings, averaged over seven interventions	Country ranking
Australia	19.0	6
Denmark	11.4	2
Finland	14.6	3
France	20.4	9
Germany	15.1	4
Iceland	20.5	10
Norway	16.0	5
Sweden	19.4	7
United Kingdom	9.6	1
United States	19.9	8

Using GDP per capita measured in basic prices to deflate national unit costs

Table A13 displays unit costs for each of the seven interventions covered measured relative to GDP per capita measured in basic prices (2005 is the latest year for which population data are available). Data are taken from the OECD National Accounts Database.

Table A13. **Unit costs for seven hospital interventions measured relative to GDP per capita, basic prices, 2005**

	GDP per capita in basic prices, national currency 2005	Unit costs, national currency	Unit costs in % of GDP per capita in basic prices
		Primary prosthetic operation	
Australia	45 930	18 667	42.8
Denmark	286 937	74 567	30.7
Finland	30 030	7 879	30.3
France	28 050	11 697	46.5
Germany	27 060	11 576	47.3
Iceland	3 421 168	1 042 110	39.9
Norway	411 793	142 263	38.1
Sweden	295 742	94 387	36.6
United Kingdom	20 351	5 206	27.5
United States	42 022	11 761	31.8
		Laparoscopic cholecystectomy	
Australia	45 930	4 618	10.6
Denmark	286 937	19 103	7.9
Finland	30 030	2 173	8.4
France	28 050	3 390	13.5
Germany	27 060	2 641	10.8
Iceland	3 421 168	309 497	11.9
Norway	411 793	48 686	13.0
Sweden	295 742	38 983	15.1
United Kingdom	20 351	1 734	9.2
United States	42 022	5 971	16.1
		Inguinal and femoral hernia	
Australia	45 930	3 265	7.5
Denmark	286 937	14 830	6.1
Finland	30 030	1 456	5.6
France	28 050	2 312	9.2
Germany	27 060	2 483	10.1
Iceland	3 421 168	220 939	8.5
Norway	411 793	18 020	4.8
Sweden	295 742	27 193	10.5
United Kingdom	20 351	1 001	5.3
United States	42 022	..	**7.5**[1]

Table A13. **Unit costs for seven hospital interventions measured relative to GDP per capita, basic prices, 2005** *(cont.)*

	GDP per capita in basic prices, national currency 2005	Unit costs, national currency	Unit costs in % of GDP per capita in basic prices
		Coronary bypass	
Australia	45 930	32 389	74.3
Denmark	286 937	119 140	49.1
Finland	30 030	17 235	66.3
France	28 050	18 237	72.5
Germany	27 060	18 497	75.6
Iceland	3 421 168	2 254 378	86.4
Norway	411 793	155 225	41.6
Sweden	295 742	186 090	72.1
United Kingdom	20 351	7 195	38.0
United States	42 022	..	**64.0**[1]
		Lens procedures	
Australia	45 930	3 373	7.7
Denmark	286 937	8 293	3.4
Finland	30 030	1 065	4.1
France	28 050	2 081	8.3
Germany	27 060	1 325	5.4
Iceland	3 421 168	147 382	5.6
Norway	411 793	13 278	3.6
Sweden	295 742	18 057	7.0
United Kingdom	20 351	719	3.8
United States	42 022	..	**5.4**[1]
		Simple pneumonia and pleurisy	
Australia	45 930	..	**14.9**[1]
Denmark	286 937	24 507	10.1
Finland	30 030	3 109	12.0
France	28 050	4 689	18.6
Germany	27 060	..	**14.9**[1]
Iceland	3 421 168	384 303	14.7
Norway	411 793	50 582	13.6
Sweden	295 742	42 430	16.4
United Kingdom	20 351	3 359	17.8
United States	42 022	5 934	16.0
		Vaginal delivery	
Australia	45 930	2 669	6.1
Denmark	286 937	10 557	4.3
Finland	30 030	1 388	5.3
France	28 050	2 131	8.5
Germany	27 060	1 657	6.8
Iceland	3 421 168	217 604	8.3
Norway	411 793	15 807	4.2
Sweden	295 742	25 605	9.9
United Kingdom	20 351	735	3.9
United States	42 022	..	**6.4**[1]

1. Figures in bold indicate that the average value has been set in.
Source: OECD National Accounts Database, 2005.

Table A14 shows the resulting country rankings when simply averaging across the seven interventions.

Table A14. **Country ranking when unit costs are measured relative to GDP per capita**
Indicator range from 1 to 10, with 1 as best performance

	Unit costs in % of GDP per capita measured in basic prices, averaged over seven interventions	Country ranking
Australia	23.4	6
Denmark	15.9	2
Finland	18.9	4
France	25.3	10
Germany	24.4	8
Iceland	25.1	9
Norway	17.0	3
Sweden	24.0	7
United Kingdom	15.1	1
United States	21.0	5

Source: OECD National Accounts Database, 2005.

Summarising the different sets of country rankings

Table A15 shows country rankings on unit cost performance based on three different deflators. Overall, the correlation between the ranking based on PPP adjustment and those based on alternative deflators is relatively high (0.842 when using gross wage earnings, and 0.624 when using GDP per capita in basic prices).

Table A15. **Country rankings based on three types of deflator**
Indicator range from 1 to 10, with 1 as best performance

	PPPs	Gross wage earnings	GDP per capita in basic prices
Australia	8	6	6
Denmark	1	2	2
Finland	3	3	4
France	9	9	10
Germany	4	4	8
Iceland	6	10	9
Norway	5	5	3
Sweden	7	7	7
United Kingdom	2	1	1
United States	10	8	5

Source: See Tables 12 and 14.

Utilising empirical studies to construct measures of domestic dispersion in hospital efficiency

Table A16 shows the national studies utilised in calculating measures of domestic dispersion in aggregate efficiency.

Table A16. **Within-country hospital studies**

	Within-country analyses
Australia	• Webster, R., S. Kennedy and L. Johnson (1998), "Comparing Techniques for Measuring the Efficiency and Productivity of Australian Private Hospitals", *Australian Bureau of Statistics, Working Papers in Econometrics and Applied Statistics* No. 98/3.
Germany	• Staat, M. (2006), "Efficiency of Hospitals in Germany: A DEA-bootstrap Approach", *Applied Economics*, 38, pp. 2255-2263.
Italy	• Cellini, R., G. Pignataro and I. Rizzo (2000), "Competition and Efficiency in Health Care: An Analysis of the Italian Case", International Tax and Public Finance, 7, pp. 503-519. • Rebba, V. and D. Rizzi (2006), "Measuring Hospital Efficiency through Data Envelopment Analysis when Policy-makers' Preferences Matter", *University of Venice, Department of Economics Working Paper.*
Norway	• Biørn, E., T.P. Hagen, T. Iversen and J. Magnussen (2006), "Heterogeneity in Hospitals' Responses to a Financial Reform – A Random Coefficient Analysis of the Impact of Activity-based Financing on Efficiency", *Health Economics Research Programme Working Paper* No. 2006:9, University of Oslo. • Magnussen, J. (1996), "Efficiency Measurement and the Operationalization of Hospital Production", *Health Services Research,* 31:1, pp. 22-37.
Spain	• Dalmau-Matarrodona, E. and J. Puig-Junoy (1998), "Market Structure and Hospital Efficiency: Evaluating Potential Effects of Deregulation in a National Health Service", *Review of Industrial Organization*, 13, pp. 447-466. • Lopez-Valcarcel, B.G. and P.B. Perez (1996), "Changes in the Efficiency of Spanish Public Hospitals after the Introduction of Program Contracts", *Investigaciones Economicas*, XX (3), pp. 377-402. • Prior, D. and M. Solà (2000), "Technical Efficiency and Economies of Diversification in Health Care", *Health Care Management Science*, 3, pp. 299-307.
United Kingdom	• Jacobs, R., P.C. Smith and A. Street (2006), *Measuring Efficiency in Health Car*e, Cambridge University Press, Cambridge, UK. • Parkin, D. and B. Hollingsworth (1997), "Measuring Production Efficiency of Acute Hospitals in Scotland, 1991-94: Validity Issues in Data Envelopment Analysis", *Applied Economics,* 29, 1 pp. 425-1433.
United States	• Bates, L.J., K. Mukherjee and R.E. Santerre (2005), "The Impact of Market Pressure on Hospital X-Inefficiency: A DEA approach", *mimeo*. • Ferrier, G.D. and V.G. Valdmanis (2005), "Peer Effects and Efficiency: The Influence of Competitors' Performance on Hospital Efficiency", *mimeo*. • Friesner, D.L., M.Q. McPherson and R. Rosenman (2006), "Are Hospitals Seasonally Inefficient? Evidence from Washington State Hospitals", *School of Economic Sciences Working Paper* No. 3, Washington State Univeristy. • Harrison, J.P., M.N. Coppola and M. Wakefield (2004), "Efficiency of Federal Hospitals in the United States", *Journal of Medical System*s, 28, 5, pp. 411-422.

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Globalisation and Employment in the OECD

by
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Introduction 84
Recent trends in international investment 86
Multinationals and labour markets in home countries 91
Vertical and horizontal multinationals 91
The labour market effects of foreign direct investment 94
Empirical studies of multinationals and home country labour markets . . 96
Foreign direct investment and employment 96
Internationalisation and the price elasticity of labour demand 98
The industry-level effects of foreign direct investment on labour demand . . 99
Employment in foreign affiliates and domestic employment 101
Outward direct investment and domestic employment 106
Conclusions and policy implications 111
Notes 112
Bibliography 114

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Introduction

In the long run, enhanced international engagement can normally be expected to be welfare-improving for each country involved, with greater specialisation and competition and the ability to access foreign knowledge all helping to raise productivity levels and per capita incomes. But such improvements in income levels need not be experienced by all factors of production, especially comparatively unskilled workers in developed countries. The process of labour market adjustment following changes in international investment and trade patterns can also be prolonged.

This paper reviews some of the possible changes that may occur in the national labour markets of many OECD countries as a result of the internationalisation of production by multinational companies, with a particular focus on the impact of outward foreign direct investment (FDI) from OECD countries on employment in the home country of the investing firms. Although this provides only a partial picture of the overall effects of globalisation on labour market outcomes, it is an aspect about which comparatively little has been known until recently. The paper complements other analytical studies at the OECD on the labour market impact of international trade (Baldwin, 1995; OECD, 2005; OECD, 2007).

In the economy as a whole, relative factor prices will reflect the full impact of globalisation if they are sufficiently flexible, with the price of factors of production that were comparatively scarce prior to enhanced global engagement falling relative to the price of more abundant factors. For most OECD countries the wages of more skilled workers and the returns to capital might thus be expected to rise relative to the wages of less skilled workers. But if there are significant labour market rigidities, or institutional features such as binding floors for the wages of less skilled workers, then it becomes more likely that there will a greater quantitative effect on aggregate employment and a smaller adjustment in the relative wages of different types of workers (Davis, 1998; Moore and Ranjan, 2005; OECD, 2005).

The issues examined in this paper have potentially important macroeconomic consequences. The integration and expansion of cross-border production networks increases the ability of companies to change the location of production of both finished and intermediate goods and services. Such changes affect both the sensitivity of national factor demands to changes in factor prices and the speed and the extent to which economic shocks are transmitted across national borders. Recent research has also begun to suggest that international trade in labour tasks, which is one consequence of the international fragmentation of production, might also have positive effects on productivity growth in firms that use intermediate inputs produced offshore (Grossman and Rossi-Hansberg, 2006; Amiti and Wei, 2005). Empirical investigation of this latter point is limited, but the results in this paper are suggestive that it might matter.

The existing theoretical and empirical literature is large, with a wide variety of approaches being used to study the effects of enhanced global engagement on the labour markets of developed countries. Most studies suggest that the overall impact of the

internationalisation of production on aggregate labour market developments is comparatively small. As with international trade, different occupational and skill groups have been found to be affected in different ways. In particular, international investment (and trade) account for a non-negligible proportion of the rising returns to skilled labour relative to those of unskilled labour.

Existing studies also provide evidence of considerable heterogeneity in the impact of the increased internationalisation of production, with the effects on home-country labour markets depending on whether domestic and foreign components of production are complements or substitutes, the location in which investment takes place and also the activities of the foreign affiliates of domestic parent companies. In general, the labour market effects of the internationalisation of production should be strongest for cost-saving investments (one component of vertical FDI), and also the smaller the home country relative to the location of affiliates.

The substitution of employment between parent companies and foreign affiliates is typically found to be stronger for affiliates located in Asia and Central and Eastern Europe than with affiliates located in other emerging countries. However, perhaps surprisingly, several have reported that in-company employment substitution is on average higher with affiliates located in industralised countries than with affiliates located in developing countries.

The absence of empirical evidence of large effects in most of the studies conducted to date does not provide an indication that this will be the case in future periods. The internationalisation of production is continuing rapidly and shifting towards organisational forms that can be expected to have larger labour market effects on home countries.

This paper contains two new empirical analyses using industry-level data on the outward stocks of foreign direct investment (FDI) and employment in the foreign affiliates of the G3 economies to investigate the impact of the greater internationalisation of production on employment in home countries in the OECD. In general, these results suggest that the findings from studies of individual countries or particular industry groupings should be regarded with a degree of caution until they have been investigated more widely on other data sets, with the effects of outward investment in different industries and also in different countries found to be very heterogeneous.

The remainder of this paper is as follows. First, the next section provides a short overview of recent trends in foreign direct investment, international sourcing and the activities of multinational companies. The terms offshoring, outsourcing and foreign production by multinationals are often used interchangeably, but in fact they are distinct concepts that overlap only partially (Box 1). The next two sections review the theory of multinational companies, and some of the associated implications for the ways in which FDI will affect labour markets, and provide an overview of existing empirical studies of the activities of the affiliate companies of multinational companies. New empirical work on the impact of the internationalisation of production on the demand for labour is then reported in the following section, with the final section summarising the main findings and discussing the implications for policymakers.

Box 1. **Outsourcing, offshoring and the internationalisation of production**

The terms outsourcing and offshoring are frequently used interchangeably to describe the process whereby intermediate goods and services are purchased from foreign suppliers, usually with slightly different definitions. In fact there is only a partial overlap between outsourcing and offshoring, and between both terms and the internationalisation of production by multinational companies.

Outsourcing refers to the purchase of goods and services that were previously produced inside the purchasing company. The company providing the intermediate inputs can be located inside (domestic outsourcing) or outside (international outsourcing) the country of the sourcing company. All firms outsource particular activities, but relatively few do so across national boundaries (Tomiura, 2005). Trade-based measures of outsourcing are discussed further in Molnar *et al.* 2007, Annex A.

Offshoring refers to the purchase from companies in locations outside the country of goods and services previously produced inside the purchasing company. Thus it includes not only international outsourcing, but also international insourcing, with the foreign affiliates of domestic parent companies exporting to their parents.

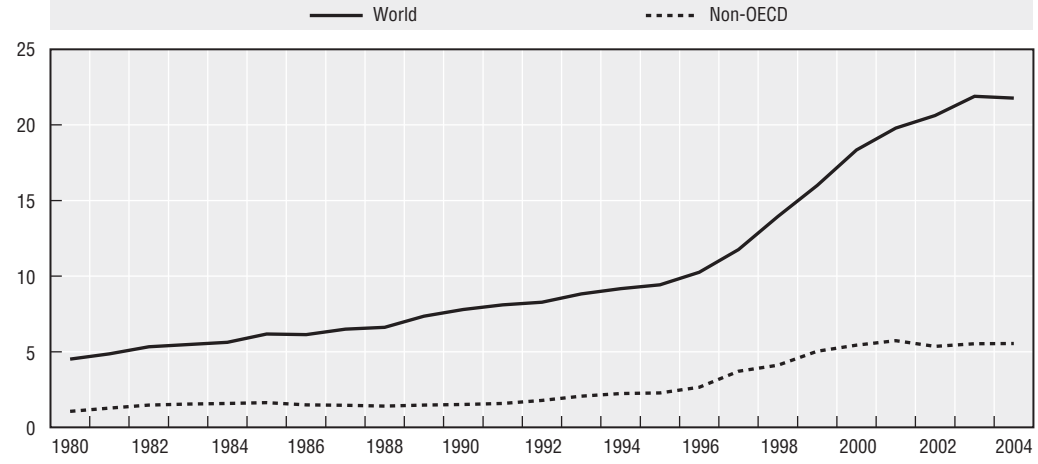
The internationalisation of production refers to the establishment of affiliates abroad by parent companies in the home country. These affiliates may export back to the parent company (international insourcing), or provide goods and services to home and foreign markets. The goods and services produced by affiliates need not have been previously produced inside the parent company.

Recent trends in international investment

This section provides an overview of some of the major recent trends in international integration.[1] The creation and expansion of international production networks is a longstanding and ongoing process which has accelerated over the past decade. This is readily apparent from Figures 1 and 2. The global stock of foreign direct investment relative to global GDP has accelerated noticeably since the early 1990s, as has the stock of inward

Figure 1. **The global stock of inward foreign direct investment**

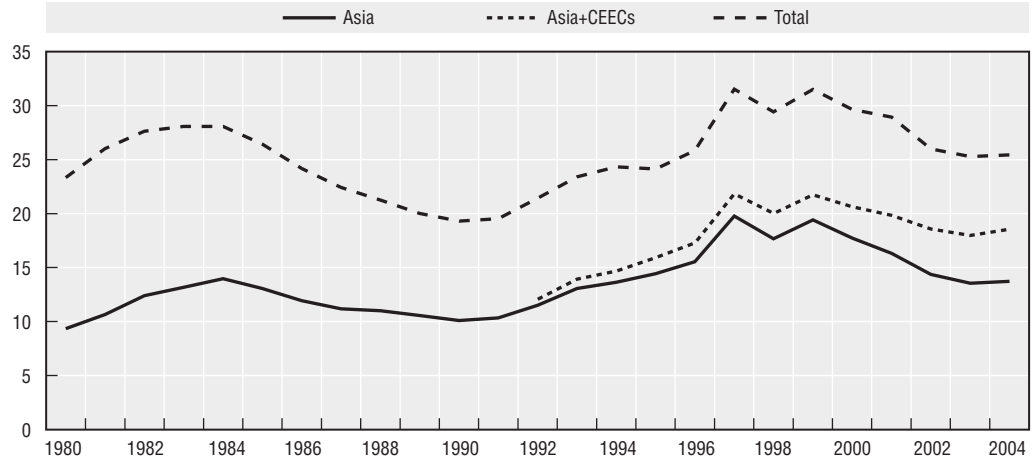
Per cent of world GDP at current prices



Source: UNCTAD World Investment Report Database and *IMF Economic Outlook Database.*

Figure 2. **The inward investment stock in the non-OECD economies**

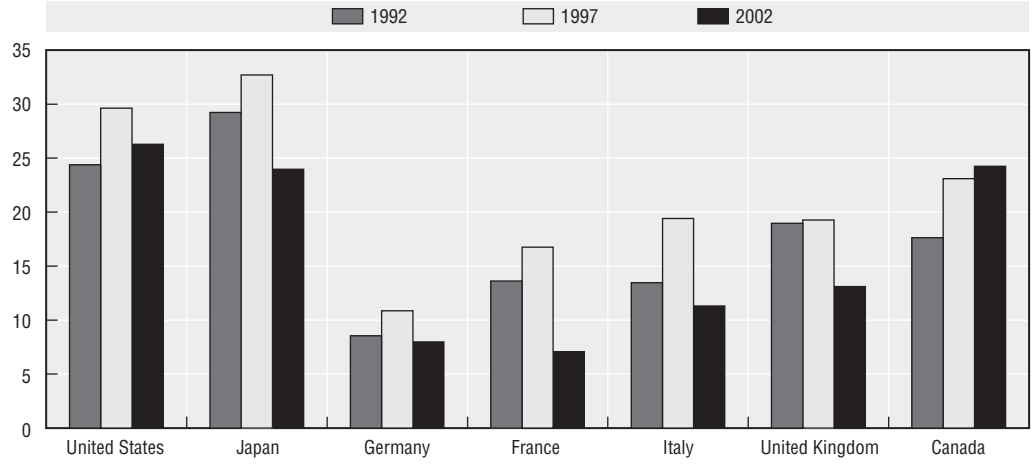
Per cent of global stock



Source: UNCTAD World Investment Report Database.

Figure 3. **The G7 outward FDI stock in the non-OECD economies**

Per cent of total



Source: Adapted from OECD (2005b).

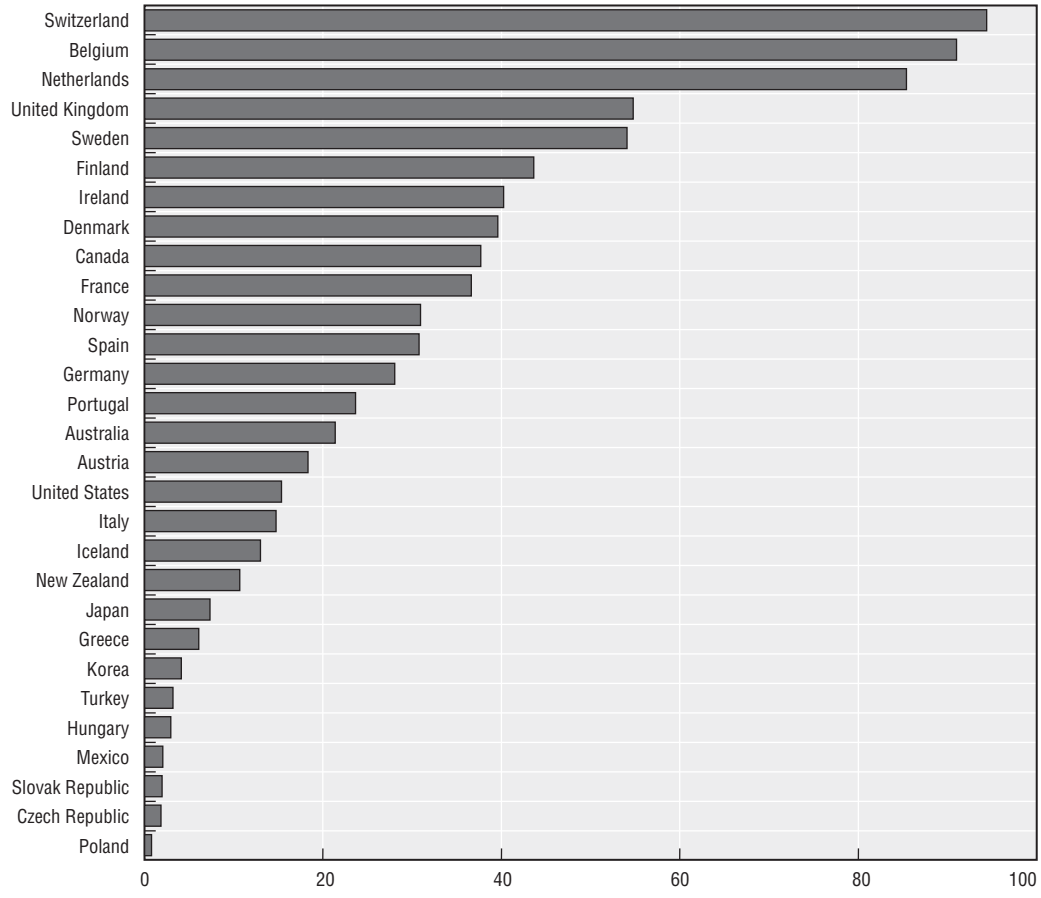
FDI in the non-OECD economies. Coinciding with this change, imports from non-OECD countries into the OECD have also risen markedly since the early 1990s (Molnar *et al.* 2007, Figure 2).

The acceleration in the global stock of FDI is unlikely to be due only to increasing investments in production facilities in lower-wage economies, although that is clearly a powerful motivation for some investors. The majority of global FDI remains located in the OECD economies, with the proportion held in the non-OECD economies fluctuating between 25-30%, changing little in recent years (Figure 2). A similar pattern is apparent from the geographical distribution of the outward FDI stocks of the G7 economies (Figure 3). However, the destination for investment within the non-OECD is changing, with a rising share of investments being located in Central and Eastern Europe and, to a lesser extent, the Asian economies.

The available data suggest that outward FDI stocks are typically larger in proportion to domestic output in smaller, open economies with comparatively higher labour costs, especially in Europe (Figure 5). Amongst the G7 economies the United Kingdom has the highest outward stock relative to the size of the domestic economy. As of the end of 2002, the size dispersion of FDI stocks was very wide, although this partly reflects the high level of stocks in three European economies that have a significant proportion of multinational holding companies – Switzerland, the Netherlands and Belgium. All three countries have high flows of both inward and outward FDI.

Figure 4. **The outward FDI stocks of OECD countries in 2002**

Per cent of GDP



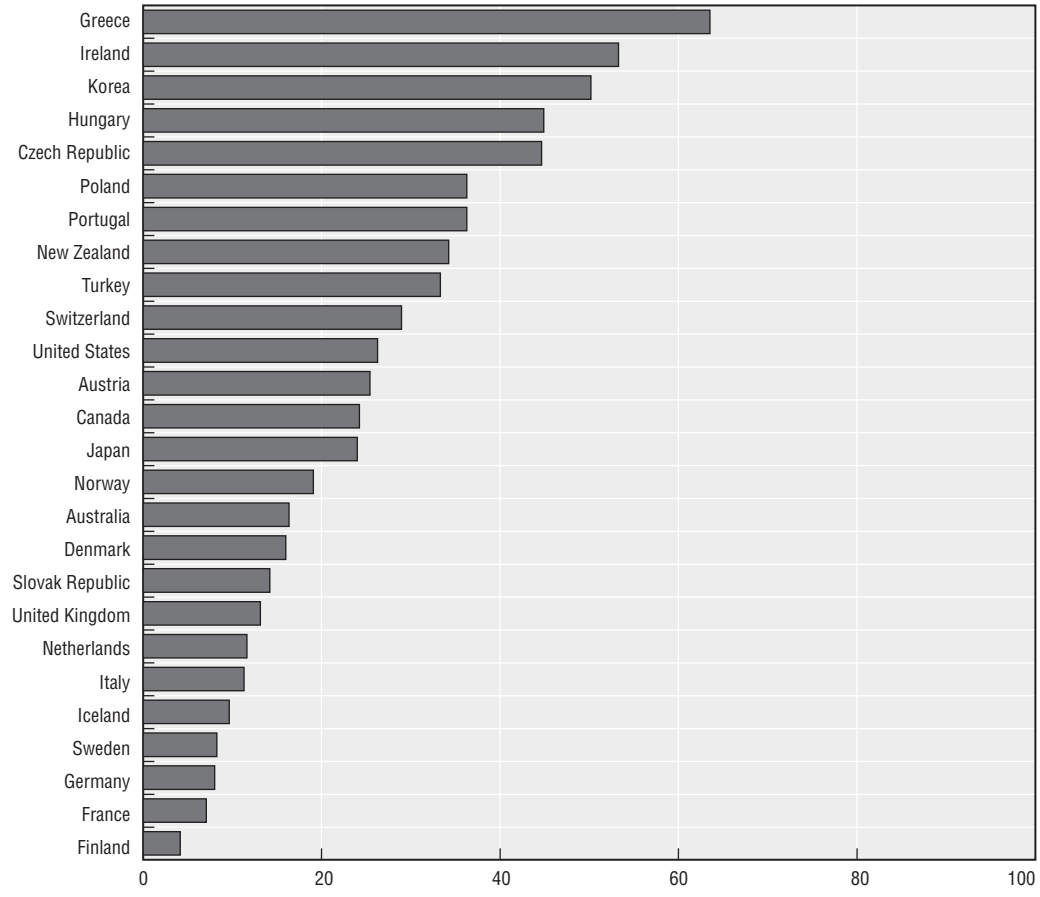
Source: Adapted from OECD 2005(b).

Perhaps surprisingly, the available data suggest that many of the lower income OECD economies are amongst those with the highest proportions of their outward FDI stock invested in non-OECD countries (Figure 4). One possible explanation is that many of these countries have a higher proportion of longstanding commercial ties through trade with the non-OECD economies, especially those in close geographical proximity. However, the aggregate level of outward FDI from many lower income OECD economies is comparatively small, so that their investment in non-OECD economies is low in relation to their domestic GDP.

A further feature of direct investment is that in most countries it is dominated by investments in primary and service sectors rather than manufacturing ones (Figure 6). Of

Figure 5. **FDI in non-OECD countries by OECD countries**

Per cent of total outward FDI stock in 2002



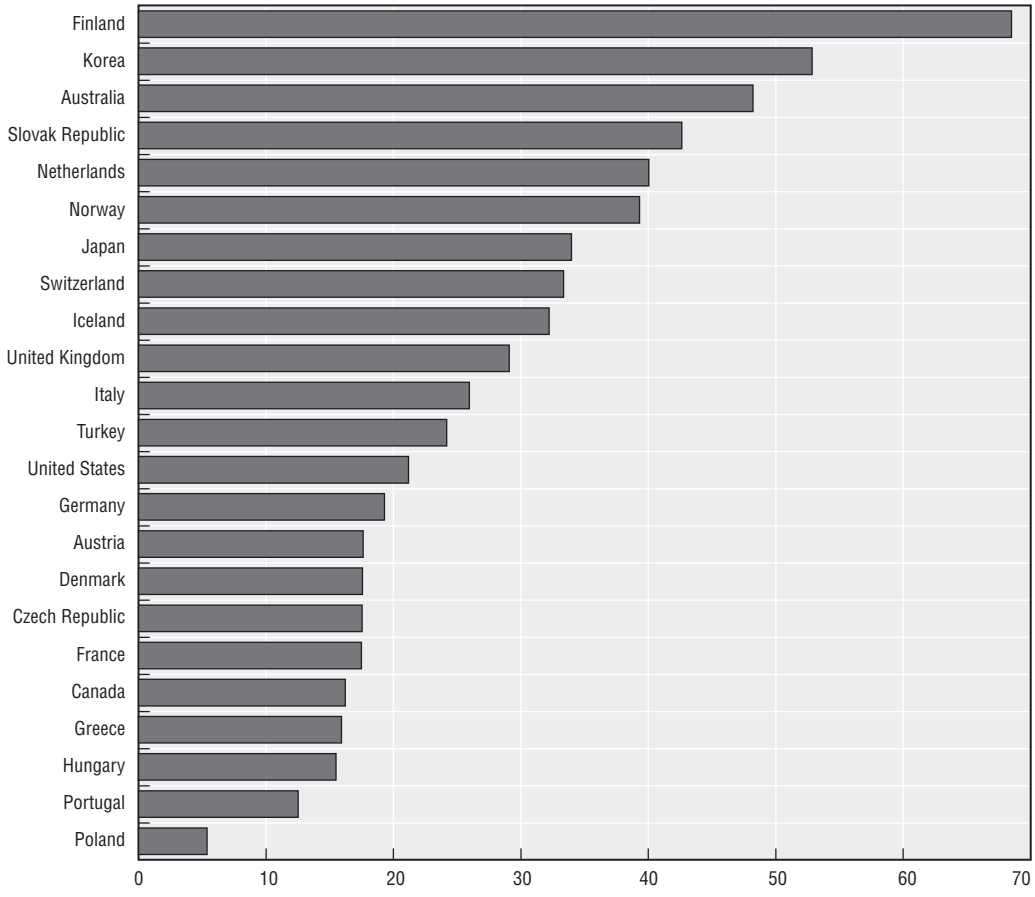
Source: Adapted from OECD (2005b).

the countries shown, only Finland and Korea have more than half their total outward stock in manufacturing activities. Despite the smaller scale of manufacturing investments compared with services investments, cross-border linkages appear to be a lot deeper in manufacturing. For instance, employment in foreign affiliates in the manufacturing sector is generally much larger as a share of domestic employment than employment in foreign affiliates in the primary and tertiary sectors (Figure 7). There is considerable potential for cost savings by locating some activities in non-OECD economies, although this is offset to some extent by likely average differences in labour productivity.

A part of the production of many foreign affiliates will be used as intermediate inputs by parent companies. The extent of this, and indeed the extent of other forms of international sourcing, is difficult to measure, and a number of different concepts have been used, as discussed further in Molnar *et al.* (2007, Annex A). Despite common perceptions that international sourcing has risen significantly, at least one commonly used measure suggests that imports of intermediate goods have not risen much faster than imports of final goods (Figure 8).[2] Imports of parts and components have indeed risen as a proportion of domestic output, but this seems to have as much to do with the general rise in import penetration over time as with the fragmentation of production by multinational companies. Indeed, the share of OECD manufacturing imports accounted for by intermediate goods, parts

Figure 6. **Outward FDI in manufacturing industries**

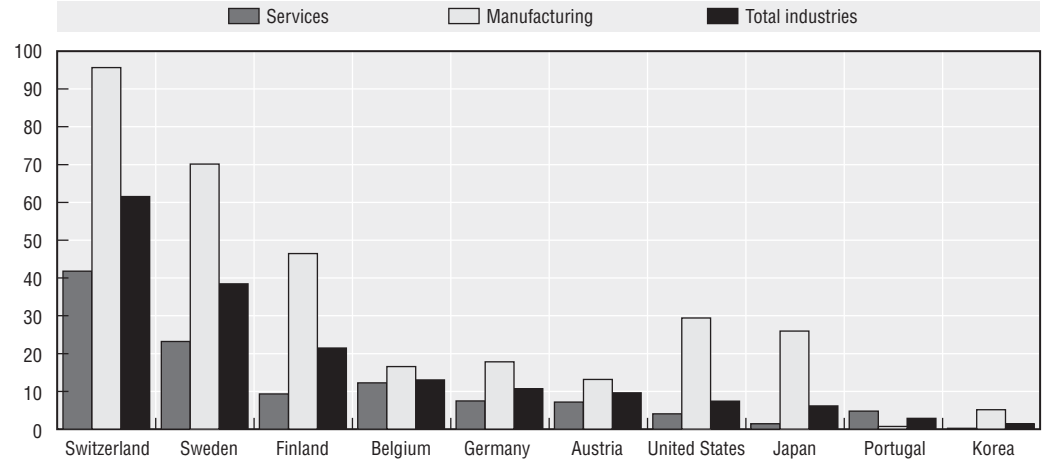
Per cent of total outward FDI stock in 2002



Source: Adapted from OECD (2005b).

Figure 7. **Employment in outward foreign affiliates**

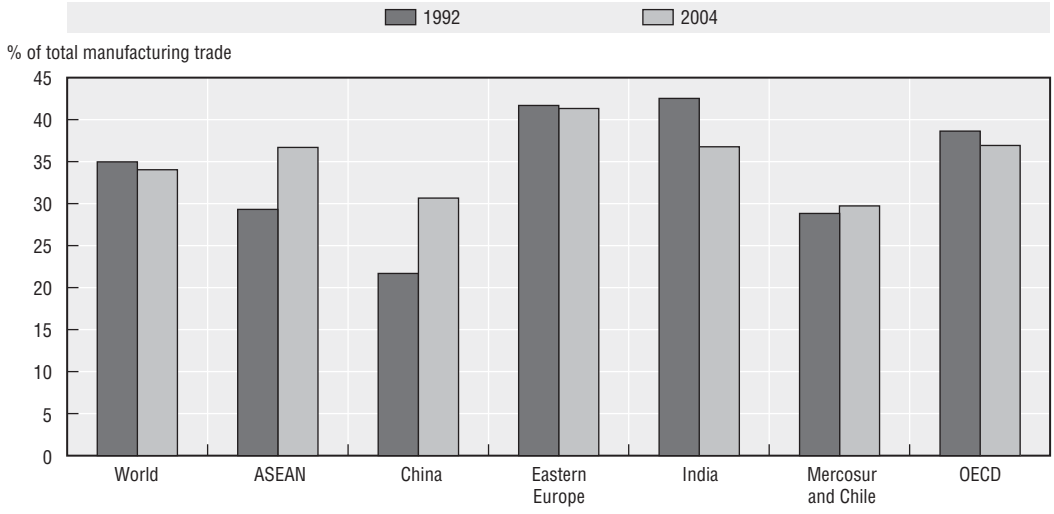
As a percentage of total national employment



Source: Adapted from OECD (2005b); data for Japan and Korea from the Ministry of Economy, Trade and Industry and the Korea Development Institute.

Figure 8. **OECD imports of intermediate goods, parts and components 1992 and 2004**

Per cent of total manufacturing imports from selected countries/regions. % of total manufacturing imports



Sources: Authors' calculations using data from the United Nations COMTRADE database.

and components has hardly changed at all between 1992 and 2004. Whilst intermediate imports into the OECD as a whole from China and the ASEAN have risen sharply (as a share of total manufacturing imports), this has been offset by reductions in intermediate imports from other countries. The share of imports from non-OECD economies has risen a little over time in most OECD countries, but has reached a similar level to imports from other OECD countries only in Japan and Korea (Figure 9). It is clear that regional integration in East Asia is well advanced (Ng and Yeats, 2003).

There appears to be little direct correlation between the general trend towards greater international openness in all OECD economies, as measured by the sum of exports and imports relative to GDP, and differences across countries in evolution of employment rates (OECD, 2005 and 2007).[3] Greater international openness has however coincided with a widening of wage dispersions in almost all OECD countries over the past two decades (OECD, 2007), as well a modest downward adjustment in the labour share of national income (IMF, 2007). This is much more apparent in some economies than in others, possibly reflecting differences in specific institutional features in the labour market.

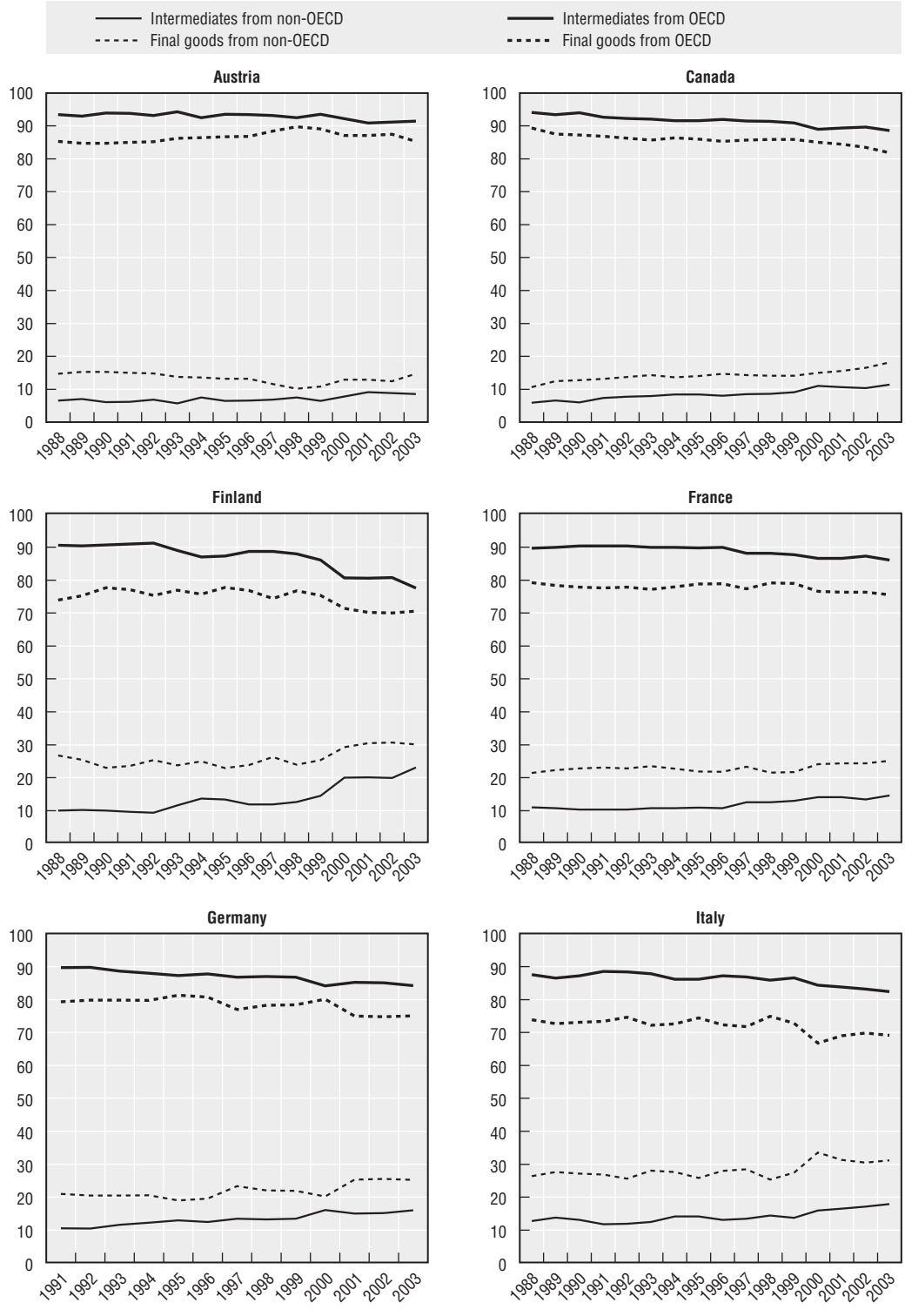
Multinationals and labour markets in home countries

Vertical and horizontal multinationals

This section summarises some of the effects that the operations of multinational firms and foreign direct investment (FDI hereafter) might have on the labour markets in source economies. As apparent from the definitions in Box 1, there are likely to be some similarities between the effects of international investment by multinational enterprises (MNEs) on home country labour markets and those from international trade. But the overlap is only partial – imports of finished and intermediate goods and services do not have to be purchased from the foreign affiliates of parent companies. Equally, parent companies may establish their foreign affiliates in order to enhance foreign market access

Figure 9. **The sources of imports of finished goods and parts and components**

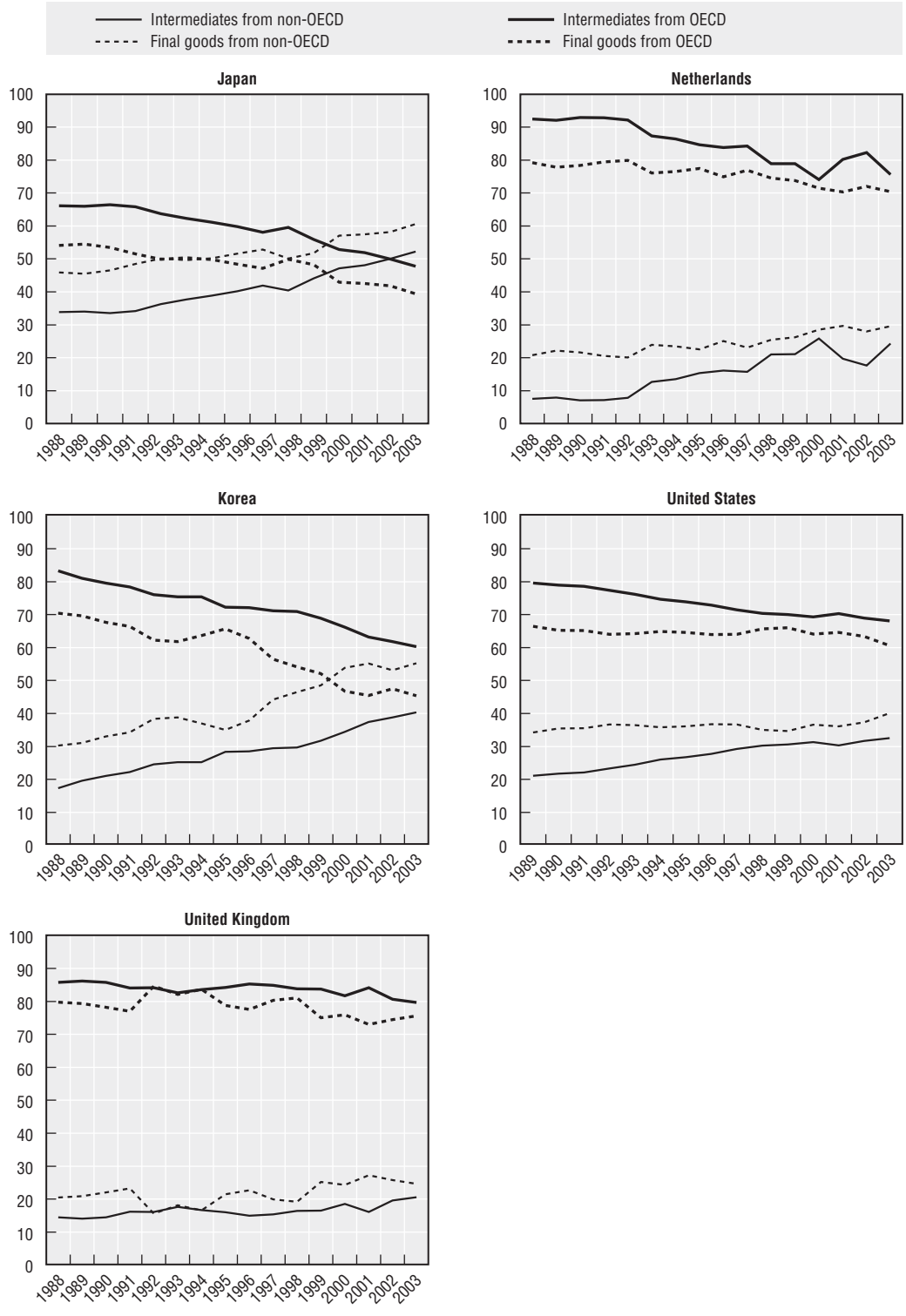
Per cent of total finished goods and total parts and components



Source: Authors' calculations using data from the *United Nations COMTRADE Database*. See Molnar *et al.* (2007) for further details.

Figure 9. **The sources of imports of finished goods and parts and components** *(cont.)*

Per cent of total finished goods and total parts and components



Source: Authors' calculations using data from the *United Nations COMTRADE Database*. See Molnar *et al.* (2007) for further details.

beyond what could otherwise have been achieved through exporting, including access to third countries (Ekholm *et al.*, 2007).

One basic distinction is between "vertical" and "horizontal" multinationals. Vertical MNEs are ones that fragment different stages of the production process across different countries, with the location of stages depending on the relative cost of the factor of production they use intensively. Each activity, including final production, occurs in only a few, or even a single, location, depending on endowments and factor prices. Horizontal MNEs are multi-plant firms that produce similar outputs in both home and host countries, thus economising on any costs of exporting. Such firms are more likely to occur when the host countries are of similar size (to avoid the costs of having costly capacity in small markets), have similar factor endowments, and there are positive costs to international trade (Brainard, 1997). Both forms of multinational are particular examples of the knowledge capital model set out by Carr *et al.* (2001) and Markusen (2002). The knowledge capital model exploits the insight that multinational firms must possess some kind of knowledge-based firm-specific asset to allow them to take advantage of profitable opportunities in foreign markets that other national companies in those markets cannot exploit.

Knowledge capital has three principal characteristics – it can be easily transferred between parent companies and their affiliates, it can be used simultaneously in a number of different production activities and locations and it has a high skill intensity. The ability to use knowledge capital in multiple locations at the same time implies that multinational firms will have firm-level scale economies, providing a motive for horizontal MNEs. The transportability of knowledge capital and its high skill intensity facilitate the vertical fragmentation of production. Such fragmentation is more likely to occur between countries with comparatively dissimilar factor endowments, and also as trading costs, or more generally the costs of market access, come down. Knowledge capital also becomes more easily exploitable as international communications costs decline. All these factors suggest that vertical multinationals should be becoming more prevalent over time, with different parts of the production of goods and services being produced increasingly in different locations.

In practice, the distinction between horizontal and vertical multinationals is rarely clear cut. Many firms have "complex" integration strategies, involving a mixture of both kinds of outward investment (Yeaple, 2003). It is also rarely the case that firms within an industry have identical levels of productivity, not least because of the existence of firm-specific knowledge based assets. The existence of non-zero transport costs, and differences in the fixed costs of establishing foreign affiliates in different locations offer firms a rich variety of possible production strategies (Grossman *et al.*, 2006). Choosing between them will depend on the costs of outsourcing, the costs of trade in finished goods, the costs of establishing foreign affiliates and the intra-industry dispersion of productivity.[4]

The labour market effects of foreign direct investment

The importance of distinguishing between different models of FDI is that each offers different predictions about the possible effects of investment on home country labour markets, and in particular the relationship between employment in the parent company and its foreign affiliates.

For vertical-type foreign investments, the effect on home countries will vary on the stages of production moved offshore and, more generally, with the relative factor abundance of home and host countries. If investment takes place from countries with a high relative endowment of skilled labour, other stages of the production chain will produce comparatively lower-skill labour intensive activities, with parent companies producing higher-skill outputs such as "headquarter services" (Helpman and Krugman, 1985).

Assuming perfect factor markets, the initial effects at the level of the parent company (the home country) are likely to involve a reduction in employment and a rise in the relative demand for skilled labour. Subsequently, employment is likely to rise, both because of additional production of skill-intensive inputs for foreign affiliates, and because the cost savings from production fragmentation may be reflected in price reductions, expanding market share and the scale of output.[5] In the economy as a whole, the cost of skilled labour is likely to rise relative to the cost of unskilled labour. If factor markets clear, then eventually there should be a negligible effect on total employment, but a change in the relative price of skilled-unskilled labour. So the overall outcome is likely to depend in part on the structural features of national labour markets. If there are significant labour market rigidities, or institutional features such as binding wage floors for less skilled workers, then it becomes more likely that there will a greater quantitative effect on (un)employment and a smaller adjustment in the relative wages of different types of workers (Moore and Ranjan, 2005; OECD, 2005).

For horizontal-type foreign investments, the effect on the labour market in the home country will depend in part on the exact scope of the production processes being replicated by the parent company and its affiliates (Head and Ries, 2002). At one extreme, with affiliates located abroad replicating all activities of the parent using identical factor proportions, employment and output growth in the home country after the investment takes place could be weaker than might otherwise have been the case. Foreign market growth is met by production in foreign affiliates rather than by the parent company.[6] A second possibility is that horizontal affiliates replicate only the final goods part of production in the parent company. In this case demand for intermediate goods and services produced by the parent company could rise if the overall scale of production by the multinational firm increases. The knowledge capital model implies that at least some of these additional activities in the parent will be high-skill intensive.

The examples discussed so far assume that the activities undertaken by foreign affiliates are either less or as skill-intensive as those that continue to be undertaken by parent companies. It is also possible that high skill-intensive activities are undertaken in affiliates; a recent example of this is provided by the increasing globalisation of many R&D activities (UNCTAD, 2005). The effect of this on the home country depends on the motivating factors for such investments. One possibility is that the short-run demand for highly-skilled activities at home is decreased. But if high-skill intensive investments are being made to access and exploit knowledge in the host countries, then the eventual result could be faster technical change and productivity growth in the home country (Grossman and Helpman, 1991; Amiti and Wei, 2005a) and a higher level of economic activity and employment.

Empirical studies of multinationals and home country labour markets

Foreign direct investment and employment

The full impact of the internationalisation of production on employment in home countries depends on many factors, including those that affect labour demand directly and others that have an indirect effect, such as induced changes in exports and fixed investment (Andersen and Hainaut, 1998). This section contains an overview of the findings from a series of recent studies that have sought to test directly the substitutability of aggregate employment in parent companies and their affiliates, using firm or industry level data on multinationals. Many of the studies test whether the effects on employment in the home country of establishing or expanding foreign affiliates differ according to the location of the affiliates. The most commonly used empirical approach is to augment otherwise standard labour demand models for the parent companies with measures of labour employed in, or the wage costs of affiliate companies.[7]

The findings from studies of the transfer of production within multinational companies fail to provide a clear picture across countries and industries of the relationship between the expansion of activities abroad and total employment at home. One example is provided by a series of studies using data for the United States. Desai *et al.* (2005) and Hanson *et al.* (2003) both find that over a period spanning 1982-99, an expansion in the scale of activities in US-owned foreign affiliates has a significant positive association with employment growth in the parent companies of United States multinationals in the manufacturing sector.[8] In contrast, using a related data set over a sub-sample of 1983-92, Brainard and Riker (1997) obtain evidence of substitution between labour in the parent companies of United States manufacturing MNEs and labour in their affiliates, although the effects are generally small.[9] The evidence of employment substitution between affiliates in different countries is found to be markedly higher than between the parent company and the affiliates. This is especially so for affiliates in low value-added sectors and comparatively low income locations. Harrison and McMillan (2006) also find that employment in US-owned foreign affiliates in high-income economies is complementary with employment in parent companies, whereas employment in US-owned foreign affiliates in low-income economies substitutes for employment in parent companies.

Using a related data set for Sweden, Hatzius (1998) reports that employment in the parent companies (affiliates) of Swedish multinational companies is positively associated with foreign (Swedish) labour costs. This also suggests that foreign and domestic employment may be substitutable at the margin. However, in contrast to the results for the United States, Braconier and Ekholm (2000) report that the labour substitution between Swedish parent companies and their affiliates is more likely to occur with affiliates in higher-income countries than with affiliates in lower-income countries, suggesting that FDI in low cost locations was not at the expense of employment in Sweden.

Ahn *et al.* (2005) include measures of both FDI and imports in an econometric model of plant-level employment growth in Korea over the period 1990-2002. This is one of the few studies to allow directly for possible effects on domestic employment from both forms of global engagement. The results across a range of different empirical specifications show that employment changes in Korea are more closely related to outward FDI than to the growth of imports. In general, industry-level outward FDI is found to have a significant positive relationship with domestic employment growth. The sole exception is for FDI in

China, which is found to have a significant negative effect on domestic employment growth, possibly reflecting the direct substitution of labour intensive activities.

A number of studies using data on European multinationals have sought to test whether employment in parent companies and employment in affiliates located in Central and Eastern Europe (CEE) are substitutes. Recent examples include Konings and Murphy (2003), Becker *et al.* (2005), Cuyvers *et al.* (2005) and European Commission (2005). On balance, the studies suggest that there is evidence of employment substitution, though for some countries the effects are small. A 10% reduction in labour costs in CEE affiliates is found to be associated with a 0.3% reduction in parent employment in Belgium and a 0.2% reduction in France (European Commission, 2005). Larger effects for German and Swedish multinationals are obtained by Becker *et al.* (2005), who find that a 10% reduction in wage costs in CEE host countries is associated with a decline of 0.5% in parent company employment in Germany and a decline of 0.9% in parent company employment in Sweden.

The studies by Konings and Murphy (2003) and Becker *et al.* (2005) both find that substitution between parent company and affiliate employment is significantly higher for affiliates located in the EU15 than it is for affiliates located in Central and Eastern Europe. In contrast, the results in European Commission (2005) suggest that employment in parent companies in Belgium is not affected by that in EU15 affiliates, while employment in French parent companies and EU15 affiliates is complementary. It is difficult to know what lies behind these different results, but it may suggest that firms from each of these countries have followed different integration strategies within Europe.

The question of whether the impact of outward FDI on employment in parent companies might differ with their size as well as the location of affiliates is examined by Falzoni and Grasseni (2005), using a sample of Italian multinationals over the period 1994-98.[10] Their findings suggest that foreign operations in both developed and developing countries have a negative effect on domestic employment only for small firms (those in the lower half of the size distribution). For larger firms, it is only employment in Asian affiliates that has a significant negative effect on employment in parent companies. It is not clear whether these results reflect only the comparatively unusual size distribution of firms in Italy, or whether they are more generally applicable.

An important issue when evaluating the impact of outward FDI is the possible counterfactual if investment had not taken place.[11] For this to be evaluated properly, firms making outward investment need to be compared with other, purely domestic, firms who had similar characteristics immediately before the outward investment took place. One of the few studies of this type is that of Barba Navaretti and Castellani (2004). Using a matched sample of Italian multinationals and purely national companies, they report that there are no significant differences between the growth rate of domestic employment in either set of companies after foreign investment took place. For these firms at least, expansion abroad appears not to have affected directly employment in the parent company. Becker and Mündler (2007), using linked employee-employee data for Germany also report that there is a significant reduction in the probability of job separation in multinationals who expand abroad relative to other German companies.

Another issue to consider, as suggested by the differing results discussed above using data on United States MNEs, is that the relationship between outward investment and the activities of the parent company may change over time (Hanson *et al.*, 2003). Higuchi and Matsuura (2003), using firm-level data for Japan, find that job losses in firms with overseas

production plants can persist for up to five years after the establishment of the overseas plant. Thereafter, employment growth is stronger in firms with overseas production plants than in purely domestic firms.

Several empirical studies also find that outward investment has differential effects on different skill groups in the home country, with skilled workers more likely to benefit than unskilled workers, as might be expected in many skill-abundant OECD economies.[12] For example, Head and Ries (2002) find that changes in the ratio of foreign affiliate employment to domestic employment can explain about one-tenth of the rise in the share of non-production workers in the labour costs of Japanese manufacturing sectors during the 1970s and 1980s. Sasaki and Sakura (2004) find that overseas production shifted labour demand toward high-skilled workers (university graduates) and so did the increasing share of imports from East Asia. The widening wage gap between the skilled and the unskilled, however, is attributable to skill-biased technological change as much as to globalisation.

Related results are reported by Hanson *et al.* (2003) who find that the relationship between employment in United States parent companies and their foreign affiliates varies by skill. For a given level of output, employment in the parent is found to be a price complement with high-skilled foreign labour and a price substitute with low-skilled foreign labour.

Overall, it is clear from the empirical literature that there is considerable heterogeneity in the effects of outward investment on employment in the home country. In part this may reflect the different motives underlying different forms of foreign investment. Some studies have found evidence of substitution between employment in foreign affiliates and parent companies, but others have found that the two are complements. In either case the reported effects are generally small and may vary over time.

Internationalisation and the price elasticity of labour demand

The studies discussed above all consider whether enhanced internationalisation results in the substitution of employment between the home country and foreign countries. One general implication of the finding of (weak) substitutability between parent and affiliate employment, as well as the increasing use made of international sourcing by non-multinational companies, is that labour demand curves may have become more elastic, both in home and host countries (Rodrik, 1999; Hatzius, 1998), because of greater opportunities to move production to lower cost locations following a rise in domestic costs.[13] Other things being equal, a more elastic demand curve implies that national factor demands may become more sensitive to changes in factor prices over time as FDI and international sourcing increase, although there is no theoretical reason why this will always be the case (Panagariya, 1999). It also implies that the relative bargaining power of workers and employers could change.[14] This is discussed further in Molnar *et al.* (2007, Box 2).

Indirect evidence in favour of the proposition that factor demands have become more sensitive to factor prices over time is provided by Hatzius (2000), who shows that the elasticity of manufacturing fixed investment with respect to labour costs has risen over time in the United Kingdom and Germany, especially in industries with comparatively high FDI levels. Related evidence for the United States is provided by Slaughter (2001), who finds that the price elasticity of demand for unskilled workers has risen over time in a number of manufacturing industries. In contrast, few changes are found over time in the elasticity of demand for skilled workers. The proportion of the assets of multinational companies held by foreign affiliates, the

international sourcing of intermediate inputs and net exports and are each found to explain part of the different outcomes found for the different skill groups.

Other studies that have tested for the impact of greater openness on the price elasticity of labour demand have focused largely on the impact of international trade, see, for example, Jean (2000), Bruno *et al.* (2004), Riihimäki (2005), Senses (2006) and OECD (2007). Overall, these studies provide some support for the proposition that in at least some industries in some countries, the demand for labour has become more elastic over time as a result of enhanced international openness. However, this is not a universal finding and uncertainty remains about the possible magnitude of such shifts and the factors responsible for them. This suggests that it would be worthwhile to undertake an equivalent analysis using measures of outward direct investment. It is possible that two offsetting forces are at work – the availability of foreign labour can increase domestic labour demand elasticities, but this might also reduce the share of unskilled workers in employment, pushing down the overall labour demand elasticity (Senses, 2006). Ultimately the balance of these forces is an empirical matter.[15]

A related question is whether multinationals are also able to adjust their labour demand more quickly than purely domestic firms, especially if they have a low-cost option to move particular tasks to their affiliates. There are also comparatively few empirical tests of this issue, despite the importance of adjustment speeds for determining the pace at which labour markets adjust to economic "shocks".

The most comprehensive study is that of Barba Navaretti *et al.* (2003), using firm-level data for a number of European countries. Their results suggest that the speed of employment adjustment in foreign-owned firms is significantly faster than in purely national companies. They also report evidence that the wage elasticities of labour demand in the affiliates of multinational firms vary little across countries when interacted with country-level indicators of labour market regulation. In contrast, wage elasticities in purely domestic firms are lower in countries with more heavily regulated labour markets. One explanation of this finding is that multinational firms may be less affected by some labour market regulations than are purely domestic companies, although the extent to which this occurs in practice is far from clear.

The industry-level effects of foreign direct investment on labour demand

The implication of both the theoretical literature and existing empirical studies is that the effects of the internationalisation of production are likely to be heterogeneous, both across countries and across industries. This section reports new estimates from a series of models that examine the effects of the internationalisation of production on employment in the home country of the investing companies. Two sets of models are estimated, one using industry data on employment in the foreign affiliates of parent companies from the G3 countries, and one using industry data on the stock of outward foreign direct investment (as a percentage of domestic industry output) for 11 OECD economies.[16] Foreign direct investment may be an imperfect measure of the scale of activities carried out in foreign affiliates,[17] but for many countries it is the only data available.

The industries covered consist of (up to) eight manufacturing sectors and five service sectors, with the availability of data on internationalisation normally determining those included in the sample for each country. A summary of the sectors included is given in Table 1. All domestic industry data are taken from the OECD STAN database over the period 1980-2003. The industries chosen each cover a wide variety of different types of

Table 1. **Industries included in the empirical analysis**

	Industry	ISIC Rev. 3 Group
Manufacturing	Food, beverages and tobacco	15, 16
	Textiles	17, 18
	Wood, paper, printing and publishing	20, 21, 22
	Chemicals, rubber and plastics	24, 25
	Basic metals and fabricated metal products	27, 28
	Machinery	29
	Electrical and optical equipment	30, 31, 32, 33
	Transport equipment	34, 35
Services	Wholesale and retail trade	50, 51, 52
	Transport and storage	60, 61, 62, 63
	Post and telecommunications	64
	Financial services	65, 66, 67
	Business services	71, 72, 73, 74

activity and products, and it is likely that there is considerable within-industry specialisation (Schott, 2004). The data for the G3 countries come directly from the providers of the data in the respective countries.[18] Data on outward direct investment stocks are from the OECD International Direct Investment Statistics database, and adjusted for breaks in definitions and coverage as far as possible, with additional data being obtained from national sources for seven of the 11 countries for which figures are available in sufficient detail.[19] In general, the level of industrial and country detail available in the direct investment data is more limited than that available in the STAN database, placing a constraint on the degree of disaggregation possible in the empirical work.

In both estimated models the indicators of internationalisation in each sector are used to augment otherwise conventional conditional labour demand relationships in which domestic employment in that sector is related to the volume of domestic output and real producer wages in the sector and a sector-specific time trend to allow for labour-augmenting technical progress. Two sets of relationships are estimated for each model. The first simply tests whether there is an association between internationalisation and domestic employment after controlling for the scale of production and labour costs. The second enables tests to be undertaken of two propositions in the literature – whether internationalisation changes the domestic price elasticity of demand for labour in the sector in which internationalisation takes place, and whether internationalisation changes the speed at which domestic employment in that sector is adjusted following changes in output or wages. The underlying specifications of the separate models are set out in Box 2.

The specifications of the equations set out in Box 2 are more likely to identify the effects of vertical-type outward investments designed to move parts of the production process from the domestic company to foreign affiliates. The direction of such effects will depend in part on the stages of production that are moved. Pure horizontal-type investments, in which the factor proportions and activities of the foreign affiliate are identical to those of the parent company, are less likely to be identified, as the model controls for any substitution of production away from the parent by including domestic output as a scale measure. The scale effect from horizontal investments can be controlled for fully only by either conditioning on the (unobserved) total volume of output produced at home and in foreign affiliates, or by estimating a further equation relating the share of OECD output produced in the home country to (net) outward FDI.[20]

Box 2. **The empirical framework**

The empirical work undertaken for the two sets of studies uses different baseline models, reflecting the nature of the data available. For the analyses of the G3 countries using data on employment in foreign affiliates, only a short time span of data is available. Thus while it is possible to look at the factors affecting employment growth, it is not practicable to examine those affecting the long-run level of employment. The equations used take the basic form set out in [1] and [2] (augmented by additional lags of output and wage growth where possible):

$$\Delta \ln L_{i,t} = \alpha_0 + \alpha_1 \Delta \ln Y_{i,t} + \alpha_2 \Delta \ln RW_{i,t} + \alpha_3 \Delta \ln LF_i + \varepsilon_{i,t} \quad [1]$$

$$\Delta \ln L_{i,t} = \alpha_0 + \alpha_1 \Delta \ln Y_{i,t} + [\alpha_2 + \gamma(LF_{i,t-1} / L_{i,t-1})] \Delta \ln RW_{i,t} + \alpha_3 \Delta \ln LF_i + \varepsilon_{i,t} \quad [2]$$

Here, Li denotes domestic employment in industry i, Y and RW denote output and real wages respectively, and LF denotes employment in the foreign affiliates of home country parent companies. Industry fixed effects are included to pick-up any otherwise excluded industry specific factors. The specification shown in [2] enables a test to be undertaken of whether a rising share of employment in foreign affiliates has any short-run effect on the response of employment to a change in wages ($\gamma = 0$).

For the analysis of the impact of outward FDI stocks on domestic employment two related specifications were used, shown as [3] and [4], where FDI denotes the (log) ratio of the outward stock of foreign direct investment to the nominal value of domestic output in the sector concerned. The span of the data is considerably greater, with detailed industry level stocks on foreign direct investment being available back to the early 1980s for some countries, making it possible to look for long-run effects on employment.

$$\Delta \ln L_{i,t} = \alpha_0 + \alpha_1 \Delta \ln Y_{i,t} + \alpha_2 \Delta \ln RW_{i,t} + \alpha_4 (\ln L_{i,t-1} + \lambda_1 \ln Y_{i,t-1} + \lambda_2 \ln RW_{i,t-1} + \lambda_3 FDI_{i,t-1}) + \beta T_i + \varepsilon_{i,t} \quad [3]$$

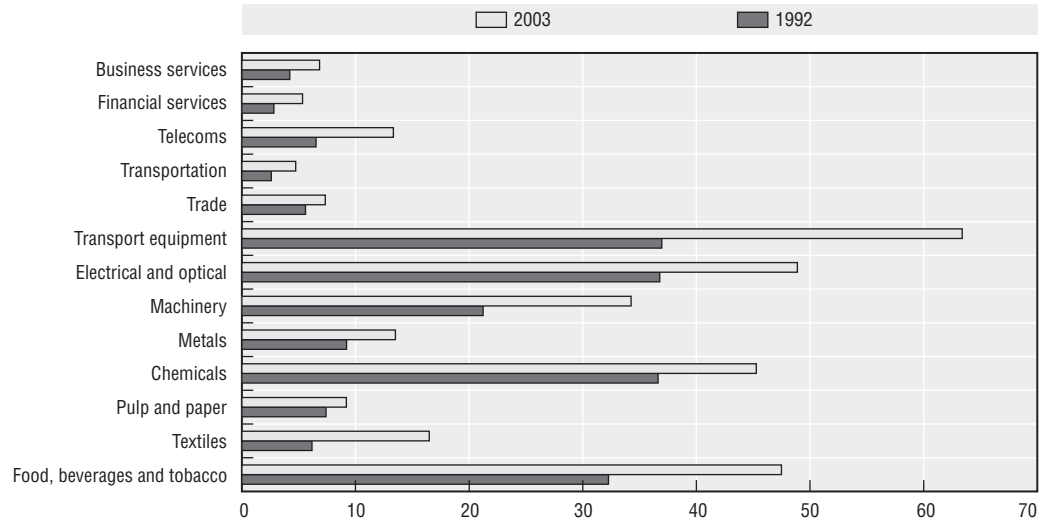
$$\Delta \ln L_{i,t} = \alpha_0 + \alpha_1 \Delta \ln Y_{i,t} + \alpha_2 \Delta \ln RW_{i,t} + [\alpha_4 + \gamma_1 FDI_{i,t-1}](\ln L_{i,t-1} + \{\lambda_1 + \gamma_2 FDI_{i,t-1}\} \ln Y_{i,t-1} + \{\lambda_2 + \gamma_3 FDI_{i,t-1}\} \ln RW_{i,t-1} + \lambda_3 FDI_{i,t-1}) + \beta T_i + \varepsilon_{i,t} \quad [4]$$

The specification shown in [4] permits a direct test of whether higher levels of foreign direct investment raise the speed of adjustment of employment towards its long-run sustainable level ($\gamma_1 > 0$). It also provides a test of whether higher levels of foreign direct investment change the price elasticity of the demand for labour ($\gamma_3 = 0$).

Employment in foreign affiliates and domestic employment

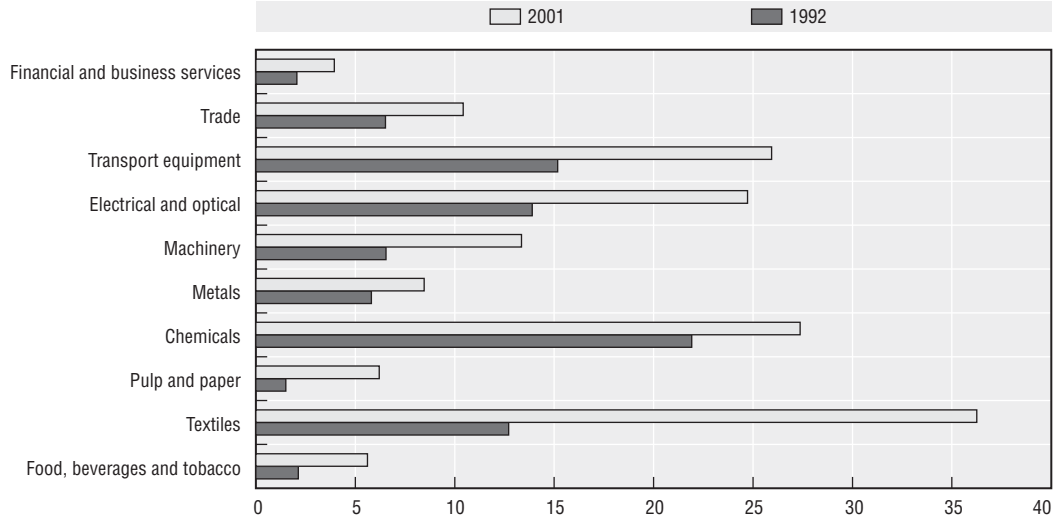
Data for each of the G3 economies provide an indication of the extent to which employment in foreign affiliates has risen over time relative to employment in the same domestic sectors (Figures 10, and 11 and 12).[21] As might be expected, in all three countries the ratio of foreign to domestic employment is typically higher in manufacturing industries than in service sectors (see also Figure 7). The transport equipment, the electrical and optical equipment and the chemical industries are amongst the industries with the highest foreign-domestic employment ratio in all three countries. Although the data used do not cover every industry in which outward investment has occurred, the omitted industries have a comparatively low share of total employment in foreign affiliates.

Figure 10. **Employment in United States foreign affiliates relative to domestic employment (%)**



Source: Bureau of Economic Analysis and OECD *STAN Database*.

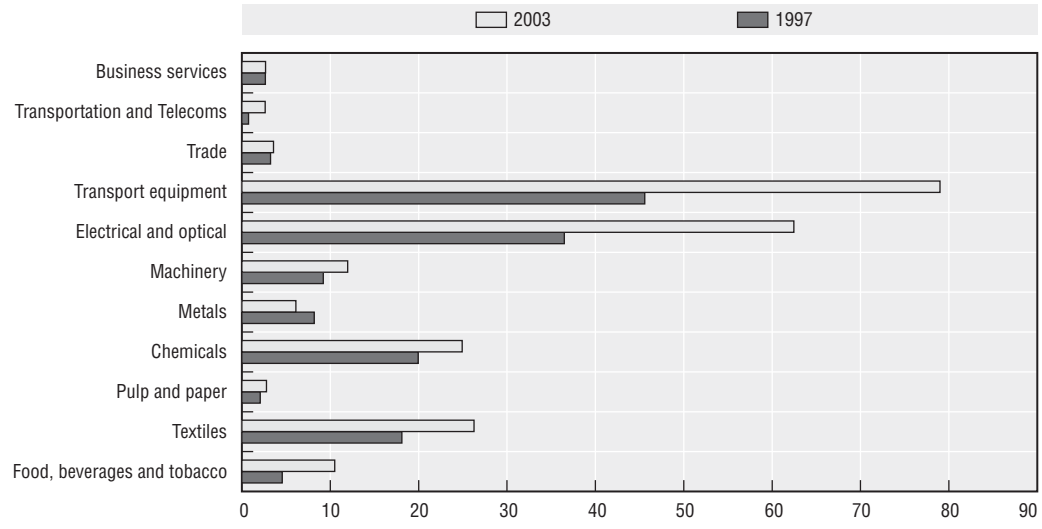
Figure 11. **Employment in German States foreign affiliates relative to domestic employment (%)**



Source: Deutsche Bundesbank and OECD *STAN Database*.

The estimation period differs for each country. The full sample of data is truncated for estimation purposes in order to retain some lagged observations for use in the instrumental variable estimates of [1] and [2]. The largest sample used is for the United States, with data for all 13 of the sectors identified in Table 1. For Germany, the estimation sample spans 1994-2001. Japan has the shortest sample, covering only six years from 1998 to 2003. Both the German and Japanese samples have one sector missing, reflecting the unavailability of data for some service industries. Common slope parameters are imposed across all industries in each country model, with the short sample period making it unfeasible to test for differing parameters across industries by estimating separate

Figure 12. **Employment in Japanese foreign affiliates relative to domestic employment (%)**



Source: METI Survey on Activities of Foreign Affiliates and OECD *STAN Database*.

equations for particular industries or industry groups. However, this question is addressed in the subsequent regressions that use the outward FDI stock.

The sign and significance of the coefficients on the foreign employment terms are summarised in Table 2. After controlling for domestic output and wage effects, significant coefficients on the growth of employment in foreign affiliates are found for both the United States and, to a lesser extent, Japan. No significant effects were found in Germany. In most cases the differences between the OLS results and the IV results are small.

Table 2. **Summary of impact of foreign affiliate employment on domestic employment growth**

	United States		Japan		Germany	
	OLS	IV	OLS	IV	OLS	IV
MODEL 1						
Foreign employment growth	+**	+**	−**	−	+	+
MODEL 2						
Foreign employment growth	+**	+**	−**	−	+	+
Wage interaction term	−	−	+	+	+	+

Note: +/− de notes the sign of the estimated coefficient in Table 4 and ** denotes a coefficient significant at the 5% level. For definitions of Model 1 and Model 2, see Box 5 of Molnar *et al.* (2007). For the wage interaction term, a negative (positive) sign means that foreign employment has raised (reduced) the responsiveness of domestic employment to a change in domestic wages.

The complete set of regression results from estimating relationships [1] and [2] in Box 2 is reported in Table 3.[22] In all three countries stronger output growth and slower growth of real wages are found to be significantly positively related to domestic employment growth, as might be expected, although the magnitude of the estimated effects differs considerably across countries and across different estimation techniques. The first year effects on employment of changes in output and wages are typically found to be larger in the United

States than in the other two countries. Japan has the smallest first year effects from changes in output and wages.

For the United States, stronger employment growth in affiliates is found to have a significant positive association with domestic employment growth for given levels of domestic value-added output and real wages. However, the magnitude of the estimated effect is relatively small. A 1% rise in foreign employment is associated with a rise of between 0.1-0.2% in domestic employment after two years if output and real wages are unchanged.

In contrast, for Japan there is evidence of a negative coefficient on foreign employment growth, implying that foreign and domestic employment may have been substitutes, all else equal, over this period.[23] The coefficient is statistically significant using conventional fixed effects estimation, but not when using instrumental variable techniques. The magnitude of the effect from the first of these results is smaller in absolute terms than for the United States, with a 1% rise in foreign employment growth found to be associated with a reduction in domestic employment growth of 0.02% after one year.

To further investigate the negative effect of foreign affiliate employment on domestic employment in Japan, affiliate employment was disaggregated by geographical area. The resulting estimates show that the increase in affiliate employment in China has a significant negative effect on domestic employment in Japan and its size is much larger than that of worldwide affiliate employment. Rising employment in Asian affiliates is also found to have had a negative impact on domestic employment, though this effect is only marginally significant (at the 10% level). Employment growth in affiliates in other country groups such as the ASEAN or the NIES (Newly Industrialised Economies, including Korea; Hong Kong, China; Singapore and Chinese Taipei) are not found to have a significant negative association with employment in Japan.

The findings from estimating model [2] in Box 2 are summarised in the lower line of the respective country panels in Table 3. In all three countries there is no statistically significant evidence that changes in the ratio of foreign to domestic employment have any impact on the short-run price elasticity of labour demand.

For the United States there are also sufficient observations available to estimate the labour demand equation using gross output rather than value added as the scale variable in [1]. Gross output includes any intermediate inputs that are produced by the foreign affiliates of parent companies. Thus if there are important scale effects on the overall level of domestic employment, with some formerly domestic activities being moved offshore, they are more likely to appear in the regressions with gross output.

The resulting estimates show that foreign employment growth continues to be positively associated with domestic employment growth, but the short-run effects are weaker than found when using value-added output. This suggests that some of the effects of outward investment are reflected in gross output, and that at least some imported intermediates are complements to domestic employment. A further feature of the results using gross output is that the short-run effects of higher wage growth on domestic employment are lower than found when using value-added output as the scale variable.

The question arises as to why different results are found for the United States and Japan. A possible explanation relates to the time period covered and the maturity of foreign investments from the different countries. American multinationals have typically been established for longer than Japanese multinationals. As suggested by other empirical

Table 3. **Foreign affiliate employment and domestic employment**

Dependent variable = Δ ln(domestic employment)$_t$

	[1]	[2]	[3]	[4]	[5]	[6]
United States						
Δ ln(output growth)$_t$	0.406 (10.1)	0.376 (8.4)	0.406 (10.0)	0.606 (5.8)	0.594 (4.9)	0.606 (6.5)
Δ ln(output growth)$_{t-1}$	0.357 (8.0)	0.372 (8.5)	0.366 (8.0)	0.272 (4.3)	0.259 (3.5)	0.302 (4.8)
Δ ln(real wage inflation)$_t$	–0.344 (8.3)	–0.120 (3.9)	–0.266 (4.2)	–0.608 (4.6)	–0.362 (3.4)	–0.349 (2.3)
Δ ln(real wage inflation)$_{t-1}$	–0.242 (5.3)	0.010 (0.3)	–0.229 (3.2)	–0.075 (0.9)	0.173 (2.3)	–0.215 (1.0)
Δ ln(foreign employment growth)$_t$	0.056 (3.1)	0.028 (1.4)	0.054 (3.0)	0.189 (2.7)	0.072 (1.0)	0.136 (2.2)
Δ ln(foreign employment growth)$_{t-1}$	0.033 (1.6)	0.046 (3.0)	0.034 (1.7)	0.036 (1.3)	0.064 (2.9)	0.032 (1.4)
FRAT*Δ ln(real wage inflation)$_t$			–0.200 (1.2)			–0.521 (0.8)
FRAT*Δ ln(real wage inflation)$_{t-1}$			–0.037 (0.2)			0.249 (0.4)
R^2 adj.	0.765	0.787	0.764	0.676	0.702	0.709
Log-likelihood	370.2	377.2	370.9			
Serial correlation [p-value]	0.11	0.001	0.106	0.259	0.801	0.744
Over-identifying restrictions [p-value]				0.11	0.30	0.05
No. of observations	143	143	143	143	143	143
Output measure	Value added	Gross output	Value added	Value added	Gross output	Value added
Estimation method	OLS	OLS	OLS	IV	IV	IV
Germany						
Δ ln(output growth)$_t$	0.139 (2.6)		0.127 (2.4)	0.561 (2.8)		0.245 (1.0)
Δ ln(output growth)$_{t-1}$	0.366 (10.2)		0.364 (9.9)	0.407 (4.9)		0.388 (4.2)
Δ ln(real wage inflation)$_t$	–0.074 (0.6)		–0.112 (0.8)	–0.239 (1.1)		–0.785 (1.8)
Δ ln(real wage inflation)$_{t-1}$	–0.342 (5.2)		–0.378 (4.6)	–0.268 (2.2)		–0.526 (1.0)
Δ ln(foreign employment growth)$_t$	0.020 (1.3)		0.021 (1.4)	0.032 (0.4)		0.035 (0.6)
Δ ln(foreign employment growth)$_{t-1}$	0.005 (0.3)		0.006 (0.3)	0.003 (0.1)		0.012 (0.4)
FRAT*Δ ln(real wage inflation)$_t$			0.463 (0.5)			0.542 (1.6)
FRAT*Δ ln(real wage inflation)$_{t-1}$			0.350 (0.7)			0.185 (0.8)
R^2 adj.	0.714		0.707	0.531		0.525
Log-likelihood	207.5		207.8			
Serial correlation [p-value]	0.49		0.36	0.61		0.86
Over-identifying restrictions [p-value]				0.11		0.59
No. of observations	80		80	80		80
Output measure	Value added		Value added	Value added		Value added
Estimation method	OLS		OLS	IV		IV
Japan I						
Δ ln(output growth)$_t$	0.150 (2.96)		0.155 (3.00)	0.123 (1.91)		0.154 (2.38)
Δ ln(real wage inflation)$_t$	–0.034 (1.68)		–0.024 (0.91)	–0.039 (1.58)		–0.024 (0.68)
Δ ln(foreign employment growth)$_t$	–0.019 (1.73)		–0.019 (1.71)	–0.020 (0.98)		–0.024 (1.14)
FRAT*Δ ln(real wage inflation)$_t$			–0.102 (0.66)			–0.157 (0.85)
R^2 adj.	0.614		0.608	0.609		0.605
Log-likelihood	175.4		175.816			
Serial correlation [p-value]	0.5886		0.5387	0.4474		0.4257
Over-identifying restrictions [p-value]				0.2208		0.1493
No. of observations	62		62	62		62
Output measure	Value added		Value added	Value added		Value added
Estimation method	OLS		OLS	IV		IV
Japan II						
Δ ln(output growth)$_t$	0.123 (2.60)		0.127 (2.64)	0.090 (1.53)		0.087 (1.42)
Δ ln(real wage inflation)$_t$	–0.029 (1.50)		–0.021 (0.98)	–0.034 (1.48)		–0.037 (1.31)
Δ ln(Chinese affiliate employment growth)$_t$	–0.026 (3.02)		–0.027 (3.04)	–0.006 (0.29)		–0.007 (0.32)
FRAT*Δ ln(real wage inflation)$_t$			0.027 (0.72)			–0.424 (0.50)
R^2 adj.	0.665		0.661	0.665		0.6375
Log-likelihood	179.86		180.3054			
Serial correlation [p-value]	0.2312		0.1448	0.851		0.9026
Over-identifying restrictions [p-value]				0.22		0.06

Table 3. **Foreign affiliate employment and domestic employment** *(cont.)*

Dependent variable = Δ ln(domestic employment)$_t$

	[1]	[2]	[3]	[4]	[5]	[6]
No. of observations	62		62	51		51
Output measure	Value added		Value added	Value added		Value added
Estimation method	OLS		OLS	IV		IV
Japan III						
Δ ln(output growth)$_t$	0.155 (3.04)		0.158 (3.05)	0.130 (2.10)		0.098 (1.57)
Δ ln(real wage inflation)$_t$	–0.034 (1.66)		–0.028 (1.18)	–0.042 (1.78)		–0.035 (1.28)
Δ ln(Asian affiliate employment growth)$_t$	–0.029 (1.83)		–0.029 (1.82)	–0.031 (0.94)		–0.028 (1.00)
FRAT*Δ ln(real wage inflation)$_t$			–0.116 (0.48)			–0.018 (0.07)
R^2 adj.	0.618		0.610	0.594		0.6025
Log-likelihood	175.73		175.92			
Serial correlation [p-value]	0.5682		0.0222	0.2621		0.236
Over-identifying restrictions [p-value]				0.303		0.509
No. of observations	62		62	62		62
Output measure	Value added		Value added	Value added		Value added
Estimation method	OLS		OLS	IV		IV

Variable definitions: FRAT = one year lag of ratio of foreign employment to domestic employment.

Note: The panels for Germany and Japan have the same format as for the United States; however, some regressions are not possible given the available data. These are denoted with a ? symbol. All regressions use industry-specific data. Industry fixed effects are also included in the regressions. All t-statistics are heteroscedastic-consistent. Sample period is 1993-2003 for the United States and 1998-2003 for Germany and Japan. The IV regressions treat current dated terms in output, wages and foreign employment as endogenous. The Panel Japan I uses data on employment in all Japanese-owned foreign affiliates. Panels Japan II and Japan III use data on affiliate employment in China and all Asian affiliates respectively.

studies, it is possible that after having initially been substitutes during the initial process of changing the location of production, employment at home and in foreign affiliates become complementary over time (Andersen and Hainaut, 1998). If so, it could be argued that job losses at home are more likely to coincide with job creation abroad in Japan than the United States.

Outward direct investment and domestic employment

The second model estimated uses stocks of outward foreign investment (as a proportion of domestic output) as the indicator of internationalisation. The available data set is much richer, with over 2000 observations in total, compared with that for the initial analysis using the foreign affiliate employment data for the G3 economies. The principal focus of the analysis using outward FDI stocks has been on potential differences in the effect of internationalisation on employment across industries.[24] A variety of different specifications are estimated using both value added output and gross output as alternate scale variables.

For the purposes of testing whether the effects of internationalisation differ across industries, the thirteen sectors in the dataset were separated into three groups. One of these groups comprises the five service sectors. The manufacturing sectors were separated into two groups using information from the G7 economies on the share of imports in these sectors coming from non-OECD countries and the proportion of outward investment in these sectors located in non-OECD economies. A high share of imports from the non-OECD and a high proportion of FDI in non-OECD economies are suggestive of sectors in which production may have been, or is able to be, moved offshore to comparatively lower cost locations. The four sectors that were found to have the highest commercial ties with the non-OECD were textiles, transport equipment, electrical and optical equipment, and food,

beverages and tobacco. These four sectors were thus included in a second group, with the remaining four manufacturing sectors forming a third group.

The complete set of regression results from estimating relationships [3] and [4] in Box 2 are summarised in Table 4 and reported in detail in Tables 5 and 6.[25] The models are estimated both for the full panel and separately for each of the three groups of different sectors.[26] The results provide strong evidence of clear, statistically significant, differences in the factors affecting labour demand across the three groups of different sectors. Likelihood ratio tests of imposing common coefficients and a common error variance across all three groups, as would be required for the full panel model to be valid, are heavily rejected by the data. This does not only reflect differences between manufacturing and services sectors – common parameters are also rejected across the two manufacturing groups.

Table 4. **Summary of impact of outward direct investment on domestic employment growth**

	All industries		Manufacturing industries with strong links to non-OECD		Other manufacturing industries		Services	
A. Value-added output								
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
MODEL 3								
Outward FDI	+**	-**	-**	-**	-*	+	+	+
MODEL 4								
Outward FDI	–	-*	-**	-**	+	+	+**	+**
Wage interaction term	–	-**	-**	-**	+	–	+	+*
Adjustment speed to long-run	+**	–	-**	-*	+**	+	+**	+**
B. Gross output								
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
MODEL 3								
Outward FDI	-**	-**	-**	-**	+	+	–	–

Note: +/- denotes the sign of the estimated coefficient in Tables 5 and 6 and ** denotes a coefficient significant at the 5% level. A negative (positive) sign for the wage interaction term means that the labour demand curve has become more (less) elastic. A negative (positive) sign for the adjustment coefficient means that the adjustment of employment has risen (slowed).

In all three industry groupings, as well as the single combined panel, there is evidence that higher output and lower real wages are significantly positively related to domestic employment, both in the short term and in the long run. In almost all the regressions the long-run output elasticity is less than two standard deviations away from unity, and the long-run real wage elasticity is less than two standard deviations away from –1. The point estimates of the long-run output and wage elasticities in the group of service sectors (labelled Group 3 in Table 5 and Table 6) are generally above those found for the two manufacturing groups.

As shown in Table 4, there are marked differences across groups in the impact of outward direct investment, especially in the coefficients found on the separate outward FDI stock term (λ_3 in [3] in Box 2). For all specifications shown it is the case that significant negative effects are found for the group of manufacturing sectors with the strongest commercial ties with the non-OECD countries. Other things being equal, a rise in the

Table 5. **Outward foreign direct investment and labour demand in the home country: OLS estimates**

	All sectors		Group 1		Group 2		Group 3	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Long-run coefficients								
Output	0.845	35.5	0.851	21.5	0.707	17.0	1.088	13.1
Wage	–0.917	–30.9	–0.871	–17.9	–0.871	–15.1	–1.197	–11.9
FDI	0.022	4.9	–0.058	–5.5	–0.015	–1.9	0.006	0.9
Short-run coefficients								
Dynamic coefficient	–0.281	–26.3	–0.260	–13.0	–0.341	–14.9	–0.229	–12.6
Output	0.420	26.9	0.390	15.4	0.460	18.6	0.377	10.8
Wage	–0.263	–16.4	–0.268	–9.0	–0.297	–11.8	–0.180	–6.2
No. of observations	2 131		709		741		681	
R^2	0.541		0.510		0.618		0.593	
Log likelihood	4 066.52		1 284.68		1 487.95		1 314.51	
Output measure	Value added		Value added		Value added		Value added	
Long-run coefficients								
Output	0.838	35.0	0.844	23.7	0.767	15.0	1.111	14.6
Wage	–0.943	–31.0	–0.928	–19.9	–0.886	–13.9	–1.170	–12.5
FDI	–0.011	–0.1	–0.564	–4.3	0.170	0.9	0.659	3.0
Short-run coefficients								
Dynamic coefficient	–0.265	–18.4	–0.315	–10.3	–0.285	–9.3	–0.218	–10.2
Output	0.401	26.2	0.370	14.9	0.467	18.9	0.383	11.6
Wage	–0.270	–17.3	–0.266	–9.2	–0.301	–12.0	–0.193	–6.9
Interaction term coefficients								
FDI-VA	–0.003	–1.0	0.021	3.3	–0.010	–1.9	–0.018	–4.2
FDI-W	–0.002	–0.6	–0.027	–3.9	0.009	1.4	0.007	1.7
FDI-employment	0.006	2.0	–0.019	–2.8	0.013	2.3	0.020	4.6
No. of observations	2 131		709		741		681	
R^2	0.564		0.541		0.624		0.638	
Log likelihood	4 121.07		1 327.69		1 497.16		1 397.60	
Output measure	Value added		Value added		Value added		Value added	
Long-run coefficients								
Output	0.826	16.2	1.137	6.8	0.613	8.4	0.853	11.2
Wage	–0.561	–11.2	–0.569	–4.6	–0.882	–8.2	–0.870	–9.7
FDI	–0.044	–4.4	–0.130	–3.1	0.013	0.8	–0.002	–0.3
Short-run coefficients								
Dynamic coefficient	–0.182	–13.6	–0.110	–5.3	–0.268	–8.9	–0.238	–12.0
Output	0.432	19.1	0.450	11.4	0.415	12.2	0.403	10.6
Wage	–0.088	–4.6	–0.055	–1.7	–0.143	–4.2	–0.173	–5.8
No. of observations	1 357		512		419		426	
R^2	0.498		0.478		0.548		0.715	
Log likelihood	2 477.66		873.06		813.68		841.07	
Output measure	Gross output		Gross output		Gross output		Gross output	

Note: The table reports the coefficients obtained when estimating equations [3] and [4] in Box 2. Group 1 comprises four manufacturing industries – food/beverages/tobacco, textiles, transport equipment and electrical and optical equipment with strong commercial links with the non-OECD. Group 2 consists of wood/paper/printing, chemicals, basic metals and machinery. Group 3 comprises five service sectors. Further details of the industries are reported in Table 1.

outward investment-output ratio in this group will be associated with some reductions in domestic employment.

There are two possible explanations for this finding. The first is that labour at home may be directly substitutable with foreign labour in this group of manufacturing sectors.

Table 6. **Outward foreign direct investment and labour demand in the home country: IV estimates**

	All sectors		Group 1		Group 2		Group 3	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Long-run coefficients								
Output	0.818	15.0	0.915	12.1	0.743	8.9	1.377	7.2
Wage	–0.906	15.8	–0.952	–12.7	–1.054	–7.2	–1.100	–5.2
FDI	–0.025	–3.6	–0.050	–3.1	0.005	0.5	–0.005	–0.6
Short-run coefficients								
Dynamic coefficient	–0.271	–11.6	–0.273	–6.1	–0.385	–9.1	–0.229	–9.6
Output	0.730	6.9	0.764	4.3	0.380	2.3	0.784	0.2
Wage	0.052	0.3	–0.463	–1.6	–0.807	–3.5	0.002	0.0
No. of observations	2031		701		737		657	
R^2	0.223		0.346		0.368		0.376	
Output measure	Value added		Value added		Value added		Value added	
Long-run coefficients								
Output	0.857	20.2	0.941	13.0	0.824	6.9	1.284	7.3
Wage	–0.966	–22.1	–0.975	–15.3	–1.165	–6.4	–1.078	–4.9
FDI	–0.394	–3.6	–0.546	–3.0	0.015	0.1	0.678	2.3
Short-run coefficients								
Dynamic coefficient	–0.326	–11.9	–0.378	–7.6	–0.345	–5.2	–0.220	–8.2
Output	0.712	7.2	0.855	4.9	0.449	2.5	0.684	3.2
Wage	–0.066	–0.4	–0.739	–2.4	–0.873	–3.8	–0.070	–0.3
Interaction term coefficients								
FDI-VA	0.014	2.8	0.024	2.1	0.000	–0.1	–0.019	–3.7
FDI-W	–0.017	–3.4	–0.030	–2.4	–0.002	–0.3	0.010	1.9
FDI-employment	–0.012	–2.4	–0.023	–1.8	0.001	0.1	0.021	4.1
No. of observations	2031		701		737		657	
R^2	0.333		0.226		0.330		0.517	
Output measure	Value added		Value added		Value added		Value added	
Long-run coefficients								
Output	0.710	13.3	0.877	7.1	0.546	5.2	0.999	10.0
Wage	–0.422	–8.6	–0.520	–3.4	–0.915	–5.3	–0.791	–7.3
FDI	–0.038	–3.6	–0.114	–3.0	0.027	1.3	–0.014	–1.6
Short-run coefficients								
Dynamic coefficient	–0.236	–10.6	–0.154	–4.4	–0.358	–6.4	–0.233	–10.2
Output	0.290	4.9	0.271	2.5	0.169	0.8	0.616	5.5
Wage	0.469	2.1	0.358	1.3	–0.579	–2.5	–0.078	–0.6
No. of observations	1 303		497		403		408	
R^2	0.136		0.287		0.286		0.681	
Output measure	Gross output		Gross output		Gross output		Gross output	

Note: The table reports the coefficients obtained from instrumental variables estimation of the relationships in Table 5. Group 1 comprises four manufacturing industries – food/beverages/tobacco, textiles, transport equipment and electrical and optical equipment with strong commercial links with the non-OECD. Group 2 consists of wood/paper/printing, chemicals, basic metals and machinery. Group 3 comprises five service sectors. Further details of the industries are reported in Table 1.

An alternative is that outward investment helps to raise productivity at home, reducing the level of employment required to achieve a given level of output in the short term, but raising output and employment in the longer term (Grossman and Rossi-Hansberg, 2006). It is not possible to distinguish fully between these two hypotheses in the model.[27]

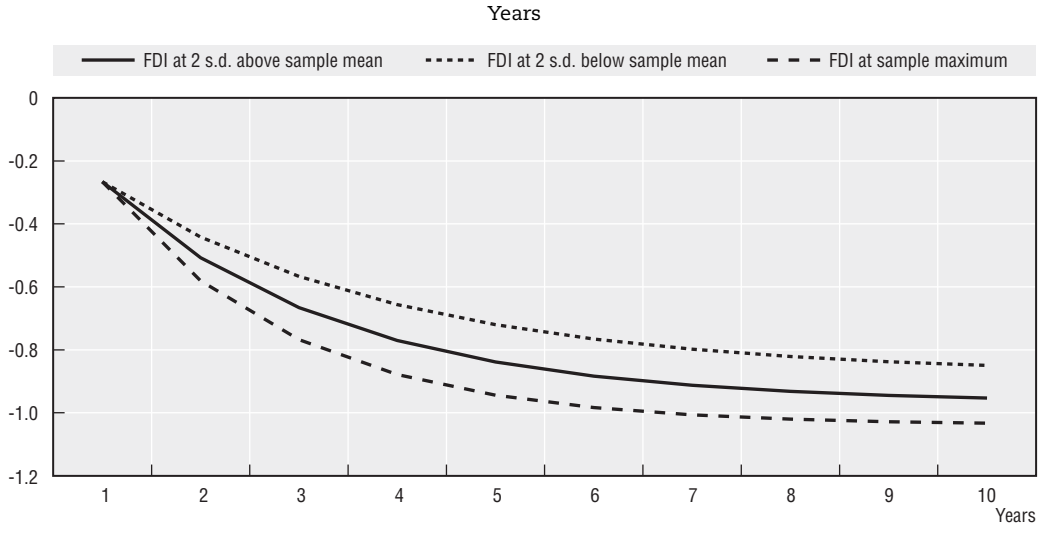
In the remaining two groups the long-run coefficients found on the separate outward investment-output ratio are generally insignificant, although there are two occasions in

which a significant positive coefficient is found for the group of service sectors when estimating model [4] in Box 2.[28]

There are also noticeable differences in the findings obtained for each group when testing whether outward investment has a significant effect on either the long-run wage elasticity of demand or the speed at which employment adjusts towards its long-run sustainable level. For the group of manufacturing sectors that have strong commercial links with the non-OECD countries, there is statistically significant evidence that increases in outward investment raise the long-run wage elasticity and also the speed of adjustment of domestic employment. In contrast, for the group of service sectors, an increase in outward investment is found to be associated with significant reductions in the speed of adjustment of employment, other things being equal. Thus whilst there is evidence that domestic and foreign employment are substitutable to some extent in industries with strong linkages with the non-OECD, they are more likely to be possible complements in services sectors.

The estimated coefficients imply that the strong growth of outward investment seen over the sample period is having noticeable effects on the price elasticity of demand for labour in at least some industries. For example, for the group of manufacturing industries with strong commercial links with the non-OECD, a sustained rise of 1% in real wages is found to reduce domestic employment by between 0.8-0.9% when evaluated at two standard deviations below the sample mean for the FDI ratio. But evaluated at two standard deviations above the sample mean for the FDI ratio, the elasticity rises to between 0.9-1.0%. If the sample maximum is used,[29] the elasticity rises to above 1%, although not significantly so. The changes in FDI are also reflected in differing speeds of employment adjustment towards the long run, as can be seen from Figure 13. The impact on the average economy wide price elasticity of demand for labour is much smaller, with the increases found for manufacturing sectors being offset by the reduction found for non-manufacturing sectors.

Figure 13. **The direct effect on domestic employment of a 1% increase in real wages in manufacturing industries with strong commercial links with non-OECD economies (per cent)**



Source: Calculated using the coefficients reported for the industries in Group 1 in Table 5.

Conclusions and policy implications

The empirical evidence obtained at both the country and the industry level supports several of the propositions advanced in the literature about the possible effects of the internationalisation of production. However, there are significant differences in the effects of outward investment across countries and industries, making it difficult to draw strong conclusions. But there is evidence for at least some countries and industries that outward investment has a significant negative association with the domestic demand for labour after controlling for domestic output and real wages. One possible explanation for this is that enhanced offshoring may reduce the level of employment required to achieve a given level of output in the short-term, but raise productivity, output and employment in the longer term (Grossman and Rossi-Hansberg, 2006).

There is evidence that in manufacturing industries in which there are comparatively strong commercial links between OECD and non-OECD countries there is significant evidence that outward investment makes the labour demand curve more elastic in the home country. There is also evidence that outward investment raises the speed at which employment adjusts in these industries following changes in demand and wages. However, there is also evidence that the opposite may have occurred in some services sectors. At the country level, the expansion of employment in the foreign affiliates of domestically owned companies appears to have a significant positive association with the level of domestic employment in the United States, but not in Germany or Japan. In the later there appears to be a negative association, particularly from outward investment in China.

Overall, the findings from existing studies and from the additional empirical work in this paper provide few reasons for suggesting that the aggregate employment effects of outward investment differ greatly from the general effects of international trade, with overall gains and individual winners and losers. Neither of these factors necessarily changes the appropriate policies to encourage job creation and facilitate the reallocation of labour across sectors. But the increasing speed and scope of global integration does increase the need to have such policies in place, and also raises the potential costs of labour market distortions.

In particular, labour market adjustment is likely to be facilitated by carefully designed policies that help to compensate displaced workers for their foregone earnings, at least for a while, and also, in at least some instance, by the prompt use of active labour market policies (OECD, 2005 and 2007). New forms of globalisation could however require the changes in the design of some of these policies. In particular, the increasing tradability and relocation of many service sector activities is likely to result in the displacement of workers that typically have a higher average skill level than those displaced in manufacturing (Jensen and Kletzer, 2006). Such workers may have relatively less need of proactive labour market schemes to acquire the general skills necessary to move to new activities.

More broadly, the restated *OECD Jobs Strategy* (OECD, 2006) suggests that new job creation is also likely to be aided by stability-orientated macroeconomic policy, the removal of impediments to labour market participation and measures to enhance the flexibility of labour and product markets and labour skills and competencies.

There are a number of additional ways in which the issues explored in this paper might be studied. One approach would be to further extend the new databases in order to incorporate additional country data on employment in foreign affiliates and an enhanced

degree of industrial disaggregation, although this is almost certainly likely to reveal even greater heterogeneity. A second approach might to be to seek to allow for other factors that can affect labour demand, such as anti-competitive product market regulations and other aspects of globalisation, to see whether the effects of outward investment can be estimated more precisely. A third approach would be to either estimate an equation in which the share of OECD value-added output produced in different member states is related to (net) outward FDI stocks or, equivalently, use OECD-wide output in the national labour demand equations (Barrell *et al.*, 1995). Finally, it would be of interest to gain a more complete picture of labour market developments by also exploring the impact of the internationalisation of production on real wages in the home country.

Notes

1. See also OECD (2005b).
2. Information for tradeable services is not available on the same basis.
3. Over the period 1994-2004, there is a small negative correlation of –0.19 in OECD economies between greater openness and changes in employment rates. This is not significant, and becomes almost zero if the four OECD Central European economies are excluded.
4. For example, empirical evidence suggests that foreign direct investment becomes more prevalent relative to trade when the intra-industry dispersion of productivity is higher, as more (higher productivity) firms are able to bear the fixed costs of establishing foreign affiliates (Helpman *et al.*, 2004). Related models consider the choice between international sourcing and undertaking production abroad in foreign affiliates (Grossman and Helpman, 2005).
5. These are referred to as the substitution, scope and scale effects by Hanson *et al.* (2003).
6. This assumes that the parent company would be otherwise be able to export to foreign markets. Evidence for services sectors in the United States, suggests that outward investment does weaken the growth of services exports for given market size (Pain and van Welsum, 2004).
7. The majority of studies reviewed in this section provide direct evidence about the impact of the internationalisation of production by using firm level data for parent companies and their foreign affiliates. Such data include the full range of activities produced by foreign affiliates. Other studies have focused more closely on one particular aspect related to the activities of foreign affiliates – the production of intermediate goods and services for parent companies. Often this can be observed only indirectly, using international trade data on imports of intermediates. Using such data it is difficult to separate out the effects of the international insourcing of production of intermediates within multinational companies and international outsourcing between otherwise unrelated companies. Whilst both are important for understanding the effects of enhanced international openness, the particular focus in this paper is on the impact of the transfer of production within multinational companies. For more detailed overviews of third-party trade and the general offshoring of services activities see OECD (2005) and van Welsum and Vickery (2005).
8. Desai *et al.* (2005) use the growth of employment in foreign affiliates, Hanson *et al.* (2003) use the growth of sales by foreign affiliates.
9. For example, a 10% fall in wages in affiliates in Mexico is found to be associated with a reduction of 0.17% in employment in parent companies in the United States.
10. The basic data show that small and medium-sized companies have a higher share of affiliate employment in developing countries rather than developed countries. The share of affiliate employment in total employment is also found to be decreasing by size of company.
11. For example, relocating particular stages of production to lower cost locations might be necessary to ensure survival of the firm. In such cases, even if employment in the parent company did decline, the job losses would be smaller than if the firm had not survived.
12. Theoretically there is no necessary reason why this should always be the case. Depending on the range of commodities produced and traded, and the endowments of the factors required as inputs for each, the fragmentation of production across national borders and the transfer of unskilled labour fragment to foreign countries could even result in a higher local return to unskilled workers (Jones, 2003).

13. Purely domestic firms may also be able to switch if they are able to outsource production.

14. FDI, in particular, may increase workers' insecurity in some countries (Scheve and Slaughter, 2004; OECD 2007).

15. Gorg *et al.* (2006) also find for Ireland that the price elasticity of labour demand for multinational firms is greater than that of purely domestic firms. This difference is found to be reduced, although not eliminated, as multinationals develop "backward" linkages with domestic firms.

16. The G7 economies plus Austria, Finland, the Netherlands and Korea.

17. This is because foreign direct investment is a financial flow rather than a measure of the fixed capital investment undertaken by foreign affiliates. Fixed capital investment by affiliates that is financed by borrowing in the host country will not be reflected in the outward FDI data.

18. These are the Bureau of Economic Analysis in the United States, the Ministry of Economy, Trade and Industry in Japan and the Deutsche Bundesbank.

19. The International Direct Investment Statistics database contains separate information on the industrial composition of direct investment and on the geographical location of total direct investment. It does not contain combined information on the geographical location of investment in each industry. This information is available from national sources in some countries, but has not been collected for the current paper.

20. Either of these approaches is complicated because all countries are also hosts to the affiliates of multinationals in other countries. So inward FDI and the output of the foreign parent companies would also have to be taken into account.

21. The data for Germany stop in 2001 because of a change in the definition of foreign employment after then.

22. The panel relationships are estimated using a standard industry fixed effect estimator. This is found to be statistically preferable to a random effects model.

23. The specification used in Table 4 does not provide an indication of whether the estimated negative short-run effect persists into the longer term.

24. It is not feasible to estimate a separate model for each industry in each country, because sufficient data are not always available in all cases. So standard fixed effects panel data estimators and estimators robust to the presence of heterogeneity have been used to estimate models across industry groups, with every country within each of the industries implicitly having a common coefficient.

25. The panel relationships are again estimated using a fixed effects estimator. Separate fixed effects are included for each industry-country pair. Common slope parameters are imposed across countries within each industrial sector.

26. The models were also estimated with a common variance for the three industry groups, which did not produce significantly different results.

27. In the latter case, the higher level of productivity may help to reduce costs and expand output, offsetting any subsequent decline in employment levels.

28. The effect of FDI does not change substantially when controlling for employment protection practices for regular workers. In the manufacturing sectors with close ties with non-OECD countries, its impact is still negative and significant, albeit the size of the impact is reduced to one-half. In services, the employment-creating impact of outward FDI is larger and more significant when controlling for employment protection of regular workers.

29. This is approximately three standard deviations away from the sample mean.

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Globalisation and OECD Consumer Price Inflation

by
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Introduction 118
Recent trends in inflation and global economic conditions 119
Imports from emerging markets and inflation 121
Estimates of the direct impact of imports from non-OECD Asia on OECD consumer price inflation 122
Estimates of the direct impact of imports from the non-OECD on OECD import price inflation 123
The impact of non-OECD output growth on commodity prices 124
Demand growth in the non-OECD 124
Estimates of the impact of output growth on commodity prices . . . 125
Estimates of the impact of non-OECD growth on commodity prices . 126
The impact of globalisation on consumer price inflation 129
Existing studies of globalisation and inflation 129
Testing for the impact of globalisation 133
Summary of empirical results 135
Quantifying the overall impact of globalisation 138
Concluding remarks 140
Notes 143
Bibliography 146

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Introduction

Over the past 25 years consumer price inflation has moderated considerably in all OECD economies, and also worldwide. The decline in OECD inflation from above 10% in the early 1980s to around 2% over the decade from 1995-2005 has been accompanied by a reduction in the variability of inflation and cross-country dispersion. These developments have coincided with a marked increase in the extent of globalisation, with the production of many goods and services becoming increasingly internationalised and the level of trade in goods and services between the OECD and non-OECD economies rising as a share of OECD GDP.

Ultimately, inflation should be determined by monetary policy. But many other factors can influence inflation and in the short to medium term it can be difficult to assess whether any observed moderation in inflation results from monetary policy, structural factors – such as globalisation – or just good fortune. Globalisation itself, as reflected in trade and foreign direct investment, potentially affects inflation through a variety of channels (IMF, 2006a; Kohn, 2006). Enhanced trade integration with lower-cost economies may help to hold down domestic inflation by depressing trade prices and increasing the share of imports in domestic demand. Related to this, enhanced product market competition may have reduced the mark-ups of domestic producers. These forces and the internationalisation of production may also have helped to raise the cyclical influence of global capacity utilisation on domestic price inflation (Borio and Filardo, 2006). Against this must be set the extent to which the strong globalisation-related growth in many non-OECD economies, and especially China, is putting upward pressure on the prices of many commodities.

This paper explores some of these issues in order to quantify the contribution of particular aspects of globalisation to the decline in OECD inflation. In doing so, the study extends the recent literature on this topic in several respects. In particular, wider allowance is made for possible price level effects from globalisation, a larger number of countries are included in the sample and the separate impacts of commodity and non-commodity import prices are considered.

The analysis suggests that the inflation process in OECD countries has indeed changed around the mid-1990s, around the time at which the extent of globalisation began to rise markedly. Accounting for this structural change leads to several important findings. Of these, the most notable is that the impact of import prices on consumer prices is higher after the break in all countries. In addition, the short to medium-term response of inflation to domestic cyclical output variations is found to have declined over the past decade, implying an increase in the sacrifice ratio. By contrast, inflation has become more sensitive to foreign economic conditions, working through import prices.

A simulation exercise reveals that globalisation has, on balance, contributed to lower inflation in most OECD economies. Although strong GDP growth in the non-OECD economies has pushed up real oil and metals prices in OECD economies, this has been more than offset by the disinflationary impact of declining import prices of goods and

services. Nonetheless, the net effect is small, with globalisation having been associated with a decline in the rate of consumer price inflation of between 0 to ¼ percentage point per annum since 2000.

The paper is organised as follows. First, it provides a short overview of inflation-related developments and some key indicators of the world economy that are drawn on in the analytical work. Next, it presents the findings of recent studies on the impact of non-OECD economies on consumer and import price inflation in OECD economies. The paper then continues by discussing the key findings from new estimates of the influence of non-OECD economies on selected commodity prices. The wider importance of globalisation and international trade for consumer price inflation is addressed in the subsequent section, which first reviews the range of evidence based on existing studies and then provides new estimates based on an econometric analysis of the factors determining consumer price inflation in the OECD economies. This is followed by an evaluation of the overall impact of commodity and non-commodity prices on consumer prices, using these new estimates in a scenario analysis. The final section summarises the key findings and concludes with a number of policy implications.

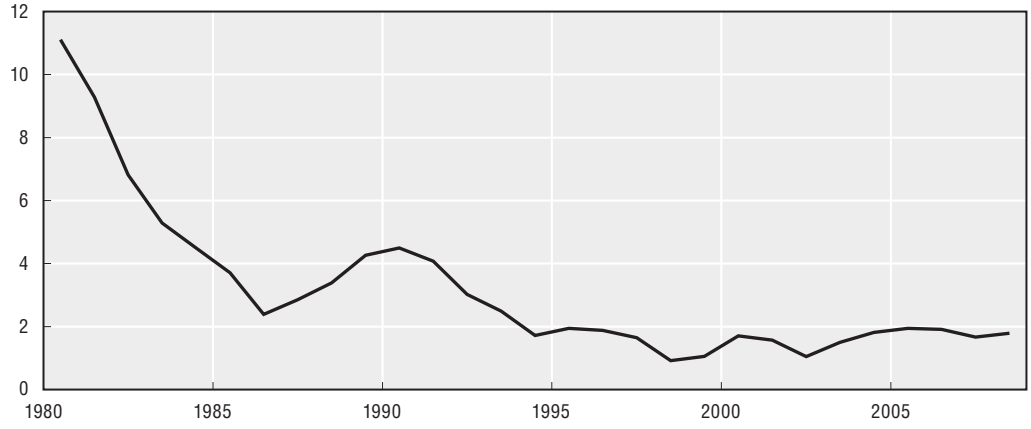
Recent trends in inflation and global economic conditions

Over the past 25 years inflation has fallen considerably across OECD countries. In 1980 the annual inflation rate was over 10% in many OECD countries compared with an average annual rate of 2 to 3% since the second half of the 1990s (see Figure 1). Much of this decline occurred during the first half of the 1980s when average inflation fell by more than 1 percentage point per annum. Inflation rates continued to decline in subsequent years, though much more slowly. This fall in average inflation rates has been accompanied by decline in inflation variability and also in inflation expectations. On average across OECD countries, the standard deviation of annual consumer price inflation has declined from above 3% in the early 1980s to around 0.5% in recent years.

A number of different factors have contributed to the fall in both average inflation and inflation variability; the focus here is on the role of external factors. Figure 2 compares the evolution of the aggregate price deflator for imported goods and services with domestic producer prices in manufacturing over the period 1980 to 2005. On average, import prices

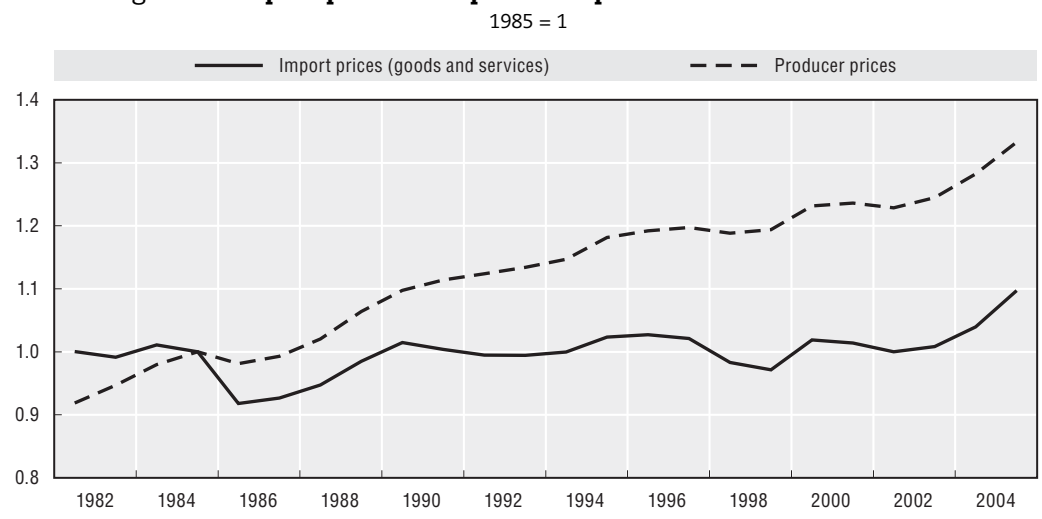
Figure 1. **Consumer price inflation in the G7 economies**

In per cent



Source: OECD Economic Outlook database.

Figure 2. **Import prices and producer prices in the G7 economies**



Note: The producer price index covers all manufacturing goods.

Source: OECD Economic Outlook database, OECD Main Economic Indicators database.

declined relative to producer prices during this period.[1] Non-commodity import prices have risen at a very moderate rate since the early 1990s and in some countries have even declined. More recently, the modest rate of non-commodity import price inflation has been partly offset by rising prices for commodity imports.

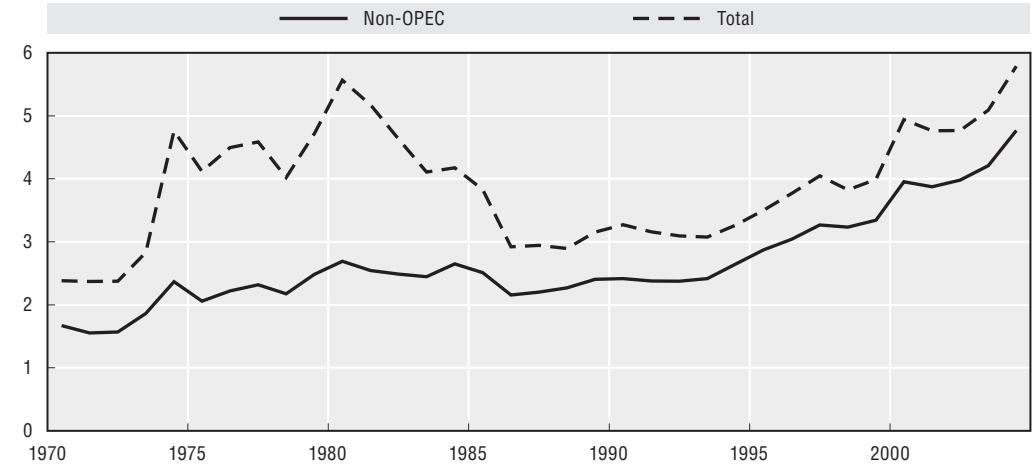
Low import price inflation in OECD countries can in part be attributed to the rising trade integration of low-cost countries from Asia and Latin America. Since the beginning of the 1990s the share of non-OECD countries in total world trade has increased markedly: from about a quarter of total world trade in 1990 to about a third in 2005. The rise in the trade share of non-OECD countries reflects the increasing openness of these countries as well as higher GDP growth rates compared with OECD countries. Between 1980 and 2005 the GDP of non-OECD countries grew by 5% per annum on average, compared with growth of 3% per annum in the OECD countries.

The integration of non-OECD countries into international trade and production networks has also progressed since the mid-1990s, albeit from a low level. One indicator of this is the global stock of foreign direct investment relative to global GDP, which increased throughout the 1990s (see Pain *et al.*, 2007, Figure 1). Although this increase was mainly due to higher intra-OECD flows, inward FDI to non-OECD countries also picked up, particularly in the mid-1990s. Coinciding with the rise in international FDI flows, imports of OECD countries from non-OECD countries also rose markedly from the mid-1990s onwards (see Figure 3). In part, this trend reflects the recent strengthening of oil and other commodity prices. But it mainly reflects the increasing extent of international sourcing of finished and intermediate goods and services from the non-oil producing countries in the non-OECD.

During 2002 to 2005 the prices of several commodities moved towards or past historical peaks in real terms, when expressed relative to weighted world export prices in US dollars (Figure 4).[2] These increases have been especially marked for real oil and metals prices. Between the fourth quarter of 2003 and the fourth quarter of 2005, oil prices rose by 74% in real terms, with metals prices increasing by 47% in real terms.[3] Additional increases occurred in 2006. The size and persistence of recent increases is unusual but, as can be seen from Figure 4, not outside all historical experience.

Figure 3. **OECD imports from non-OECD countries**

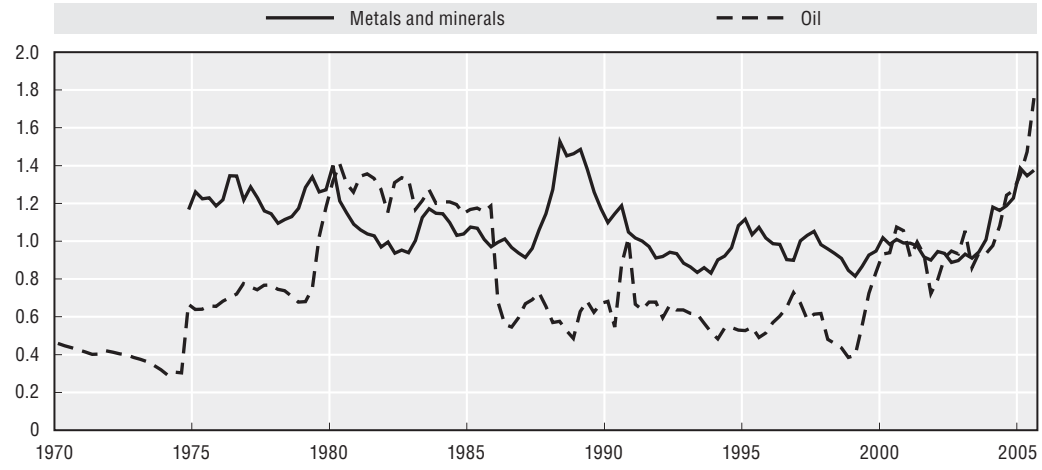
Per cent of GDP, current prices



Source: OECD International Trade Statistics database and *Economic Outlook database.*

Figure 4. **Real oil and metals prices**

2000 = 1; deflated by world export prices in US dollar terms



Source: OECD Economic Outlook database.

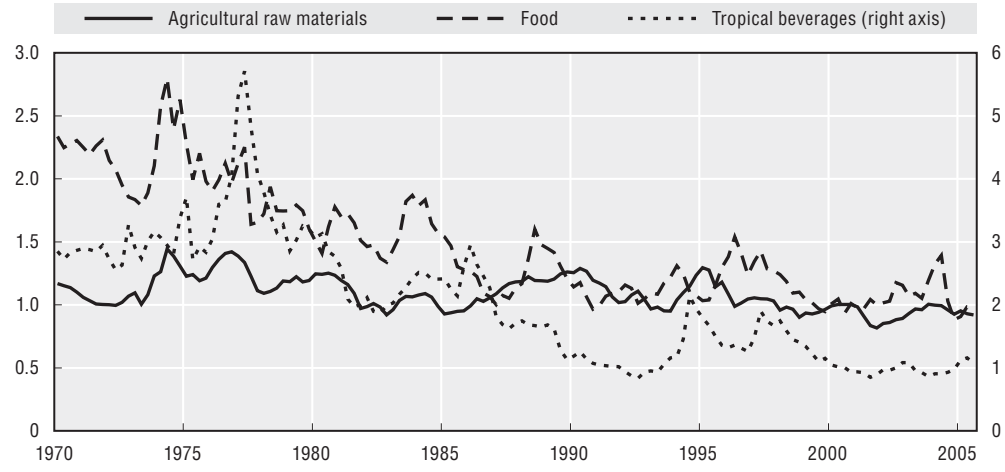
In contrast to oil and metals prices, the real prices of agricultural raw materials, foods and tropical beverages did not increase significantly over 2002-05 and remained well below historical peaks at the end of 2005 (Figure 5). The broad agricultural commodity groups also comprise bio fuels, so that changes in oil prices can be propagated to other commodity prices (IMF, 2006b). Up to the end of 2005, however, any such spillovers appeared to have been limited.

Imports from emerging markets and inflation

The increasing importance of China and other lower-cost producers in global production networks is likely to have placed downward pressure on the global prices of many goods and services, and hence import prices in OECD countries, through several

Figure 5. **Real agricultural prices**

2000 = 1; deflated by world export prices in US dollar terms



Source: OECD Economic Outlook database.

different channels. This section discusses the findings from a number of studies that have sought to estimate the initial impact of imports from lower-cost producers on either domestic inflation or on the growth rate of import prices.

Estimates of the direct impact of imports from non-OECD Asia on OECD consumer price inflation

Using a simple accounting framework, a recent study by the OECD shows that over the past decade imports from China and, to a lesser extent, other dynamic Asian economies, have placed downward pressure on the rate of consumer price inflation in the United States and the euro area (OECD, 2006). In the reported calculations this arises from two sources – an increase in import penetration by lower-price Asian producers, and the differences between the rate of growth of their export prices and producer prices in the importing economies. Overall, the combined impact effect of imports from China and other dynamic Asian economies is estimated to have reduced domestic inflation in the United States by 0.1 percentage point per annum on average from 1996 to 2005. In the euro area, it is estimated to have reduced domestic inflation by 0.3 percentage points per annum between 2000 and 2005. Prior to that point, the effect was negligible.

Although this would appear to suggest that trade with lower-cost producers is placing downward pressure on domestic prices in OECD economies, the eventual effect on inflation is less clear as the calculations show only *ex ante* effects. The extent to which they eventually lead to lower consumer price inflation will depend on the effect they have on the behaviour of other competitors and domestically generated inflation.[4] The latter will depend on whether the initial impacts are accommodated by the stance of monetary policy in the importing economy. Deflationary pressures on the general price level can, at least in principle, be offset eventually by monetary policy relaxation, although this does depend on the extent to which they are recognised, estimated accurately and acted upon promptly.[5]

Such estimates provide only a partial view of the effects on OECD economies of increased trade with lower-cost producers in Asia and elsewhere. In particular, there is no allowance for any offsetting effects of higher world commodity prices that may result from strong growth in comparatively commodity-intensive economies such as China.

Estimates of the direct impact of imports from the non-OECD on OECD import price inflation

The results of OECD (2006) are broadly comparable with those reported in other recent studies of the impact of the switch of sourcing to low-cost countries, although most of these other studies consider the impact on trade prices in the importing country rather than on consumer prices. For the United Kingdom, estimates suggest that the move to low-cost producers during the period 2000-04 reduced the rate of world export price inflation to the United Kingdom[6] by 0.55 percentage point per annum on average (Nickell, 2005).[7] For the United States, Kamin *et al.* (2006) estimate that the growing share of imports from China lowered import price inflation by around 0.8 percentage point per annum on average between 1993-2002, all else being equal. The direct impact of this on consumer price inflation during this period would have been small, at around 0.1 percentage point or less, similar to the estimates in OECD (2006).[8]

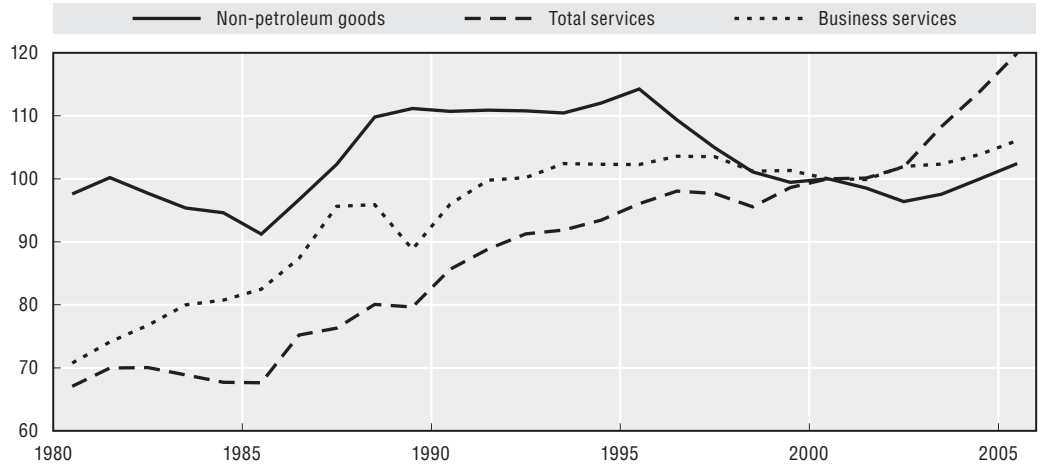
Over the decade 1993-2002, only Japan and Korea are estimated to have experienced a reduction in import prices as a result of trade with China similar to that in the United States (Kamin *et al.*, 2006). For the median OECD economy, import price inflation is estimated to have declined by only 0.13 percentage points per year on average. Many of these economies, especially those in Europe, have a smaller share of their trade with Asian economies than the United States and Japan do. On the other hand, these economies are likely to have received additional benefits from low-cost imports from other economies, especially those in Central and Eastern Europe, and the size of any effect is likely to have become larger in more recent years due to the further rapid increase in import penetration by lower-cost producers.

The *ex ante* effects of low-cost production on trade prices are likely to be concentrated in particular sectors of the economy. Using data for the euro area from 1995 to 2005, estimates produced by the European Central Bank indicate that the combined impact of the rising import penetration of low-cost producers in the manufacturing sector, and the differentials in inflation between them and other producers, has dampened euro area manufacturing import price growth by approximately 2 percentage points per annum (ECB, 2006). In contrast to the studies discussed above, these calculations also include an allowance for the impact of production in regions other than Asia.[9] Feyzioğlu and Willard (2006) find that the impact of trade with China on inflation in the United States and Japan is relatively strong on particular items such as household furnishings and food, rather than on the general consumer price level.

Overall, it appears reasonable to conclude that rising levels of imports from all lower-cost producers will have acted directly to reduce non-commodity import price inflation by up to 1 to 2% per annum in most OECD economies over the past decade, with globalisation-related effects in goods prices also being reflected in some services prices as well. To date, there have been no studies of the impact of service sector offshoring on the prices of imported services in the OECD economies. Some possible evidence on this is provided in Figure 6, which shows import price deflators from the United States national accounts. Up until the early-1990s the price of imported business services, a category which will include imported services that were moved offshore from the United States, rose faster than the prices of other service imports. But since that time, prices of business service imports have broadly stagnated whereas those of other service imports have continued to rise, suggesting that a globalisation effect may be present.[10]

Figure 6. **Goods and services import prices in the United States**

US Import prices (2000 = 100)



Source: Bureau of Economic Analysis, United States.

Changes in the domestic price level that stem from developments in only a few sectors of the economy may be less likely to generate a monetary policy response than equivalent changes in the domestic price level that are widespread throughout the economy (Rogoff, 2006). If so, the initial impact of an appreciation in the terms of trade (due to declining import costs) may be to push inflation below the medium-term target trajectory of the monetary authorities. The extent to which it does so, and the time over which this is allowed to persist, will depend not only on the behaviour of import prices but also on whether there are adverse effects on policy credibility and inflation expectations (Bean, 2006).

The impact of non-OECD output growth on commodity prices

Strong growth in China and other emerging markets in recent years has coincided with a sizable increase in global commodity prices. This section discusses the extent to which these developments are related, focussing in particular on the linkages between macroeconomic conditions, including the relatively higher rate of growth in non-OECD economies, and oil and non-oil commodity prices. Using the "reduced form" equations for a selection of commodities reported by Pain *et al.* (2006), calculations are reported of what might have happened to commodity prices over the past five years if the non-OECD economies had not grown faster than the OECD economies. Such calculations, although only illustrative, help to evaluate the impact of growth in emerging markets on commodity prices and may thereby also help to indicate whether prices will continue to rise beyond the current high price levels or whether these are only temporary.

Demand growth in the non-OECD

Earlier periods of rapid growth in real oil prices in the mid and late 1970s were characterised by marked constraints on oil production, notably by producers in OPEC. In contrast, the present upturn in oil prices has occurred at a time when the growth rates of both oil consumption and oil production have accelerated (IEA, 2006, Table 1). Over the decade to 2001 global oil demand rose by 1.4% per annum on average. In the subsequent four years demand growth accelerated to an average rate of 2% per annum.

The acceleration in global demand is more than accounted for by developments in non-OECD economies, where demand growth accelerated to just under 4% per annum on average from 2001 to 2005, after averaging 1½ per cent per annum in the previous decade. In China, average annual demand growth rose from just under 6½ per cent to just below 9% per annum. By 2005 the non-OECD economies accounted for 40% of total global oil consumption, with one-fifth of this being due to China.[11]

The acceleration in oil demand in the non-OECD economies in recent years reflects in part strong output growth, especially in industrial sectors, a higher level of energy consumption per unit of output than the average OECD economy (OECD, 2005; Markandya *et al.*, 2006) and rising private usage of motor vehicles. Strong world trade growth may also have contributed because of the associated growth in demand for aviation and shipping transportation.

Although the growth in final demand for oil would appear to have been the primary factor behind the recent rise in oil prices, this need not mean that other factors have been absent. Almost certainly there has been increasing precautionary demand as well, with concerns about possible supply disruptions in the Middle East and the possibility of short to medium-term supply shortages because of low rates of past investment and natural disasters all acting to raise risk premia. Speculation may also have played a role (IMF, 2006b).

The non-oil commodity group contains a wide range of different commodities, with few common elements in their prices. Metals and, to a lesser extent, agricultural raw materials are the most likely to be affected by a rise in the level of activity in commodity-intensive economies, as well as by the business cycle. China has also been a significant influence behind the strong global growth in demand for many metals over the past few years. During the period 2002-05, the growth in demand from China accounted for almost all of the increase in global demand for nickel and tin, and over half of the increase in demand for aluminium, copper and steel, reflected in marked increases in the share of China in total global consumption.[12]

Estimates of the impact of output growth on commodity prices

To obtain a more precise estimate of the impact of the recent rapid output growth in the non-OECD countries on commodity prices, reduced-form price equations were estimated by Pain *et al.* (2006) for five main commodity groups – oil, metals and minerals, agricultural raw materials, food and tropical beverages. The oil price measure used was the price of Brent crude, while for the remaining commodity groupings the prices variables considered are the aggregate price indices compiled by the Hamburg Institute of World Economics (HWWA).[13] The equations relate real prices to measures of the level and growth of global activity, as well as measures of the share of world trade and world GDP accounted for by non-OECD economies.[14] Measures of the global output gap, and output gaps in the OECD and the non-OECD economies were also included in the analysis.[15] It is well established that the global output gap is an important factor behind the cyclical behaviour of commodity prices, especially when output growth is above potential (Adams and Ichino, 1995; Rae and Turner, 2001).[16]

The econometric estimates in Pain *et al.* (2006, Appendix 2) provide significant empirical evidence that the present upturn in real oil and metals prices has been amplified by the rapid output growth in emerging markets. For oil, two statistically similar specifications were obtained. In the first, the effects of strong growth in the non-OECD economies are reflected in a long-run levels term in the volume of world GDP and in a

dynamic term in the share of the non-OECD economies in the level of world trade. A limitation of this equation, estimated over a sample from the mid-1980s to 2005, is that the long-run income elasticity is very high, at 1.7%, almost certainly reflecting the strong growth in oil demand and real oil prices over the estimation sample.

The second specification sought to test directly for the possible recent impact of strong growth in the non-OECD by including a variable for the differential between the rates of GDP growth in the non-OECD and the OECD starting in 2001. The coefficient on this term is both positive and statistically significant. Incorporating the additional measure also causes the long-run income elasticity to halve, although it remains significantly different from zero (at the 10% level).[17]

For metals prices in real terms, recent demand-related pressures were also found to be best reflected by the differential between the rates of GDP growth in the non-OECD and the OECD. In effect, this corresponds to the rate of change of the non-OECD share of world GDP. The level of world GDP and the non-OECD trade share measure were not found to be significant determinants of metals prices. No significant effects from any of these variables were found for the three agricultural commodity prices either. The differences between these findings and those for oil prices are likely to stem from supply being more elastic for non-oil commodities, with any initial increase in demand more rapidly offset by an expansion in supply.

An implication of these results is that a period in which growth in the non-OECD economies is faster than that in the OECD economies will ultimately have only a temporary positive impact on the level of real metals prices. In contrast, the impact on real oil prices will be permanent because the higher level of global GDP that results is implicitly taken to imply a permanent increase in the level of oil demand with supply being less than fully elastic. In practice it seems unlikely that the longer-term difference in the impact on metals and oil prices would be as pronounced as this, even if such a feature is present in the comparatively short sample used for estimation.

Fluctuations in output gaps are also found to have a significant short to medium-term influence on each of the commodity prices by Pain *et al.* (2006), although there are marked differences in the size and direction of the effect on individual commodities. An increase in global output relative to trend is found to raise initially the real price of each commodity group. This change quickly fades for the prices of food and tropical beverages, but is found to persist for several years for oil prices and, to a lesser extent, metals and agricultural raw materials prices. For oil prices, the impact of an increase in the global output gap is found to be larger if it coincides with an increase in the non-OECD output gap, consistent with what might be expected given the different industrial structures in the OECD and the non-OECD.

Estimates of the impact of non-OECD growth on commodity prices

In order to quantify the impact of the strong growth in the non-OECD economies on commodity prices in recent years the econometric equations were simulated under two assumptions. Firstly, that the share of the non-OECD in world trade remained unchanged from the average level in the year 2000, and secondly that GDP in the non-OECD economies grew only at the rate of OECD GDP from 2000. The resulting calculations of the change in prices are only suggestive, but serve to illustrate the possible orders of magnitude involved. As the non-OECD share of world trade and GDP rose throughout the period from 2001-05, the alternative path implies an increasingly large divergence from the actual outturn.[18] As a result, the impact on real prices of the change also increases in size over time.

For oil prices, the impact of holding the non-OECD trade share fixed at its level in 2000, and letting non-OECD GDP grow in line with OECD GDP, is to bring about a decline relative to baseline of just over 40% in the level of the real oil price by the end of 2005 (Figure 7a) when using the second oil price equation. In nominal terms this is equivalent to a decline to just under $35 per barrel in the price of oil in the fourth quarter of 2005. Although this represents a sizable difference from the actual outturn, it does not entirely remove the strong growth in oil prices after 2002, as can be seen from Figure 7b. In the alternative oil price specification without the extra variable for the growth differential from 2001, the real oil price was lowered by some 20% by the end of 2005 from its baseline level.

Figure 7a. **Removing the impact of non-OECD growth on real oil prices**

Percentage deviations from baseline

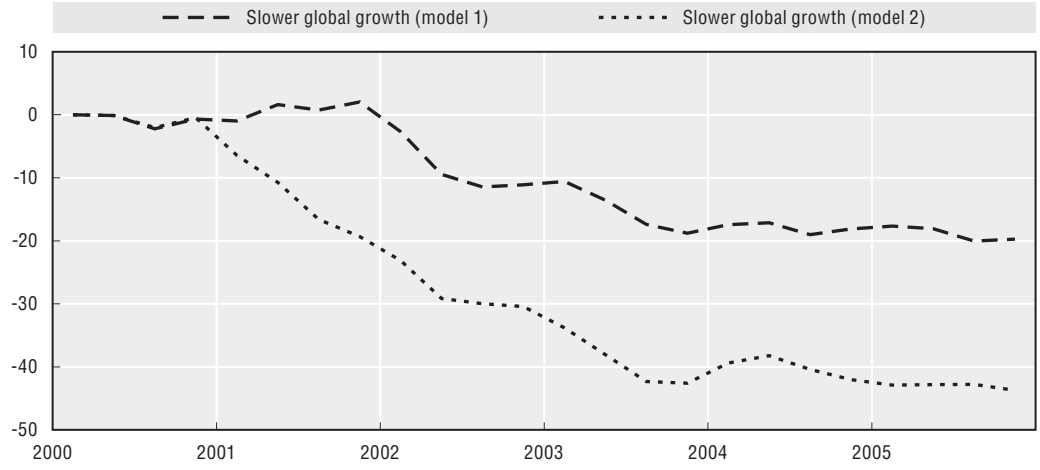
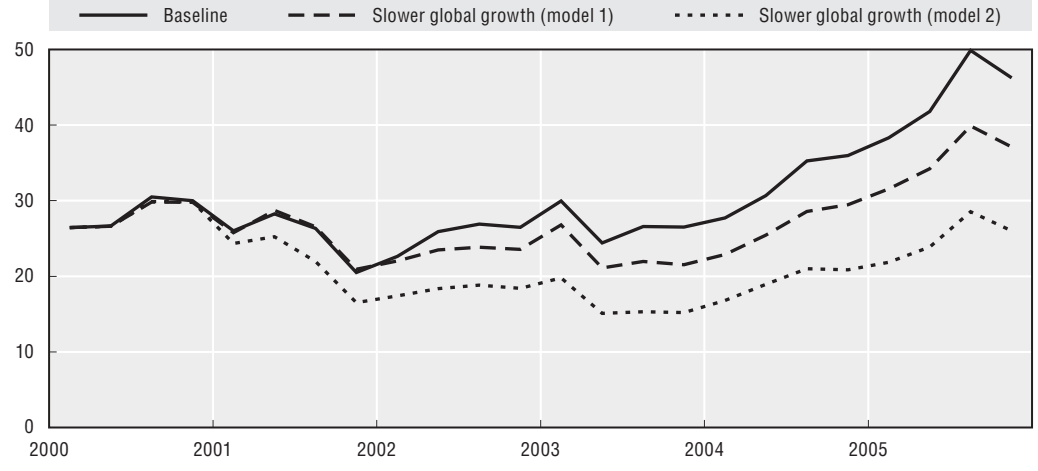


Figure 7b. **The profile of real oil prices**

$ per barrel, 2000 prices



For metals prices, corresponding estimates are also based on the assumption that GDP in the non-OECD economies grew at the rate of OECD GDP from 2000. The resulting changes in the profile of metals prices are smaller than for oil prices, with the real metals price being about 10% lower by the fourth quarter of 2005 than would otherwise have been the case. This accounts for only a small fraction of the actual growth in metals prices after 2002 (Figures 8a and 8b).

Figure 8a. **Removing the impact of non-OECD growth on real metals prices**

Percentage deviations from baseline

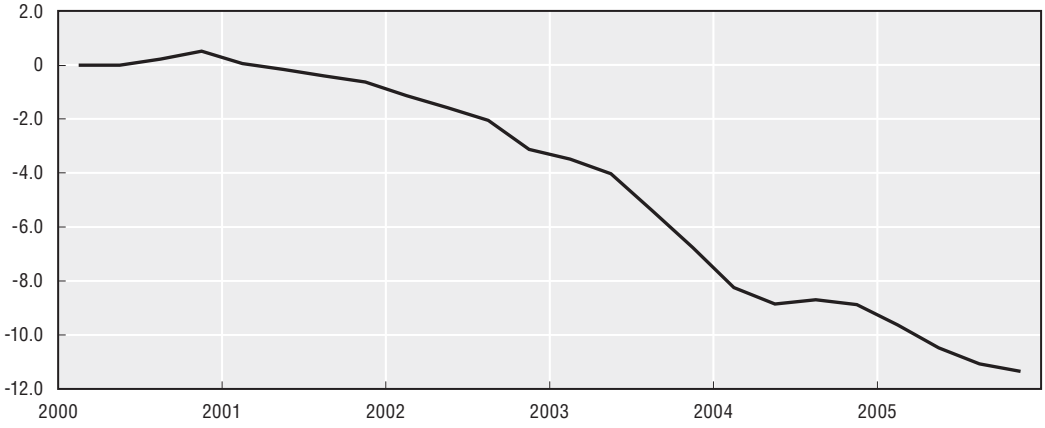
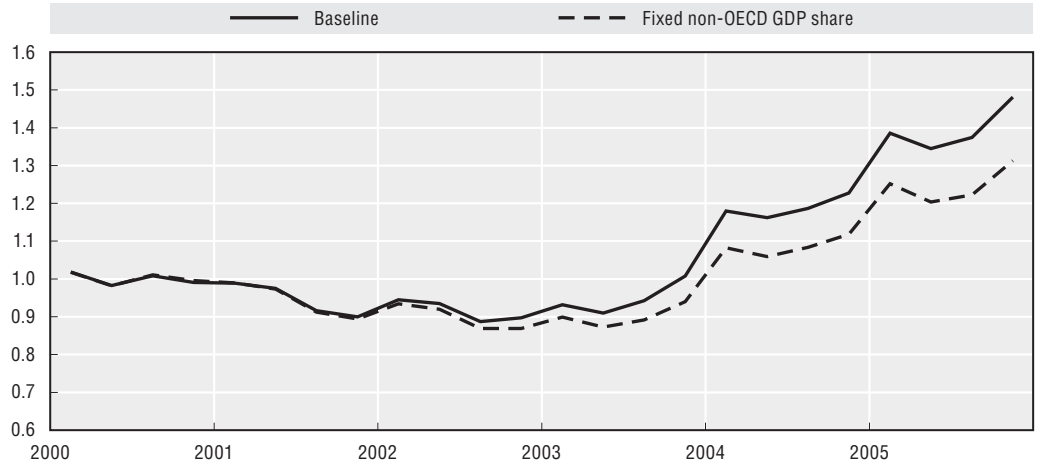


Figure 8b. **The profile of real metals prices**

2000 = 1.0



The alternative profile of oil prices also has a small impact on the prices of agricultural raw materials, reducing these prices by between 1-1½ per cent over the course of 2003-05 in the scenario in which oil prices declined by just over 40% by the end of 2005. The prices of food and tropical beverages remain unchanged.

Other analytical studies have also suggested that strong output growth could have a sizable effect on commodity prices. A related scenario for future oil demand in China is considered in CBO (2006), with oil demand in China from 2006 to 2010 rising by 7½ per cent per annum, similar to the rate seen from 2000 to 2005. This is estimated to be associated with an increase of $14 per barrel in real oil prices, which would be equivalent to an increase of almost 25% on the average price of a barrel of Brent crude oil in 2005. Adams and Ichino (1995) estimate that a sustained rise of 0.5 percentage point in the annual rate of growth of world GDP is associated with increases of almost 12 and 10% in real oil and metals prices respectively, after six years.

The scenario analysis of the impact of reduced levels of activity in the non-OECD economies does not consider short-term cyclical influences on prices, with world and non-OECD output gaps being left unchanged. However, if slower growth originated at least

in part from the demand side, it could be argued that they should also weaken.[19] In order to evaluate the sensitivity of commodity prices to cyclical changes in output gaps, a second set of scenarios was constructed in which the output gap was changed for a short period of time. Two alternative paths were considered – a 2 percentage-point reduction in output lasting for one year and a 1 percentage point reduction in demand relative to potential lasting for two years. Both changes would imply relatively large movements in the world output gap compared with those seen over the estimation period.

The results of this exercise, again holding world export prices and all other factors constant, also illustrate the different sensitivities of each real commodity price to cyclical influences (Figure 9). The largest and most persistent effect is on real oil prices, with prices reduced by up to 20-25% in the two scenarios, and returning back to their baseline levels only after five years. The real prices of agricultural raw materials and metals initially fall by up to 8 and 10% respectively, before rising and returning above the baseline level after two years, which is consistent with what might be expected in these markets as supply responds to the initial demand-driven reduction in prices. The real prices of food and tropical beverages initially decline by between 5 and 10% in the first year in which the output gaps are reduced, before rising above previous levels in the second year.

Overall, it is clear that the recent period of strong output and trade growth in the non-OECD economies and, by extension, the increasing internationalisation of production and offshoring from the OECD to the non-OECD economies, has placed significant upward pressure on the prices of many commodities. This is especially so for oil. The impact varies across commodities and has also built up over time. However, it is equally clear that growth in the non-OECD is not the only factor behind the recent acceleration in commodity prices after 2002.

The impact of globalisation on consumer price inflation

This section provides an overview of the main findings from existing studies and then presents new empirical estimates of the wider impact of globalisation on consumer price inflation in OECD economies. The new evidence includes tests of whether inflation dynamics changed in the mid-1990s when the extent of globalisation began to increase. Given that the determinants of domestic inflation process are found to have changed around that time, the following section then explores the size of the impact of globalisation by conducting a scenario analysis, which explicitly distinguishes between the impact via non-commodity and commodity import prices.

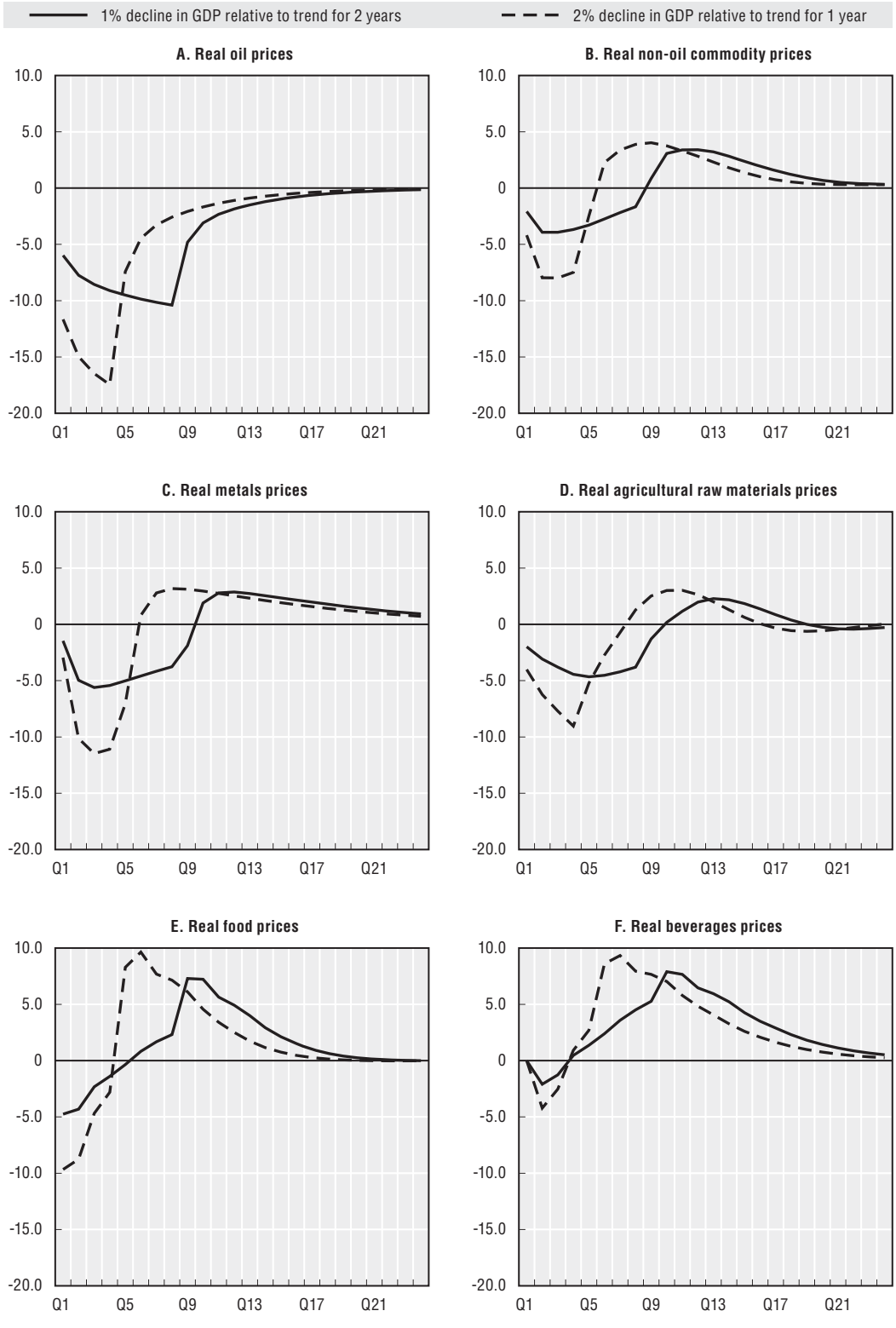
Existing studies of globalisation and inflation

Although there is a sizeable literature on the determinants of inflation in OECD countries (Melick and Galati, 2006), only a few papers assess the impact of globalisation on inflation directly. Other studies find evidence of structural changes in the inflation process that may possibly be related to aspects of globalisation, but this is not tested explicitly.

Several general conclusions emerge from this literature. Firstly, imports from low-cost countries contribute to lower domestic inflation via both a direct accounting effect and also an indirect effect, whereby lower cost imports put pressure on domestic producers in import-competing industries to lower their prices. The size of this indirect effect appears to be positively related to the intensity of foreign competition. Secondly, increased trade integration appears to have changed the intensity of the response of inflation to cyclical output fluctuations in OECD economies. With the prices of many domestic goods being

Figure 9. **Real commodity prices**

Per cent effect of a temporary increase in output gaps



determined increasingly by global demand and supply conditions, domestic inflation has become less sensitive to measures of domestic economic slack and more sensitive to measures of foreign economic slack. Thirdly, global competition is generally found to have reduced the extent to which exporting firms are passing through exchange rate changes into domestic currency prices. Finally, inflation persistence seems to have declined in many countries over the past decades, helped by greater central bank credibility. A more detailed overview of several recent studies is given below.

The existing literature also suggests that the results of these studies vary across countries and are sensitive to the sample period that is used. The general conclusions drawn in the previous paragraph do not necessarily apply to all OECD countries. In particular, the evidence of changes in inflation persistence and the relative influence of domestic and foreign economic conditions on inflation is sensitive to the countries included in the estimation sample.[20] For these reasons, the empirical work below allows for the possibility of different coefficients across countries, rather than simply imposing common coefficients on all.

Trade openness and inflation

Several studies have examined the relationship between trade openness and the level of inflation both for the economy as a whole and for particular manufacturing industries. One approach has been to directly estimate the "mechanical" impact of imported goods from lower-cost economies on inflation in the importing economies (Kamin *et al.*, 2006; OECD, 2006). They typically find that lower cost imports place a modest, *ex ante* downward impact on consumer price inflation, with a more marked impact on import price inflation. These effects are found to vary over time and across countries. More generally, the impact of enhanced trade openness on consumer price inflation has also been found to be sensitive to the countries included in the estimation sample. Typically, smaller estimates are found for developed economies than for developing ones (Temple, 2002; Wu and Lin, 2006).

The impact of globalisation on inflation is explored in IMF (2006a), using a Phillips curve framework in which current inflation is related to lagged inflation, import price inflation, the change in the oil price, and the output gap. To account for the impact of globalisation, interaction terms are introduced, with past inflation being interacted with a measure of monetary credibility, import price inflation being interacted with import penetration, and the output gap being interacted with openness, monetary credibility, average inflation, and a wage bargaining index. The model is estimated for a panel of eight countries (the G7 countries and Australia) over the period 1960 to 2004. The sensitivity of inflation to the domestic output gap is found to have fallen over the sample period.[21] The key factor behind this decline is found to be trade openness. In general, import prices are found to have only a small influence on domestic inflation. Although a fall in import prices drives down consumer price inflation initially, the effect vanishes after about two years.

A number of studies have shown that industry-level price inflation is significantly related to measures of import competition (Gamber and Hung, 2001; Chen *et al.*, 2004; IMF, 2006a). Gamber and Hung (2001) relate price inflation in 44 industries in the United States to import price inflation and an interaction term between import price inflation and industry-level import penetration, which is a measure of the intensity of foreign competition. Both terms are found to have statistically significant coefficients, suggesting that the impact of import prices on domestic prices is positively related to the intensity of foreign competition. In a related study using data for a sample of manufacturing industries

in seven European Union member states, Chen *et al.* (2004) estimate that the observed increase in openness over the sample period reduced industry mark-ups by 1.6 percentage points on average.[22] Although the impact of the mark-up and productivity effects at the sectoral level is marked, reducing inflation by 0.3 percentage points per annum on average in the industries concerned, the impact is minimal at the economy wide level.

The determinants of changes in producer prices for 16 manufacturing industries in 11 OECD countries are also explored in IMF (2006a). It is found that changes in relative producer prices in a certain sector (measured by the deviation of producer prices in that sector from average producer prices across all sectors) are negatively related to changes in that sector's exposure to globalisation as measured by its import-to production ratio. On average, a 1 percentage-point increase in the import-to-production ratio is estimated to reduce relative producer prices by 0.1%.[23] The contribution of increased openness to lower inflation appears to be twice as strong in low-tech sectors as in high-tech sectors. Moreover, the impact has increased over time; about 40% of the decline in relative prices of the manufacturing sector since 1995 is explained by openness, compared with only 25% during the 1980s and early 1990s.

The influence of foreign capacity on domestic inflation

A number of studies have sought to test directly whether measures of foreign output gaps or capacity utilisation have a direct impact on domestic inflation. The findings from such studies have been mixed. For the United States, some have found little evidence that foreign capacity utilisation has a significant impact on domestic inflation (Corrado and Mattey, 1997; Tootell, 1998), but others have come to the opposite conclusion (Gamber and Hung, 2001). More recent multi-country studies also yielded mixed results. For example, while the studies by Borio and Filardo (2006) and Vega and Winkelried (2004) suggest that measures of foreign economic slack play an important role in explaining inflation dynamics in OECD countries, Ihrig *et al.* (2007) find insignificant or incorrectly signed coefficients on foreign output gaps in Phillips curve equations for a set of eleven industrial countries.

Borio and Filardo (2006) test whether the gap between headline and core inflation is related to measures of the global output gap. Using a sample of 16 OECD economies it is found that the global output gap is significant, with its inclusion reducing the significance of the domestic output gap.[24] Moreover, a rolling regression exercise suggests that the importance of global measures of economic slack has risen over time.[25] To some extent these findings are not surprising. The gap between headline and underlying inflation includes energy and food prices, where global conditions on commodity prices have an important influence on domestic pricing. As discussed above, estimates of the global output gap have a significant positive relationship with commodity price inflation.

A related approach to the possible link between global economic conditions and national inflation rates is pursued by Ciccarelli and Mojon (2005). This study uses a dynamic factor approach to obtain a measure of global inflation from the national inflation rates of 22 economies. This measure is then found to be an attractor of national inflation rates suggesting that national inflation rates are indeed sensitive to economic conditions in other countries. This leaves open the issue of what is driving global inflation.[26]

A possible corollary to the finding that inflation has become more sensitive to global conditions over time is that it may have become less sensitive to domestic conditions. The latter appears to be a common finding from many empirical studies for individual OECD

economies (Melick and Galati, 2006), although it is not a universal one. For the United States, Dexter *et al.* (2005) demonstrate that the breakdown in the relationship between domestic capacity utilisation and domestic inflation found in other empirical studies disappears once controls are included for the effects of international trade. Ihrig *et al.* (2007) find evidence of a decline in the sensitivity of inflation to movements in the domestic output gap, but do not find significant evidence that this is due to globalisation.

Changes in exchange-rate pass-through to domestic prices

A number of recent studies have sought to test the proposition by Taylor (2000) that global competition should reduce the extent to which exporting firms are able to pass through exchange rate movements into the domestic currency prices charged to importers. This has been found to have considerable empirical support (see, for example, Olivei, 2002, Gagnon and Ihrig, 2004 and Marazzi *et al.*, 2005). The latter study estimates that exchange rate pass-through to United States import prices has declined from above one-half during the 1980s to around one-fifth during the last decade. This decline is found to be due to both a shift of imports away from commodities to manufacturing goods which tend to have lower pass-through rates (Campa and Goldberg, 2003; Pain *et al.*, 2005) and to a general decline in the exchange rate pass-through across all product categories (Olivei, 2002). Gust *et al.* (2006) demonstrate in a dynamic general equilibrium model that this observed decline in the exchange rate pass-through stems mainly from the increasing trade integration of the United States. For Japan, a decline in exchange rate pass-through is found to be spread across products, rather than being due to a shift in the composition of imports (Otani *et al.*, 2003). For the euro area, Campa *et al.* (2005) find that a structural break in the exchange rate pass-through into import prices is evident only in a small number of manufacturing industries. Overall, these results provide indirect evidence that the competitive impact of enhanced openness may matter and that it might vary across economies.

Changes in inflation persistence

An important issue for monetary policy is whether past inflation has a significant role in determining present inflation (*i.e.* whether inflation is persistent) or whether expectations of future inflation are more important.[27] A higher degree of inflation persistence implies that stabilising inflation following economic "shocks" may require higher temporary costs to output. This has led to a series of studies testing whether the persistence of domestic inflation has changed over time. Again, the findings differ by country, by period considered and by the estimation technique used (Melick and Galati, 2006).[28]

Altissimo *et al.* (2006) find that inflation persistence in the euro area has declined substantially since the 1970s once changes in the mean of inflation are allowed for and that the breaks in the mean coincide with shifts in the monetary policy regime. The link between changes in inflation persistence and changes in monetary credibility is confirmed by IMF (2006a) for a set of eight OECD countries. According to these estimates, strengthened monetary credibility reduced inflation persistence (as measured by the coefficient on lagged inflation) from 0.7 in the early 1980 to 0.6 in 2004.

Testing for the impact of globalisation

The empirical analysis in the present study differs from the above studies in several respects. First, the above studies examine the relationship between globalisation and inflation within an extended Philips-curve framework. Such a framework does not allow

for a potential effect of measures of globalisation on price levels. The present study attempts to overcome this by estimating an error correction model for consumer prices, relating prices to import prices, unit labour costs and the domestic output gap.[29] It thus accounts explicitly for a possible price level effect from globalisation, as reflected in the level of import prices. Secondly, the present study takes a broader view than many others by examining a range of possible effects from globalisation for a large set of OECD countries. Finally, the econometric analysis is complemented by a scenario analysis which quantifies some of the possible impacts of globalisation on domestic inflation, with import price inflation split into commodity and non-commodity components. This provides a richer analysis of underlying inflation dynamics than previous studies.

The empirical work examines the impact of globalisation as reflected in the price of imported goods and services. This is done using an error-correction model for the private consumption deflator in 21 OECD economies over the period 1980-2005,[30] with consumer prices being related to import prices, unit labour costs and the domestic output gap:

$$\Delta \ln P_{i,t} = (\alpha_{0i} + \varphi_{0i}D) + (\alpha_{1i} + \varphi_{1i}D)\left(\ln P_{i,t-1} - (\alpha_{2i} + \varphi_{2i}D)M^{SH}_{i,t-1} \ln P^{M}_{i,t-1} - \left(1 - (\alpha_{2i} + \varphi_{2i}D)M^{SH}_{i,t-1}\right)\ln C_{i,t-1}\right)$$
$$+ \sum_{j=1}^{4}\left(\beta_{ji} + \varphi_{ji}D\right)\Delta \ln P_{i,t-j} + \sum_{j=0}^{4}\left(\gamma_{ji} + \lambda_{ji}D\right)\Delta \ln P^{M}_{i,t-j} + \sum_{j=0}^{4}\left(\delta_{ji} + \kappa_{ji}D\right)\Delta \ln C_{i,t-j} \qquad [1]$$
$$+ (\alpha_{3i} + \varphi_{3i}D)GAP_{i,t-1} + \varepsilon_{it}.$$

The subscript *i* denotes the country and the subscript *t* the time period. The variables are defined as follows: *P* represents domestic prices measured by the private consumption expenditure deflator,[31] P^M represents import prices measured by the deflator of imports of goods and services, *C* represents domestic costs, proxied by unit labour costs of the total economy, *GAP* is the domestic output gap, and ε is an error term. The equations also include seasonal dummies as well as time dummies to account for changes in indirect taxes and similar events. Static homogeneity is imposed on all equations so that the mark-up of prices over costs is independent of the price level. Dynamic homogeneity is not directly imposed on the system. A test of this restriction is carried out after estimating the system and found to be strongly rejected by the data.

Initial parameter stability tests revealed evidence of a significant structural break in the parameters in the consumer price equations in the mid-1990s. To overcome this, two modifications were found to be necessary. The first was to interact the long-run import price coefficient with the share of imports in domestic demand, denoted M^{SH} in [1].[32] This implies that the long-run coefficient on import prices rises over time in most countries in the sample, in line with increases in import penetration, with an equivalent decline in the long-run coefficient on domestic unit labour costs. But even with this modification, there continued to be evidence of parameter instability in the mid-1990s. The second modification was thus to allow for separate parameter estimates before and after 1995 by introducing a dummy variable *D* that is equal to unity from 1995 onwards. This overcomes the parameter instability when there is only a single set of parameters for the whole estimation period.[33]

The set of equations is estimated jointly using the seemingly unrelated regression procedure (SUR), first proposed by Zellner (1962). Cross-country restrictions are imposed as the data permit.[34] In the empirical model the long-run coefficient on the import price term will reflect not only the direct weight of imports in private consumption, but also the wider influence of import competition on the prices set by actual and potential competitors. The unit labour costs term will reflect indirect effects from globalisation via wages and productivity.[35]

Summary of empirical results

The empirical analysis highlights a number of important ways in which the behaviour of consumer prices appears to have changed over the past decade. Of these, the most notable is the extent to which import prices have become a more important determinant of consumer prices over time in all OECD countries, implying that foreign economic conditions have become a more important influence on domestic inflation. At the same time, domestic inflation is found to have become less sensitive to temporary changes in the domestic output gap. Other notable changes include evidence that inflation persistence has declined in most OECD countries and that the speed of adjustment towards the "desired" price level has slowed over the past decade.

During the first part of the sample period, from 1980 to 1994, the data support the formation of two country groups for the interaction term between import prices and import penetration. The long-run coefficients on the two interaction terms are very different, having values of 2.1 and 0.4 respectively (Table 1).[36] In the second part of the sample period, from 1995-2005, the long-run coefficient on the interaction term is found to rise to a common value of 2.6 for both groups of countries (Table 2).[37] This suggests that during the more recent period domestic producers have increasingly taken greater account of foreign competitors when setting their prices, so that import prices have a larger influence on domestic prices than their share in domestic demand would suggest.[38] The results also imply that the sensitivity of consumer prices to import prices will differ considerably across countries, reflecting differences in import penetration.[39]

The domestic output gap is found to have a significant impact on consumer price inflation in all of the countries in the sample, with the size of the initial impact being smaller in the more recent period. On average across countries, a rise in the domestic output gap by 2 percentage points for four consecutive quarters raises inflation in the following two years by 0.1 percentage point per annum less in the second part of the sample (1995-2005) than in the first part (1980-94). This is similar to, but slightly smaller than, the finding reported in IMF (2006a).

The model employed in the analysis automatically incorporates an indirect effect from foreign economic conditions, as mediated through import prices.[40] Augmenting the model with an additional world output gap variable and testing the joint significance of the coefficients on this term for all countries suggests that the world output gap does not have a significant additional direct influence on domestic inflation in either of the two sub-periods. Hence the indirect effect through import prices seems to be the only channel through which foreign economic conditions affect consumer price inflation.[41, 42] This implies that the importance of foreign economic conditions for domestic inflation will vary across countries, reflecting the different forces that influence international trade prices for each country (Pain *et al.*, 2005), as well as differences in import penetration. The coefficients on the domestic output gap are not affected by the inclusion of the foreign output gap; they remain significant with magnitudes that are close to the base specification.

There is also no strong evidence that the short-run reaction of domestic producers to import price changes varies with the type of import goods. When augmenting the equation with current and lagged changes of commodity import prices, these additional terms were found to be significant for only a small number of countries,[43] suggesting that, in general, changes in commodity import prices have the same impact on consumer price inflation as do changes in non-commodity import prices.

Table 1. **Regression results, 1980-94**

	α_0	α_1	α_2	β_1	β_2	β_3	β_4	γ_0	γ_1	γ_2	γ_3	γ_4	δ_0	δ_1	δ_2	δ_3	δ_4	α_3
AUS	–0.031	–0.047	2.074		0.084	0.263		0.061	0.012	–0.022			0.059		0.033			0.00068
	[0.216]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]	[0.011]	[0.009]			[0.000]		[0.000]			[0.000]
AUT	0.016	–0.022	0.378	0.118	0.269	0.263		0.020	0.116		0.060	–0.105	0.016	0.027		0.020		0.00031
	[0.657]	[0.000]	[0.007]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]	[0.000]	[0.103]	[0.019]		[0.043]		[0.001]
BEL	0.091	–0.022	2.074	0.858	–0.426	0.099		0.182	–0.141	0.060	–0.046	0.022	0.193	–0.130		0.020		0.00012
	[0.017]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.023]	[0.012]	[0.000]	[0.000]	[0.000]		[0.043]		[0.000]
CAN	0.039	–0.059	2.074	0.118				0.020	0.039				0.193		0.077	0.020	0.032	0.00025
	[0.017]	[0.000]	[0.000]	[0.000]				[0.000]	[0.000]				[0.000]		[0.000]	[0.043]	[0.025]	[0.000]
DNK	0.029	–0.059	0.378	0.118	0.084		0.303	0.182					0.016	0.072				0.00025
	[0.172]	[0.000]	[0.007]	[0.000]	[0.000]		[0.000]	[0.000]					[0.103]	[0.000]				[0.000]
FIN	0.039	–0.047	2.074	–0.172	0.084	0.099		0.020	0.039		0.021	0.022	0.016	0.027	0.077		0.032	0.00026
	[0.176]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]		[0.016]	[0.000]	[0.103]	[0.019]	[0.000]		[0.025]	[0.000]
FRA	0.025	–0.059	0.378	0.480		0.099		0.084	–0.033	0.028			0.016	0.072				0.00025
	[0.02]	[0.000]	[0.007]	[0.000]		[0.000]		[0.000]	[0.000]	[0.000]			[0.103]	[0.000]				[0.000]
DEU	0.079	–0.022	0.378	0.118	0.269			0.104	–0.033		0.060		0.104		0.033	0.020		0.00012
	[0.052]	[0.000]	[0.007]	[0.000]	[0.000]			[0.000]	[0.000]		[0.000]		[0.000]		[0.000]	[0.043]		[0.000]
GRC	0.552	–0.047	0.378		0.084		0.408	0.020		0.028		0.022			0.033	0.020	0.032	0.00068
	[0.000]	[0.000]	[0.007]		[0.000]		[0.000]	[0.000]		[0.000]		[0.000]			[0.000]	[0.043]	[0.025]	[0.000]
IRL	–0.008	–0.022	2.074	0.118	0.084		0.212	0.084		0.060	–0.046	0.111	0.059		0.033			0.00051
	[0.871]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]		[0.023]	[0.012]	[0.000]	[0.000]		[0.000]			[0.000]
ITA	0.047	–0.059	2.074	0.232		0.099		0.061	0.012				0.016	0.027	0.033			0.00033
	[0.014]	[0.000]	[0.000]	[0.000]		[0.000]		[0.000]	[0.011]				[0.103]	[0.019]	[0.000]			[0.001]
JPN	0.049	–0.022	0.378		0.084	0.099	0.212	0.020	0.012				0.104	0.027				0.00012
	[0.159]	[0.000]	[0.007]		[0.000]	[0.000]	[0.000]	[0.000]	[0.011]				[0.000]	[0.019]				[0.001]
KOR	0.038	–0.047	0.378	–0.172		0.099	0.303	0.061	0.039						0.033		0.032	0.00026
	[0.402]	[0.000]	[0.007]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]						[0.000]		[0.025]	[0.000]
NLD	0.057	–0.022	0.378	–0.213	0.084		0.212	0.084	0.037	0.028	0.021	0.022	0.193	0.072	0.077	0.020		0.00031
	[0.362]	[0.000]	[0.007]	[0.000]	[0.000]		[0.000]	[0.000]	[0.001]	[0.000]	[0.016]	[0.000]	[0.000]	[0.000]	[0.000]	[0.043]		[0.000]
NOR	0.037	–0.059	2.074		–0.426	0.099		0.020	0.037				0.016		0.077		0.235	0.00025
	[0.356]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]	[0.001]				[0.103]		[0.000]		[0.000]	[0.000]
PRT	0.081	–0.047	2.074	0.480	0.084			0.104	–0.033			0.022	0.104	–0.130		0.020	0.032	0.00020
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]	[0.000]			[0.000]	[0.000]	[0.000]		[0.043]	[0.025]	[0.000]
ESP	0.103	–0.047	2.074	–0.172	0.269	0.099			0.037	0.028	0.021		0.016	0.180	0.033	0.020	0.032	0.00020
	[0.013]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]			[0.001]	[0.000]	[0.016]		[0.103]	[0.001]	[0.000]	[0.043]	[0.025]	[0.000]
SWE	0.074	–0.022	2.074	0.118		0.099	0.212	0.104				0.022	0.059	0.072	0.033	0.020		0.00009
	[0.331]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]				[0.000]	[0.000]	[0.000]	[0.000]	[0.043]		[0.000]
CHE	0.033	–0.022	2.074	0.480	0.084			0.061					0.059	0.027	0.033			0.00012
	[0.315]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]					[0.000]	[0.019]	[0.000]			[0.001]
GBR	0.013	–0.022	2.074			0.099	0.303	0.020	0.039	0.028		0.022	0.193	0.072	0.077	–0.145	0.032	0.00009
	[0.795]	[0.000]	[0.000]			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.025]	[0.000]
USA	0.095	–0.022	2.074	0.118		0.099	0.212	0.104					0.016			0.020		0.00012
	[0.001]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]					[0.103]			[0.043]		[0.001]

Note: The numbers in parentheses are the *p*-values of exclusion restrictions on the coefficients.

Table 2. **Regression results, 1995-2005**

	α_0	α_1	α_2	β_1	β_2	β_3	β_4	γ_0	γ_1	γ_2	γ_3	γ_4	δ_0	δ_1	δ_2	δ_3	δ_4	α_3
AUS	0.047	–0.020	2.608		0.084	0.263		0.061	0.012	–0.022			0.059		0.033			0.00029
	[0.381]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]	[0.011]	[0.009]			[0.000]		[0.000]			[0.000]
AUT	0.096	–0.020	2.608	0.118		0.263		0.020	0.116		0.060	–0.105	0.016	0.027				0.00029
	[0.012]	[0.000]	[0.000]	[0.000]		[0.000]		[0.000]	[0.000]		[0.000]	[0.000]	[0.103]	[0.019]				[0.000]
BEL	0.029	–0.020	2.608	0.363	–0.257	0.099		0.182	–0.141	0.131	–0.046	0.022	0.193	–0.130				0.00011
	[0.465]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]	[0.012]	[0.000]	[0.000]	[0.000]				[0.002]
CAN	0.094	–0.020	2.608	0.118				0.020					0.193		0.077		0.116	0.00008
	[0.060]	[0.000]	[0.000]	[0.000]				[0.000]					[0.000]		[0.000]		[0.000]	[0.001]
DNK	0.224	–0.020	2.608	0.118	0.084			0.182					0.016	0.072				0.00008
	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]					[0.103]	[0.000]				[0.001]
FIN	0.069	–0.020	2.608		0.084	0.099		0.020			0.021	0.022	0.016	0.027	0.077		0.116	0.00011
	[0.291]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]			[0.016]	[0.000]	[0.103]	[0.019]	[0.000]		[0.000]	[0.002]
FRA	0.062	–0.020	2.608	0.314		0.099		0.084	–0.033	0.028			0.016	0.072				0.00008
	[0.058]	[0.000]	[0.000]	[0.000]		[0.000]		[0.000]	[0.000]	[0.000]			[0.103]	[0.000]				[0.001]
DEU	0.162	–0.020	2.608	0.118				0.104	–0.033		0.060		0.104		0.033			0.00011
	[0.001]	[0.000]	[0.000]	[0.000]				[0.000]	[0.000]		[0.000]		[0.000]		[0.000]			[0.001]
GRC	0.102	–0.020	2.608		0.084		0.635	0.020		0.028		0.022			0.033		0.116	0.00029
	[0.267]	[0.000]	[0.000]		[0.000]		[0.000]	[0.000]		[0.000]		[0.000]			[0.000]		[0.000]	[0.000]
IRL	–0.079	–0.020	2.608	0.118	0.084		0.212	0.084		0.131	–0.046	0.111	0.059		0.033			0.00048
	[0.134]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]	[0.012]	[0.000]	[0.000]		[0.000]			[0.000]
ITA	0.017	–0.020	2.608	0.483		0.099		0.061	0.012				0.016	0.027	0.033			0.00011
	[0.742]	[0.000]	[0.000]	[0.000]		[0.000]		[0.000]	[0.011]				[0.103]	[0.019]	[0.000]			[0.002]
JPN	–0.064	–0.020	2.608		0.084	0.099	0.212	0.020	0.012				0.104	0.027				0.00011
	[0.121]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]	[0.011]				[0.000]	[0.019]				[0.002]
KOR	0.437	–0.020	2.608			0.099		0.061							0.033		0.116	0.00011
	[0.001]	[0.000]	[0.000]			[0.000]		[0.000]							[0.000]		[0.000]	[0.002]
NLD	0.200	–0.020	2.608	–0.213	0.084		0.212	0.084	0.037	0.028	0.021	0.022	0.193	0.072	0.077			0.00029
	[0.012]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.001]	[0.000]	[0.016]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]
NOR	0.075	–0.020	2.608		–0.257	0.099		0.020	0.037				0.016		0.077		0.235	0.00008
	[0.480]	[0.000]	[0.000]		[0.000]	[0.000]		[0.000]	[0.001]				[0.103]		[0.000]		[0.000]	[0.001]
PRT	0.211	–0.020	2.608	0.314	0.084			0.104	–0.033			0.022	0.104	–0.130			0.116	0.00008
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]	[0.000]			[0.000]	[0.000]	[0.000]			[0.000]	[0.001]
ESP	0.191	–0.020	2.608			0.099			0.037	0.028	0.021		0.016	0.180	0.033		0.116	0.00008
	[0.030]	[0.000]	[0.000]			[0.000]			[0.001]	[0.000]	[0.016]		[0.103]	[0.001]	[0.000]		[0.000]	[0.001]
SWE	–0.055	–0.020	2.608	0.118		0.099	0.212	0.104				0.022	0.059	0.072	0.033			0.00008
	[0.532]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]				[0.000]	[0.000]	[0.000]	[0.000]			[0.001]
CHE	0.065	–0.020	2.608	0.314	0.084			0.061					0.059	0.027	0.033			0.00011
	[0.082]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]					[0.000]	[0.019]	[0.000]			[0.002]
GBR	0.072	–0.020	2.608			0.099		0.020		0.028		0.022	0.193	0.072	0.077	–0.145	0.116	0.00008
	[0.178]	[0.000]	[0.000]			[0.000]		[0.000]		[0.000]		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
USA	0.147	–0.020	2.608	0.118		0.099	0.212	0.104					0.016					0.00011
	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]					[0.103]					[0.002]

Note: The numbers in parentheses are the *p*-values of exclusion restrictions on the coefficients.

The empirical results also indicate that the inflation process has become less persistent in the majority of the countries over the past decade, although in a small number of countries (Finland, Greece, Ireland, and Italy) past inflation appears to have become a more important determinant of current inflation.[44] Given that the model employed in the analysis is equivalent to one in which current inflation is related to past inflation and a fixed level of inflation expectations,[45] the change in inflation persistence might be related to a change in the relationship between inflation and inflation expectations.[46]

The error correction coefficients, though small in magnitude, are all highly significant in both sub-samples.[47] For the majority of the countries, the error correction coefficients become smaller in the second part of the sample period, implying that the speed of adjustment towards the "desired" price level has slowed. A possible explanation is the more direct focus of monetary policy on inflation objectives over the past decade, with the associated possibility of some degree of price level drift (Svensson, 1999).

Quantifying the overall impact of globalisation

On the basis of the preceding results a series of scenario analyses were carried out to obtain illustrative estimates of the possible direct impact of globalisation on consumer price inflation over the past ten years. These incorporate the main findings from the scenario analyses for commodity prices and the estimated "mechanical" impact on import prices as a result of the higher shares of trade with lower-cost producers discussed in the previous sections. Two alternative starting points for these scenarios are considered, the first quarter of 1995 and the first quarter of 2000.

A baseline scenario was obtained by forecasting consumer price inflation employing the coefficient estimates obtained for the period 1995-2005 and actual values of all exogenous variables. The forecast is dynamic in the sense that projected values of consumer prices are employed for the right-hand-side variables rather than the actual values of the lagged dependent variables. The average annual consumer price inflation rates in the baseline scenario are generally very close to actual annual inflation rates (see Table 3).

Then, various scenarios are undertaken by modifying the series on import price inflation, with import price inflation separated into its commodity and non-commodity parts. This requires assumptions about the rate of commodity and non-commodity import price inflation if globalisation had not taken place.[48] To take account of the uncertainty that surrounds the impact of globalisation on import prices, the scenario analysis derives a range of estimates employing different assumptions about the change in commodity and non-commodity import price inflation.

For commodity import prices, the scenario analysis uses the results discussed above, which derive an alternative path for each commodity price under the assumption of slower rates of growth in non-OECD trade and GDP since 2000. These changes are then combined using information on the composition of commodity imports to generate an alternative profile for the price of imported commodities in each OECD economy in the sample.[49] Two alternative profiles are constructed, one for each of the separate oil price estimates.

For the growth rate of non-commodity import prices, the scenario analysis assumes that in the absence of the rising level of imports from low-cost producers, price inflation would have exceeded the actual growth rate by 1 or 2 percentage points per annum, respectively. This reflects the range of estimates discussed earlier.

Table 3. **Average annual consumer price inflation, scenario analysis 1995Q1-2005Q4**

	Average annual inflation (in per cent)		Scenario, difference from baseline (in percentage points)	
	Actual	Baseline	1% point	2% points
Australia	2.0	2.0	0.2	0.4
Austria	1.5	1.5	0.3	0.5
Belgium	1.8	1.8	0.3	0.6
Canada	1.6	1.6	0.1	0.3
Denmark	1.9	1.8	0.3	0.6
Finland	1.7	1.7	0.2	0.3
France	1.2	1.2	0.2	0.4
Germany	1.1	1.1	0.2	0.4
Greece	4.8	4.7	0.3	0.6
Ireland	2.8	2.8	0.5	0.9
Italy	3.0	3.0	0.2	0.5
Japan	–0.5	–0.5	0.1	0.2
Korea	4.6	4.6	0.2	0.4
Netherlands	2.2	2.2	0.3	0.6
Norway	2.0	2.1	0.2	0.4
Portugal	2.9	2.9	0.3	0.5
Spain	3.2	3.1	0.2	0.4
Sweden	1.5	1.6	0.3	0.6
Switzerland	0.8	0.8	0.2	0.4
United Kingdom	2.2	2.2	0.2	0.4
United States	2.0	2.0	0.2	0.4
Euro area	2.0	2.0	0.2	0.5
OECD	1.7	1.7	0.2	0.4

Note: The scenario assumes that import price inflation (total goods and services) was 1 and 2 percentage points per annum above baseline, respectively.

Tables 3 and 4 compare the different scenarios by reporting differences from the baseline in average annual rates of inflation. For the simulation period from 1995 to 2005, only the results of the modification of non-commodity import price inflation are reported in Table 3. This provides a longer-term perspective on the influence of globalisation in the absence of any impact on commodity prices. If the prices of non-commodity imports had risen by 1 percentage point (2 percentage points) more per annum since 1995, inflation would, on average, have been 0.2 percentage point (0.4 percentage point) per annum higher in the OECD economies.[50] Starting the simulation in 2000 reduces the difference in OECD inflation from the baseline to 0.1 and 0.2 percentage point per annum, respectively.[51]

The impact of the changes in commodity import prices over the period 2000-05 is reported in Table 4 and summarised in Figure 10. In the scenario with a 20% decline in oil prices, OECD inflation is found to be reduced by 0.08 percentage point per annum on average from 2000 onwards. In the scenario with a 40% decline in oil prices, OECD inflation is reduced by 0.15 percentage point per annum. The impact differs considerably across countries, with the smallest changes found for Norway, Canada and the United Kingdom, and the highest found for Korea.[52]

The final column in Table 3 shows the combined effect on consumer inflation from higher non-commodity import price inflation and lower commodity import price inflation (see also Figure 10). The analysis suggests that consumer price inflation could have been up to 0.3 percentage point higher per annum in the euro area had the estimated effect of

Table 4. **Average annual consumer price inflation, scenario analysis 2000Q1-2005Q4**

	Average annual inflation (actual, in %)	Difference from baseline (in percentage points)				
		Non-commodity component		Commodity component		Net effect
		1% point	2% points	40% oil 10% metals	20% oil 10% metals	
Australia	2.4	0.1	0.3	0.0	–0.1	0.0 – 0.2
Austria	1.8	0.2	0.4	–0.1	–0.1	0.1 – 0.3
Belgium	2.3	0.2	0.4	–0.1	–0.2	0.0 – 0.3
Canada	1.8	0.1	0.2	0.0	0.0	0.0 – 0.1
Denmark	2.1	0.2	0.5	0.0	–0.1	0.2 – 0.4
Finland	1.9	0.1	0.2	–0.1	–0.1	0.0 – 0.2
France	1.5	0.2	0.3	–0.1	–0.1	0.0 – 0.3
Germany	1.4	0.2	0.3	–0.1	–0.1	0.0 – 0.2
Greece	3.4	0.2	0.4	–0.1	–0.2	0.0 – 0.3
Ireland	2.5	0.4	0.8	0.0	–0.1	0.3 – 0.7
Italy	2.8	0.2	0.4	–0.1	–0.2	0.0 – 0.3
Japan	–1.0	0.1	0.1	–0.1	–0.1	0.0 – 0.1
Korea	3.6	0.1	0.3	–0.1	–0.3	–0.1 – 0.1
Netherlands	2.7	0.2	0.4	–0.1	–0.2	0.0 – 0.3
Norway	1.9	0.1	0.2	0.0	0.0	0.1 – 0.2
Portugal	3.0	0.2	0.4	–0.1	–0.2	0.0 – 0.3
Spain	3.3	0.1	0.3	–0.1	–0.1	0.0 – 0.2
Sweden	1.5	0.2	0.5	–0.1	–0.2	0.1 – 0.4
Switzerland	1.0	0.1	0.3	0.0	–0.1	0.1 – 0.3
United Kingdom	1.7	0.1	0.2	0.0	–0.1	0.1 – 0.2
United States	2.2	0.2	0.3	–0.1	–0.2	0.0 – 0.2
Euro area	2.1	0.2	0.3	–0.1	–0.1	0.0 – 0.3
OECD	1.8	0.1	0.3	–0.1	–0.1	0.0 – 0.2

Note: The lower (upper) bound of the total impact is calculated assuming that the prices of non-commodity import price inflation was 1 percentage point (2 percentage points) per annum above baseline and that commodity import prices reflect the 20% (40%) oil price estimate. In both cases the metals price effect is 10%.

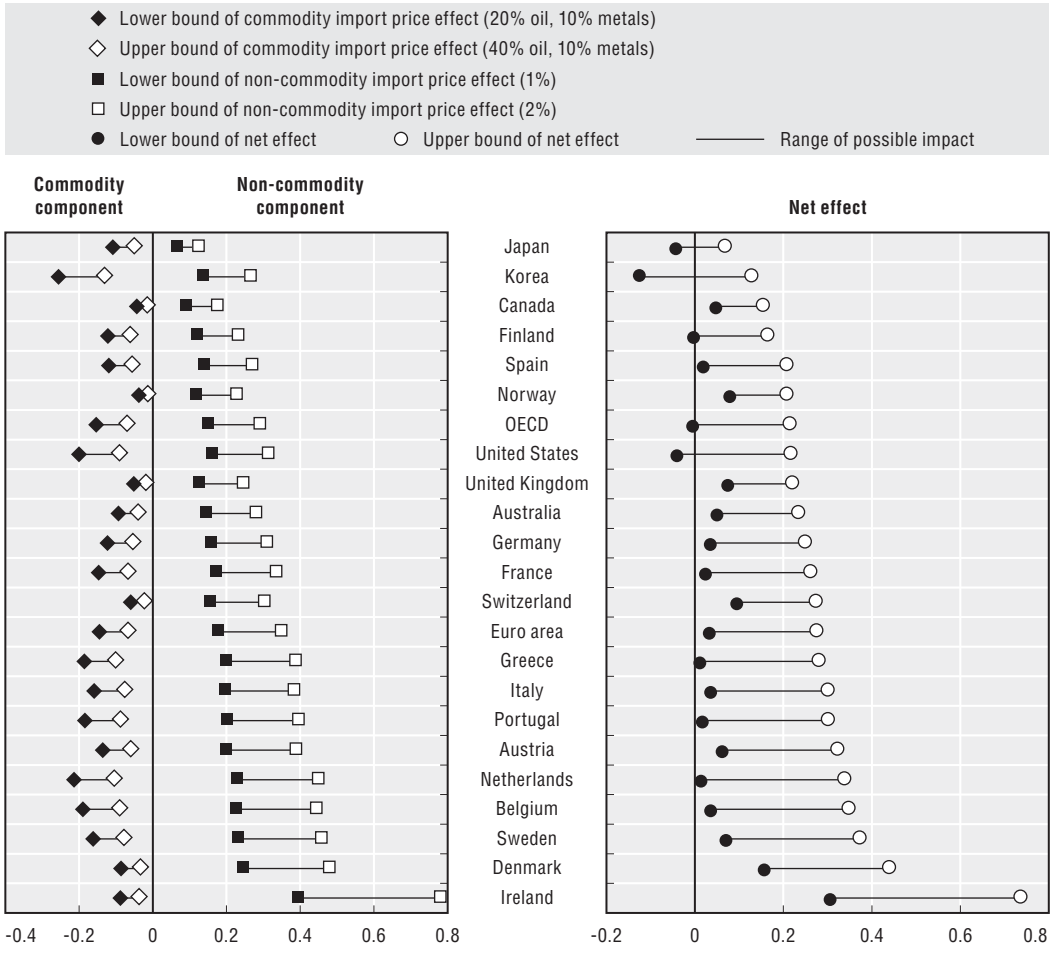
globalisation not occurred. For the United States, the estimated impact ranges from –0.04 to 0.21 percentage point per annum, suggesting that US inflation might even have been lower in the absence of globalisation.[53] For Japan, the net effect is very small, ranging from –0.04 to 0.06 percentage point per annum. The uncertainty surrounding the estimates for most countries tends to be quite large as indicated by the difference between the lower and the upper bound which amounts to over 0.2 percentage point on average.

Concluding remarks

The decline in consumer price inflation observed over the past 25 years in all OECD economies has coincided with a marked increase in the level of trade between the OECD and non-OECD economies. Against this background, this study has investigated the contribution of the increasing trade integration of non-OECD economies on the decline in OECD inflation. In doing so, the study has extended the existing literature on this topic in several important respects: a wider allowance is made for possible price level effects from globalisation, a larger number of countries are included in the analysis and separate impacts of commodity and non-commodity import prices are considered.

Figure 10. **The impact on consumer price inflation from removing globalisation effects 2000-05**

Average percentage point difference per annum



Note: See note to Table 4.

The main globalisation-related findings from the new econometric analyses of consumer and commodity prices in this paper are as follows:

- Import prices are found to have become a significantly more important influence on domestic consumer prices since the mid-1990s, coinciding with the growing participation of non-OECD countries in international goods and services trade.
- The impact of import prices on domestic prices in all countries over the past decade is estimated to be significantly larger than the weight of imported goods and services in domestic demand, suggesting that competition from lower-priced imports has placed pressure on domestic producers in import-competing industries to lower the mark-ups of prices over domestic costs.
- The cyclical sensitivity of inflation to domestic economic conditions has declined. At the same time, domestic inflation has become more sensitive to foreign economic conditions, working through import prices. However, there is no evidence of a robust significant impact from global output gaps in addition to that embodied in import prices.

- Strong GDP growth in the non-OECD economies since 2000 is found to be an important factor underlying the growth of real oil prices and real metals prices since 2002. A scenario analysis in which the non-OECD economies are assumed to grow at the same (lower) rate as the OECD economies since 2000 is found to be associated with a decline in real oil prices from baseline by 20-40% by the fourth quarter of 2005, and a decline in real metals prices of just over 10% from their baseline. This removes some, but not all of the strong growth in these commodity prices after 2002.

The econometric findings are also used to quantify the overall impact of particular aspects of globalisation on consumer price inflation in OECD countries over the period from 2000 to 2005. Two facets of globalisation are considered – the growth in commodity prices estimated to have resulted from strong output growth in the non-OECD economies, and a decline in the average rate of non-commodity import price inflation that is estimated to have resulted from higher levels of trade with non-OECD economies. Both of these estimates are uncertain and so a range of possible outcomes is considered in the quantification exercise.

On balance, if such changes had not occurred, it is likely that inflation would have been higher in all the OECD economies considered, all else being equal, consistent with the view that globalisation has had a disinflationary effect. For most countries globalisation is estimated to have been associated with a decline in the rate of consumer price inflation of between 0 to ¼ percentage point per annum since 2000. The impact was found to be a little larger in many European economies than elsewhere.

Even at the peak of the possible range of net effects the estimated impact on annual consumer price inflation appears to be modest, and no greater than the potential change in annual inflation that could result from a change in indirect taxes or administered prices. However, these calculations take the behaviour of domestic costs as given. To the extent that aspects of globalisation may be helping to restrain the cost of capital or labour costs (Rodrick, 1999; Dumont *et al.*, 2006; IMF, 2007), and also because of the potential feedback of changes in price inflation to wages, it is possible that the implicit net disinflationary impact of globalisation on price inflation is understated in this paper. The same holds for inflation expectations, if globalisation has led to a decline in inflation expectations or helped expectations to become better anchored.

Globalisation-related developments generate considerable challenges to monetary policy makers, even if they are continuing to place some downward pressure on inflation in almost all economies. Identifying the extent and persistence of structural change in the economy is difficult and could result in policy mistakes. To the extent that globalisation is changing the price level of imported non-commodity goods and services, the econometric analysis implies that in the long term there will be an effect only on the domestic price level rather than on domestic inflation. However, the adjustment to this new steady state is likely to be a lengthy process that will persist over several years to come, especially if the prices of traded services also begin to decline significantly relative to the prices of non-traded services.[54]

As regards non-oil commodities, increased supply should eventually lead to a reversal of currently high real metals prices, at least if past behaviour is a guide to the future. As regards oil, continued strong growth in the non-OECD economies can be expected to help keep prices high in real terms. At the margin, however, the effects of this may be attenuated in the longer-term as the non-OECD economies begin to attain less energy-intensive stages of development.

The uncertainty about the relative strengths of the various influences on inflation suggests that policymakers should examine developments in headline inflation as well as core inflation (Bean, 2006). The latter is usually regarded as a better signal of ongoing inflationary pressures, but the former will reflect both influences from globalisation.[55] If the favourable external conditions for low inflation begin to wane going forward, higher nominal interest rates may be required to keep inflation low.

Notes

1. Using disaggregated EU import price data (classified at the 8-digit level) Kaplinsky (2005) demonstrates that the proportion of sectors in which import prices fell between 1988 and 2001 is the higher the lower the per capita income of the country of origin.
2. The rise relative to domestic output or consumer prices is less marked, with trade prices having declined in real terms (Pain *et al.*, 2005).
3. The price series for metals and the agricultural commodities are composite indicators produced by the Hamburg Institute for World Economics (HWWA). The oil price series is the price of Brent crude.
4. Kamin *et al.* (2006) find little evidence that the rising share of Chinese goods in the United States has had a marked impact on producer price inflation.
5. To this extent, domestically generated inflation may end up being higher than otherwise. In this sense, the impact of higher trade with low-cost producers is inflationary (Rogoff, 2006).
6. World export prices are a weighted average of the export prices of those countries that export to the United Kingdom in US dollars.
7. Related findings for Norway, Sweden and New Zealand are reported by Melick and Galati (2006) and Hodgetts (2006).
8. Thus implicitly, the findings in OECD (2006) can be regarded as consistent with a view that trade with China and the other Dynamic Asian economies will have been lowered import price inflation in the United States and the euro zone by at least 1% per annum.
9. The group of "low-cost" producers considered in ECB (2006) includes the new member states and candidate countries of the EU, the CIS, Latin America, Africa and all Asian countries other than Japan.
10. Business services prices are measured using the deflator for imports of "other private services" in the United States national accounts.
11. Insofar as certain commodity-intensive activities have moved from other countries (including OECD countries) to China, the growth of Chinese demand for commodities may give an exaggerated impression of the net impact on demand for commodities of the emergence of China. For this reason, total non-OECD output measures are used in the empirical work, rather than just measures for China.
12. Although China and other emerging markets also make a significant contribution to global demand for other agricultural commodities (IMF, 2006b), the speed of response in supply can act to offset the impact of demand pressures on prices. Observed prices may also rise rapidly for reasons unconnected to demand pressures, such as weather-related supply fluctuations.
13. The weightings on individual commodities within these broad price indices will reflect global demand, rather than country-specific factors. In some cases important commodities for particular countries may not be included in the aggregate price measures at all.
14. A broader set of control variables were also considered initially for other possible macroeconomic influences, such as the US effective exchange rate and real short-term interest rate (Adams and Ichino, 1995; Hua, 1998).
15. The output gap is measured as the ratio of actual GDP to potential GDP.
16. The global output gap used in estimation is a GDP weighted average of separately estimated output gaps for the OECD and the non-OECD economies. The OECD output gap is calculated using a production function approach to assess potential output. The non-OECD output gap was derived using a measure of potential output derived from a Hodrick-Prescott filter.

17. Significant econometric results for oil prices could be obtained only when using a sample beginning in the mid-1980s. The findings were inconclusive when the estimation period was lengthened by including the acceleration in oil prices in the 1970s. One possible explanation for this is that supply-side factors were the dominant influence on prices in these earlier periods.

18. By the fourth quarter of 2005, world GDP in constant prices is around 10% below its actual value as a result of allowing non-OECD GDP to grow at the rate of OECD GDP from 2000 onwards.

19. To this extent, the results reported above may suggest a slight underestimation of the effects on real commodity prices.

20. See, for instance, the different findings for each of six OECD economies in Debelle and Wilkinson (2002).

21. For 2004, the estimation results imply an inflation-output elasticity of 0.2 compared with a value of 0.3 for 1960 and 1983.

22. Openness is also found to be associated with an increase in productivity of 11%, consistent with the hypothesis that the least productive domestic firms are forced to exit from the market as a result of additional import competition.

23. In addition to this direct effect, the study detects a small indirect effect of globalisation on producer prices that works through increased productivity growth.

24. This result is robust to the inclusion of three control variables (import prices, oil prices, and domestic unit labour costs).

25. The rolling regression results use pooled estimates across countries. As noted by Borio and Filardo (2006), the pre-conditions for obtaining unbiased parameters are not fulfilled in the data set used and these results should therefore be interpreted with care.

26. There are some preliminary results in the paper which suggest that the constructed measure of global inflation is significantly correlated with measures of global real and monetary conditions.

27. It is possible that future expectations are based, at least in part, on past inflation.

28. For example, Rudd and Whelan (2005) and O'Reilly and Whelan (2005) find little evidence that inflation persistence in the United States and in the euro area has changed over time, whereas Cogley and Sargent (2001), Clark (2003), Levin and Piger (2004) and Altissimo *et al.* (2006) all suggest that inflation persistence is markedly lower in recent years. Debelle and Wilkinson (2002) find that inflation persistence has declined in Australia and New Zealand, but has risen in the United Kingdom and the United States. Cecchetti and Debelle (2006) report only weak evidence of a decline in inflation persistence in recent years, even after allowing for a break in the mean of inflation.

29. In this respect, the present study is very similar to that of Ihrig and Marquez (2004), who use an error correction model to examine the contribution of productivity advancements and labour market slack to low inflation in OECD countries. However, in contrast to the present study, Ihrig and Marquez (2004) look entirely on domestic factors as drivers of the decline in inflation and do not address the extent to which globalisation lies behind the decline.

30. The countries included in the analysis are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. All data are taken from the OECD Economic Outlook database if not otherwise specified.

31. The private consumption deflator provides a broader measure of inflation than many national consumer or retail price series, and is in principle more directly comparable across countries because it comes from the system of national accounts.

32. A similar approach has been adopted in a number of related studies (see, for instance, Gamber and Hung, 2001 and IMF, 2006a). The import content of consumption is calculated as $M^{SH}_{i,t} = (M_{i,t} - \eta_i X_{i,t})/(M_{i,t} + Y_{i,t} - X_{i,t})$, where M denotes total imports, X denotes total exports, Y denotes domestic output and η is the share of imports used in the production of export goods. Estimates of η_i are taken from Pain *et al.* (2005, Table 7).

33. This was done by interacting the coefficients with dummy variables that are equal to unity from 1995 onwards. For simplicity, only the results of the final specification are summarised in the main part of the paper. A discussion of the results of the intermediate specifications can be found in Appendix 1 of Pain *et al.* (2006).

34. Imposing a single set of parameters common to all countries, as in other studies (IMF, 2006a, Borio and Filardo, 2006), was strongly rejected by the data.

35. Specification [1] has two important implications for the behaviour of the mark-up over marginal costs. First, the mark-up behaves pro-cyclically, increasing during an economic upturn and falling during an economic downturn. This proposition is in line with the empirical evidence provided by Haskel *et al.* (1995) and Ghosal (2000). Second, the reaction of the mark-up to changes in the import content of consumption depends on the ratio between import prices and unit labour costs: $\partial \ln (P_i/C_i)/\partial M_i^{SH} = \alpha_{2i} \ln (P_{i,t}^M/C_{i,t})$. If import prices are initially higher (lower) than unit labour costs, the mark-up increases (decreases) with a rise in the import content of consumption.

36. A coefficient of unity would indicate that the weight on import prices was exactly as might be expected given the share of imports in domestic demand.

37. For the G7 economies, the size of the coefficient on the interaction term implies that domestic costs have a bigger influence on domestic consumer prices than do import prices. Not surprisingly, for most of the smaller economies in the sample domestic costs have a smaller weight than import prices, implying that domestic prices in these countries are to a large extent driven by world market prices in the long-run. The size of the coefficient also implies that the direct (long-run) impact of a change in world oil prices is very similar to the present shares of energy in total private consumption expenditure in OECD economies.

38. This interpretation rests on the assumption that import prices are weakly exogenous to the system. Testing for weak exogeneity of import prices is not feasible in the current setting as it would require including a full set of import price equations in the system being estimated. If import prices were not exogenous, the rise in the coefficient could also reflect an increase in pricing to market by importers. However, it is possible to establish that the current change term in import prices is exogenous to the system, as shown by a Wu-Hausman test (the respective *p*-value is 0.11). The tests entails regressing the current change in import prices on a set of explanatory variables that are clearly exogenous to the system and then testing whether the residuals from this regression have any explanatory power in addition to the variables already included in the system.

39. Earlier attempts at imposing a common long-run coefficient on import prices in each country were rejected by the data, confirming that there are significant differences across countries in the influence of import prices.

40. Import prices of OECD economies depend on world export prices which, in turn, reflect capacity constraints and other cyclical conditions in the exporting economy (Pain *et al.*, 2005).

41. The coefficient on the world output gap is allowed to differ across countries in both sub-periods.

42. This finding differs from Borio and Filardo (2006) who demonstrate that measures of global economic slack have a significant influence on the inflation process even after controlling for the indirect impact via import prices. However, the results of the two studies are not directly comparable as Borio and Filardo (2006) use the gap between headline and core inflation as the dependent variable. In contrast, Ihrig *et al.* (2007) also find insignificant or wrongly signed coefficients on the foreign output gap term in Phillips-curve equations.

43. These are Canada and Germany in the first half of the sample and Canada, France and Ireland in the second half.

44. These mixed results are consistent with previous research, demonstrating that inflation persistence has risen in some countries but declined in others (Melick and Galati, 2006).

45. This can be seen by transforming a simplified version of equation [1] as follows:
$\Delta lnP_t = \alpha + \beta\Delta lnP_{t-1} = \beta\Delta lnP_{t-1} + (1-\beta)\Delta lnP^e + \xi$, where $\xi = \alpha - (1-\beta)\Delta lnP^e$.

46. For this reason, the finding that the sum of the coefficients on the lagged inflation terms is below unity need not imply a long-run trade-off exists between the level of inflation and the output gap. Inflation expectations, as reflected in the constants, in the estimated equations, also need to be taken into account.

47. Ihrig and Marquez (2004), who estimate a similar model on a country-by-country basis, obtain error-correction parameters that are in many cases not significantly different from zero or even positive.

48. To simplify the analyses, exchange rates are assumed to remain unaffected by globalisation so that they follow their true time paths throughout the simulation exercise.

49. The weights of individual commodities in total imports are calculated as described in Pain *et al.* (2005).

50. Ireland is an exception, with average annual inflation rates some 0.5 and 0.9 percentage point higher than in the baseline. This reflects both the comparatively high level of import penetration in Ireland and the faster speed at which changes in import prices are reflected in domestic prices.

51. The calculations do not account for differences in the regional composition of imports. For example, the disinflationary impact may be underestimated for Japan given the comparatively higher share of imports from China in total Japanese imports.

52. This stems from the comparatively high share of oil in Korea's imports.

53. This requires that globalisation has had a large impact on commodity import prices, but a small impact on non-commodity import prices.

54. The disinflationary impacts might be weakened by real exchange rate appreciations in non-OECD economies.

55. Since headline inflation may be rather volatile, short-run changes in headline inflation may not always be very informative. Nonetheless, persistent movements in headline inflation over the medium to long run may contain useful information for monetary policy makers and are taken into account by many central banks when assessing future inflationary pressures.

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The Macroeconomic Policy Challenges of Continued Globalisation

by
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Introduction 150
Recent developments in economic integration 151
Trade and financial integration 151
International differences in asset returns 154
Growth and income convergence 155
Global imbalances 157
Long-term scenarios to 2025 158
The continued globalisation scenario 158
The moderated globalisation scenario 170
The impact of non-OECD economic developments on OECD economies . . 173
Higher domestic demand in non-OECD countries 174
A loss of financial market confidence in the non-OECD economies . . 175
Conclusion 177
Notes 178
Bibliography 180
Appendix 182

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Introduction

Over the past decade international economic integration has proceeded rapidly, with global trade and cross-border capital flows rising substantially relative to GDP. These developments have been accompanied by robust economic growth, especially in many non-OECD economies, and rising output per capita. Whilst enhanced integration has provided many benefits, it has also coincided with marked structural changes in product and labour markets in the OECD economies, with the presumed effects on income distributions and employment prompting political pressures to slow down the globalisation process.

This paper investigates the macroeconomic policy challenges that may be associated with a prospective continuation of international trade and financial integration over coming decades, making use of a global macroeconomic model and associated database newly developed by the OECD. The initial step is to construct two possible scenarios for the world economy out to 2025. The first of these reflects the continuation of current globalisation trends, whereas the second moderates these trends considerably. Such a moderation may result from the social and political concerns about income distributions, labour market outcomes and the environmental impact associated with ongoing globalisation. Both scenarios provide insights into the possible future paths of global economic growth, international trade and cross-border asset holdings, as well as the macroeconomic policy settings that may help to secure such outcomes. The first scenario is then used as a baseline for a number of different simulations of the impact of economic shocks arising from the non-OECD economies on the OECD economies. These are conducted at different points in time to examine whether the rising level of trade and financial market cross-border linkages affects the impact of such shocks on the OECD economies and thereby OECD country policy responses.

The analysis reveals that global economic developments will become much more dependent on developments in the non-OECD economies if the process of globalisation continues. The shares of the non-OECD economies in world output, trade, and capital markets are projected to increase considerably, particularly if the current pace of international economic integration persists. The associated increase in trade and financial linkages across countries implies that macroeconomic shocks in a given country or region will have a larger impact on other economies in the future than they do today. In particular, OECD economies will become more exposed to economic shocks originating in non-OECD economies, with the impact of a shock on the GDP of OECD economies set to double between 2005 and 2015. This implies that policymakers in the OECD may have to act more promptly and more vigorously to economic "shocks" originating in the non-OECD economies in order to limit their impact.

Moreover, the analysis provides insights into the future sustainability of current external imbalances. Specifically, the likelihood of exchange rate crises and financial market disruption will depend in part on the future build-up and composition of

international assets and liabilities. If globalisation continues at its current pace a large US current account deficit could be consistent with the United States' share in world foreign liability holdings remaining broadly constant throughout the projection period as rapid economic growth and financial integration will increase the global pool of funds to be invested. Although the share of portfolios that investors would wish to hold in US liabilities is likely to diminish as the US economy is set to decline as a share of the world economy, the effect of a rising supply of investment capital may dominate in the near to medium term. By contrast, a slowdown of the globalisation process would raise the likelihood of a disruptive depreciation of the US dollar.

The remainder of this paper is organised as follows. The next section contains an overview of selected developments in the world economy over the past decade or so, including the marked growth of financial integration and trade openness, trends in GDP growth, and the evidence about the role of openness and financial integration in influencing income convergence across countries. This sets the scene for the following section in which two alternative long-term scenarios for the world economy to 2025 are developed. The scenario with the highest extent of globalisation is then used for the simulation exercises. Finally, the last section concludes with a number of policy implications regarding the sustainability of current external imbalances, the transmission of macroeconomic shocks across countries, and the convergence of GDP per capita between OECD and non-OECD economies.

Recent developments in economic integration

International economic integration has proceeded rapidly over recent decades, especially from the mid-1990s onwards. This section provides an overview of these recent globalisation trends with a focus on financial flows, trade flows and GDP growth.[1]

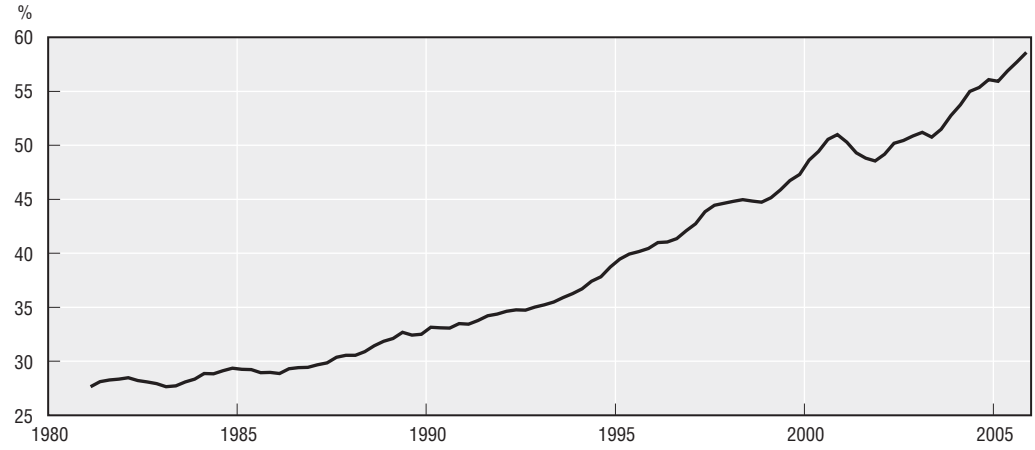
Trade and financial integration

Global trade has expanded markedly over the past 25 years; the ratio of world trade (imports plus exports of goods and services) to world GDP has more than doubled between 1980 and 2005 (Figure 1). This rise in world trade was to a large extent driven by developments in non-OECD economies whose share in world trade rose from about one-fourth in the early 1980s to about one-third by 2005. The expansion of international trade flows was particularly strong after 1995.[2]

Financial integration has also proceeded rapidly. For the OECD, the ratio of the sum of the stocks of foreign assets and liabilities to GDP has increased fivefold since the early 1980s (Figure 2).[3, 4] The increase in cross-border financial flows was particularly strong during the past decade, with the share of assets and liabilities in GDP rising by more than 130 percentage points between 1995 and 2005. In the non-OECD economies the process has evolved much more gradually, at least during recent years.[5]

The rise in cross-border trade and capital flows has been driven by a number of different factors, including the ongoing liberalisation of trade policies and capital controls in many countries and the continued reductions in transport, communication and information costs. These developments have helped the production of many goods and services to become more fragmented into components that are dispersed over different countries via international outsourcing and off-shoring, raising international trade.[6] Improvements in ICT have also fostered cross-border financial flows by facilitating the

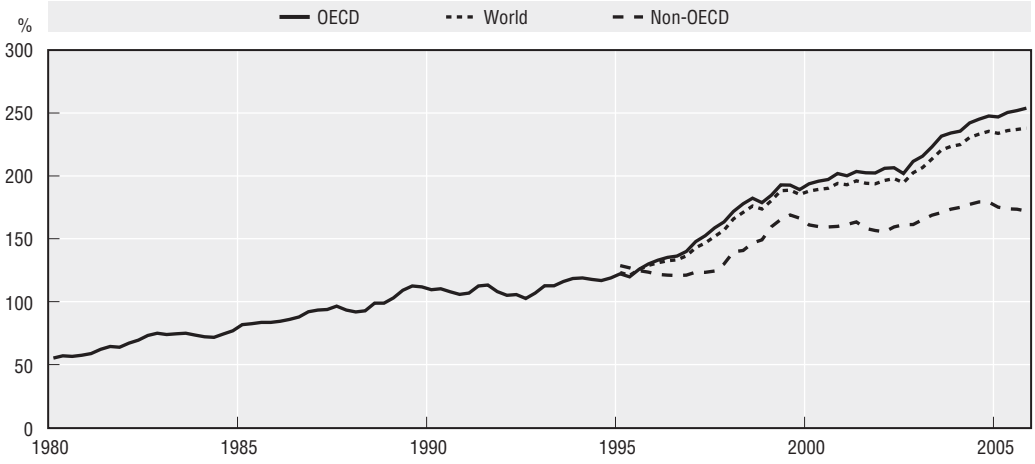
Figure 1. **International trade integration**



Note: Trade integration as measured by the ratio of world trade (imports plus exports of goods and services) to world GDP, both in volume terms.

Source: World Trade Organisation.

Figure 2. **International financial integration**



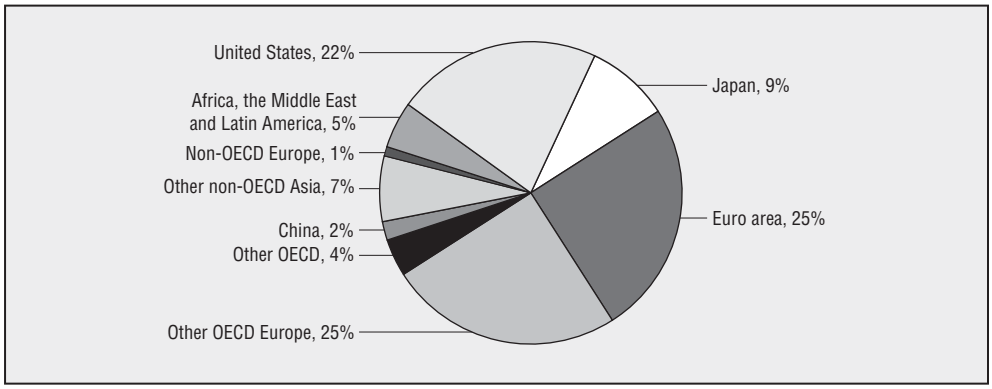
Note: Financial integration as measured by the ratio of the stock of foreign assets plus liabilities to GDP.

Source: IMF, *International Financial Statistics*.

development of new financial instruments as a result of declining transaction costs. Worldwide financial integration has also been encouraged by the tendency towards improved domestic economic policies since the early 1990s, especially in Asian and a number of Latin American economies. Trade integration and financial integration also tend to reinforce each other in various ways.[7] For example, larger trade flows will increase the demand for financial instruments for risk hedging. Similarly, "greenfield" foreign direct investment is normally associated with increased imports of capital goods during the construction phase and increased exports after the completion of the investment project.

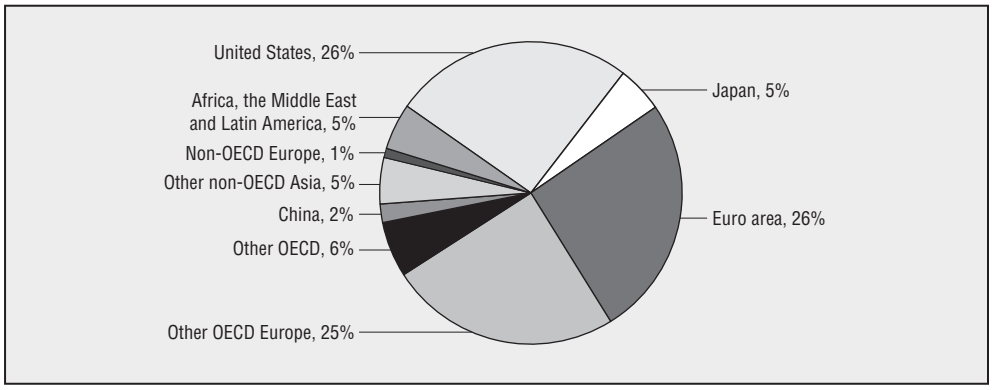
The OECD economies continue to hold over four-fifths of cross-border assets and liabilities, suggesting that considerable scope remains for further growth in cross-border investments by the non-OECD economies (Figures 3 and 4). China and the rest of non-OECD Asia are both estimated to have positive net international assets, whereas the

Figure 3. **Regional composition of foreign asset holdings in 2005**
As a percentage of world total



Source: IMF International Financial Statistics.

Figure 4. **Regional composition of foreign liability holdings in 2005**
As a percentage of world total



Source: IMF, *International Financial Statistics*.

combined net assets of Africa, the Middle East and Latin America are approximately in balance, and non-OECD Europe has net international liabilities, which is what might normally be expected for emerging economies.

The composition of investments has evolved over time, changing the importance of revaluation effects from movements in different asset prices. For the OECD, foreign portfolio investment (FPI) has become the largest asset category held cross-border comprising one-third of the total stock of foreign assets and over two-fifths of the total stock of foreign liabilities in 2004. A substantial part of FPI is invested in equities,[8] making the OECD stock positions more affected by changes in international equity prices. Although high expected returns have made non-OECD economies a more attractive location for FPI in recent years, most of the investment undertaken by OECD economies still remains within the OECD. As the perceived risks of investing in the non-OECD economies begin to wane, there could well be higher levels of capital flows to those countries to take advantage of the prospective higher returns there.

Inward FDI flows to non-OECD countries have also risen significantly since the mid-1990s although, as with FPI, intra-OECD flows still dominate. The surge in inflows into the non-OECD economies was substantial, with the share of FDI liabilities in GDP increasing from

22% in 1995 to 41% in 2005. As discussed below, this may well have increased the level of knowledge transfers to the non-OECD economies, helping to raise productivity. The asset side of the balance sheet of the non-OECD economies is dominated by "other foreign investment" which makes up almost half of the total. The rapid increase of this category in recent years has been driven by the accumulation of foreign exchange reserves.

The future evolution of cross-border asset holdings is contingent on the evolution of two main factors: the correlation of international asset returns and home bias. International return correlations affect the extent of cross-border asset holdings because a rise in the co-movement of national asset markets is tantamount to a decline in the potential gains from international portfolio diversification. Although the literature on international return correlations, and in particular stock market correlations, does not give any clear guidance as to the future evolution of cross-border asset holdings,[9] the literature on home bias suggests that cross border asset holdings might expand further in the future if information costs continue to fall (see, for example, Ahearne *et al.*, 2004, Portes *et al.*, 2005, and Sørensen *et al.*, 2005).

International differences in asset returns

The strong growth in the size of gross international portfolio holdings in recent decades has raised the extent to which economies are exposed to exchange rate and international asset price fluctuations. Financial market disturbances such as the emerging market crises of the 1990s could thus have a much greater impact on the world economy today than at the time of the crises.[10] Given the stronger financial linkages between OECD and non-OECD economies, such events may also have macroeconomic consequences for the OECD.

The growth of international portfolio holdings also implies that a given rate of return differential between the assets and liabilities of a country or region now has a much larger effect on the dynamics of its net foreign investment position. For example, the United States has, until recently, had a positive international investment income balance despite rising net liabilities to the rest of the world, with the returns earned on (smaller) US foreign assets more than offsetting the returns paid on (larger) US foreign liabilities. With portfolios likely to continue to increase in size over time, differences in relative returns, as well as valuation effects, could become larger still.

Total returns consist of two components, measured yields and valuation adjustments to existing assets and liabilities associated with asset price and currency fluctuations. Over the past decade, the OECD has in general earned a higher yield on its assets than it paid on its liabilities, whereas non-OECD economies persistently earned a lower yield on their assets than they paid on their liabilities. On top of these measured return differentials come valuation gains that, for some countries, have been sizeable. For the United States, for example, Meredith (2007) estimates that the valuation gains on existing assets and liabilities amounted to 2% of GDP over the period 1996 to 2005.

One factor behind the positive return differential enjoyed by the OECD economies is the tendency of countries with well-developed financial markets to invest in higher-risk financial assets overseas in expectation of higher returns, be it in the form of investment income or capital gains. As such, financial outflows of the OECD in recent years were predominantly associated with high-yield FDI and foreign equity investment. Financial inflows, especially to the United States, were on the contrary associated with purchases of

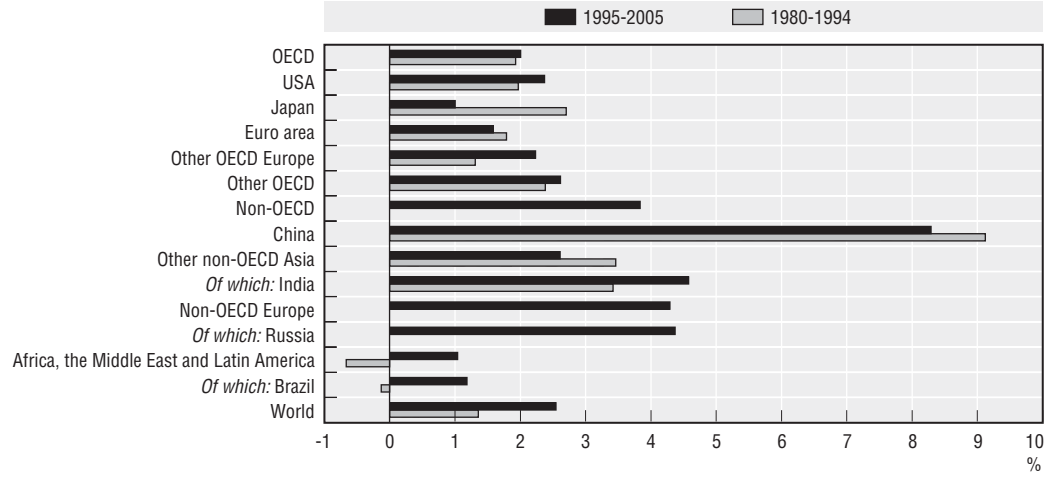
low-risk securities such as government and corporate bonds, and the build-up of official reserve holdings by foreign governments.[11] A continuation of these investment patterns should help to maintain the present differential between the returns on international assets held by OECD countries relative to those on the assets held by non-OECD countries.

Growth and income convergence

The recent past has seen a period of comparatively rapid global economic growth. World GDP growth averaged 4% per annum during 1995 to 2005, compared with 3% per annum during 1980 to 1994. Developments in non-OECD economies have steadily become a more important influence on global economic growth than in the past, reflecting their strong growth and rising share in world GDP.[12] Economic growth was particularly strong in China and several other Asian economies, in spite of the temporary setbacks associated with the regional crisis in the late 1990s.

GDP per capita also rose more rapidly in the non-OECD economies than in the OECD (Figure 5). In particular, there was a marked improvement in per capita output in China, with GDP per capita estimated to have risen from 14% of the OECD average in 1995 to 25% by 2005.

Figure 5. **GDP per capita growth**



Source: OECD Model database, World Bank World Development Indicators.

Several empirical studies have investigated the extent to which the process of economic integration has contributed to the convergence of output per capita. Although trade and financial openness are generally found to be an important influence on economic growth and income convergence, the benefits do not accrue automatically, especially in developing economies. Besides proper institutions and a conducive macroeconomic environment, investments in human capital and R&D are stressed as important factors in enabling economies to benefit from increased openness. Both raise an economy's absorptive capacity and thus facilitate the absorption of foreign technology (see Hervé *et al.*, 2007, Box 2 for further details).

To help judge the scope for future convergence in per capita incomes a set of simple convergence equations was estimated for nine different economic regions (Box 1),

Box 1. **Estimates of GDP per capita convergence**

A system of equations is estimated that takes the following general form:[1]

$$\Delta \log(GDPCAP_{it}) = a_{1i} + (a_{2i} + a_{3i}OPEN_{i,t-1}) \log(GDPCAP_{USA,t-1}/GDPCAP_{i,t-1}) + \varepsilon_{it} .$$

Here, the subscript i denotes the country, the subscript t the time period, *GDPCAP* is GDP per capita in PPP US dollars, *OPEN* is trade openness measured as *OPEN* = (0.5 exports + 0.5 imports)/GDP,[2] and ε is an error term.[3] The data set comprises annual data over the period 1960 to 2005, although data limitations require that the sample period starts later for some regions/countries, leading to an unbalanced panel data set. The system of equations is estimated with least squares. Initially the system is estimated as nine independent equations. To obtain a parsimonious model, the parameters are restricted subsequently to be equal across subsets of countries/regions as the data permit. These restrictions are accepted by the data at conventional levels of significance. It should be noted that the groups that are formed are based on statistical criteria and do not necessarily have a direct economic interpretation. Moreover, two dummy variables are included in the specification to account for country-specific structural breaks in the estimated relationship.[4]

The specification implies that each country has an equilibrium level of per capita output relative to the United States which is contingent on underlying structural factors. The annual change in per capita output will be affected in part by its current per capita output relative to that of the United States. The specification also allows for the impact of openness on the speed of convergence, with more open economies being expected to experience faster convergence towards their conditional long-run equilibrium position as they are more likely to benefit from productivity spillovers from the rest of the world. Although the openness variable measures trade openness, it is likely to capture other aspects of economic openness as well, given the positive correlations between trade and financial openness.

The estimation results suggest that poorer countries experience faster output growth rates than richer countries as indicated by a positive value of the term $a_{2i} + a_{3i}\, OPEN_{i,t-1}$.[5] For example, in the case of China the size of the estimated coefficients signifies that at current openness levels and at the current level of per capita output in the United States, 6.2% of the per capita output gap to the conditional long-run equilibrium position would be corrected each year. This implies that in 11 years time half of the adjustment to the long-run equilibrium would have taken place.[6]

The estimation also supports the view that more open economies converge faster to the underlying equilibrium position, as the coefficient on openness is significantly positive for all countries/regions. The coefficient on openness is equal to 0.03 for all countries/regions, implying that a 10 percentage point increase in openness would increase the rate of per capita output convergence to the new conditional equilibrium by 0.3 percentage points per annum. For China, the convergence rate would rise to 6.5% per year, reducing the time taken for half of the adjustment to the equilibrium by about half a year.

The estimated equations are used in the third section of the paper to project per capita output to 2025, employing the globalisation baseline projections for openness and per capita output in the United States. Given these assumptions, per capita output in the non-OECD economies would be projected to catch up considerably to that in the United States, with the catch-up being the most pronounced for China and non-OECD Europe. Output per capita in the Euro area and Japan relative to that in the United States would remain broadly constant, implying some improvement compared with the recent past.

Box 1. **Estimates of GDP per capita convergence** *(cont.)*

1. The framework applied in this analysis is consistent with prior work on economic growth carried out within the OECD (see OECD, 2003). It slightly differs from that earlier work in that the focus is on openness (thus ignoring other important determinants of economic growth) and its role for adjustment speeds rather than output levels.
2. Intra-regional trade flows are included for all groups of economies except for the euro area. Some care is required in interpreting the estimation results below, since measured openness could rise even if the respective groups did not collectively trade more with other economies.
3. Financial openness is not considered in the analysis due to the lack of sufficiently long time spans of data.
4. The dummy variables are a dummy for China that is equal to unity from 1992 onwards to account for the acceleration of the economic integration of China that set in around that time and a dummy variable for non-OECD Europe that is equal to unity from 1991 to 1998 to account for special influences of the transition process that occurred most of the countries in this group.
5. For the rest of OECD Europe the model does not fit well. A potential explanation for this lack of fit is the diversity of the group as it combines countries with very different per capita output levels (within the group, the United Kingdom and Turkey have the highest (population) weights).
6. The model yields a non-linear adjustment path to the new long-run equilibrium so that the rate of adjustment slows down over time.

reflecting the geographical structure of the preliminary version of the new global macro-econometric model currently being developed at the OECD (see Hervé *et al.*, 2007, Annex A).[13]

One important finding is that poorer regions/countries can experience faster GDP per capita growth rates than richer ones for some time, even if in the long-run the levels of per capita output differ. Moreover, more open economies experience faster convergence to the technological leader (in this instance, the United States). This supports the proposition that more open economies benefit from technology spillovers from foreign countries and thus achieve higher economic growth. The estimation suggests that at current openness levels and at the current level of GDP per capita in the United States, half of the expected adjustment towards its long-run GDP per capita level relative to the United States (which is contingent on given structural factors) would have taken place within the next ten years for most countries. On average, raising openness by 10 percentage points would reduce the time taken for adjustment by 5%.

Global imbalances

The strong economic growth experienced in recent years led to rising demand for commodities, thereby raising several commodity prices towards or past historical peaks in real terms. Non-OECD economies have been the main driver behind the increase in demand as they have experienced above-average output growth rates and at the same time have a higher level of energy consumption per unit of incremental output than the average OECD economy (see Pain *et al.*, 2006, for a more detailed discussion).

The associated increases in the terms of trade of the major oil producers have contributed to the increase in global current account imbalances in recent years, with the United States having a sizable current account deficit and a number of countries in East Asia and the Middle East having rising current account surpluses (OECD, 2006). These imbalances have been matched by corresponding changes in net foreign asset positions, although as discussed above, especially in the case of the United States, this has been partially offset by revaluation effects, stemming from movements in exchange rates and asset prices.

Long-term scenarios to 2025

Looking forward, this section discusses a number of important macroeconomic aspects of two alternative long-term scenarios for the world economy out to 2025. These scenarios embody two possible future paths for the extent of globalisation. One possibility, reflected in the first scenario, is for current trends to continue, with considerably enhanced future levels of global trade and capital flows, broadly in line with the trends seen over the recent past. With GDP per capita levels in most non-OECD economies still far below those in the OECD, there is a large potential for catching-up which may translate into a prolonged period of profound economic growth. An alternative possibility is that social, political, and environmental concerns associated with ongoing globalisation may lead to pressures to slow down the trend towards greater global integration. This is reflected in the second scenario, which shows a modest slowing in the trend towards continued globalisation. Both scenarios provide insights about possible future economic growth and development, the associated evolution of cross-border trade and capital market linkages and some of the policy settings that may be associated with such outcomes.

The two long-term scenarios were prepared using a framework broadly similar to that outlined by Beffy *et al.*, (2006) for the OECD Medium-Term Baseline. In this framework economic growth is ultimately determined by supply-side factors such as demography, labour force participation, trend hours worked and productivity growth. Monetary and fiscal policies are assumed to be set to achieve medium-term monetary objectives and fiscal sustainability respectively. Global trade linkages for both prices and volumes are endogenous, as is the future evolution of financial domestic and international asset stocks, the latter being conditional on specific assumptions about the pace of international financial integration. The projections are two representative descriptions of possible long-run changes in the global economy. Given their reliance on specific assumptions and abstraction from possible cyclical events, neither of the scenarios can be seen as a central forecast with specific probabilities. The key assumptions made in the continued globalisation scenario are summarised in Box 2. A number of these are amended in the alternative scenario, as discussed under the heading "The moderated globalisation scenario".

The continued globalisation scenario

Output growth and output per capita

The continued globalisation scenario embodies a sustained period of comparatively robust growth in the world economy, with global GDP increasing by an average of 4¼ per cent per annum when expressed in constant prices at purchasing power parities (PPPs), as shown in Tables 1 and A1.[14, 15] Global output growth over the first decade of the scenario (2006-15) is just under around ½ percentage point higher per annum than in the subsequent decade (2016-25), reflecting the gradual moderation of productivity growth and slower labour force growth in many economies during the latter decade.

Within the OECD, the annual GDP growth of the United States and the other OECD Europe and rest of the OECD groups is projected to be about 1 percentage point above that of the euro area and Japan, largely as a result of demographic factors. Amongst the non-OECD, GDP growth is projected to be more robust in China and the rest of non-OECD Asia than elsewhere, reflecting stronger productivity growth and corresponding to generally higher levels of international openness.

Box 2. **Key assumptions in the continued globalisation scenario**

The key assumptions imposed in the continued globalisation scenario include:

- The gaps between actual and potential GDP are eliminated over the projection period for all OECD countries, so that the level and growth of GDP return to estimated potential rates (as defined by the underlying supply-side assumptions).
- Population in the different economies is assumed to grow at the mid-range of the current UN population projections out to 2025. Almost all of this growth occurs in the non-OECD economies. In three of the economies considered – the euro area, Japan and non-OECD Europe, the aggregate population is projected to begin declining before the end of the scenario horizon. The ageing of the population brings about earlier and more substantial declines in the working age population in these regions during the scenario period. There is also expected to be a small decline in the number of people aged 15-64 in China towards the end of the scenario horizon. The rate of growth in the working age population in the United States, other OECD Europe and the rest of the OECD is expected to remain positive through the projection period, as it is in the rest of non-OECD Asia and in Africa, the Middle East and Latin America.
- Average trend labour productivity growth in the United States, Japan and the euro area is assumed to eventually converge to a common rate of 1¾ per cent per annum over 2020-25, compared with initial growth rates of 2, 2¼ and 1¼ per cent per annum over 2005-10. Further details on the supply side assumptions of the continued globalisation scenario can be found in Table 2. In contrast, productivity growth in the two other OECD country groups remains between 2¼-2½ per cent per annum throughout the scenario, reflecting the greater scope for catch-up in some of the countries within these groups.
- For the non-OECD economies, productivity growth in the near future is assumed to continue at similar rates to those seen over the past five years, helped by further structural reforms to improve efficiency, as well as capital deepening and enhanced knowledge transfers from the continued growth in trade openness and inward FDI. In some countries the gradual movement of workers from the primary sector into secondary and tertiary sectors could also have a positive one-time effect on productivity levels (OECD, 2005).
- Unemployment returns to its estimated structural rate (the NAIRU) in the OECD economies. For all economies, with the exception of the United States, the NAIRU is assumed to decline a little over the course of the continued globalisation scenario, reflecting increased competition as a result of greater openness as well as the full impact of recent structural labour market reforms (Bassanini and Duval, 2006). These reforms are also assumed to bring about a modest rise in labour force participation rates in most of the OECD economies.
- Individual commodity prices are assumed to follow specific profiles that are broadly consistent with the implications of the econometric equations in Pain *et al.*, (2006). With economic growth per annum in the non-OECD economies being over 2 percentage points higher than growth in the OECD economies, oil prices are assumed to rise by 1½ per cent per year in real terms. In contrast, metals and minerals prices are held constant in real terms, whilst food and agricultural raw materials prices are assumed to decline by between ½-1 per cent per annum in real terms.
- Equity prices are assumed to rise by 4% per annum in the OECD economies, and by 7% in the non-OECD economies, broadly in line with average productivity growth differentials.*

Box 2. **Key assumptions in the continued globalisation scenario** *(cont.)*

- The bilateral nominal exchange rates of the non-OECD economies with the OECD economies are assumed to appreciate by 3% per annum over the projection period from their levels in 2006, approximately in line with average productivity growth differentials. The decision to start from actual exchange rate levels rather than some underlying equilibrium levels reflects the difficulties involved in estimating equilibrium exchange rates with precision (see, for example, Driver and Westaway, 2005).
- Monetary policies are directed at keeping inflation low, or bringing it into line with medium-term objectives. Effective direct tax rates on households are assumed to adjust so as to stabilise the government debt to GDP ratio in the medium term, with the particular adjustments for each economy reflecting the initial fiscal position and the need to prevent the net general government debt to GDP ratio from changing substantially. No allowance is made for possible supply-side repercussions stemming from changes in tax rates.

To develop estimates of the future evolution of international asset stocks several assumptions are required, including ones for the underlying rate of gross capital flows (the flows that would occur even if the current account were balanced), the asset composition of such flows and the locations in which they are held. Asset stocks are split into three components for the scenarios, comprising FDI, equity assets and a residual category that includes debt holdings, banking sector assets and official reserves.

- Current account surpluses (deficits) are assumed to flow entirely into the stock of residual assets (liabilities).
- Stocks of equity assets/liabilities in the OECD are subject to upward revaluations of 4% per year; equity stocks in the non-OECD are subject to upward revaluations of 7% per year. The US dollar value of all assets and liabilities held in the currencies of non-OECD countries is also revalued upwards by 3% per annum, reflecting the nominal exchange rate appreciation for the non-OECD countries. On average over the scenario horizon, approximately 20% of all assets are invested in the non-OECD countries.
- Underlying capital flows as a percentage of GDP are initially set in line with average levels in the recent past. Their subsequent path differs across economies. The United States is assumed to already be a financially globalised economy, and so underlying capital flows remain at 7% of GDP per annum throughout the scenario. The European economies are currently undergoing a period of rapid financial globalisation, with underlying capital flows in excess of 10% of GDP in the euro area, and around 20% in the rest of the European economies in the OECD. Over time, these rates are assumed to slow gradually to the levels seen currently in the United States. Japan, although it has steadily accumulated international assets as a result of sustained surpluses on the current account, has a low level of underlying capital flows. Over the scenario it is assumed to rise from an initial level of 2% of GDP per annum up to 7% of GDP by 2025. The overall impact of these assumptions is to help bring about a partial convergence in the level of international asset and liability holdings over time.
- Capital markets in the non-OECD economies are assumed to become increasingly liberalised over the course of the scenario, with underlying gross capital flows rising from an 8% of GDP average over the recent past and the early part of the scenario to around 11% of GDP by 2025.

* Rising asset prices over the projection period can also be justified by aging effects. For a detailed discussion see Oliveira Martins *et al.* (2005).

Table 1. **Supply-side assumptions – Continued globalisation scenario**

	Trend growth		Trend productivity		NAIRU		Trend labour force		Trend participation rate		Working-age population	
	Growth rate per annum				Per cent		Growth rate per annum					
	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25
OECD												
United States	3.2	2.6	2.2	1.8	4.8	4.8	1.0	0.8	66.3	65.5	1.2	0.8
Japan	1.6	1.3	1.6	1.8	3.9	3.7	0	–0.5	78.5	80.0	–0.4	–0.5
Euro Area	1.8	1.5	0.8	1.8	8.0	6.5	1.0	–0.3	71.1	73.8	0.4	–0.3
Other OECD Europe	2.8	2.4	2.2	2.3	7.9	7.0	0.6	0.1	72.2	72.7	0.6	0.1
Other OECD	3.7	2.4	2.4	2.2	5.4	4.4	1.3	0.2	72.6	74.6	1.0	0.2
Non-OECD												
China	8.2	7.0										
Other non-OECD Asia	5.8	5.6										
Non-OECD Europe	6.5	4.1										
Africa, the Middle East and Latin America	3.5	3.5										

Table 2. **GDP growth – Continued globalisation scenario**

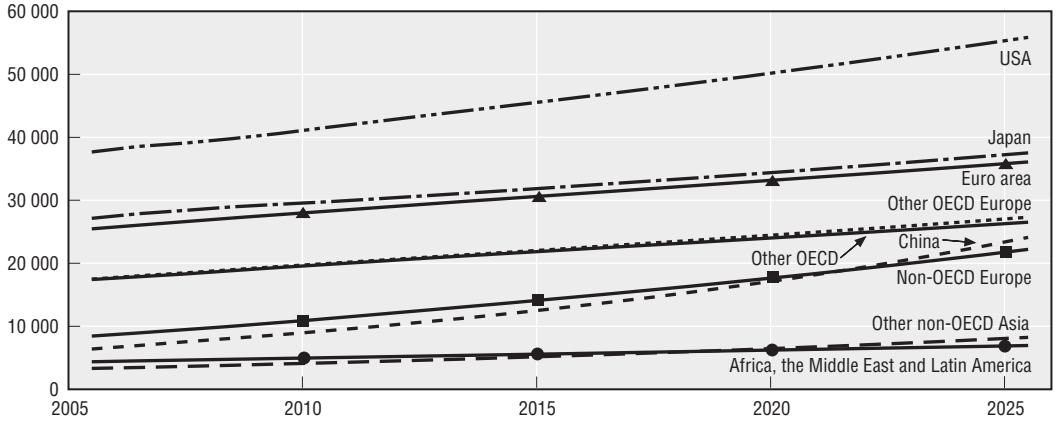
	Average GDP growth rates			Average GDP per capita growth rates			GDP per capita relative to United States at projected PPP exchange rates as percentage		
	2006-25	2006-15	2016-25	2006-25	2006-15	2016-25	2005	2015	2025
United States	2.8	2.9	2.7	2.0	2.0	2.0			
Japan	1.5	1.7	1.3	1.6	1.7	1.6	72	70	67
Euro area	1.8	2.1	1.6	1.8	1.9	1.6	68	67	65
Other OECD Europe	2.7	2.9	2.4	2.3	2.4	2.1	46	48	49
Rest of OECD	2.9	3.2	2.5	2.1	2.4	1.9	46	48	47
China	7.5	7.9	7.0	6.9	7.3	6.5	17	28	43
Other non-OECD Asia	5.9	6.1	5.6	4.7	4.8	4.6	9	11	15
Non-OECD Europe	4.8	5.3	4.3	4.9	5.5	4.4	22	31	40
Africa, the Middle East and Latin America	3.9	4.3	3.6	2.4	2.6	2.1	12	12	12
OECD *(2000 PPP US$)*	2.4	2.6	2.2	2.0	2.1	1.9			
Non-OECD *(2000 PPP US$)*	6.0	6.3	5.7	4.8	5.0	4.6			
World *(2000 PPP US$)*	4.3	4.4	4.2	3.3	3.3	3.3			

Over the course of the scenario global economic conditions become increasingly influenced by developments in the non-OECD economies, whose share of global output is projected to rise from just over two-fifths in 2005, to around three-fifths by 2025 (at PPP exchange rates). This acts to raise GDP per capita in the non-OECD economies relative to those in the OECD economies, which grow by an average 2% per annum.

The evolution of per capita output in the individual economies is summarised in the middle panel in Table 2 and Figure 6. In the euro area and Japan, per capita output relative to the United States declines by 3-5 percentage points over the scenario period, largely reflecting differences in dependency trends. Output per capita in the remaining OECD zones broadly grows in line with that in the United States. Amongst the non-OECD, per capita output in China and non-OECD Europe rises significantly relative to that in the OECD

Figure 6. **GDP per capita – Continued globalisation scenario**

2000 PPP US$



economies, reflecting the continuation of robust output growth at a time when there is limited growth in their overall populations. Per capita output in the rest of non-OECD Asia also rises, but more modestly. In Africa, the Middle East and Latin America there is little convergence, reflecting comparatively modest productivity growth and continued population growth.

A comparison of the scenario projections for per capita output with those from the econometric convergence equations in Box 1 is shown in Figure 7. The separate convergence model projections show the implied path of per capita output in each economy given the scenario estimates of trade openness and per capita output in the United States. Overall, the path implied by the convergence equations is broadly similar to that in the scenario, with the exception of other OECD Europe and China, where per capita output levels in the scenario are respectively lower and higher than the levels obtained from the convergence model.[16]

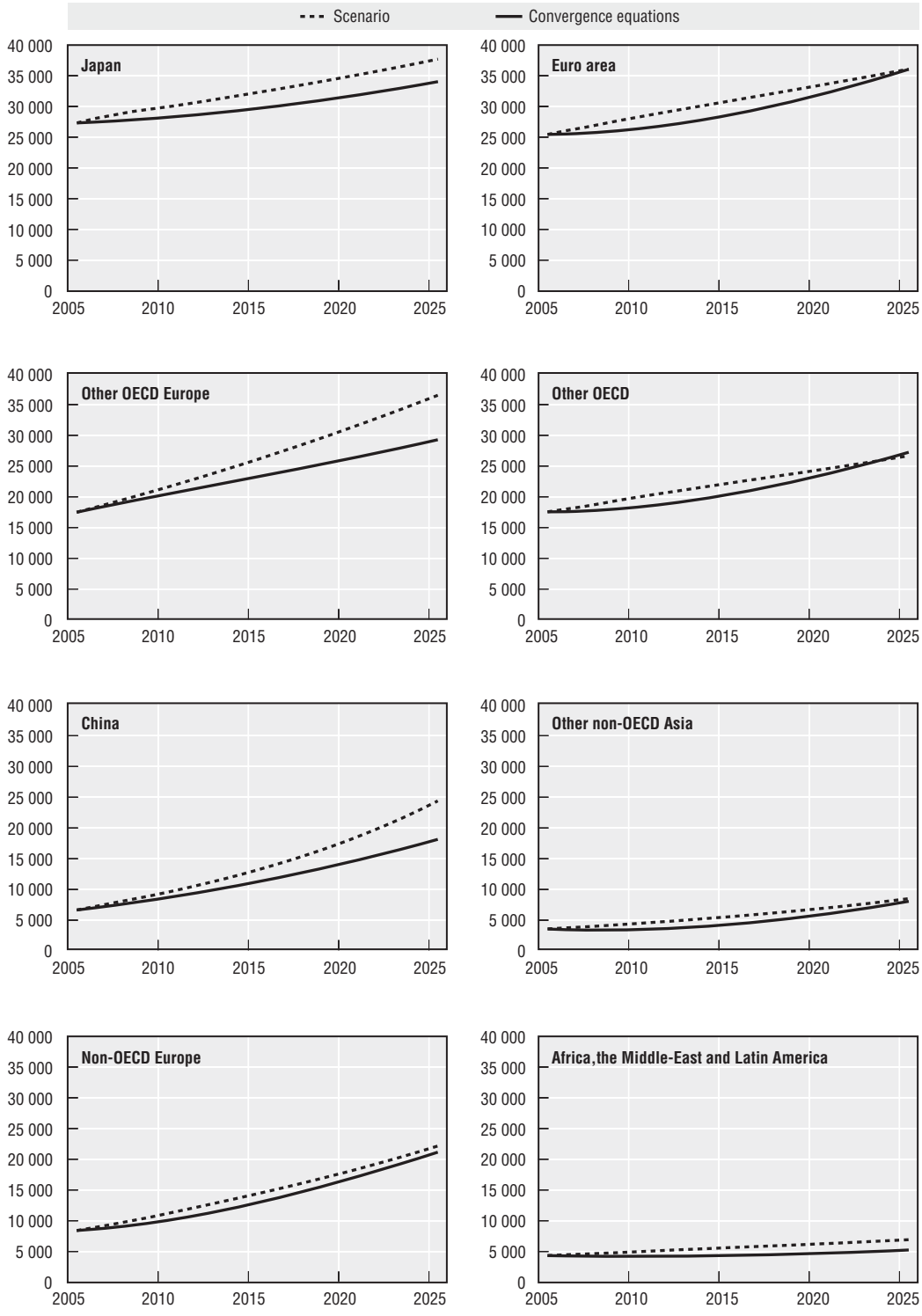
The overall gains in real income for the OECD economies will also depend on net investment income flows and movements in the aggregate terms of trade (Sefton and Weale, 2006). All of the OECD economies are expected to have modest declines in their terms of trade, primarily because of the increase in real oil prices that results from strong demand growth in the non-OECD economies. The evolution of net investment income largely reflects the evolution of net international assets; the United States and, to a lesser extent, the rest of the OECD group make positive net investment income payments, reflecting their negative net asset position. But Japan and the other OECD Europe group have rising net investment income, reflecting improvements in their respective net asset positions. This raises real incomes a little in these economies.

Global trade and current accounts

World trade integration is projected to continue at a rapid pace throughout the scenario. With GDP growth in the non-OECD being well above that in the OECD, the share of the non-OECD economies in total world trade will rise markedly by 2025. As shown in Figure 8, in volume terms their share in total world trade is set to increase from just under one-third in 2005 to over one-half by 2025. This development would continue the trend over the past decade with the trade share of the non-OECD regions in total world trade

Figure 7. **GDP per capita comparisons – Continued globalisation scenario**

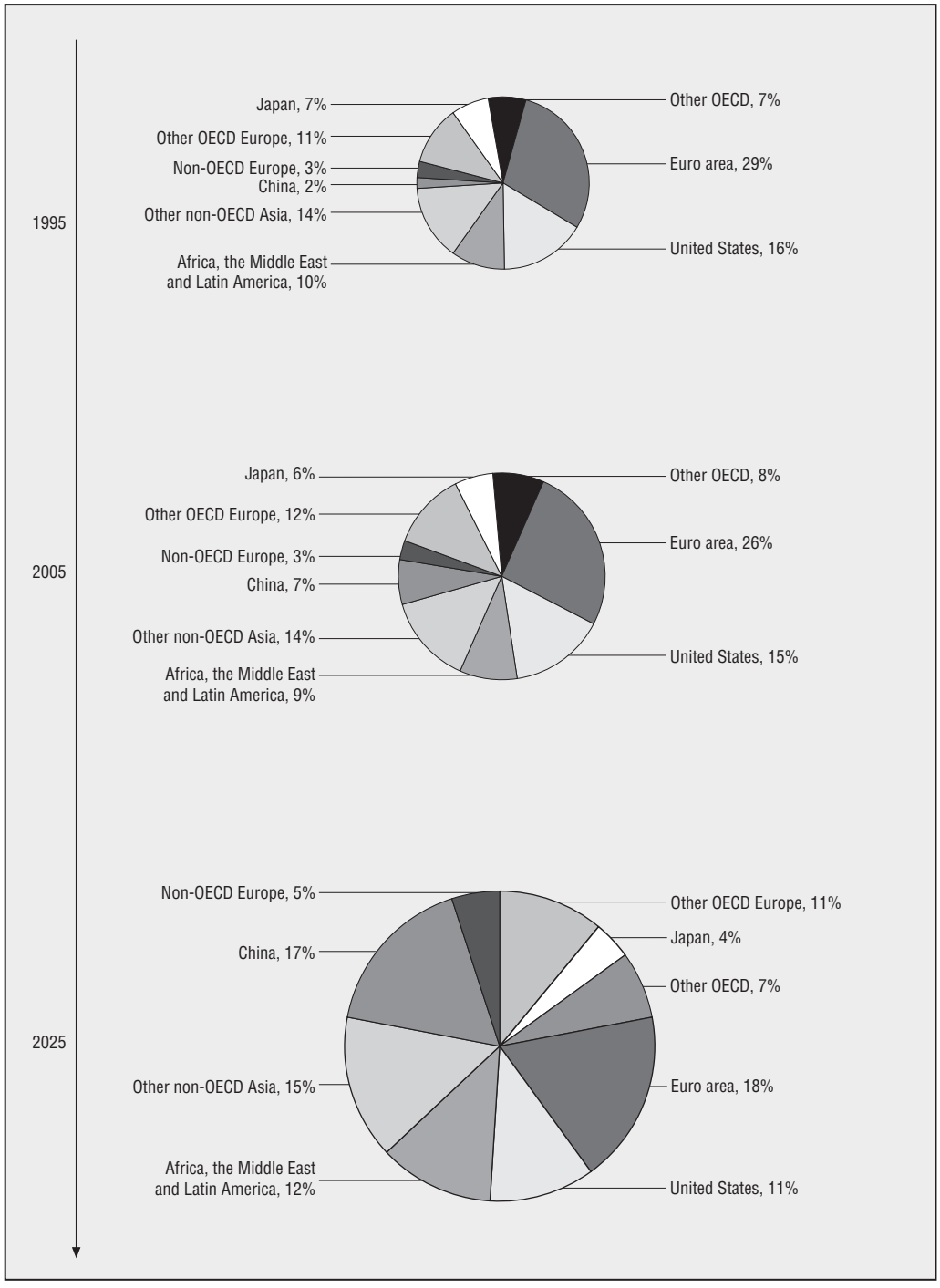
PPP US$



Note: The graphs compare GDP per capita for the continued globalisation scenario with the predicted values of the convergence equations as described in Box 3 of the main text and Table 1.

Figure 8. **Regional composition of world trade – Continued globalisation scenario**

2000 US$



Note: Trade is defined as exports plus imports. The regions are not consolidated. *i.e.* intra regional trade is included.
Source: OECD Economic Outlook database.

having risen by 5 percentage points between 1995 and 2005. The rising importance of non-OECD regions in world trade is primarily driven by China, whose trade share rises from 6% in 2005 to over 17% by 2025.

These developments are also reflected in the export performance of the various regions, with performance measured by the ratio of export volumes to export market size. All of the OECD regions are projected to having gradual declines in export performance, while most of the non-OECD regions are projected to have an improvement. This is especially marked for China, with export volumes rising by almost twice the rate of export market growth. Of the non-OECD economies, only the rest of non-OECD Asia experiences a small deterioration in export performance, which can be interpreted as reflecting the extent to which some companies in the region lose market share to Chinese competitors.[17] For the OECD countries, the decline in market share is projected to be more pronounced for Japan and the euro area than elsewhere.

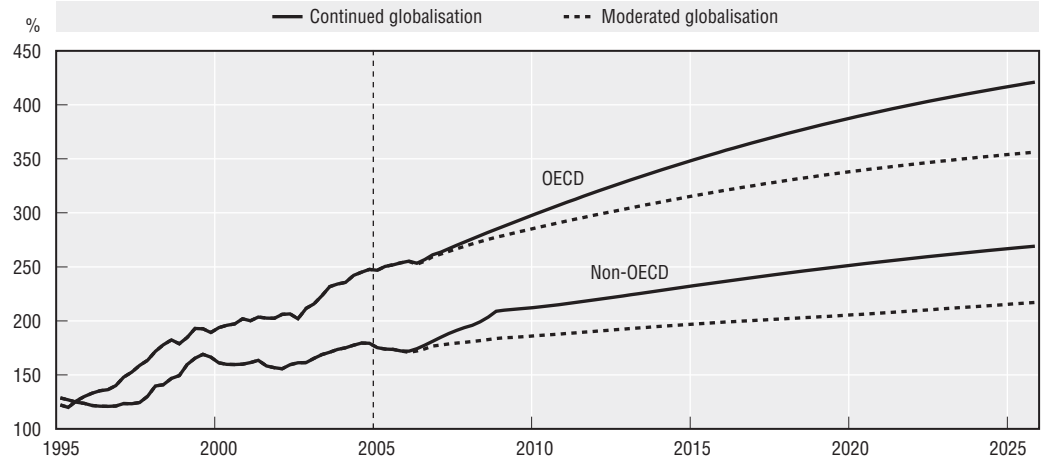
The growth of oil prices in real terms and the declines in the real prices of agricultural commodities also affect the terms of trade of all the economies, with those OECD regions that include major oil exporters facing the smallest terms-of-trade losses and oil-exporting non-OECD regions seeing the strongest terms-of-trade improvements. The terms of trade of non-OECD Europe, which includes Russia and countries of the former Soviet Union, and Africa, the Middle East and Latin America, which includes oil-producers in the Middle East and Latin America, rise by 14 and 10%, respectively, in the main scenario.

Global capital markets

The scenario is characterised by further rapid growth in global financial integration, with the sum of international assets and liabilities projected to rise from 240% of global GDP in 2005 to 350% of GDP by 2025 (Figure 9). Given the assumptions made about the growth of capital flows, the relative returns on assets in different locations and the profile of current account imbalances, the non-OECD regions would hold a higher share of total world assets and liabilities in 2025 than in 2005 (see Table 3 and Figures 10 and 11). By 2025, non-OECD regions would account for close to two-fifths of total world assets and one-third of total world liabilities (compared with just under 15% in 2005). In particular, the importance of China in international capital markets would have risen significantly, with

Figure 9. **Financial integration – Comparison of continued and moderated globalisation**

Percentage points



Note: Financial integration as measured by the ratio of the world's total stock of foreign assets plus liabilities to its GDP.

Table 3. **OECD and non-OECD's share in world assets and liabilities, continued globalisation scenario**

Percentage points

	Assets			
	2004		2025	
	OECD	Non-OECD	OECD	Non-OECD
Foreign direct investment	91	9	72	28
Foreign equity investment	91	9	81	19
Other foreign investment	82	18	54	46
Total foreign investment	86	14	63	37
	Liabilities			
	2004		2025	
	OECD	Non-OECD	OECD	Non-OECD
Foreign direct investment	78	22	47	53
Foreign equity investment	92	8	72	28
Other foreign investment	90	10	72	28
Total foreign investment	87	13	67	33

Figure 10. **Regional composition of foreign asset holdings in 2025 – Continued globalisation scenario**

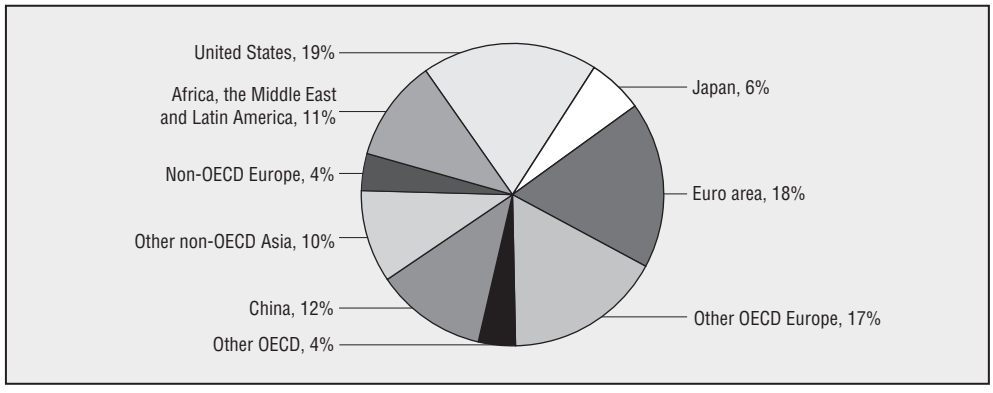
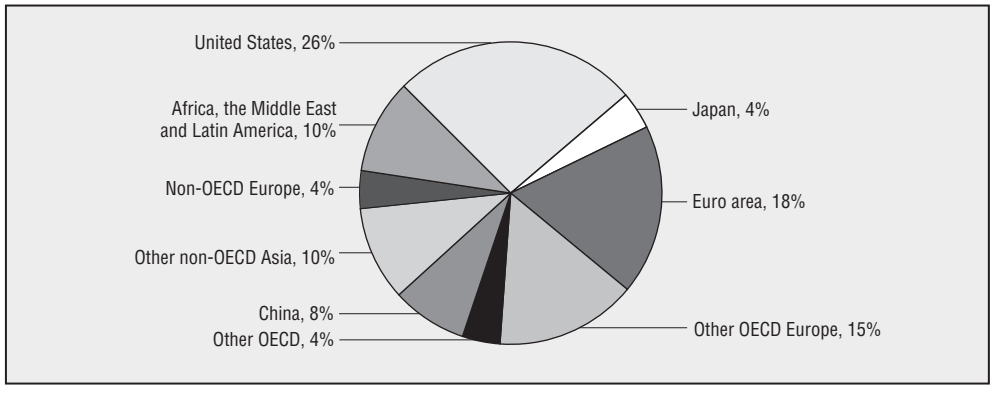


Figure 11. **Regional composition of foreign liability holdings in 2025 – Continued globalisation scenario**



gross holdings of 12% of total international financial assets and 8% of total international financial liabilities by 2025.[18]

As shown in Table 3, the proportion of assets and liabilities held by the non-OECD economies rises for each different category of investment. On the asset side, there is a significant rise in the share of non-equity, non-FDI assets held by the non-OECD economies, reflecting in part their accumulated current account surpluses.[19] On the liability side, there is projected to be significant growth of foreign direct investment into the non-OECD economies, with their share in total world holdings more than tripling between 2005 and 2025. By 2025, over half the global stock of inward FDI is expected to be in the non-OECD economies,[20] with over 30% being in the non-OECD economies in Asia. This would imply a considerable rise in the level of knowledge transfers to domestic companies in the non-OECD.

Valuation effects are found to have an important effect on the evolution of net foreign asset positions (Figure 12). In general, the non-OECD economies have negative revaluation effects, reflecting their faster rate of equity price growth and nominal exchange rate appreciations, while the OECD countries benefit from positive revaluation gains on their net foreign assets. Indeed, the accumulated valuation effects for the United States are equivalent to 10% of GDP by 2025, so that net international liabilities rise to only 65% of GDP by then, rather than the 75% of GDP that would have resulted from taking net liabilities in 2005 and adding on the cumulated current deficits over 2006-25.

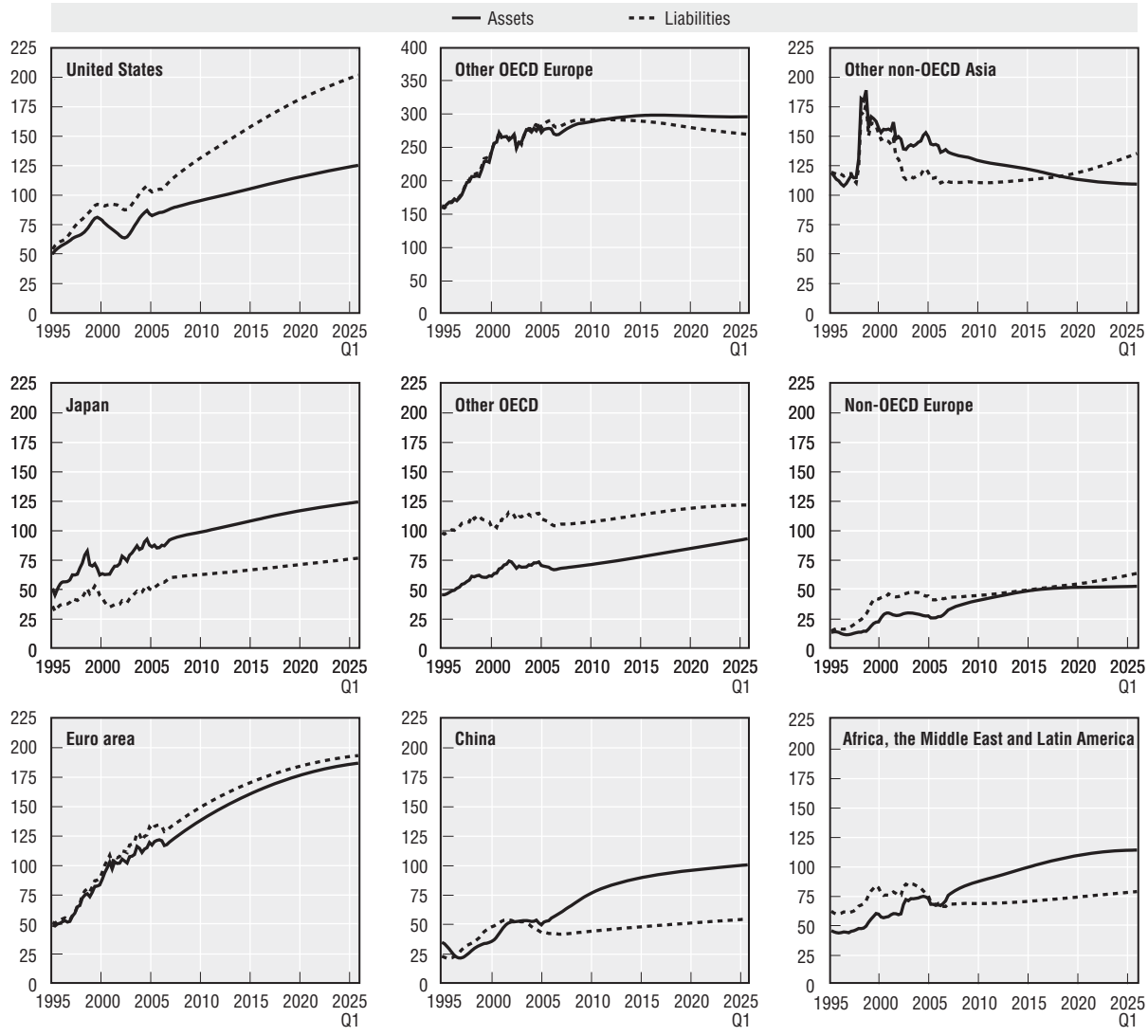
Japan and China also experience significant valuation adjustments, but of very different kinds. Japan has current account surpluses more or less throughout the scenario, and the resulting accumulation of international assets is reinforced by favourable valuation effects.[21] In contrast, in China, which also has a current account surplus through much of the scenario period, the associated improvement in net international assets is moderated and ultimately almost offset by unfavourable valuation effects. A similar tendency for net international assets to decline can be seen in other non-OECD economies as well (Figure 12). The unfavourable valuation effects in the non-OECD economies stem from two main sources. First, the continual appreciation of the nominal exchange rate acts to reduce the domestic currency value of foreign assets held by domestic residents. In addition, equity prices are assumed to rise more rapidly in the non-OECD economies than in the OECD.[22]

Going forward, the emerging constellation of current and capital balances will continue to be influenced by globalisation. As regards the sustainability of a continued large US current account deficit, the effect of globalisation will involve two counteracting forces. Rapid economic growth and financial integration will increase the global pool of funds that can be invested, including in US liabilities. Against this, the share of portfolios that investors would wish to hold in US liabilities is likely to diminish as the US economy is set to decline as a share of the world economy. Given that US financial markets currently enjoy an advantage in terms of depth and efficiency, the first of these forces may have a stronger influence in the near to medium term. The continued globalisation scenario suggests that, under a number of assumptions a large US current account deficit could be consistent with the United States retaining broadly the same share of world foreign liability holdings in 2025 as in 2005 despite continued large net capital inflows.

The scenario also implies a continuation of current trends in that China and other developing countries running current account surpluses would get very low returns on

Figure 12. **International assets and liabilities – Continued globalisation scenario**

As percentage of GDP



Note: The scale is different for other OECD Europe.

their foreign assets. Taking the example of China, net foreign assets as a ratio to GDP would as a result fall from just under 50% of GDP in 2015 to around 40% in 2025. Faced with this prospect, and because the US weight in the world economy is gradually diminishing, China and other developing countries running current account surpluses may at some point choose to reduce the share of US liabilities in their portfolios. If this occurs, such a rebalancing will require a lower US capital account surplus, which could result in a disorderly adjustment in financial markets.

Macroeconomic policy settings

For simplicity, all the OECD economies are assumed to have a medium-term monetary objective of a 2% annual inflation rate. Policy interest rates are set at levels which ensure that this objective is satisfied. The yield curve is upward-sloping in all economies, with interest rates on long-term government bonds settling at 75 basis points above shorter-term

money market rates. By the end of the scenario horizon, the level of short-term interest rates varies from 3½ per cent in Japan to 5% in the United States. Such settings serve to ensure that the real short-term interest rate is approximately in line with the growth rates of output in the different OECD economies. The marked divergence in the output growth rates across the OECD economies suffices to offset underlying pressures for the equalisation of (expected) real interest rates in an increasingly open global capital market. Non-OECD economies are assumed to have an inflation rate of about 3% to 4%.

Fiscal policy settings differ across the separate OECD economies. In the United States, an annual budget deficit of 3% of GDP is consistent with the general government net debt to GDP ratio remaining approximately constant throughout the scenario. Japan has the same budget deficit to GDP ratio as the United States, even though this still leaves the stabilised debt to GDP ratio at almost twice the level in the United States in 2025. The euro area has an annual budget deficit of a size needed to bring gross government debt within the Maastricht objective of 60% of GDP; this is achieved with an annual deficit of just under 1½ per cent of GDP. The remaining two OECD country groups have a budget surplus at the

Box 3. **Key assumptions in the moderated globalisation scenario**

Demographic assumptions, fiscal and monetary policy objectives and the evolution of output gaps remain as set out in Box 2. Other key assumptions vary from those used in the first scenario. The changes include:

- Annual trend labour productivity growth throughout the OECD is assumed to be ¼ per cent per annum lower than in the first scenario, reflecting a lower level of openness to trade and FDI (OECD, 2003). Annual productivity growth is lowered by ½ per cent per annum in all the non-OECD economies in the scenario with moderated globalisation, reflecting the larger potential cost for these economies from a reduced level of international openness.
- The structural rate of unemployment in the OECD economies is approximately ½ percentage point higher than in the first scenario, reflecting the lower level of product market competition in the second scenario. Table 4 provides full details on the revised supply-side assumptions.
- Individual commodity prices are assumed to follow specific profiles that are broadly consistent with the implications of the econometric equations in Pain *et al.*, (2006). With economic growth per annum being reduced in the second scenario, oil prices are now held constant in real terms.
- Equity prices are now assumed to rise by 3¾ per cent per annum in the OECD economies, and by 6½ per cent in the non-OECD economies, and the bilateral nominal exchange rates of the non-OECD economies with the OECD economies are now assumed to appreciate by 2¾ per cent per annum, reflecting the revisions to average productivity growth per annum. There are corresponding changes in the rate of revaluations to the stocks of international assets and liabilities.
- In the moderated globalisation scenario, the level of underlying capital flows is reduced considerably, ending up between 4-5% of GDP for most OECD economies and between 5-7% of GDP for most non-OECD economies. Japan is an exception, with underlying capital flows rising from 2% of GDP to 3½ per cent over the course of the scenario. Gross flows in the rest of non-OECD Asia are left unchanged from the first scenario, as asset and liability stocks would otherwise decline markedly as a share of GDP.

Table 4. **Supply side assumptions – Moderated globalisation scenario**

	Trend growth		Trend productivity		NAIRU		Trend labour force		Trend participation rate		Working-age population	
	Growth rate per annum				Per cent		Growth rate per annum					
	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25	2001-05	2020-25
OECD												
United States	3.2	2.4	2.2	1.6	4.8	5.3	1.0	0.8	66.3	65.5	1.2	0.8
Japan	1.6	1.1	1.6	1.6	3.9	4.1	0	–0.5	78.5	80.0	–0.4	–0.5
Euro Area	1.8	1.3	0.8	1.6	8.0	7.0	1.0	–0.3	71.1	73.8	0.4	–0.3
Other OECD Europe	2.8	2.2	2.2	2.1	7.9	7.4	0.6	0.1	72.2	72.7	0.6	0.1
Other OECD	3.7	2.2	2.4	2.0	5.4	4.9	1.3	0.2	72.6	74.6	1.0	0.2
Non-OECD												
China	8.2	6.5										
Other non-OECD Asia	5.8	5.1										
Non-OECD Europe	6.5	3.6										
Africa, the Middle East and Latin America	3.5	3.0										

start of the scenario and are assumed to move back gradually to having a small budget deficit of around ¼ per cent of GDP over the course of the projection period, broadly consistent with a small negative, or even a positive public sector position.

The main budgetary pressures come from the likely growth of public expenditure as a result of demographic changes that lead to a rise in the ratio of the dependent population to the working-age population. Ageing-related pressures on public expenditure are likely to be reflected in health-care expenditures as well as in public transfers;[23] in the scenario the pressures are represented exclusively on the transfer side, with public consumption and investment stable as a share of GDP. In the average OECD economy transfer expenditures are projected to rise by some 3% of GDP over the course of the scenario OECD (2007).

It is assumed that pressures that would further raise the size of budget deficits are offset by increases in the effective direct tax rate on household incomes. The need to achieve the specified budgetary outcomes induces increases in the effective tax rate of 3½-4 percentage points in the United States and the euro area, and 6 percentage points in Japan over the scenario horizon. The remaining two OECD groups can be seen as ones in which the impact of rising dependency rates is partially offset by the move from budget surplus to budget deficit. The effective direct tax rate on household incomes is broadly flat in these regions throughout the scenario.

The moderated globalisation scenario

The relatively benign macroeconomic outcomes shown in the first scenario almost certainly require continued structural changes in the composition of output and employment in the OECD economies, reflecting the increasing integration of non-OECD economies into global trade and production networks. Such changes generate winners and losers, and it is possible that social and political concerns about income distributions, labour market outcomes and the environmental impact could act to moderate the pace of integration, even without the formal imposition of barriers to trade and capital movements. The second scenario explores the possible outcomes of a moderation in the future increase in globalisation.

The second scenario can be viewed as a possible configuration of the world economy in the event of a simultaneous slowing in the growth of output, trade and capital flows. The future increase in trade and financial integration is approximately half that in the first scenario. The magnitude of this slowing in the prospective extent of globalisation is not meant to be indicative of the likely policy response to the current social and political concerns. Rather, the scenario is meant to provide an indication of the possible consequences of a deceleration in the globalisation process. Stronger (and weaker) reactions could be imagined, leading to correspondingly stronger (weaker) impacts on GDP growth and other macroeconomic outcomes.

The scenario is characterised by lower growth in both the OECD and the non-OECD economies, reflecting the revised supply-side assumptions (see Box 3 and Tables 5 and A2). Non-OECD countries lose relatively more from the moderation of globalisation than the OECD countries, so that their catch-up in terms of GDP per capita is slower (Table 6). Annual GDP per capita growth is on average ¼ percentage point lower in the OECD (measured at current prices and current PPPs) and ½ percentage point lower in the non-OECD.[24] These lower growth rates imply that in 2025, output per capita in the OECD is 7% below the level in the first scenario; non-OECD output per capita income are 11% lower.

Table 5. **GDP growth – Moderated globalisation scenario**

	Average GDP growth rates			Average GDP per capita growth rates			GDP per capita relative to United States at projected PPP exchange rates as percentage		
	2006-25	2006-15	2016-25	2006-25	2006-15	2016-25	2005	2015	2025
United States	2.5	2.6	2.4	1.7	1.7	1.7			
Japan	1.4	1.6	1.1	1.5	1.6	1.4	72	72	70
Euro area	1.6	1.9	1.4	1.6	1.7	1.4	68	68	66
Other OECD Europe	2.5	2.7	2.3	2.1	2.2	1.9	46	49	50
Other OECD	2.6	3.0	2.3	1.9	2.1	1.6	46	48	48
China	7.0	7.5	6.4	6.4	6.8	5.9	17	28	42
Other non-OECD Asia	5.4	5.6	5.1	4.2	4.3	4.0	9	11	14
Non-OECD Europe	4.3	4.8	3.7	4.4	5.0	3.9	22	31	38
Africa, the Middle East and Latin America	3.4	3.9	3.0	1.9	2.2	1.6	12	12	12
OECD *(2000 PPP US$)*	2.2	2.4	2.0	1.7	1.8	1.6			
Non-OECD *(2000 PPP US$)*	5.5	5.8	5.1	4.3	4.5	4.1			
World *(2000 PPP US$)*	3.9	4.0	3.7	2.9	3.0	2.9			

Table 6. **Per capita incomes in the alternative globalisation scenarios**

Current PPP US$

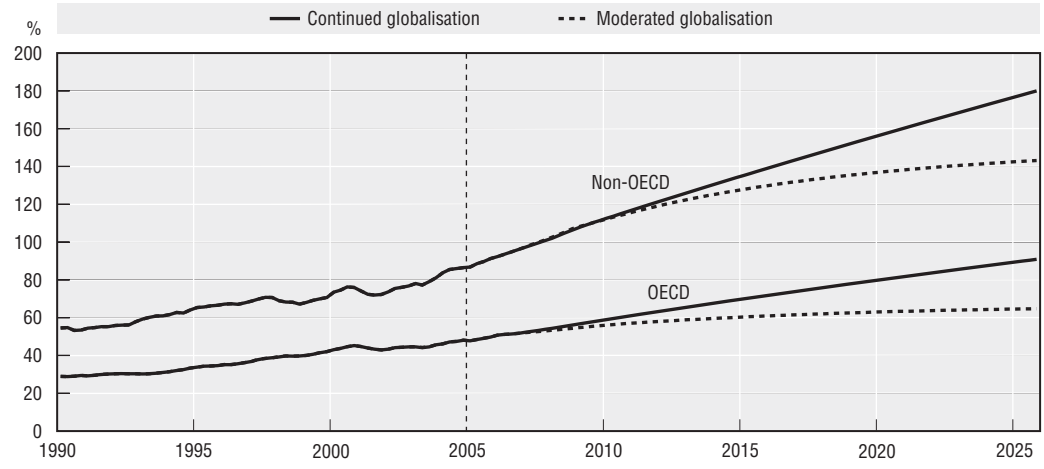
	OECD	Non-OECD	World
	Continued globalisation		
2005	28 440	5 085	9 345
2025	63 587	20 003	28 852
	Moderated globalisation		
2005	28 440	5 085	9 345
2025	59 264	17 779	24 627

Comparing the revised scenario projections for real output per capita with those from the econometric convergence equations suggests that the path implied by the convergence equations is again broadly similar to that in the new scenario in all regions apart from other OECD Europe and China (see Hervé *et al.*, 2007 for further details). The broad pattern of developments across economies remains similar to that in the first scenario, with China and the non-OECD Europe economies catching-up with the United States by rather more than the remaining non-OECD economies.

The second scenario is also characterised by lower growth in cross-border trade and financial flows. World trade as a share of GDP (in constant prices) is more than 30 percentage points lower than in the first scenario and world assets plus liabilities as a share of GDP are almost 60 percentage points lower (Figures 9 and 13). The differences are particularly pronounced for the non-OECD economies.

Figure 13. **Trade integration – Comparison of continued and moderated globalisation scenario**

Percentage points



Note: Trade integration as measured by the ratio of exports plus imports to GDP, both in volume terms.

While the regional composition of trade in 2025 is broadly similar to the first scenario, the composition of asset and liability holdings has changed somewhat (Figures 14 and 15). The share of total global liabilities owed by the United States in 2025 is 2 percentage points higher than before, at 28%. If the extent of global integration in the future was to slow down much more markedly than shown, it is likely that the share of global liabilities owed by the United States would be higher still, raising the risk of an exchange rate adjustment to help correct growing global imbalances.[25]

The composition by asset class projected for 2025 also differs across the two scenarios. Most notably, the stock of inward foreign direct investment in non-OECD economies as a share of GDP is more than 11 percentage points lower under the moderated globalisation scenario. Given that foreign direct investment is a major source of technology spillovers these lower FDI inflows are consistent with the lower productivity growth experienced by non-OECD economies.

A slight tightening of the monetary stance in the United States generates a modest easing in inflation and higher short-term real interest rates. In other countries, interest

Figure 14. **Regional composition of foreign assets holdings in 2025 – Moderated globalisation scenario**

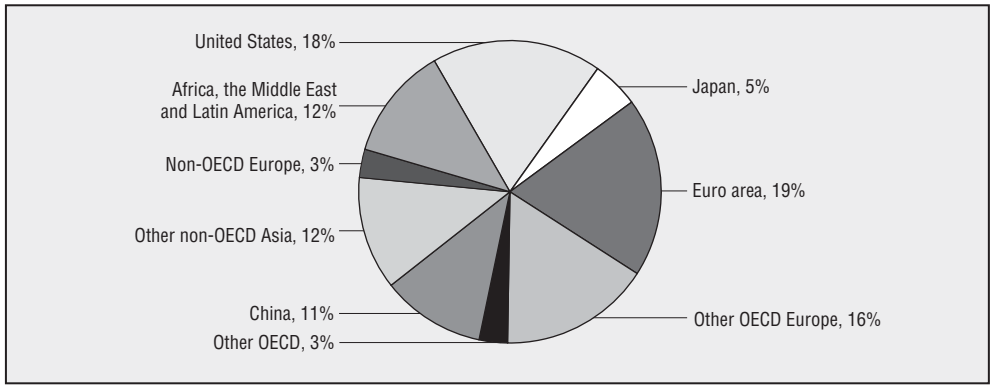
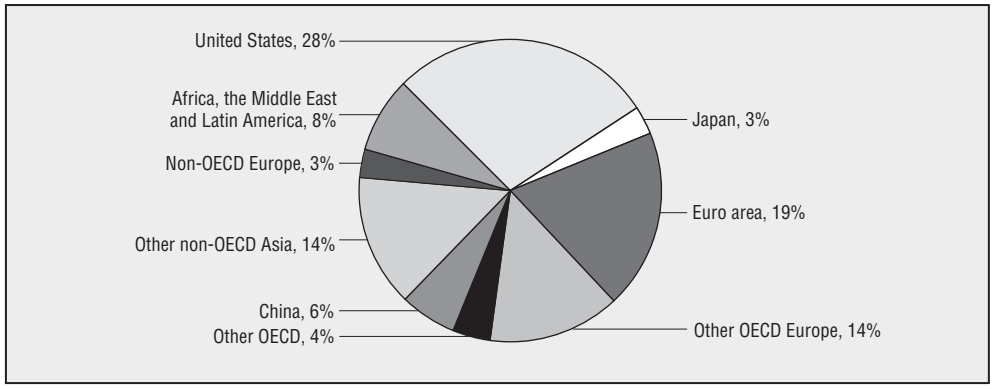


Figure 15. **Regional composition of foreign liability holdings in 2025 – Moderated globalisation scenario**



rates remain unchanged from the first scenario; in consequence, government debt interest payments as a percentage of GDP are higher in the second scenario. This, together with higher transfer payments stemming from an increase in unemployment rates and slower growth of the tax base, requires an additional rise of 1-1½ percentage point in the effective tax rate on household incomes in all OECD economies to ensure the stability of the debt to GDP ratio.

Overall, in spite of the small differences in assumptions between the first and second scenarios, it is clear that the future slowing of the increase in globalisation has visible detrimental effects. If protectionist pressures were to become stronger still, the resulting changes from the continued globalisation scenario would be considerably larger and could possibly appear more rapidly.

The impact of non-OECD economic developments on OECD economies

With the share of the non-OECD economies in the global economy expected to increase steadily out to 2025, and their cross-border trade and financial linkages with the OECD economies projected to deepen further, macroeconomic developments in the OECD economies are likely to be increasingly affected by those in the non-OECD economies.[26] This section contains an assessment of such spillovers, using selected simulations on the

new global macro-econometric model currently being developed at the OECD. Identical simulations are conducted over ten-year intervals on the continued globalisation baseline discussed above, starting initially in 2005 and then in 2015.[27]

The first "shock" considered is an *ex ante* rise of 1% in domestic demand in the non-OECD economies, maintained for ten years.[28] The second "shock" is of a loss of financial market confidence in the non-OECD economies, with rising interest rates in the non-OECD economies and a depreciation of their currencies against those of the OECD economies.[29] In all cases the impact on output in the OECD economies in the shocks beginning in 2015 is found to be approximately double that from the same shocks beginning in 2005.[30] The main factors behind this are that any given (percentage) changes in OECD exports to the non-OECD or in the value of OECD financial assets invested in the non-OECD are equivalent to a considerably larger share of OECD GDP in 2015 than at present.

To offset this, monetary policy in the OECD economies is likely to have to respond more quickly and more vigorously in the future to economic "shocks" in the non-OECD economies. The extent to which it becomes more responsive will vary across economies within the OECD, depending on the respective strengths of cross-border linkages with the non-OECD economies. A corollary of this is that monetary policy may need to respond less to domestic country-specific "shocks", since stronger cross-border linkages ensure that a larger proportion of such "shocks" will have to absorbed by foreign economies. Whilst globalisation has altered the impact of monetary policies in the OECD economies, it has not diminished their capacity to eventually stabilise the economies.

In all simulations short-term interest rates are determined by a Taylor rule, with rates moving to help stabilise price inflation when it is away from the baseline levels and/or when output gaps are not at baseline levels. Fiscal stability is ensured by varying the effective direct tax rate on households so as to eliminate any deviation of public sector deficits (as a per cent of GDP) from their baseline levels. Nominal exchange rates are held as base levels unless otherwise specified.[31]

Higher domestic demand in non-OECD countries

Private sector savings relative to GDP are comparatively high in many non-OECD economies at present. In part this can be attributed to a need for precautionary savings in the face of a limited social safety net at a time when traditional family-based redistribution plays a smaller role. Comparatively under-developed financial sectors also increase the need for precautionary savings. In time, it can be expected that such effects will begin to moderate, with the consequent reductions in household saving ratios then acting as a temporary demand stimulus. To illustrate the possible macroeconomic implications of a change of this type, an initial simulation was run of an *ex ante* increase of 1% in domestic demand in all the non-OECD economies for ten years, with accompanying increases in non-OECD import volumes and equity prices.[32]

In the long run, output returns to the baseline level in both the OECD and the non-OECD economies since the simulation does not involve a permanent change in potential output. In the shorter term, there is an increase in GDP, with an associated rise in output gaps, inflation and interest rates. The overall effects on GDP, short-term interest rates and export volumes are summarised in Figures A1-A3, with additional detail given in Tables A3 and A4.

The overall effects on non-OECD GDP in the simulation beginning in 2005 are of a broadly similar magnitude to those in the simulation beginning ten years later. Non-OECD GDP rises by almost 1% in the first year of the simulation and then gradually returns towards baseline levels over the remainder of the simulation period, reflecting higher net imports and the extent to which the initial rise in domestic demand is offset by eventual declines in real incomes and rising real interest rates.

In contrast, the short-run impact on GDP levels in the OECD economies in the simulation beginning in 2015 is found to be approximately twice the size of that in the simulation beginning in 2005, although in both cases output returns to baseline levels by the end of the simulations (Figure A1). The demand "shock" in the non-OECD acts as a stimulus to the OECD economies by raising external demand for exports from the OECD, and by raising both the value of, and the returns from, the financial assets held by OECD economies in the non-OECD. These changes represent a larger share of OECD GDP in 2015 than in 2005, because of the growth over the intervening period in trade and financial assets relative to GDP. The value of the international assets held by the OECD economies rises by a peak of 3% in the simulation from 2015, compared with a peak increase of 2½ per cent in the simulation from 2005.[33]

The impact of the higher level of output in the non-OECD economies differs across OECD economies. Japan, the United States and the rest of the OECD group receive the largest short-term stimulus to export volumes (Figure A3), reflecting their stronger trade ties with the non-OECD economies and, for the rest of the OECD group, their strong ties to developments in the United States. The European economies receive a larger stimulus to private consumption than the other OECD economies because higher investment income from the non-OECD and increases in the value of investment assets in the non-OECD represent a bigger stimulus to the European economies. The rise in net investment income is, at its peak, worth around 0.2% of GDP in all the OECD economies, with the exception of the other OECD Europe group, where it is worth approximately 0.5% of GDP.[34]

Monetary policy in the OECD economies is set to limit and eventually offset the inflationary pressures that rise as a result of stronger demand growth and positive output gaps. Short-term interest rates rise much more in the simulation from 2015 than in the simulation from 2005 (Figure A2), reflecting a greater need for stronger action to damp incipient inflationary pressures in the OECD economies in the second simulation. This arises because stronger output growth pushes output gaps further above baseline in the second simulation than in the first.

The fiscal rule initially generates a small decline in effective tax rates on households in the OECD countries, but after ten years, the effective rate is at or above baseline levels. In the short term, the positive stimulus to demand lowers unemployment and raises tax receipts. Thus effective tax rates decline a little in order to hold the fiscal balance at baseline levels. But in the longer term, the demand stimulus fades away, and higher interest rates raise government debt payments. Effective tax rates thus have to rise a little to ensure that the fiscal balance remains at baseline levels.

A loss of financial market confidence in the non-OECD economies

The globalisation scenario used as a baseline for the simulations contains a significant increase in the level of international assets invested in the non-OECD economies, associated with a sustained period of robust economic growth. If uncertainty about the

prospective returns from investment in the non-OECD were to rise, for instance because of greater political risks, there would be some downward adjustments in the market valuation of assets held in the non-OECD economies. Such an event would be likely to be associated with higher nominal interest rates in the non-OECD economies, declines in equity prices and possibly a marked exchange rate depreciation, reflecting the impact of rising risk premia on non-OECD bond and equity prices, and the need for the exchange rates of the non-OECD economies to decline to levels from which they are expected to appreciate in the future.

The simulations seek to illustrate the mechanisms through which this might affect the OECD economies, and examine whether the effect of these mechanisms changes over time. The "shock" considered is, however, comparatively drawn out compared with the speed at which a real-time loss of confidence might be expected to occur. Short and long-term interest rates in the non-OECD economies are raised by 1 percentage point above baseline levels for ten years, adversely affecting domestic demand in these economies, and the nominal bilateral dollar exchange rate of each non-OECD economy is assumed to depreciate by 10%.[35] The effective exchange rates of the OECD economies appreciate by 2-4½ per cent, depending on the extent to which they trade with and compete against the non-OECD economies. The largest currency appreciation is in Japan. Finally, the heightened uncertainty in financial markets is assumed to also be associated with a decline of 2% in equity prices in the OECD economies.

This shock acts to depress domestic demand in the non-OECD economies throughout the first ten years of the simulation, with demand being around 2% below baseline levels. However this is gradually offset by improvements in the volume of net trade in the non-OECD economies, helped by the initial depreciation of their nominal (and real) exchange rates. The improvement is limited as demand growth is below base levels in the OECD economies. The overall effects on GDP, short-term interest rates and export volumes are summarised in Figures A4-A6, with additional detail being available in Tables A5 and A6. The decline in GDP in the non-OECD economies is slightly less in the simulation beginning in 2015 than in the simulation beginning in 2005; this reflects the extent to which trade has risen relative to GDP. The improvement in net trade represents a larger share of GDP in 2015 than in 2005.

The OECD economies are hit by declines in the value of domestic equities and in the domestic currency values of financial assets held in the non-OECD economies, generating a negative wealth effect on domestic demand. On average, the value of net foreign assets is around 2½ per cent below baseline levels in the OECD economies. Incomes earned from investments in the non-OECD also decline. In addition, there is an initial loss of competitiveness because of the appreciation of effective exchange rates in the OECD economies; this reinforces the negative impact on exports stemming from the decline in external demand in the non-OECD economies. The combined impact of all these changes varies across the OECD economies, depending on the comparative importance of wealth effects and the extent to which net exports are adversely affected. Both of these factors are comparatively more important in the simulation from 2015 than in the one from 2005, again reflecting the growth of trade and financial assets relative to GDP that is embodied in the baseline.

On average, the negative short-term impact on the level of GDP in the OECD economies is around 50% higher in the simulation beginning in 2015 than in the simulation beginning

in 2005. The shorter-term effects of the shock are approximately twice the size in the United States, Japan and the rest of the OECD group, reflecting both the comparative importance of trade with the non-OECD for these economies, and the greater impact of equity-related wealth effects on domestic demand in the United States. Ultimately, however, output is approximately back at base levels after ten years in all economies.

Monetary policy in the OECD economies responds to the shock so as to help bring inflation back to baseline levels in the medium term. The differences between the simulations in 2005 and 2015 are limited by the different monetary policy responses involved in the OECD economies. Short-term interest rates are reduced considerably more in the latter simulation, with interest rates declining by over 2 percentage points in the OECD economies on average. The associated declines in real short-term interest rates in both simulations also help to stabilise domestic demand in the OECD economies and eventually help to bring it back to, or even slightly above, base levels.

Conclusion

This paper has explored the possible macroeconomic policy challenges associated with a prospective continuation of international trade and financial integration over coming decades, making use of a global macroeconomic model and associated database newly developed by the OECD. Two possible scenarios for the world economy out to 2025 were constructed, the first one reflecting the continuation of current globalisation trends and the second one moderating these trends considerably. The first scenario was used as a baseline for a number of different simulations of the impact of economic shocks arising from the non-OECD economies on the OECD economies.

The most important feature of the analysis is that global economic developments would become much more dependent on developments in the non-OECD economies than they used to be. The shares of the non-OECD economies in world output, trade, and capital markets are set to increase substantially over the next two decades. If the process of globalisation continues at its current pace, non-OECD economies are projected to account for approximately 60% of world real output (evaluated in PPP terms), one-half of nominal world trade (at current market rates), and a third of nominal cross-border asset and liability holdings by 2025.

World output growth is projected to average 4-5% per annum over the period 2005 to 2025 if globalisation continues at its current pace. GDP growth in the non-OECD economies will remain well above that in the OECD economies, reflecting higher productivity growth and more favourable demographic developments. This helps to raise per capita output in the non-OECD economies relative to those in the OECD. Per capita output in the non-OECD economies is projected to rise by close to 5% per annum over the next two decades if globalisation continues at its current pace, compared with growth of 2% per annum in the OECD. Amongst the non-OECD, China and non-OECD Europe are projected to enjoy comparatively strong increases in per capita output.

The analysis has important implications for the future sustainability of current external imbalances, with the likelihood of exchange rate crises and financial market disruption depending in part on the future build-up and composition of international assets and liabilities. The continued globalisation scenario suggests that, under a number of assumptions, a large US current account deficit could be consistent with the United States retaining broadly the same share of world foreign liability holdings in 2025 as

in 2005 despite continued large net capital inflows. Rapid economic growth and financial integration will increase the global pool of funds that can be invested, including in US liabilities. Against this, the share of portfolios that investors would wish to hold in US liabilities is likely to diminish as the US economy is set to decline as a share of the world economy. Given that US financial markets currently enjoy an advantage in terms of depth and efficiency, the first of these forces may have a stronger influence in the near to medium term.

A slowdown of the globalisation process would raise the likelihood of a disruptive depreciation of the US dollar. This is illustrated in the moderated globalisation scenario, showing that US external liabilities would rise further as a share of global financial liabilities if the pace of global economic integration decelerated. Given the modest slowing in the prospective extent of globalisation, the scenario has only a small increase in US external liabilities. A much stronger slow-down could be imagined, leading to a correspondingly stronger impact on the external position of the United States.

In many non-OECD economies, notably China, adverse valuation effects would act to offset the impact of any continued accumulation of current account surpluses on net international asset holdings. This might also help to bring about an eventual rebalancing of portfolios and a decline in the share of assets held in the US economy.

Finally, the simulations carried out on the continued globalisation scenario provide insights into the future transmission of macroeconomic shocks across countries. With the level of international trade and cross-border asset holdings set to rise significantly relative to GDP over the period 2005-2025, macroeconomic shocks in a given country or region will have a larger impact on other economies in the future than they do today. In particular, countries are set to have larger external assets and liabilities than at present, raising their exposure to financial market disturbances associated with abrupt changes in asset prices and exchange rates. Simulation analyses suggest that the impact of economic shocks in non-OECD economies on the GDP of OECD economies might be twice as large in 2015 as in 2005.

An important implication of this is that monetary policy in the OECD economies will need to take greater account of developments in the non-OECD economies in the future. Policymakers in the OECD may have to act more promptly and more vigorously to economic "shocks" in the non-OECD economies in order to limit the impact on OECD economies. At the same time, policymakers may need to respond less to domestic country-specific "shocks" in the future, since a greater share of the effects of such shocks will be absorbed by other countries via trade and financial linkages.

Notes

1. Developments up to the mid-1990s were discussed in detail in Richardson (1997).
2. Between 1995 and 2005 the ratio of world exports to world GDP rose by about 1 percentage point per year, compared with growth of less than ½ percentage point per year from 1980 to 1994.
3. See Kose *et al.* (2006), for a comprehensive discussion of various measures of international financial integration.
4. The calculation of the stocks of foreign assets and liabilities is based on all financial transactions that are recorded in a country's capital account. Major categories are direct investment, portfolio investment and financial derivatives.

5. Lane and Milesi-Ferretti (2003) show that prior to 1995 the pace of financial integration of non-OECD countries was similar to that of the OECD.

6. The fragmentation of the production process has led to rising levels of trade in specific tasks that are needed to accomplish individual steps in the supply chain (Baldwin, 2006, and Grossman and Rossi-Hansberg, 2006).

7. Lane and Milesi-Ferretti (2003) demonstrate that trade flows are significantly correlated with financial flows and that the size of the induced financial flows is generally a positive multiple of size of the original trade flows.

8. In 2004, equity investment accounted for 48% and 41%, respectively, of the total stocks of foreign portfolio assets and liabilities of the OECD.

9. For example, while Shawky *et al.* (1997) and Yang *et al.* (2006) demonstrate that the returns from international securities are becoming more correlated over time, Brooks and Del Negro (2004) and Ciner (2006) argue that this increase in return correlations is driven by the information technology bubble and therefore has to be considered as temporary.

10. Rising financial integration might also be associated with more effective risk pooling, thereby mitigating the risk of severe financial disruptions.

11. Gourinchas and Rey (2005) demonstrate for the United States that although this composition effect gained in importance in recent years, it was not the main source of its positive total return differentials. Instead, the United States earned higher returns on its assets than it paid on its liabilities within each single asset class.

12. Between 1981 and 2005, the share of non-OECD economies in total world GDP increased from 35% to 44% (measured in 2000 PPP US$).

13. For the OECD, projections are made for the United States, Japan, the Euro area, other OECD Europe and the rest of the OECD. Amongst the non-OECD economies, China is separately identified, with the remaining economies being partitioned into three blocs – the rest of non-OECD Asia (ASI), non-OECD Europe and the rest of the non-OECD (AFMLAT). The latter bloc includes Africa, the Middle East and Latin America. The choice of the aggregate blocs predominantly reflects the prevailing patterns of global trade linkages, with particularly strong cross-border linkages amongst countries within Europe and countries within Pacific-Asia.

14. Measured in constant US dollars, annual GDP growth is over 1 percentage point lower, reflecting the greater weight given to the faster growing non-OECD economies when using PPPs.

15. Volume data are converted into PPP US$ by using the PPP rates of 2000. To convert value data into PPP US$, moving PPP rates are used that are projected out to 2025 consistent with relative price movements (a detailed discussion of the usage of purchasing power parities for converting volume and value data can be found in Schreyer and Koechlin, 2002). In interpreting data expressed in PPP terms, it should be kept in mind that PPPs are generally rather difficult to measure precisely for non-OECD economies (see OECD, 2005, for a discussion).

16. It is of course not a necessary requirement that the path of per capita output is similar in the model simulations and in the separate convergence equations.

17. See Rodrik (2006) for an extensive discussion of the impact of China's growth on other countries in East Asia.

18. The respective ratios of assets and liabilities to GDP both tend towards 125% of GDP in all the non-OECD economies given the assumptions made about the rate of average gross capital flows over the scenario. The profile for the rest of non-OECD Asia is different from that of the other non-OECD economies. This mainly reflects the fact that the ratio of assets and liabilities to GDP is much higher than in other non-OECD groups at the start of the baseline. However, recent flows (as a percentage of GDP) are not, and so, the asset and liability levels tend to converge to a similar number to those for China and Africa, the Middle East and Latin America.

19. China is also projected to become the world's second largest FDI holder by 2025 (about 15% of the world total) after the United States (approximately 15½ per cent of the world total).

20. This partially reflects the younger age of FDI in the non-OECD economies, with such investments typically being recorded in book values (adjusted for currency movements) rather than at current market values.

21. It is possible that the accumulation of overseas assets could generate stronger growth in domestic demand than shown in the scenario. If associated with a weaker current account surplus, this would help to moderate the build-up in net international assets.

22. Ultimately, such differences are unlikely to persist.

23. A detailed discussion of the budgetary pressures of rising health-care spending is provided in Oliveira Martins and de la Maisonneuve (2006).

24. The difference in annual GDP per capita growth of the world is higher than the one of the OECD in both 2006-2015 and 2016-2025, although this is not directly apparent in Tables 3 and 9 due to rounding.

25. As such, the outcome projected for 2025 may not materialise as market reactions could bring about an adjustment before the end of the projection horizon.

26. It is possible that cross-country spillovers may be more important for product specific shocks than for country specific shocks, given that the rise in international trade flows is driven in part by the international fragmentation of the production process.

27. A brief overview of the new model is given in Hervé *et al.*, 2007, Annex A.

28. Although in practice such a shock may occur over a much shorter time horizon, the simulation serves to illustrate the underlying forces at work.

29. The shocks discussed in this paper are meant to be illustrative not exhaustive. It could also be of interest to analyse shocks occurring in a specific country or region or shocks that mimic those experienced during the financial crises of the 1990s.

30. Although the precise magnitude of the impact will reflect the specific properties of the macroeconomic model to some extent, the general finding that a shock matters more in 2015 than it does in 2005 is unlikely to be contingent on the model used.

31. This implies that the exchange rate does not respond to an exogenous shock and that any adjustment has to fall entirely on other variables in the model. This may act to magnify the extent to which interest rates have to adjust to stabilise price inflation.

32. The increase in domestic demand is an endogenous one, so that the resulting impacts on the rest of the economy feed back and affect the actual path of domestic demand relative to the baseline. The positive stimulus from domestic demand on equity prices in the non-OECD is assumed to outweigh the impact of rising interest rates on equity prices.

33. The valuation effects reflect changes in the value of assets held in OECD economies as well as those held in non-OECD economies.

34. The ratio of international assets to GDP is higher for this group of economies than elsewhere (Figure 12).

35. This gives an effective exchange rate depreciation of less than 10% as the bilateral exchange rates between non-OECD economies are unchanged.

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APPENDIX

Table A1. **Continued globalisation scenario – Summary**

	2006-25	2006-15	2016-25
World		*Average annual percentage change*	
Gross domestic product, volume at 2000 US$	2.8	3.1	2.6
Gross domestic product, volume at 2000 PPP US$	4.3	4.4	4.2
Exports of goods and services, volume	7.0	7.9	6.1
OECD		*Average annual percentage change*	
Gross domestic product, volume at 2000 US$	1.8	2.0	1.7
Gross domestic product, volume at 2000 PPP US$	2.4	2.6	2.2
		Average	
Current account percentage of GDP	–1.7	–1.7	–1.7
Non-OECD		*Average annual percentage change*	
Gross domestic product, volume at 2000 US$	5.2	5.6	4.8
Gross domestic product, volume at 2000 PPP US$	6.0	6.3	5.7
Current account percentage of GDP		*Average*	
	4.3	5.3	3.2
Non-OECD			
China		*Average annual percentage change*	
Gross domestic product, volume	7.5	7.9	7.0
		Average	
Current account percentage of GDP	6.5	8.4	5.8
Net foreign assets percentage of GDP[1]		47.4	38.6
Other non-OECD Asia		*Average annual percentage change*	
Gross domestic product, volume	5.9	6.1	5.6
		Average	
Current account percentage of GDP	1.4	1.9	1.1
Net foreign assets percentage of GDP[1]		6.8	–12.0
Non-OECD Europe		*Average annual percentage change*	
Gross domestic product, volume	4.8	5.3	4.3
		Average	
Current account percentage of GDP	1.5	2.5	1.1
Net foreign assets percentage of GDP[1]		1.3	–5.8
Africa, the Middle East and Latin America		*Average annual percentage change*	
Gross domestic product, volume	3.9	4.3	3.6
		Average	
Current account percentage of GDP	3.7	5.7	2.7
Net foreign assets percentage of GDP[1]		27.1	11.8
OECD			
United States		*Average annual percentage change*	
Gross domestic product, volume	2.8	2.9	2.7
Private final consumption expenditure, volume	2.6	2.7	2.5
Gross total fixed capital formation, volume	2.7	2.8	2.7
Total employment	1.0	1.0	0.9
Private final consumption expenditure, deflator	2.1	2.2	2.0
Compensation of employees, value	5.2	5.5	4.8
		Average	
Nominal short-term interest rate	5.1	5.2	5.0
Current account percentage of GDP	–5.3	–6.0	–4.9
Government net lending percentage of GDP	–2.1	–2.3	–2.0
Government debt percentage of GDP[1]		57.2	52.3
Net foreign assets percentage of GDP[1]		–53.5	–66.1

Table A1. **Continued globalisation scenario – Summary** *(cont.)*

	2006-25	2006-15	2016-25
Japan		*Average annual percentage change*	
Gross domestic product, volume	1.5	1.7	1.3
Private final consumption expenditure, volume	1.3	1.3	1.3
Gross total fixed capital formation, volume	1.5	1.7	1.3
Total employment	–0.5	–0.5	–0.6
Private final consumption expenditure, deflator	1.9	1.6	2.1
Compensation of employees, value	3.0	2.7	3.4
		Average	
Nominal short-term interest rate	2.8	2.2	3.5
Current account percentage of GDP	2.5	3.9	1.5
Government net lending percentage of GDP	–3.2	–3.4	–3.0
Government debt percentage of GDP[1]		151.5	135.0
Net foreign assets percentage of GDP[1]		56.4	54.1
Euro area		*Average annual percentage change*	
Gross domestic product, volume	1.8	2.1	1.6
Private final consumption expenditure, volume	1.8	1.9	1.6
Gross total fixed capital formation, volume	2.0	2.5	1.5
Total employment	0.2	0.5	–0.2
Private final consumption expenditure, deflator	2.0	2.0	2.1
Compensation of employees, value	3.7	3.8	3.7
		Average	
Nominal short-term interest rate	3.7	3.7	3.8
Current account percentage of GDP	–0.5	0.0	–0.8
Government net lending percentage of GDP	–1.4	–1.5	–1.4
Government debt percentage of GDP[1]		66.2	58.4
Net foreign assets percentage of GDP[1]		–7.2	–7.9
Other OECD Europe		*Average annual percentage change*	
Gross domestic product, volume	2.7	2.9	2.4
Private final consumption expenditure, volume	2.6	2.7	2.4
Gross total fixed capital formation, volume	3.5	4.2	2.8
Total employment	0.3	0.6	0.1
Private final consumption expenditure, deflator	2.1	2.1	2.0
Compensation of employees, value	4.6	4.7	4.5
		Average	
Nominal short-term interest rate	4.5	4.5	4.5
Current account percentage of GDP	2.2	2.0	2.3
Government net lending percentage of GDP	–0.3	–0.3	–0.3
Government debt percentage of GDP[1]		30.7	22.2
Net foreign assets percentage of GDP[1]		17.1	46.2
Other OECD		*Average annual percentage change*	
Gross domestic product, volume	2.9	3.2	2.5
Private final consumption expenditure, volume	3.1	3.4	2.7
Gross total fixed capital formation, volume	2.9	3.3	2.5
Total employment	0.6	0.9	0.3
Private final consumption expenditure, deflator	2.1	2.1	2.0
Compensation of employees, value	4.9	5.2	4.6
		Average	
Nominal short-term interest rate	4.6	4.6	4.5
Current account percentage of GDP	–0.7	–1.4	–0.3
Government net lending percentage of GDP	0.1	0.5	–0.1
Government debt percentage of GDP[1]		14.6	10.2
Net foreign assets percentage of GDP[1]		–34.3	–22.2

1. The ratios "Net foreign assets percentage of GDP" and "Government debt percentage of GDP are represented for the end of period of, respectively, year 2015 and 2025".

Table A2. **Moderated globalisation scenario – Summary**

	2006-25	2006-15	2016-25
World		*Average annual percentage change*	
Gross domestic product, volume at 2000 US$	2.6	2.8	2.3
Gross domestic product, volume at 2000 PPP US$	3.9	4.0	3.7
Exports of goods and services, volume	5.2	6.3	4.0
OECD		*Average annual percentage change*	
Gross domestic product, volume at 2000 US$	1.7	1.8	1.5
Gross domestic product, volume at 2000 PPP US$	2.2	2.4	2.0
		Average	
Current account percentage of GDP	–2.0	–1.9	–2.0
Non-OECD		*Average annual percentage change*	
Gross domestic product, volume at 2000 US$	4.7	5.1	4.3
Gross domestic product, volume at 2000 PPP US$	5.5	5.8	5.1
		Average	
Current account percentage of GDP	4.1	5.1	3.1
Non-OECD			
China		*Average annual percentage change*	
Gross domestic product, volume	7.0	7.5	6.4
		Average	
Current account percentage of GDP	6.9	7.6	6.6
Net foreign assets percentage of GDP[1]		47.2	50.6
Other non-OECD Asia		*Average annual percentage change*	
Gross domestic product, volume	5.4	5.6	5.1
		Average	
Current account percentage of GDP	–1.4	1.7	–1.8
Net foreign assets percentage of GDP[1]		7.9	–35.8
Non-OECD Europe		*Average annual percentage change*	
Gross domestic product, volume	4.3	4.8	3.7
		Average	
Current account percentage of GDP	–0.3	0.1	–1.2
Net foreign assets percentage of GDP[1]		–1.2	–16.4
Africa, the Middle East and Latin America		*Average annual percentage change*	
Gross domestic product, volume	3.4	3.9	3.0
		Average	
Current account percentage of GDP	5.1	5.4	4.3
Net foreign assets percentage of GDP[1]		40.8	45.6
OECD			
United States		*Average annual percentage change*	
Gross domestic product, volume	2.5	2.6	2.4
Private final consumption expenditure, volume	2.4	2.5	2.3
Gross total fixed capital formation, volume	2.3	2.3	2.3
Total employment	0.8	0.9	0.8
Private final consumption expenditure, deflator	2.0	2.0	2.0
Compensation of employees, value	4.7	5.1	4.4
		Average	
Nominal short-term interest rate	5.3	5.2	5.3
Current account percentage of GDP	–6.0	–6.3	–5.8
Government net lending percentage of GDP	–2.4	–2.6	–2.3
Government debt percentage of GDP[1]		61.7	59.3
Net foreign assets percentage of GDP[1]		–57.8	–79.8
Japan		*Average annual percentage change*	
Gross domestic product, volume	1.4	1.6	1.1
Private final consumption expenditure, volume	1.2	1.3	1.2
Gross total fixed capital formation, volume	1.4	1.8	1.1
Total employment	–0.6	–0.6	–0.6

Table A2. **Moderated globalisation scenario – Summary** *(cont.)*

	2006-25	2006-15	2016-25
Private final consumption expenditure, deflator	2.0	1.9	2.1
Compensation of employees, value	3.1	2.9	3.2
		Average	
Nominal short-term interest rate	2.8	2.2	3.5
Current account percentage of GDP	2.9	3.8	2.1
Government net lending percentage of GDP	–3.4	–3.6	–3.2
Government debt percentage of GDP[1]		150.2	138.2
Net foreign assets percentage of GDP[1]		48.3	54.1
Euro area		*Average annual percentage change*	
Gross domestic product, volume	1.6	1.9	1.4
Private final consumption expenditure, volume	1.6	1.7	1.4
Gross total fixed capital formation, volume	1.9	2.3	1.5
Total employment	0.1	0.5	–0.2
Private final consumption expenditure, deflator	2.0	2.0	2.0
Compensation of employees, value	3.5	3.6	3.5
		Average	
Nominal short-term interest rate	3.7	3.7	3.8
Current account percentage of GDP	–0.3	–0.2	–0.4
Government net lending percentage of GDP	–1.5	–1.6	–1.5
Government debt percentage of GDP[1]		68.7	61.8
Net foreign assets percentage of GDP[1]		–10.1	–7.1
Other OECD Europe		*Average annual percentage change*	
Gross domestic product, volume	2.5	2.7	2.3
Private final consumption expenditure, volume	2.3	2.5	2.1
Gross total fixed capital formation, volume	3.3	4.0	2.6
Total employment	0.3	0.5	0.1
Private final consumption expenditure, deflator	2.1	2.1	2.0
Compensation of employees, value	4.4	4.4	4.3
		Average	
Nominal short-term interest rate	4.5	4.5	4.5
Current account percentage of GDP	1.4	1.7	1.3
Government net lending percentage of GDP	–0.4	–0.5	–0.4
Government debt percentage of GDP[1]		32.5	24.2
Net foreign assets percentage of GDP[1]		11.4	29.9
Other OECD		*Average annual percentage change*	
Gross domestic product, volume	2.6	3.0	2.3
Private final consumption expenditure, volume	2.7	3.2	2.3
Gross total fixed capital formation, volume	2.7	3.1	2.3
Total employment	0.6	0.8	0.3
Private final consumption expenditure, deflator	2.1	2.2	2.0
Compensation of employees, value	4.7	5.1	4.4
		Average	
Nominal short-term interest rate	4.6	4.6	4.5
Current account percentage of GDP	–1.0	–1.5	–0.7
Government net lending percentage of GDP	0.0	0.4	–0.2
Government debt percentage of GDP[1]		16.3	11.9
Net foreign assets percentage of GDP[1]		–36.2	–32.8

1. The ratios "Net foreign assets percentage of GDP" and "Government debt percentage of GDP are represented for the end of period of, respectively, year 2015 and 2025".

Table A3. **Simulation results: increase in non-OECD domestic demand from 2005**

	1	2	3	4	5	10
	Percentage points deviation from baseline					
World						
Gross domestic product, volume	0.3	0.3	0.3	0.3	0.3	0.1
Imports of goods and services, volume	0.7	0.7	0.5	0.4	0.3	0.2
Exports of goods and services, volume	0.7	0.7	0.5	0.4	0.3	0.2
OECD						
Gross domestic product, volume	0.1	0.2	0.2	0.2	0.2	0.1
Imports of goods and services, volume	0.5	0.6	0.4	0.3	0.3	0.1
Exports of goods and services, volume	0.6	0.7	0.6	0.5	0.4	0.2
Non-OECD						
Gross domestic product, volume	0.9	0.8	0.6	0.5	0.4	0.2
Imports of goods and services, volume	1.3	1.0	0.8	0.6	0.5	0.3
Exports of goods and services, volume	0.9	0.7	0.5	0.4	0.2	0.1
Non-OECD						
China						
Gross domestic product, volume	0.8	0.7	0.6	0.5	0.3	–0.2
Total domestic expenditure, volume	1.1	1.0	1.0	1.1	1.0	0.4
Imports of goods and services, volume	1.7	1.0	1.0	1.0	0.9	0.3
Exports of goods and services, volume	0.7	0.5	0.1	–0.2	–0.5	–0.6
Consumer price inflation	0.2	0.4	0.5	0.5	0.4	0.0
Nominal short-term interest rate	0.7	1.0	1.0	0.9	0.7	–0.2
Other non-OECD Asia						
Gross domestic product, volume	0.9	1.0	0.7	0.5	0.4	0.1
Total domestic expenditure, volume	0.9	1.1	0.8	0.5	0.3	0.0
Imports of goods and services, volume	0.9	1.0	0.7	0.5	0.4	0.1
Exports of goods and services, volume	1.0	0.8	0.6	0.5	0.5	0.2
Non-OECD Europe						
Gross domestic product, volume	0.9	0.7	0.6	0.6	0.5	0.4
Total domestic expenditure, volume	1.1	0.9	0.6	0.5	0.4	0.3
Imports of goods and services, volume	2.1	1.0	0.6	0.5	0.3	0.4
Exports of goods and services, volume	1.7	0.8	0.5	0.6	0.5	0.6
Africa, the Middle East and Latin America						
Gross domestic product, volume	0.9	0.8	0.6	0.5	0.4	0.3
Total domestic expenditure, volume	1.1	0.8	0.6	0.5	0.3	0.3
Imports of goods and services, volume	1.2	1.0	0.7	0.5	0.4	0.5
Exports of goods and services, volume	0.5	0.8	0.7	0.6	0.6	0.7
OECD						
United States						
Gross domestic product, volume	0.1	0.2	0.2	0.2	0.2	0.0
Total domestic expenditure, volume	0.1	0.1	0.2	0.2	0.2	–0.1
Imports of goods and services, volume	0.3	0.3	0.3	0.2	0.2	–0.1
Exports of goods and services, volume	0.7	0.8	0.6	0.5	0.4	0.1
Consumer price inflation	0.0	0.0	0.1	0.2	0.2	0.2
Nominal short-term interest rate	0.2	0.3	0.5	0.6	0.5	0.3
Japan						
Gross domestic product, volume	0.1	0.2	0.2	0.2	0.2	0.1
Total domestic expenditure, volume	0.0	0.1	0.1	0.1	0.1	0.1
Imports of goods and services, volume	0.4	0.3	0.2	0.2	0.2	0.0
Exports of goods and services, volume	0.9	0.9	0.7	0.6	0.5	0.5
Consumer price inflation	0.1	0.0	0.1	0.1	0.1	0.1
Nominal short-term interest rate	0.2	0.2	0.3	0.4	0.3	0.3

Table A3. **Simulation results: increase in non-OECD domestic demand from 2005** *(cont.)*

	1	2	3	4	5	10
	Percentage points deviation from baseline					
Euro area						
Gross domestic product, volume	0.1	0.2	0.2	0.2	0.2	0.0
Total domestic expenditure, volume	0.1	0.2	0.2	0.1	0.1	–0.1
Imports of goods and services, volume	0.5	0.7	0.5	0.3	0.2	0.0
Exports of goods and services, volume	0.5	0.7	0.6	0.5	0.4	0.3
Consumer price inflation	0.0	0.1	0.1	0.1	0.1	0.1
Nominal short-term interest rate	0.2	0.3	0.4	0.4	0.4	0.3
Other OECD Europe						
Gross domestic product, volume	0.3	0.4	0.4	0.5	0.5	0.3
Total domestic expenditure, volume	0.4	0.5	0.5	0.6	0.7	0.6
Imports of goods and services, volume	0.9	0.8	0.6	0.6	0.7	0.6
Exports of goods and services, volume	0.5	0.6	0.4	0.4	0.3	0.1
Consumer price inflation	0.1	0.1	0.2	0.2	0.2	0.3
Nominal short-term interest rate	0.5	0.7	0.9	0.9	1.0	1.0
Other OECD						
Gross domestic product, volume	0.1	0.2	0.2	0.2	0.2	0.1
Total domestic expenditure, volume	0.1	0.1	0.2	0.2	0.2	0.1
Imports of goods and services, volume	0.5	0.5	0.4	0.3	0.3	0.1
Exports of goods and services, volume	0.6	0.6	0.4	0.4	0.3	0.0
Consumer price inflation	0.1	0.1	0.2	0.2	0.2	0.2
Nominal short-term interest rate	0.3	0.4	0.6	0.7	0.7	0.5

Table A4. **Simulation results: increase in non-OECD domestic demand from 2015**

	1	2	3	4	5	10
	Percentage points deviation from baseline					
World						
Gross domestic product, volume	0.4	0.4	0.4	0.4	0.4	0.1
Imports of goods and services, volume	1.2	1.0	0.8	0.6	0.4	0.2
Exports of goods and services, volume	1.1	1.0	0.8	0.6	0.4	0.2
OECD						
Gross domestic product, volume	0.2	0.4	0.4	0.4	0.4	0.0
Imports of goods and services, volume	0.9	1.0	0.7	0.5	0.4	0.1
Exports of goods and services, volume	1.0	1.0	0.8	0.6	0.5	0.2
Non-OECD						
Gross domestic product, volume	0.9	0.8	0.6	0.5	0.3	0.2
Imports of goods and services, volume	1.6	1.1	0.8	0.6	0.5	0.3
Exports of goods and services, volume	1.3	1.0	0.7	0.5	0.3	0.2
Non-OECD						
China						
Gross domestic product, volume	0.7	0.7	0.5	0.3	0.2	0.0
Total domestic expenditure, volume	1.1	0.9	0.9	0.9	0.8	0.3
Imports of goods and services, volume	1.9	1.0	1.0	0.8	0.6	0.2
Exports of goods and services, volume	1.1	0.8	0.4	0.0	–0.2	–0.2
Consumer price inflation	0.2	0.4	0.5	0.4	0.3	0.1
Nominal short-term interest rate	0.6	0.9	1.0	0.8	0.6	0.1
Other non-OECD Asia						
Gross domestic product, volume	1.2	1.0	0.8	0.5	0.4	0.1
Total domestic expenditure, volume	0.8	1.0	0.7	0.4	0.2	0.1
Imports of goods and services, volume	1.1	1.0	0.8	0.5	0.3	0.1
Exports of goods and services, volume	1.5	1.0	0.8	0.6	0.4	0.1
Non-OECD Europe						
Gross domestic product, volume	0.8	0.7	0.7	0.6	0.5	0.4
Total domestic expenditure, volume	1.2	0.9	0.7	0.5	0.3	0.1
Imports of goods and services, volume	2.8	1.1	0.7	0.6	0.3	0.4
Exports of goods and services, volume	2.6	1.0	0.7	0.7	0.5	0.7
Africa, the Middle East and Latin America						
Gross domestic product, volume	0.9	0.8	0.6	0.5	0.4	0.3
Total domestic expenditure, volume	1.1	0.8	0.6	0.4	0.2	0.2
Imports of goods and services, volume	1.4	1.2	0.8	0.6	0.5	0.6
Exports of goods and services, volume	0.8	1.2	1.0	0.8	0.8	0.8
OECD						
United States						
Gross domestic product, volume	0.2	0.4	0.4	0.4	0.3	–0.1
Total domestic expenditure, volume	0.1	0.3	0.3	0.3	0.3	–0.1
Imports of goods and services, volume	0.5	0.6	0.5	0.3	0.3	–0.1
Exports of goods and services, volume	1.2	1.1	0.9	0.7	0.5	0.0
Consumer price inflation	0.0	0.1	0.3	0.4	0.3	0.3
Nominal short-term interest rate	0.4	0.6	0.9	1.0	0.9	0.3
Japan						
Gross domestic product, volume	0.3	0.3	0.3	0.3	0.3	0.2
Total domestic expenditure, volume	0.1	0.1	0.2	0.3	0.2	0.1
Imports of goods and services, volume	0.6	0.5	0.4	0.3	0.2	0.1
Exports of goods and services, volume	1.4	1.2	0.9	0.7	0.5	0.5
Consumer price inflation	0.1	0.0	0.2	0.2	0.1	0.2
Nominal short-term interest rate	0.3	0.4	0.5	0.6	0.5	0.5

Table A4. **Simulation results: increase in non-OECD domestic demand from 2015** *(cont.)*

	1	2	3	4	5	10
	Percentage points deviation from baseline					
Euro area						
Gross domestic product, volume	0.2	0.3	0.4	0.4	0.4	0.1
Total domestic expenditure, volume	0.2	0.3	0.3	0.3	0.2	–0.3
Imports of goods and services, volume	0.9	1.1	0.8	0.5	0.3	–0.1
Exports of goods and services, volume	0.9	1.1	0.9	0.7	0.5	0.3
Consumer price inflation	0.1	0.1	0.2	0.2	0.2	0.2
Nominal short-term interest rate	0.4	0.6	0.8	0.8	0.7	0.5
Other OECD Europe						
Gross domestic product, volume	0.3	0.6	0.7	0.7	0.7	0.3
Total domestic expenditure, volume	0.8	0.9	0.9	0.9	1.0	0.9
Imports of goods and services, volume	1.7	1.5	1.0	0.8	0.8	0.9
Exports of goods and services, volume	0.9	0.9	0.7	0.6	0.4	0.1
Consumer price inflation	0.1	0.1	0.3	0.3	0.3	0.3
Nominal short-term interest rate	0.6	1.0	1.4	1.4	1.4	1.2
Other OECD						
Gross domestic product, volume	0.2	0.3	0.4	0.4	0.3	0.0
Total domestic expenditure, volume	0.1	0.3	0.4	0.5	0.5	0.1
Imports of goods and services, volume	0.8	0.8	0.8	0.6	0.5	0.0
Exports of goods and services, volume	1.0	0.8	0.7	0.5	0.3	–0.1
Consumer price inflation	0.1	0.2	0.4	0.4	0.4	0.2
Nominal short-term interest rate	0.5	0.8	1.0	1.1	1.1	0.5

Table A5. **Simulation results: financial shock in non-OECD 2005**

	1	2	3	4	5	10
	Percentage points deviation from baseline					
World						
Gross domestic product, volume	–0.5	–0.6	–0.7	–0.7	–0.6	–0.2
Imports of goods and services, volume	–1.3	–1.2	–0.9	–0.7	–0.5	–0.2
Exports of goods and services, volume	–1.2	–1.1	–0.8	–0.6	–0.4	–0.1
OECD						
Gross domestic product, volume	–0.3	–0.5	–0.6	–0.6	–0.5	0.0
Imports of goods and services, volume	–0.9	–1.0	–0.7	–0.4	–0.2	0.3
Exports of goods and services, volume	–1.5	–1.7	–1.6	–1.4	–1.2	–0.7
Non-OECD						
Gross domestic product, volume	–1.4	–1.3	–1.1	–1.1	–1.1	–1.1
Imports of goods and services, volume	–2.2	–1.6	–1.2	–1.1	–0.9	–0.8
Exports of goods and services, volume	–0.7	0.0	0.6	0.7	0.9	0.8
Non-OECD						
China						
Gross domestic product, volume	–0.4	–0.2	0.0	0.2	0.3	0.2
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–3.0	–2.5	–2.1	–2.1	–1.9	–1.7
Exports of goods and services, volume	1.4	1.7	2.2	2.3	2.4	1.6
Consumer price inflation	2.7	1.1	–0.4	–0.3	–0.1	0.0
Nominal short-term interest rate	2.0	2.0	2.0	2.0	2.0	2.0
Other non-OECD Asia						
Gross domestic product, volume	–2.1	–1.9	–1.7	–1.7	–1.6	–1.4
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–2.0	–1.9	–1.8	–1.7	–1.6	–1.4
Exports of goods and services, volume	–2.1	–1.8	–1.4	–1.3	–1.1	–0.9
Non-OECD Europe						
Gross domestic product, volume	–1.4	–1.0	–1.1	–1.1	–1.0	–0.9
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–2.6	–0.3	–0.5	–0.4	–0.3	–0.5
Exports of goods and services, volume	–1.4	1.6	1.3	1.4	1.5	1.2
Africa, the Middle East and Latin America						
Gross domestic product, volume	–1.5	–1.5	–1.4	–1.4	–1.5	–1.6
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–1.6	–1.0	–0.1	0.2	0.4	0.7
Exports of goods and services, volume	0.0	0.5	1.9	2.1	2.1	2.0
OECD						
United States						
Gross domestic product, volume	–0.2	–0.5	–0.6	–0.6	–0.6	0.2
Total domestic expenditure, volume	–0.1	–0.4	–0.5	–0.5	–0.4	0.4
Imports of goods and services, volume	–0.7	–0.8	–0.7	–0.5	–0.3	0.5
Exports of goods and services, volume	–1.9	–2.3	–2.1	–1.9	–1.6	–0.6
Consumer price inflation	–0.1	–0.1	–0.4	–0.6	–0.6	–0.5
Nominal short-term interest rate	–0.5	–0.9	–1.4	–1.7	–1.6	–0.5
Japan						
Gross domestic product, volume	–0.3	–0.4	–0.6	–0.6	–0.6	–0.3
Total domestic expenditure, volume	–0.1	–0.2	–0.3	–0.3	–0.3	0.2
Imports of goods and services, volume	–0.9	–0.9	–0.7	–0.6	–0.5	0.2
Exports of goods and services, volume	–2.3	–2.7	–2.6	–2.6	–2.5	–2.4
Consumer price inflation	–0.2	–0.1	–0.3	–0.4	–0.4	–0.5
Nominal short-term interest rate	–0.7	–0.8	–1.3	–1.4	–1.3	–1.3

Table A5. **Simulation results: financial shock in non-OECD 2005** *(cont.)*

	1	2	3	4	5	10
	Percentage points deviation from baseline					
Euro area						
Gross domestic product, volume	–0.2	–0.4	–0.5	–0.5	–0.4	0.0
Total domestic expenditure, volume	–0.2	–0.4	–0.3	–0.2	–0.1	0.5
Imports of goods and services, volume	–1.1	–1.3	–0.9	–0.4	0.0	0.4
Exports of goods and services, volume	–1.1	–1.4	–1.2	–0.9	–0.7	–0.5
Consumer price inflation	–0.1	–0.2	–0.3	–0.3	–0.3	–0.2
Nominal short-term interest rate	–0.5	–0.8	–1.0	–1.0	–0.9	–0.7
Other OECD Europe						
Gross domestic product, volume	–0.4	–0.5	–0.5	–0.5	–0.5	–0.1
Total domestic expenditure, volume	–0.3	–0.2	–0.1	–0.1	–0.1	0.2
Imports of goods and services, volume	–1.1	–0.6	–0.1	–0.1	0.0	0.0
Exports of goods and services, volume	–1.3	–1.3	–1.1	–1.0	–0.8	–0.5
Consumer price inflation	–0.1	–0.3	–0.3	–0.3	–0.3	–0.3
Nominal short-term interest rate	–0.7	–1.2	–1.2	–1.1	–1.2	–1.0
Other OECD						
Gross domestic product, volume	–0.3	–0.5	–0.6	–0.6	–0.6	–0.2
Total domestic expenditure, volume	–0.1	–0.2	–0.3	–0.3	–0.3	–0.1
Imports of goods and services, volume	–1.1	–1.3	–1.1	–0.9	–0.7	–0.2
Exports of goods and services, volume	–1.7	–1.9	–1.8	–1.6	–1.4	–0.4
Consumer price inflation	–0.3	–0.3	–0.6	–0.7	–0.7	–0.6
Nominal short-term interest rate	–0.9	–1.1	–1.6	–1.8	–1.9	–1.6

Table A6. **Simulation results: financial shock in non-OECD 2015**

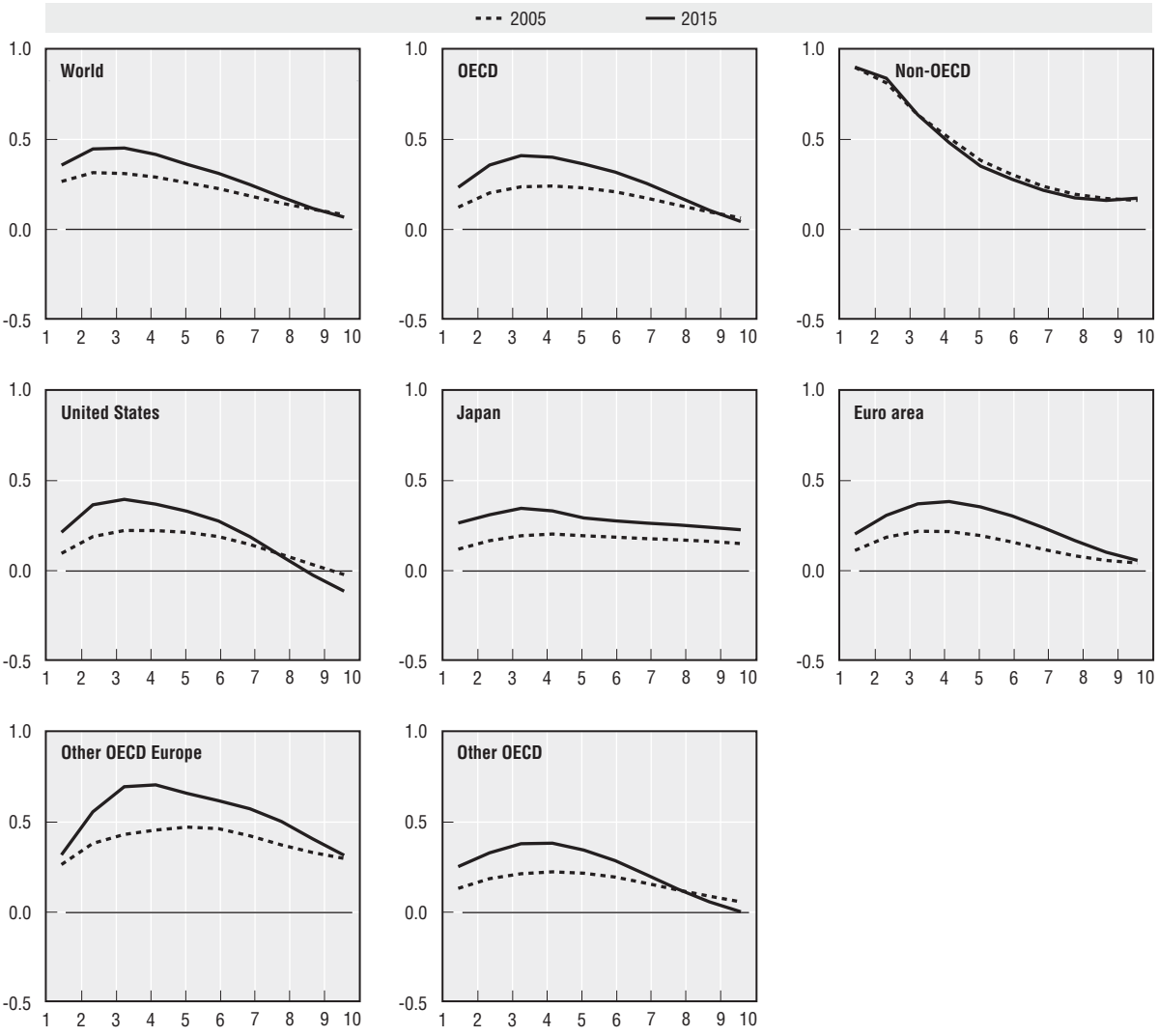
	1	2	3	4	5	10
	Percentage points deviation from baseline					
World						
Gross domestic product, volume	–0.6	–0.8	–0.9	–0.9	–0.8	–0.2
Imports of goods and services, volume	–1.8	–1.5	–1.1	–0.9	–0.8	–0.1
Exports of goods and services, volume	–1.6	–1.4	–1.0	–0.8	–0.7	0.0
OECD						
Gross domestic product, volume	–0.5	–0.7	–0.9	–0.8	–0.8	0.1
Imports of goods and services, volume	–1.3	–1.3	–0.9	–0.6	–0.4	0.5
Exports of goods and services, volume	–2.0	–2.2	–1.8	–1.7	–1.4	–0.5
Non-OECD						
Gross domestic product, volume	–1.2	–1.2	–1.0	–1.1	–1.1	–1.2
Imports of goods and services, volume	–2.6	–1.9	–1.4	–1.3	–1.1	–0.8
Exports of goods and services, volume	–1.2	–0.5	0.1	0.2	0.3	0.5
Non-OECD						
China						
Gross domestic product, volume	0.6	0.4	0.3	0.3	0.2	–0.1
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–3.3	–2.5	–2.1	–2.0	–1.8	–1.3
Exports of goods and services, volume	0.7	0.9	1.1	1.1	1.1	0.8
Consumer price inflation	2.9	1.5	–0.1	–0.1	–0.1	–0.2
Nominal short term interest rate	2.0	2.0	2.0	2.0	2.0	2.0
Other non-OECD Asia						
Gross domestic product, volume	–2.5	–2.2	–1.9	–1.8	–1.7	–1.4
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–2.4	–2.2	–2.0	–1.9	–1.8	–1.4
Exports of goods and services, volume	–2.9	–2.4	–1.8	–1.7	–1.5	–0.8
Non-OECD Europe						
Gross domestic product, volume	–1.1	–0.7	–0.8	–0.8	–0.8	–0.8
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–3.4	–0.3	–0.6	–0.7	–0.5	–0.6
Exports of goods and services, volume	–2.6	1.5	1.1	0.9	1.1	0.9
Africa, the Middle East and Latin America						
Gross domestic product, volume	–1.4	–1.4	–1.3	–1.3	–1.4	–1.7
Total domestic expenditure, volume	–2.0	–2.0	–2.0	–2.0	–2.0	–2.0
Imports of goods and services, volume	–1.9	–1.5	–0.5	–0.2	0.0	0.4
Exports of goods and services, volume	–0.5	–0.3	1.2	1.5	1.5	1.6
OECD						
United States						
Gross domestic product, volume	–0.5	–0.9	–1.0	–0.9	–0.8	0.4
Total domestic expenditure, volume	–0.2	–0.6	–0.7	–0.6	–0.5	0.6
Imports of goods and services, volume	–0.9	–1.2	–0.9	–0.7	–0.4	0.7
Exports of goods and services, volume	–2.5	–3.0	–2.6	–2.3	–1.9	–0.3
Consumer price inflation	–0.1	–0.2	–0.7	–0.9	–0.8	–0.6
Nominal short-term interest rate	–0.8	–1.5	–2.2	–2.4	–2.2	–0.5
Japan						
Gross domestic product, volume	–0.6	–0.8	–0.9	–1.0	–0.9	–0.3
Total domestic expenditure, volume	–0.2	–0.3	–0.5	–0.5	–0.4	0.3
Imports of goods and services, volume	–1.3	–1.2	–1.0	–0.9	–0.7	0.4
Exports of goods and services, volume	–3.1	–3.4	–3.1	–3.1	–2.9	–2.3
Consumer price inflation	–0.3	–0.1	–0.6	–0.6	–0.5	–0.7
Nominal short-term interest rate	–1.3	–1.2	–2.1	–2.1	–1.9	–1.8

Table A6. **Simulation results: financial shock in non-OECD 2015** *(cont.)*

	1	2	3	4	5	10
	Percentage points deviation from baseline					
Euro area						
Gross domestic product, volume	–0.3	–0.5	–0.6	–0.7	–0.6	–0.1
Total domestic expenditure, volume	–0.3	–0.5	–0.5	–0.3	–0.2	0.7
Imports of goods and services, volume	–1.4	–1.6	–1.0	–0.6	–0.3	0.6
Exports of goods and services, volume	–1.4	–1.7	–1.3	–1.1	–1.0	–0.4
Consumer price inflation	–0.1	–0.2	–0.4	–0.4	–0.4	–0.3
Nominal short-term interest rate	–0.7	–1.1	–1.4	–1.4	–1.4	–1.0
Other OECD Europe						
Gross domestic product, volume	–0.5	–0.7	–0.8	–0.7	–0.6	0.0
Total domestic expenditure, volume	–0.2	0.0	0.2	0.2	0.1	1.0
Imports of goods and services, volume	–1.3	–0.5	0.1	0.0	–0.2	0.6
Exports of goods and services, volume	–1.7	–1.5	–1.3	–1.2	–1.1	–0.6
Consumer price inflation	–0.2	–0.4	–0.5	–0.4	–0.4	–0.3
Nominal short-term interest rate	–1.0	–1.6	–1.7	–1.5	–1.5	–0.9
Other OECD						
Gross domestic product, volume	–0.6	–0.8	–1.0	–1.0	–1.0	0.0
Total domestic expenditure, volume	–0.2	–0.5	–0.7	–0.8	–0.8	0.0
Imports of goods and services, volume	–1.7	–2.0	–1.7	–1.5	–1.3	0.0
Exports of goods and services, volume	–2.4	–2.5	–2.2	–1.9	–1.6	–0.1
Consumer price inflation	–0.4	–0.5	–0.9	–1.0	–1.1	–0.6
Nominal short-term interest rate	–1.4	–1.8	–2.7	–3.0	–3.0	–1.6

Figure A1. **Increase in non-OECD domestic demand**

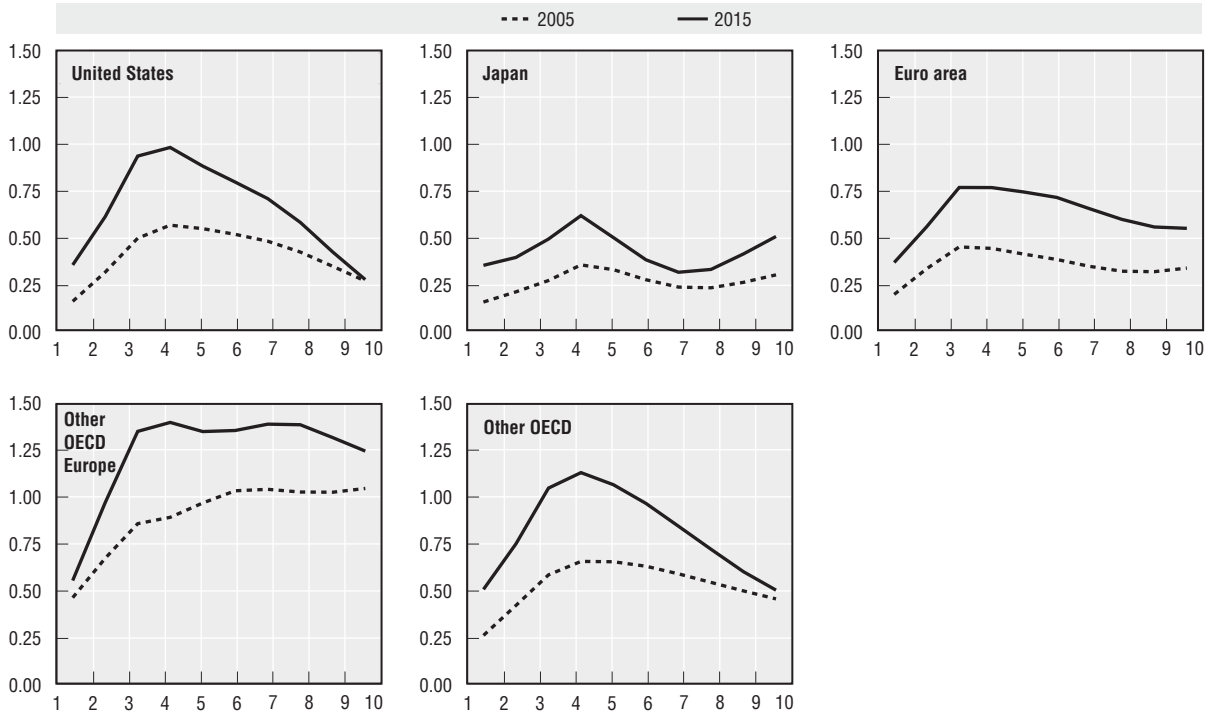
GDP, volumes
Percentage points deviation from baseline



Note: The simulated effects of an *ex ante* reduction of non-OECD domestic demand equal to 1% of GDP. See the fourth section of the main text for further details.

Figure A2. **Increase in non-OECD domestic demand**

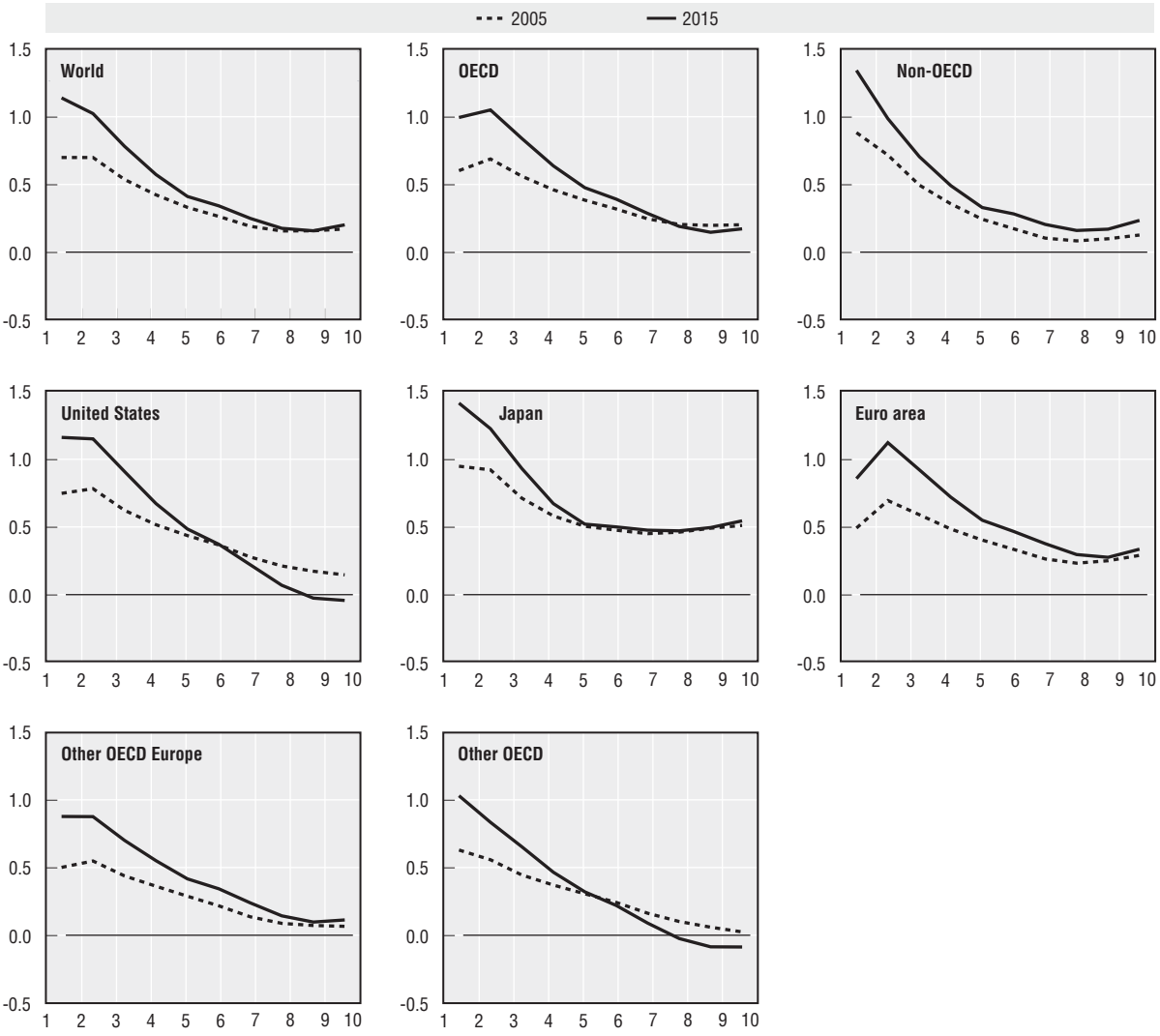
Nominal interest rates
Percentage points deviation from baseline



Note: The simulated effects of an *ex ante* reduction of non-OECD domestic demand equal to 1% of GDP. See the fourth section of the main text for further details.

Figure A3. **Increase in non-OECD domestic demand**

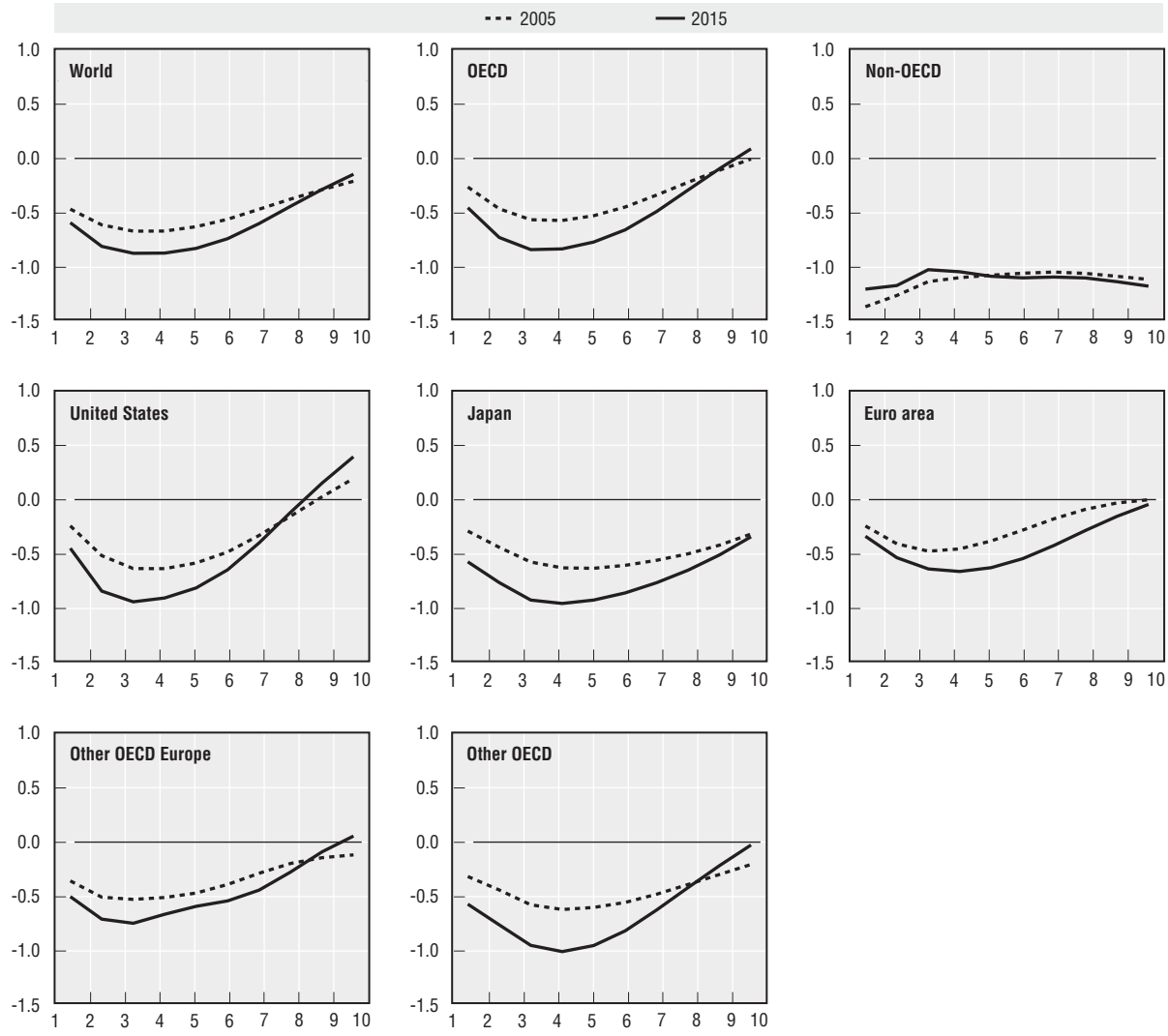
Exports of goods and services, volumes
Percentage points deviation from baseline



Note: The simulated effects of an *ex ante* reduction of non-OECD domestic demand equal to 1% of GDP. See the fourth section of the main text for further details.

Figure A4. **Financial shock in non-OECD**

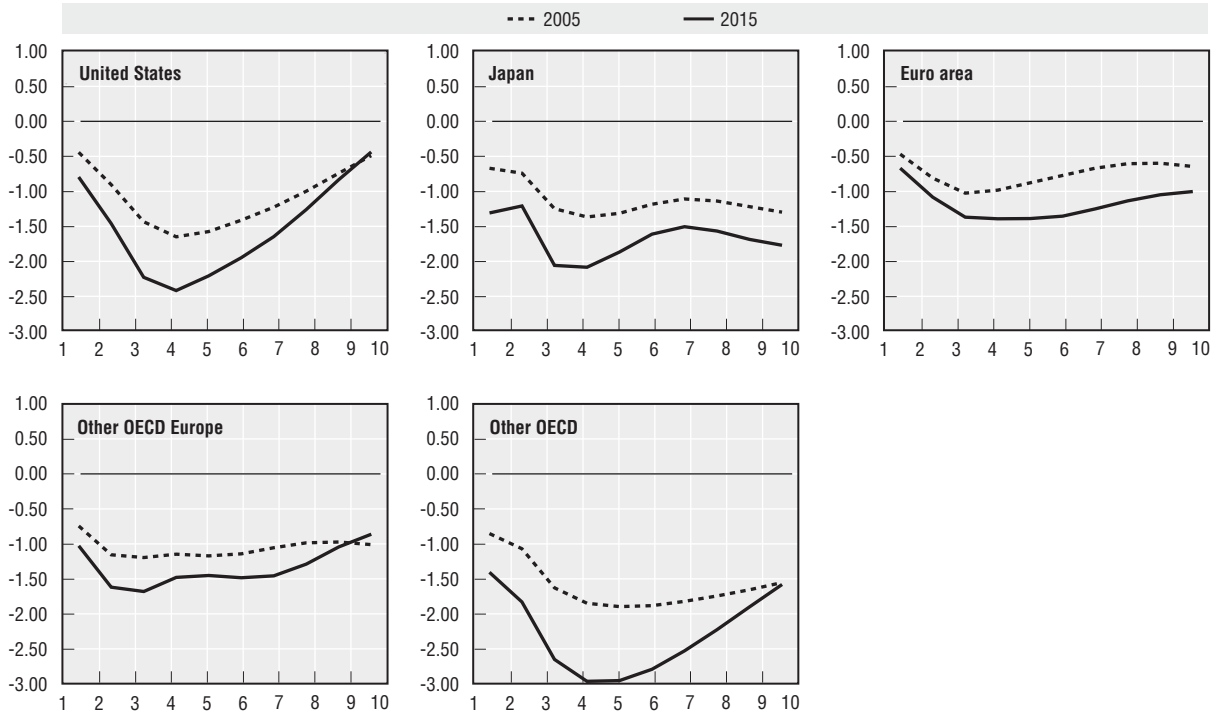
GDP, volumes
Percentage points deviation from baseline



Note: The simulated effects of an *ex ante* reduction of non-OECD domestic demand equal to 1% of GDP. See the fourth section of the main text for further details.

Figure A5. **Financial shock in non-OECD**

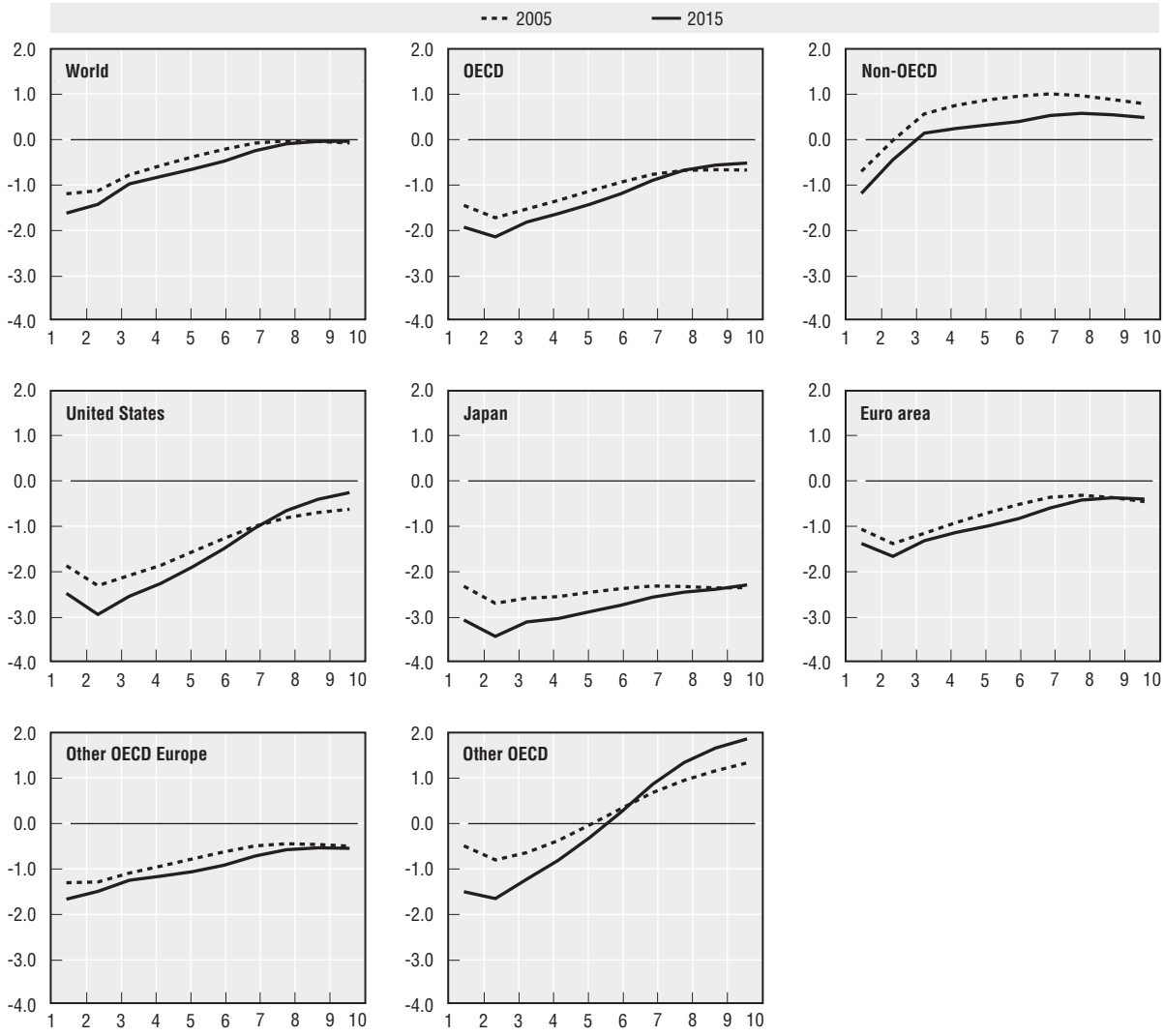
Nominal interest rates
Percentage points deviation from baseline



Note: The simulated effects of an *ex ante* reduction of non-OECD domestic demand equal to 1% of GDP. See the fourth section of the main text for further details.

Figure A6. **Financial shock in non-OECD**

Exports of goods and services, volumes
Percentage points deviation from baseline



Note: The simulated effects of an *ex ante* reduction of non-OECD domestic demand equal to 1% of GDP. See the fourth section of the main text for further details.

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Economic Resilience to Shocks: The Role of Structural Policies

by
Romain Duval and Lukas Vogel

Introduction 202
Structural policy determinants of resilience to shocks 203
Modelling strategy and preliminary cross-country comparison of business cycle patterns 205
Empirical estimates 209
The impact of labour and product market regulation on business cycle patterns 209
Monetary and financial drivers of business cycle patterns 214
Sensitivity analysis 216
Assessing the overall degree of resilience of OECD countries 222
Summary and conclusions 224
Notes 230
Bibliography 232
Appendix: Data Sources and Methodology 235

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Introduction

A trend towards more moderate business cycle fluctuations is often quoted as a stylised feature of economic developments in OECD countries over the past several decades. Among the causes frequently cited are better macroeconomic policies that have helped to anchor inflation expectations, a lower incidence and size of outside exogenous shocks, better financial market instruments for risk allocation and a reduced role for, and better control of, inventories.[1] Reflecting the more moderate cycle within countries, cyclical divergences across countries have also tended to shrink over time. As a result, macroeconomic policy requirements have become less divergent across countries. This is obviously important when it comes to countries inside the euro area, where monetary policy settings are by definition identical.

Much more controversial is whether, and to what extent, business cycles have become more synchronised across countries.[2] A factor making for synchronous business cycles are common shocks. Historically, oil price hikes have been prominent in this respect, but the oil intensity of OECD economies has tended to decline over time, implying that oil price fluctuations have become less important as a source of large common shocks. Another factor potentially making for synchronous business cycles is propagation of shocks across countries. Here, the increasing trade and financial linkages between countries are likely to have led to faster and stronger transmission of shocks across borders. A particular issue relates to business cycles across euro area countries, with the common currency potentially leading to greater integration and faster transmission, and thereby better alignment of cycles (Frankel and Rose, 1998), but also to greater specialisation and thereby a larger role for idiosyncratic shocks (Krugman, 1993).

Apart from idiosyncratic shocks, business cycle divergence across countries may also reflect different responses to common shocks. At issue here is the extent to which some economies are more resilient than others to various shocks. Since 2001, the experience of the large continental European economies contrasts with that of English-speaking OECD countries and many smaller European economies. Many of the shocks hitting countries appeared to be similar between the two groups or even marginally larger in some of the countries in the second group, such as with mass terrorism, the bursting of the equity bubble and corporate governance scandals. Yet, growth performance was generally better in the second group of countries (even adjusting for typically higher rates of potential growth) and even when recessions occurred they were usually short-lived, with economies bouncing back strongly. It seems unlikely that the differences in performance between the two country groups can be explained by different macroeconomic policy settings, even if these may in some cases have contributed.[3] As a result, the hypothesis has emerged that economic resilience is stronger in some countries than in others. Interestingly, and perhaps not coincidentally, the countries seen as more resilient also appear to be the ones that have made most progress on structural reform over the past two decades.[4]

Economic resilience may be loosely defined as the ability to maintain output close to potential in the aftermath of shocks. Hence, it comprises at least two dimensions: the extent to which shocks are dampened and the speed with which economies revert to normal following a shock. Structural policies are likely to affect both the strength and persistence of the effects of outside exogenous shocks. Macroeconomic stabilisation policies will also play an important role for resilience, but their effectiveness will also be conditioned by structural policy settings. For example, structural policy settings may affect the strength of the monetary policy transmission mechanism.

Against this background, the current paper examines the impact of a range of structural policies on the resilience of economies to shocks, both across countries and over time. The next section sketches theoretical arguments on the effect of structural settings on business cycle moderation. The third section describes the empirical strategy, and the fourth presents the empirical results. The penultimate section builds on these results to assess the overall degree of economic resilience of OECD countries and a final section sums up the main findings and concludes.

Structural policy determinants of resilience to shocks

As already noted, two key dimensions of resilience are the ability of the policy and institutional framework to cushion the initial impact of shocks and to reduce the persistence of the ensuing output gap. In this respect, those policies and institutions that dampen the initial impact of a shock may actually increase its persistence, and *vice versa,i.e.* they may have conflicting effects on resilience. For instance, strict employment protection legislation (EPL) may reduce the extent to which firms lay off workers in the short run in response to a negative shock, thereby supporting employment and private consumption. At the same time, it may slow down the wage adjustment process (Blanchard and Summers, 1986) as well as workers' reallocation towards other productive jobs, thereby delaying the return of employment and output to their initial levels. Box 1 offers a more coherent theoretical framework for thinking about links between rigidities in labour and product markets and resilience. The upshot is that there is no simple link between policy-induced rigidities and resilience and that the net effect of structural policies in product and labour markets is essentially an empirical issue.

Another potential determinant of economic resilience is the strength of monetary policy transmission channels. Here the expected effect is less ambiguous: in general, the more powerful the monetary transmission mechanism, the smaller and the less persistent the monetary policy and output responses to demand shocks.[5] Among the host of factors that contribute to shape monetary transmission channels, the degree of liberalisation of financial markets plays an important role, not least by facilitating intertemporal consumption smoothing. For example, the degree of mortgage market "completeness" (the range and variety of mortgage products available to borrowers) has been shown to amplify the transmission channel from housing wealth to consumption (Catte *et al.*, 2004). More broadly, econometric analyses of consumption behaviour typically find larger "wealth effects" from housing and financial assets in those countries that have the most liberalised financial markets (see *e.g.* Deroose, 2006). That said, the use a country can make of an effective monetary transmission mechanism depends on the chosen exchange rate policy.[6] For example, small members of a monetary union will not be helped by a strong transmission mechanism when faced with an idiosyncratic shock because monetary policy, calibrated on the union average, will not respond. Likewise, when confronted with a

Box 1. **Theoretical considerations on the link between product and labour market rigidities and resilience**

Business cycle theory allows some analysis of the links between rigidities and resilience. In a basic New Keynesian model, greater (nominal) wage and/or price stickiness flattens the (New Keynesian) Phillips curve and increases the sacrifice ratio. In turn, under optimal monetary policy,[1] an independent central bank credibly committed to medium-term price stability will react less aggressively to most shocks – including temporary but persistent cost-push or technology shocks – thereby engineering a smaller but more prolonged output gap response (see *e.g.* Altissimo *et al.*, 2006). The intuition is that since nominal rigidities worsen the inflation-output variability trade-off, a more aggressive policy reaction to a cost-push shock would induce large output losses for a limited gain in terms of reduced inflation.[2] By contrast, in the case of pure demand shocks, rigidities may be of little influence since monetary policy can readily stabilise aggregate demand without facing any trade-off between output and inflation stabilisation.

Any policy or institution that increases wage and/or price stickiness would therefore be expected to lead to a smaller but more persistent output reaction to certain shocks. Among the many theoretical underpinnings of price stickiness, imperfect competition in product markets features prominently, *e.g.* through menu costs or coordination failure[3] approaches.[4] On the empirical side, there is now fairly strong evidence at the microeconomic level that firms tend to reset their prices more frequently in more competitive markets, lending some support to the view that low product market competition increases price stickiness (see *e.g.* the recent analysis carried out within the context of the Eurosystem Inflation Persistence Network, including *inter alia* Álvaréz *et al.*, 2006, and Fabiani *et al.*, 2006). Likewise, among the various theoretical explanations for wage stickiness, some authors have stressed the role played by labour market policies and institutions.[5] For example, stringent EPL and/or high coverage of collective agreements bargained between unions and firms may slow down the adjustment of labour contracts in the face of shocks and thereby be conducive to nominal wage rigidities (Holden, 1994, 2004).

Like price stickiness, real wage rigidities flatten the Phillips curve and increase the sacrifice ratio. Real wage rigidities may be strengthened, for example, by high unemployment benefit replacement rates available over long periods. *Ceteris paribus,* rigid real wages should induce a less aggressive monetary policy response, and therefore a smaller but more persistent output reaction, to a variety of shocks. However, unlike price stickiness, real wage rigidities also increase the persistence of inflation, which should prompt monetary authorities to be more aggressive, thereby engineering a larger but less persistent output reaction to shocks. The latter effect may dominate in practice.[6] To sum up, while nominal rigidities should lead to smaller but more persistent output gaps, real rigidities might go in the opposite direction.[7] In both cases, the implications for resilience are ambiguous *a priori*.[8]

1. Minimising a quadratic loss function defined over both inflation and output gaps.
2. Given the convexity of the central bank's welfare loss function, such a policy response would not be optimal. Another reason for the central bank to react less aggressively to a cost-push shock in the presence of price stickiness is that the initial impact of the shock on inflation will be smaller, for example because firms reset prices less frequently.
3. Co-ordination failure relates to the observation that in oligopolistic markets, following a shock, firms may choose not to change their prices unless their competitors move first.
4. Furthermore, Rotemberg and Woodford (1991) have suggested that during upswings, oligopolistic firms have greater incentives to free ride on other firms' efforts to maintain collusive price behaviour, so that mark-ups should fall. This counter-cyclicality of mark-ups provides another reason to expect that low product market competition flattens the Phillips curve.
5. Other factors may also play a role. For example, in conditions of low and stable inflation, contracts may lengthen which could induce greater nominal inertia.

Box 1. **Theoretical considerations on the link between product and labour market rigidities and resilience** *(cont.)*

6. Work undertaken as part of this paper shows that when real wage rigidities *à la* Blanchard and Galí (2005) are introduced in an otherwise basic New Keynesian model, the optimal monetary response to a cost-push shock is more aggressive than under flexible real wages. This more aggressive policy response is associated with a larger but less persistent impact on the output gap. A similar conclusion appears to hold for technology shocks.
7. Model simulations suggest that this conclusion also holds within a monetary union. In a member country with an above-average degree of nominal rigidity, the initial impact of a common cost-push shock on prices is smaller. This results in a competitiveness gain which in turn mitigates the impact of the common shock on the output gap. However, this comes at the cost of a more persistent output gap, as more flexible countries quickly restore their competitiveness through the larger negative impact on inflation of their negative output gap. By contrast, in a member country with an above-average degree of real wage rigidity, the dominant effect is that the common cost-push shock brings about higher wages and therefore a loss of competitiveness. This in turn results in a larger initial impact of the common shock on the output gap.
8. It should also be stressed that the empirical notion of output gap used in this paper differs from the theoretical concept of output gap featured in New Keynesian models. The former is essentially the difference between actual and smoothed GDP, while the latter is the difference between actual and "natural" output, where – in line with the real business cycle literature – natural output may be quite volatile, *e.g.* due to temporary technology shocks.

common shock, some members of a monetary union can have too much of a good thing in the sense that a transmission mechanism that is stronger than average, together with a monetary policy response that is calibrated on the average, could be destabilizing. The analysis below controls for the influence of exchange rate policy as a constraint on monetary policy that may make it more difficult to stabilise the economy in the face of idiosyncratic shocks and/or heterogeneous propagation mechanisms of common shocks.

Some structural features of fiscal policy also affect resilience patterns, mainly *via* two channels. First, automatic stabilisers are expected to dampen the impact of shocks. Strong automatic stabilisers are typically associated with large public sectors, which in turn partly reflect some of the policies and institutions mentioned above – such as high and long-lasting unemployment benefits. Second, discretionary fiscal policy may be stabilising or destabilising, depending on whether it is counter or pro-cyclical. Here, one might expect government size, which allows strong automatic stabilisers, to be associated with a reduced need for discretionary fiscal impulses. This may not always be the case in practice, however. Evidence in Ahrend *et al.* (2006) suggests that several countries with large public sectors have supplemented automatic stabilisers with sizeable discretionary actions over the past two decades. These were on balance stabilising in Nordic countries, but destabilising in many euro-area countries. Fiscal policy was more in line with expectations in countries with smaller public sectors – such as a number of English-speaking and Asian OECD countries – with sizeable discretionary impulses contributing to output stabilisation.

Modelling strategy and preliminary cross-country comparison of business cycle patterns

With resilience determined by both amplification and persistence mechanisms, an empirical investigation of the phenomenon has to be dynamic in nature. This sub-section explores the determinants of cross-country business cycle patterns by means of dynamic, panel data output gap equations. Two issues that arise in this context are:

- *The choice of the output gap measure.* There are several possible approaches to estimate output gaps, including the Hodrick-Prescott (HP) and Baxter-King (BK) filters or the OECD methodology, which derives potential output from a production function approach (Box 2).

Box 2. **Empirical measures of business cycles and the output gap**

The output gap is the difference in per cent between actual and potential output. While actual output is observed with some precision, potential output is unobservable and must be inferred from available data.

Broadly speaking, there are two approaches to estimate potential output and the output gap, namely statistical and economic methods. Statistical methods implicitly assume that GDP embodies a long-run equilibrium component plus short-run disturbances around this trend. They perform a trend-cycle decomposition to extract the trend, which is then defined as potential output. Economic approaches derive an estimate of potential output from economic supply-side relationships, *e.g.* from the "equilibrium" value of the various components (*e.g.* population, labour force participation, unemployment, the capital stock and total factor productivity) of an aggregate production function.[1]

The analysis in this paper focuses primarily on the OECD economic (production function) approach, and checks the robustness of the results to the use of two alternative statistical measures of the output gap, namely the trend-cycle decompositions of Hodrick and Prescott (1997) and Baxter and King (1999).[2]

The (univariate) Hodrick-Prescott (HP) filter extracts a stochastic trend by introducing a trade off between achieving a good fit of the actual series and a high degree of smoothness of the trend series. The stochastic trend is assumed to measure potential output, and the residual denotes the business cycle component or the output gap. Formally, the HP filter minimises:

$$\min \sum_{t=1}^{T} (\ln Y_t - \ln Y_t^*)^2 + \lambda \sum_{t=1}^{T-1} ([\ln Y_{t+1}^* - \ln Y_t^*] - [\ln Y_t^* - \ln Y_{t-1}^*]^2$$

where Y is actual and Y^* is trend output. λ is a parameter that determines the smoothness of the trend component. Small values of λ produce a trend close to actual GDP, while high values create a trend component converging to a linear trend. Consequently, λ also determines the length of the cycle. Small values of λ will only identify high frequency cycles and include cycles with longer duration in the trend, whereas higher values of λ yield longer cycles and tend to produce larger values of the output gap. In line with most of the literature, $\lambda = 1\,600$ is chosen for quarterly data, consistent with an average duration of cycles of 4-6 years.

The Baxter-King (BK) filter decomposes the actual series and eliminates slow moving (trend) components, derived as a moving average of the series, as well as very high frequency (irregular) components from the series. Intermediate components of GDP volatility are retained as business cycle or output gap series. The basic idea is that business cycles are fluctuations of a certain frequency. BK allows for sharp cut-off points at predefined cycle length. In line with the literature, this paper fixes the range of cycle duration at 6-32 quarters and neglects all cyclical components outside these lower and upper bounds.

Unlike statistical methods, economic approaches derive their assumptions from economic theory. OECD output gap estimates adopt a production function approach, where potential output is estimated taking into account the capital stock, changes in labour supply, factor productivity and underlying non-accelerating wage rates of unemployment.[3] The methodology is hybrid in the sense that some components are still derived from statistical filters (*e.g.* the trend growth of productivity and labour supply, see Giorno *et al.*, 1995).

Box 2. **Empirical measures of business cycles and the output gap** *(cont.)*

Each method has its advantages and shortcomings. Univariate filters are simple and transparent, with results easy to reproduce. The choices of λ for HP and bounds for the cycle duration for BK rely on subjective judgement, however. In addition, because of end-point problems both methods are ill-suited to obtain output gap estimates in real time. Based on moving average trends, BK does not provide values for recent quarters. HP fits a trend through all observations, which neglects potential structural breaks. The production function approach, on the other hand, relies on debatable functional specifications and on data that are partly of poor quality (capital stock, TFP). Consequently, at least the estimated levels of potential output are subject to significant margins of error. In this paper, the focus is on the dynamics, not the level, of output gaps.

All methods that build on time-series smoothing to obtain a measure of potential GDP are likely to generate autocorrelation in the output gap. This also holds for production function approaches relying on trend series for at least some components of potential output. Consequently, output gap autocorrelation in regressions may have a spurious component. Finally, by imposing that output gaps close, trend-cycle decompositions may tend to understate output gap persistence.

1. Another, more recent approach derives output gap series from DSGE models, relying on the correlation between output gaps and inflation in New Keynesian models of the business cycle. Currently, DSGE measures are still far more model dependent than the conventional measures of potential output and output gaps however. See Basistha and Nelson (2007).
2. Additional statistical and model-based methods are discussed *e.g.* in Cotis *et al.* (2005) and McMorrow and Roeger (2001).
3. OECD estimates assume a Cobb-Douglas production function, except for Japan, where a more general CES function is used, and for Portugal, where the gap derives from HP-filtered GDP data. See Cotis *et al.* (2005) and OECD (2006).

Most features of business cycles appear to be robust to these methodological choices (for details, see Duval *et al.*, 2007). Therefore, the analysis undertaken below focuses on one method, namely the OECD output gap measure. As a complement, sensitivity analysis (towards the end of the next section) investigates the robustness of the results to the use of HP, BK and unemployment gaps.

- *The specification of output gap dynamics*. The modelled dynamics should fit output gap patterns. As discussed in Box 3, visual inspection and specification tests point to an AR(2) specification for describing output gaps (as well as unemployment gaps, dealt with later in Box 4).

As a starting point, the following dynamic (non-linear) panel regression is estimated for a sample of 20 OECD countries[7] using annual OECD output gap data over the period 1982-2003:[8]

$$GAP_{it} = \varphi_i(GAP_{it-1} - \eta GAP_{it-2}) + \lambda_t(1+\gamma_i) + \alpha_i + \varepsilon_{it} \quad [1]$$

where *i* and *t* are country and time suffixes, GAP_{it} is the OECD measure of the output gap, λ_t is a time dummy variable which aims to capture an undefined set of shocks that are common to all countries, and α_i is a country fixed effect which controls for the fact that output gaps may not have a zero mean over the finite sample period considered here. Equation [1] disentangles amplification from persistence mechanisms through the parameters φ_i and γ_i. φ_i captures country-specific output gap persistence, while γ_i captures the country-specific reaction to common shocks λ_t, *i.e.* the amplification mechanism. As explained in Box 3, the higher the value of $\eta\varphi_i$, the higher the degree of output gap

Box 3. **Further details on the econometric specification**

Equation [1] is in the spirit of the modelling strategy of Bassanini and Duval (2006), who explore the unemployment impact of interactions between common unobserved shocks and institutions by means of cross-country time-series regressions, following the seminal, static approach by Blanchard and Wolfers (2000). More broadly, all the equations estimated in the second section are of the form:

$$GAP_{it} = \varphi_{it}(GAP_{it-1} - \eta GAP_{it-2}) + \lambda_t(1 + \gamma_{it}) + \alpha_i + \varepsilon_{it}$$

where φ_{it} and γ_{it} can be either time-invariant country-specific coefficients (φ_i and γ_i in equation [1]) or can be written as a function of existing policies and institutions:

$\varphi_{it} = \varphi + \sum_j \varphi^j (X_{it}^j - \overline{X}_{..}^j)$ and $\gamma_{it} = \sum_k \gamma^k (X_{it}^k - \overline{X}_{..}^k)$ in equation [2].

The choice of an AR(2) specification is guided not only by the sinusoidal pattern of output gaps – which hint at a second-order difference equation with complex roots of absolute value lower than 1 – but also by the fact that AR(1) specifications display strong auto-correlation of residuals ε_{it} while AR(2) specifications do not.* As expected, estimating the second-order equation above is always found to yield a characteristic equation with complex roots, consistent with the sinusoidal pattern of output gaps. It should be stressed that this sinusoidal pattern is not merely a reflection of the various filtering methods applied to compute potential output, from which the OECD output gap estimates used here are derived. This sinusoidal pattern is also present in the unemployment gap estimates presented in Box 4, even though structural unemployment is not computed through filtering methods but rather is derived from the panel estimation of a reduced-form wage-setting/price-setting model of equilibrium unemployment.

Since the characteristic equation of the second-order difference equation above always has complex roots, the solution of the equation is of the form $GAP_{it} = (\eta\varphi_{it})^{t/2}(C_1 \cos \theta t + C_2 \sin \theta t)$, where C_1 and C_2 depend on initial conditions and θ is a function of parameters φ_{it} and η. Therefore, an estimate of the half-life of GAP_{it} can be computed as $-2\ln(2)/\ln(\eta\varphi_{it})$. When estimating equation [1], these estimated half-lives of output gaps can be compared statistically across countries by means of a Fisher test.

* An Arellano-Bond test on the residuals points to a rejection of the null hypothesis of no first-order autocorrelation when an AR(1) specification is used (z-stat = 7.34***, p-value = 0.00001) but to an acceptance of the null when an AR(2) specification is estimated (z-stat = 0.24, p-value = 0.8085). This test provides only an indication – albeit a strong one – of the correct specification, however, since its critical values apply to a linear dynamic panel equation, while the equation estimated here is non-linear. Another potential concern when estimating a dynamic panel equation is the standard downward dependent variable bias (Nickell, 1981). However, there is some evidence – at least in a linear framework – that the downward lagged dependent variable bias falls as the time span of the sample increases. Furthermore, it is less of a concern when the time span is large and of the same order of magnitude of the number of countries, as is the case here (Judson and Owen, 1999).

persistence in country *i*. Likewise, the higher the value of γ_i, the larger the initial impact of a common shock in country *i*. The assumption of a common η in equation [1] simplifies the analysis and is not rejected by a formal statistical test.[9]

Focusing on unobserved shocks is appealing on two grounds: *i*) it puts clear emphasis on how country-specific factors shape the output gap effects of *common* shocks, which is the primary purpose of this paper; *ii*) it is a safe approach given the wide diversity of shocks actually experienced in practice, some of which would be difficult to capture within the econometric framework adopted here.[10] However, this modelling choice also involves limitations. In particular, the omission of idiosyncratic shocks[11] and the absence of a

distinction between supply and demand shocks increase the risk of omitted variable bias in the econometric estimates in this section.[12] Another potential source of estimation bias is that output gap estimates are subject to measurement error.

Non-linear least squares estimates of $\eta\varphi_i$, the implied half-life of output gaps, and γ_i are presented in Table 1, which also tests for each OECD country whether its estimated parameter values differ statistically from those estimated for the United States. Estimated output gap persistence is low relative to that of the United States among some other English-speaking countries (Australia, Canada, New Zealand) as well as in Denmark.[13] By contrast, output gaps are found to be relatively persistent in a number of continental European countries as well as in Japan. As concerns the initial output gap effect of common shocks, most countries appear to have smaller impacts than the United States.

Some caution needs to be exerted when interpreting such descriptive results, however. In particular, estimates of equation [1] do not allow for changes in resilience over time. Yet, such changes may well have taken place in recent years, with substantial declines in business cycle volatility as described in the first section. These declines might, at least to some extent, reflect a variety of structural reforms in labour, product and financial markets. In any event, Table 1 provides information neither about the determinants of resilience nor about overall resilience (combining the persistence and amplification dimensions).

Empirical estimates

The impact of labour and product market regulation on business cycle patterns

Correlations between policies and resilience parameters

As preliminary evidence of the effects of labour and product market regulation on business cycle patterns, the country-specific persistence and amplification coefficients φ_i and γ_i estimated in Table 1 are regressed on the following indicators (averaged for each country over the period 1982-2003) in separate regressions:[14]

- The unemployment benefit replacement rate (averaged across a variety of income levels, family situations and unemployment durations).
- The stringency of employment protection legislation for regular workers (EPL).
- The stringency of product market regulation (PMR) across seven non-manufacturing industries.[15]
- Collective bargaining coverage, *i.e.* the share of workers covered by a collective agreement, a measure of union influence in wage bargaining.[16]
- The degree of centralisation/co-ordination of wage bargaining, a proxy for the concept of "corporatism" which has received widespread attention in the comparative political economy literature. In practice, the variable entered in the econometric estimates is a "low corporatism" dummy variable, which equals one if bargaining is decentralised and uncoordinated and zero otherwise.

Cross-country correlation coefficients between persistence and amplification coefficients φ_i and γ_i on the one hand, and the above policy indicators on the other, are presented in Table 2. Given that persistence and amplification coefficients are estimated rather than observed – so that standard statistical inference could be misleading – the critical values used to assess the statistical significance of each correlation coefficient are obtained by bootstrapping the regression residuals. Strict EPL, stringent PMR and a high

Table 1. **Output gap equations with country dummies**

	Persistence of shocks:[1] coefficient $\eta\varphi_i$	Implied half-life of output gaps (in years)	Amplification of shocks:[1] coefficient γ_i
Estimate for the United States:			
US	0.44	1.67	0.41
Estimates for other OECD countries and test for statistical differences in coefficients with respect to the United States:			
AUS	0.34*	1.3*	0.24
AUT	0.47	1.8	–0.85***
BEL	0.45	1.7	–0.25*
CAN	0.27**	1.1**	0.34
CHE	0.41	1.6	–0.16*
DEU[1]	0.42	1.6	–0.15
DNK	0.31*	1.2*	–0.49**
ESP	0.54**	2.3**	–0.41**
FIN[1]	0.49	2.0	0.24
FRA	0.50	2.0	–0.53***
GBR	0.41	1.6	–0.30*
IRL	0.49	1.9	0.37
ITA	0.47	1.9	–0.37**
JPN	0.50	2.0	–0.57***
NLD	0.50	2.0	–0.55**
NOR	0.57***	2.5***	–0.97***
NZL	0.38	1.4	–0.61***
PRT	0.56***	2.4***	–0.38**
SWE[1]	0.40	1.5	0.18
Time dummies		Yes	
Observations		434	
R^2		0.85	

Note: Non-linear least squares.
* (**, ***): estimated coefficient differs significantly from corresponding coefficient obtained for the US at the 10% (5%, 1%) level.
1. (Weighted) average over periods 1982-1990 and 1993-2003.

Source: Authors' estimates.

degree of corporatism appear to be negatively correlated with the initial impact of shocks but positively with output gap persistence. Similar but insignificant correlation signs are obtained for collective bargaining coverage and the unemployment benefit replacement rate.[17] In a nutshell, the results from Table 2 suggest that strict labour and product market regulations may dampen the initial impact of a common shock while making it more persistent.

This is further supported by the last row of Table 2, which finds similar and statistically significant cross-country correlations between persistence/amplification coefficients and a synthetic indicator of labour and product market regulation (averaged for each country over 1982-2003). The rationale for constructing this indicator is that countries tend to have similar stances across policy areas, thereby making it difficult to isolate the impact of a particular policy (Table 3). For instance, those countries that have strict EPL also tend to have stringent PMR, and *vice versa*. Here, this synthetic indicator is computed as the first principal component of the previous set of policy indicators

(see *e.g.* Nicoletti and Scarpetta, 2005). Based on the factor loadings produced by the analysis, it can be written as:

$$\textit{Labour and product market regulation}_{it} = 0.42^{*}(\textit{replacement rate}_{it}) + 0.45^{*}(EPL_{it}) + 0.48^{*}(\textit{collective bargaining coverage}_{it}) - 0.51^{*}(\textit{low corporatism}_{it}) + 0.37^{*}(PMR_{it})$$

This synthetic indicator has intuitive appeal. It is not very different from a simple average of the underlying policy indicators, so that it can to some extent be interpreted as a simple summary measure of the stringency of labour and product market regulation in the economy. Furthermore, it appears to explain over half of the total variance in the institutional data, which suggests that the dataset can be reduced into one single component without losing too much information in the process.[18]

Table 2. **Cross-country correlation coefficients between persistence/amplification coefficients and labour/product market policy indicators**

Based on simple regressions of country-specific coefficients on the average value of each policy indicator over the period 1982-2003, using bootstrapped critical values to assess statistical significance

	Persistence of shocks: Coefficient φ_i	Amplification of shocks: Coefficient γ_i
Benefit replacement rate	0.12	–0.39*
EPL for regular contracts	0.62***	–0.43**
PMR	0.58***	–0.46**
Collective bargaining coverage	0.29	–0.23
Low corporatism	–0.52***	0.54***
Labour and product market regulation (synthetic indicator)	0.50**	–0.51**

Source: Authors' estimates on the basis of country-specific persistence and amplification coefficients estimated in Table 1 and data sources described in the appendix.

Table 3. **Correlation coefficients between labour and product market regulation indicators**

Correlation coefficients, 1982-2003

	Benefit replacement rate	EPL	PMR	Collective bargaining coverage[1]	Low corporatism
Benefit replacement rate	1				
EPL	0.29	1			
PMR	0.15	0.37	1		
Collective bargaining coverage[1]	0.52	0.44	0.40	1	
Low corporatism	–0.53	–0.57	–0.38	–0.48	1

1. Time-invariant indicator (country average over period 1980-2000).
Source: Authors' estimates on the basis of data sources described in the appendix.

Estimating the effects of policies on business cycle patterns

In order to undertake more in-depth econometric analysis of the effects of labour and product market regulation on business cycle patterns and resilience, persistence and amplification coefficients φ_i and γ_i in equation [1] are replaced by a linear function of time-varying indicators of labour and product market regulation:

$$GAP_{it} = \left(\varphi + \sum_j \varphi^j (X_{it}^j - \overline{X}_{..}^j)\right)(GAP_{it-1} - \eta GAP_{it-2}) + \lambda_t \left(1 + \sum_k \gamma^k (X_{it}^k - \overline{X}_{..}^k)\right) + \alpha_i + \varepsilon_{it} \qquad [2]$$

where the X^js and X^ks are the indicators of policies and institutions in labour and product markets, namely the unemployment benefit replacement rate, EPL, PMR, collective bargaining coverage and the low corporatism dummy variable.

In equation [2] both the persistence and amplification of unobserved shocks are supposed to be functions of policies and institutions, while they were assumed to be constant and country-specific in equation [1]. This specification implicitly assumes that persistence and amplification coefficients depend exclusively on policy and institutional factors, and therefore does not allow for cross-country differences in these effects due to other factors.[19] A positive (negative) and significant φ^j implies that the policy or institution X^j increases (reduces) the persistence of output gaps. Likewise, a positive (negative) and significant γ^k implies that the policy or institution X^k amplifies (mitigates) the initial output gap effect of a shock.[20]

The tendency for policy settings in different domains to be correlated, as discussed above, tends to generate multicollinearity which prevents the estimation of equation [2] with the full set of policies and institutions.[21] There is no straightforward way to address this issue, all the more so as standard "general-to-specific" model selection procedures are applicable only for linear dynamic models (see *e.g.* Hoover and Perez, 1999; Krolzig and Hendry, 2001). Here, the multicollinearity issue is addressed in two alternative ways:

- A "statistical tournament" is undertaken in order to identify the most influential policy indicators within the full set of policies and institutions.
- Equation [2] is estimated using the synthetic indicator of labour and product market regulation instead of individual policy indicators.

Identifying the labour and product market policies with most influence on the business cycle

In order to identify the policies and institutions with the greatest influence on resilience patterns, the following "statistical tournament" is undertaken. As a preliminary step, equation [2] is estimated with policy indicators entered individually in separate regressions. These results, which are presented in Table 4, are fairly consistent with theoretical priors and with the simple correlation exercise above. Strict EPL and stringent PMR are found to reduce the initial impact of shocks on output gaps while at the same time increasing persistence (Table 4, Columns 2 and 5). Decentralised and uncoordinated wage bargaining processes appear to amplify the initial impact of shocks, providing some support for the view that real wages are more responsive to changes in overall macroeconomic conditions in highly corporatist systems (Table 4, Column 3). However, somewhat in contrast with this view, a low degree of corporatism appears to reduce output gap persistence. One explanation for these findings might be that decentralised bargaining processes do not properly internalise the effects of changes in the macroeconomic environment but otherwise bring in more wage flexibility. As might be expected, high rates of collective bargaining coverage are associated with stronger output gap persistence (Table 4, Column 4). In a number of OECD countries, high collective bargaining coverage stems from legal extension procedures, by which collective agreements become binding on parties which were originally non-signatories. One interpretation might be that such extension mechanisms are conducive to greater wage rigidity, thereby lengthening the adjustment process. Finally, unemployment benefit replacement rates are not found to bear any significant impact on output gap fluctuations (Table 4, Column 1).[22]

Table 4. **Output gap equations with labour and product market regulation indicators**
20 OECD countries, 1982-2003

	1	2	3	4	5	6	7
	Benefit replacement rate	EPL	Low corporatism	Bargaining coverage	PMR	Final model selected from statistical tournament	Full model with all policies and institutions
Persistence coefficients:							
φ	1.077	1.081	1.069	1.123	1.112	1.085	1.113
	[22.96]***	[24.71]***	[23.54]***	[23.98]***	[25.46]***	[24.96]***	[20.71]***
η	0.395	0.425	0.390	0.393	0.399	0.425	0.418
	[9.62]***	[11.19]***	[9.55]***	[9.68]***	[10.27]***	[11.39]***	[10.41]***
Effect of institutions on persistence: φ^j							
Benefit replacement rate	0.002						–0.004
	[0.75]						[1.23]
EPL		0.141				0.128	0.106
		[5.11]***				[4.77]***	[3.01]***
Low corporatism			–0.279				–0.070
			[3.40]***				[0.69]
Collective bargaining coverage				0.004			0.002
				[2.63]***			[1.11]
PMR					0.099		0.025
					[3.15]***		[0.68]
Effect of institutions on amplification of shocks: γ^k							
Benefit replacement rate	–0.007						0.002
	[1.09]						[0.33]
EPL		–0.242					–0.088
		[2.39]***					[0.89]
Low corporatism			0.493				0.364
			[2.47]**				[1.47]
Collective bargaining coverage				–0.002			0.005
				[0.51]			[1.22]
PMR					–0.508	–0.537	–0.431
					[6.15]***	[5.93]***	[4.15]***
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	434	434	434	434	434	434	434
R^2	0.82	0.83	0.82	0.82	0.83	0.83	0.84

Note: Non-linear least squares. Absolute value of t statistics shown in parentheses.
*, ** and *** = significant at 10%, 5% and 1%, respectively.
Source: Authors' estimates.

As a second step, those persistence and/or amplification terms that are insignificant in the individual regressions are seen as having no robust impact on output gap patterns and are thus dropped from the analysis. This leaves a set of seven significant policy and institutional terms to focus upon, four related to persistence and three concerned with the initial impact of shocks. Equation [2] is then estimated with two terms for all possible pairs of policies and institutions among the seven remaining terms. Those terms that are found to be insignificant (at the 10% confidence level) in at least one of the regressions are discarded, and the remaining ones are built upon to estimate equations with three variables. The selection procedure continues until a final model is selected. It can be safely inferred from this "statistical tournament" that "surviving" policy and/or institutional terms significantly affect output gap patterns. By contrast, no firm conclusions can be

drawn from this procedure as regards discarded terms – given that possible significant impacts may have been obscured by the even more significant effect of other variables – and, more broadly, as regards the "true" model.

The final model selected through this procedure contains two variables, namely EPL and PMR (Table 4, Column 6). It is reassuring to note that estimating the full model from the outset would point to a similar selection (Table 4, Column 7). There is therefore robust evidence that stringent PMR dampens the initial impact of shocks while strict EPL increases persistence. Overall, these findings are consistent with those obtained by Bassanini and Duval (2006) regarding unemployment patterns, although unemployment benefits are also found to have a robust positive effect on persistence in their paper.

For the average OECD country, the estimated half-life of output gaps is 1.8 years. The estimates suggest that for this "average" OECD country, a two standard deviation decline in EPL stringency would reduce the half-life of output gaps by almost half a year.[23] Similarly, a two standard deviation decline in PMR would raise the initial impact of a shock by about one-half. While the magnitude of the estimated effects does not look implausible, caution should be exercised when interpreting them. As already noted, it is plausible that although the statistical tournament approach helps single out the most significant policies and institutions, it is not guaranteed to select the "true" model. For instance, the separate impact of EPL and collective bargaining coverage may be difficult to disentangle insofar as they are highly correlated and interact with shocks through comparable channels.

The impact of overall labour and product market policies on the business cycle

An alternative approach is to re-estimate equation [2] using the synthetic indicator of labour and product market regulation as the only structural policy variable. As expected, amplification and persistence coefficients are of opposite signs and they are statistically significant at the 1% confidence level (Table 5, Column 1). This strongly suggests that strict labour and product market regulation dampens the initial impact of a shock but makes the effect more persistent.

Monetary and financial drivers of business cycle patterns

As noted earlier, output gap dynamics in the aftermath of a shock depend not only on supply-side rigidities in the economy but also on the monetary policy response as well as on the strength of the monetary policy transmission channel. A tentative and limited attempt to tackle these issues is provided here by considering three monetary and financial variables that may impact on resilience. First, household mortgage debt (as a share of GDP) can be seen as an indicator of financial market flexibility – it tends to bear a negative relationship with measures of mortgage market regulation[24] – and as such it is expected to strengthen monetary policy transmission. Second, a flexible exchange rate dummy variable[25] is aimed at capturing whether domestic monetary policy can react to shocks and thereby (under efficient monetary policy) both cushion the initial impact of shocks and make their effects less persistent.[26] Finally, a financial intermediation variable, computed as the ratio of total bank credit to stock market value traded, captures the extent to which the financial system is dominated by bank intermediation rather than by market institutions. Bank-based systems might be conducive to slower initial pass-through but more persistence of shocks than market-based systems (see *e.g.* Artis, 2005).[27] Table 6 finds estimated output gap persistence to be correlated negatively across countries with

Table 5. **Output gap equations with synthetic indicators of labour and product market regulation**

20 OECD countries, 1982-2003

	1	2	3	4	5
	With synthetic indicators of labour and product market regulation alone	' = 1 + household mortgage debt	' = 1 + flexible exchange rate regime	' = 1 + financial intermediation	Final model with synthetic indicators of labour and product market regulation and monetary factors
Persistence coefficients:					
φ	1.065	1.060	1.057	0.918	1.060
	[23.82]***	[22.81]***	[23.02]***	[11.76]***	[22.98]***
η	0.397	0.392	0.395	0.382	0.392
	[10.04]***	[9.54]***	[9.85]***	[7.51]***	[9.56]***
Effect of institutions on persistence: φ^j					
Labour and product market regulation[1]	0.090	0.083	0.103	0.079	0.073
	[4.20]***	[3.80]***	[3.64]***	[3.71]***	[3.81]***
Household mortgage debt[1]		–0.54			–0.478
		[2.01]**			[2.03]**
Flexible exchange rate regime			0.073		
			[0.87]		
Financial intermediation				0.0002	
				[1.90]*	
Effect of institutions on amplification of shocks: γ^k					
Labour and product market regulation[1]	–0.147	–0.136	–0.195	–0.281	–0.136
	[2.93]***	[2.74]***	[2.91]***	[1.50]	[2.77]***
Household mortgage debt[2]		0.076			
		[0.13]			
Flexible exchange rate regime			–0.286		
			[1.38]		
Financial intermediation				–0.003	
				[1.16]	
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes
Observations	434	412	434	410	412
R^2	0.83	0.83	0.83	0.85	0.83

Note: Non-linear least squares. Absolute value of t statistics shown in parentheses.
*, ** and *** = significant at 10%, 5% and 1%, respectively.
1. Synthetic indicators calculated as the first component of a factor analysis performed on the following set of policies and institutions: unemployment benefit replacement rate, EPL, corporatism regime, collective bargaining coverage and PMR.
2. Time-invariant indicator (country average over period 1990-2002).
Source: Authors' estimates.

household mortgage debt and the flexible exchange rate dummy variable, and positively with financial intermediation.

Table 5 extends the baseline equation featuring the synthetic indicator of labour and product market regulation (Table 5, Column 1) to incorporate the indicator of household mortgage debt (Column 2), the flexible exchange rate dummy variable (Column 3), or the financial intermediation variable (Column 4). These extensions yield only one significant finding at the 5% confidence level, namely that high levels of household mortgage debt tend to lower output gap persistence, consistent with the view that they strengthen monetary transmission. Furthermore, only household mortgage debt survives a "statistical

Table 6. **Correlation coefficients between country-specific persistence/ amplification coefficients and monetary/financial variables**

Based on simple regressions of country-specific coefficients on the average value of each indicator over the period 1982-2003, using bootstrapped critical values to assess statistical significance

	Persistence of shocks: coefficient φ_i	Amplification of shocks: coefficient γ_i
Household mortgage debt	–0.38*	0.03
Intermediation of financial system	0.36*	0.11
Flexible exchange rate regime	–0.43**	0.32

Source: Authors' estimates on the basis of country-specific persistence and amplification coefficients estimated in Table 1 and data sources described in the appendix.

tournament" between the three monetary and financial variables.[28] Reflecting this, a final, preferred specification features labour and product market regulation and household mortgage debt in the persistence term and labour and product market regulation in the amplification term (Column 5). While household mortgage debt – and the strength of monetary transmission channels more broadly – would be expected to improve resilience mainly under flexible exchange rates, in practice no significant interaction was found here between these two variables.

Sensitivity analysis

Using alternative output gap measures

The previous empirical findings are derived from OECD output gap estimates, and as such they may be sensitive to the specific methods used to produce these output gap estimates. In particular, the use of filtering methods could produce some correlation between explanatory variables (lagged output gaps) and residuals, thereby leading to biased coefficient estimates. Against this background, sensitivity analysis is carried out using three alternative measures of the output gap: the Hodrick-Prescott and Baxter-King filter estimates described in Box 1 and unemployment gap estimates, with structural unemployment being derived from the panel estimation of a standard model of equilibrium unemployment, without the use of any filtering method (see Box 4 for details).

Table 7 presents the re-estimation of three key equations – the model selected from the "statistical tournament" on labour and product market policies (Table 4, Column 6), the model using the synthetic indicator of labour and product market regulation (Table 5, Column 1) and the model incorporating the synthetic indicator of labour and product market regulation and household mortgage debt (Table 5, Column 5) – using the three alternative gap estimates. The main conclusion is that the findings are reasonably robust to the method used to construct the gaps. The only two noticeable differences with respect to previous results are the following: labour and product market regulation is no longer found to mitigate the initial impact of shocks when unemployment gap estimates are used, and household mortgage debt no longer appears to reduce gap persistence when Baxter-King filter estimates are used.

Incorporating interactions between institutions and observed shocks

All econometric estimates from the two previous sub-sections are based on equation [2], which focuses on interactions between institutions and common, unobserved shocks. One potential issue with such estimates is the omission of interactions between institutions and country-specific shocks. Such omission is a potential source of estimation

Box 4. **Computing unemployment gaps**

The unemployment gap is defined as the gap between actual and structural unemployment. Therefore, computing unemployment gap estimates requires an estimate of structural unemployment. The latter is obtained here through panel data estimation of a theoretical model of unemployment. In practice, the following reduced-form unemployment equation is estimated, consistent with a variety of theoretical models of labour market equilibrium, including standard job-search (Pissarides, 2000) and wage-setting/price-setting (*e.g.* Layard *et al.*, 1991; Nickell and Layard, 1999) models:

$$U_{it} = \sum_j \beta_j X_{it}^j + \chi G_{it} + \delta_i + \varepsilon_{it} \qquad [3]$$

where U_{it} is the aggregate unemployment rate, δ_i is a country fixed effect,[1] and G_{it} is a cyclical variable which aims to control for the unemployment effects of aggregate demand fluctuations over the business cycle. Here, the contemporaneous GDP growth rate and six lags of it[2] are used. The X^j's are policies and institutions which theory suggests may affect structural unemployment,[3] namely: the unemployment benefit replacement rate, EPL, PMR, the degree of centralisation/co-ordination of wage bargaining,[4] the tax-wedge between labour cost and take-home pay[5] and union density.[6] Estimating variants of equation [3] has become mainstream in the macroeconomic literature on the determinants of structural unemployment (see *e.g.* Bassanini and Duval, 2006; Belot and Van Ours, 2004; Blanchard and Wolfers, 2000; Nickell *et al.*, 2005).

Estimates of equation [3] are presented in the table below. The model is first estimated with all policies and institutions (Column 1). The unemployment benefit replacement rate, the labour tax wedge and product market regulation appear to increase structural unemployment, while a high degree of corporatism reduces it. By contrast, EPL and union density are not found to have any impact on structural unemployment, which in the case of EPL is consistent with most of the theoretical and empirical literature. Both variables are thus dropped from the analysis to obtain a streamlined equation (Column 2). Based on the latter estimates, one can then compute a measure of the unemployment gap as:

$$Ugap = (U_{it}^* - U_{it}) = (\sum_j \beta_j X_{it}^j + \delta_i) - U_{it} \qquad [4]$$

With these unemployment gap estimates in hand, the output gap equations shown previously can be re-estimated in order to check the robustness of the findings.[7]

1. The inclusion of country effects – which are found to be jointly significant – aims to control for omitted, country-specific determinants of structural unemployment.
2. Starting from a model with 10 lags, insignificant lags were eliminated sequentially until all remaining lags were found to be significant.
3. See *e.g.* Bassanini and Duval (2006), Nickell and Layard (1999), Nickell (1997, 1998), Pissarides (2000).
4. In line with Bassanini and Duval (2006), its influence is captured in the table through a dummy for "high corporatism" – instead of the "low corporatism" dummy used above.
5. See the appendix for details on sources and methods.
6. Union density, which is defined as the rate of union membership (see appendix for details), aims to capture union power. While the rate of collective bargaining coverage would be arguably a better proxy – which is why it was used in the econometric analysis above, it is not available over the whole sample for most OECD countries and therefore cannot be used here.
7. Ideally, one would rather estimate a dynamic unemployment equation in one step, identifying simultaneously the policy determinants of equilibrium unemployment and those of short-run unemployment dynamics. However, compared with the two-step estimation approach followed here, the large number of additional parameters to be estimated would imply a sizeable loss in the number of degrees of freedom and would make it more difficult for the non-linear estimation procedure to converge.

Box 4. **Computing unemployment gaps** *(cont.)*

Structural unemployment econometric estimates

	1	2
	Full model with all policies and institutions (dependent variable: unemployment rate)	Final model selected after dropping insignificant variables (dependent variable: unemployment rate)
Policies and institutions:		
Benefit replacement rate	0.064	0.072
	[3.11]***	[4.14]***
Labour tax wedge	0.142	0.139
	[5.20]***	[5.12]***
High corporatism	–1.203	–1.590
	[2.89]***	[4.11]***
PMR	0.711	0.661
	[6.31]***	[8.97]***
Union density	–0.031	
	[1.36]	
EPL	0.259	
	[0.85]	
Cyclical controls:		
GDP growth (t)	–0.164	–0.150
	[4.14]***	[3.74]***
GDP growth (t-1)	–0.305	–0.300
	[7.33]***	[7.19]***
GDP growth (t-2)	–0.246	–0.237
	[6.02]***	[5.68]***
GDP growth (t-3)	–0.256	–0.252
	[6.26]***	[6.10]***
GDP growth (t-4)	–0.139	–0.131
	[3.15]***	[2.81]***
GDP growth (t-5)	–0.134	–0.132
	[4.04]**	[3.84]***
GDP growth (t-6)	–0.129	–0.123
	[3.73]***	[3.53]***
Country fixed effects	Yes	Yes
Time dummies	No	No
Observations	434	434
R^2	0.98	0.98

Note: Ordinary least squares (within estimates). Absolute value of t statistics shown in parentheses.
*, ** and *** = significant at 10%, 5% and 1%, respectively.
Source: authors' estimates based on Bassanini and Duval (2006).

bias insofar as institutions that shape the propagation of common shocks would also be expected to influence the propagation of country-specific shocks.

In order to check whether this issue affects the estimates, the three key equations are re-estimated by adding several macroeconomic variables, or "observed shocks", to the set of unobserved shocks (Table 8). Concretely, the following equation is estimated:

$$GAP_{it} = \left(\varphi + \sum_j \varphi^j (X_{it}^j - \overline{X}_{..}^j)\right)(GAP_{it-1} - \eta GAP_{it-2}) + (\lambda_t + \sum_h \chi^h (Z_{it}^h - \overline{Z}_{..}^h))\left(1 + \sum_k \gamma^k (X_{it}^k - \overline{X}_{..}^k)\right) + \alpha_i + \varepsilon_{it} \quad [5]$$

Table 7. **Equations with alternative output gap definitions**

	Hodrick-Prescott filter gap estimates[1]		
	1	2	3
	Model selected from statistical tournament	Model with synthetic indicators of labour and product market regulation alone	Model with synthetic indicators of labour and product market regulation and monetary factors
Persistence coefficients:			
φ	0.995	0.983	0.975
	[22.75]***	[22.08]***	[21.09]***
η	0.430	0.408	0.394
	[10.43]***	[9.52]***	[8.88]***
Effect of institutions on persistence: φ^j			
Labour and product market regulation[2]		0.094	0.090
		[4.14]***	[3.86]***
Household mortgage debt[2]			–0.658
			[2.36]**
EPL	0.145		
	[4.84]***		
Effect of institutions on amplification of shocks: γ^k			
Labour and product market regulation[2]		–0.127	–0.126
		[2.76]***	[2.80]***
Household mortgage debt[3]			
PMR	–0.452		
	[5.90]***		
Country fixed effects	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	431	431	409
R^2	0.81	0.80	0.89
	Baxter-King filter gap estimates[1]		
	1	2	3
	Model selected from statistical tournament	Model with synthetic indicators of labour and product market regulation alone	Model with synthetic indicators of labour and product market regulation and monetary factors
Persistence coefficients:			
φ	0.551	0.541	0.541
	[12.10]***	[11.69]***	[11.18]***
η	0.480	0.439	0.428
	[6.44]***	[5.49]***	[5.21]***
Effect of institutions on persistence: φ^j			
Labour and product market regulation[2]		0.112	0.116
		[3.94]***	[3.90]***
Household mortgage debt[2]			0.019
			[0.06]
EPL	0.213		
	[5.00]***		
Effect of institutions on amplification of shocks: γ^k			
Labour and product market regulation[2]		–0.121	–0.122
		[2.67]***	[2.61]***
Household mortgage debt[3]			
PMR	–0.427		
	[5.61]***		
Country fixed effects	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	431	431	409
R^2	0.59	0.58	0.57

Table 7. **Equations with alternative output gap definitions** *(cont.)*

	Unemployment gap estimates[1]		
	1	2	3
	Model selected from statistical tournament	Model with synthetic indicators of labour and product market regulation alone	Model with synthetic indicators of labour and product market regulation and monetary factors
Persistence coefficients:			
φ	1.201	1.179	1.153
	[27.27]***	[26.00]***	[24.60]***
η	0.338	0.331	0.330
	[9.62]***	[8.96]***	[8.58]***
Effect of institutions on persistence: φ^j			
Labour and product market regulation[2]		0.046	0.038
		[2.04]**	[2.19]**
Household mortgage debt[2]			–0.560
			[3.29]***
EPL	0.069		
	[2.06]**		
Effect of institutions on amplification of shocks: γ^k			
Labour and product market regulation[2]		0.049	0.034
		[0.75]	[0.55]
Household mortgage debt[3]			
PMR	–0.548		
	[4.02]***		
Country fixed effects	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	434	434	412
R^2	0.83	0.83	0.83

Note: Non-linear least squares. Absolute value of t statistics shown in parentheses.
*, ** and *** = significant at 10%, 5% and 1%, respectively.
1. See Box 2 for definitions of the Hodrick-Prescott-filtered and the Baxter-King-filtered output gap. The unemployment gap is defined as the gap between structural and actual unemployment, where structural unemployment is estimated based on column 2 of the table in Box 4 (see text for details).
2. Synthetic indicators calculated as the first component of a factor analysis performed on the following set of policies and institutions: unemployment benefit replacement rate, EPL, corporatism regime, collective bargaining coverage and PMR.
3. Time-invariant indicator (country average over period 1990-2002).
Source: Authors' estimates.

where the Z^hs are the "observed shocks" to be interacted with policies and institutions.

In line with recent empirical literature (Bassanini and Duval, 2006; Blanchard and Wolfers, 2000; Nickell *et al.*, 2005), four types of "observed shocks" Z^h are considered for analysis (see appendix for definitions and methodological details): *i)* total factor productivity (TFP) shocks; *ii)* terms of trade shocks; *iii)* labour demand shocks; and, *iv)* real interest rate shocks, defined as the difference between the 10-year nominal US government bond yield and annual US GDP price inflation. These are country-specific observed shocks, except for the last one which is a common observed shock in order to avoid endogeneity with respect to the output gap. As shown in Table 8, the main findings are robust to the use of both observed and unobserved shocks in the estimated equation.

Controlling for fiscal policy

The response to shocks depends on both existing institutional settings in labour, product and financial markets and the monetary and fiscal policy reactions. Equation [2] focuses only

Table 8. **Output gap equations with both observed and unobserved shocks**

	1	2	3
	Model selected from statistical tournament	Model with synthetic indicators of labour and product market regulation alone	Model with synthetic indicators of labour and product market regulation and monetary factors
Persistence coefficients:			
φ	1.203	1.229	1.221
	[35.54]***	[36.87]***	[34.85]***
η	0.277	0.278	0.271
	[10.38]***	[10.64]***	[9.76]***
Effect of institutions on persistence: φ^j			
Labour and product market regulation[1]		0.028	0.029
		[2.07]**	[2.05]**
Household mortgage debt[2]			–0.322
			[1.80]*
EPL	0.066		
	[3.72]***		
Effect of institutions on amplification of shocks: γ^k			
Labour and product market regulation[1]		–0.070	–0.063
		[2.96]***	[2.60]***
Household mortgage debt[2]			
PMR	–0.074		
	[2.06]**		
Country fixed effects	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	394	394	376
R^2	0.92	0.92	0.92

Note: Non-linear least squares. Absolute value of t statistics shown in parentheses.
*, ** and *** = significant at 10%, 5% and 1%, respectively.
1. Synthetic indicators calculated as the first component of a factor analysis performed on the following set of policies and institutions: unemployment benefit replacement rate, EPL, corporatism regime, collective bargaining coverage and PMR.
2. Time-invariant indicator (country average over period 1990-2002).
Source: Authors' estimates.

on the former, based on the implicit assumption that monetary and fiscal policy is not exogenous but rather is shaped by the institutional framework. Assuming that monetary policy reaction to shocks is entirely driven by existing nominal and real rigidities may not be implausible.[29] By contrast, the assumption that fiscal policy responds optimally to shocks is arguably a stronger one, for at least two reasons. First, as noted earlier, the response of the fiscal balance depends partly on automatic stabilisers, which vary across countries and are only partially captured by the structural policy indicators in equation [2]. Second, the discretionary fiscal policy reaction is likely to be shaped by a wide range of considerations in practice. For these reasons, it cannot be ruled out that estimates of equation [2] might suffer from an omitted variable bias.

A limited attempt to tackle this issue is made here by re-estimating the three key equations with the share of overall tax receipts in GDP as an additional institutional variable to be interacted with shocks (Table 9). This variable directly captures the size of automatic stabilisers and would therefore be expected to dampen the initial impact of shocks. No attempt is made here at addressing its potential endogeneity, however.[30] Therefore, the results from Table 9 should not be seen as an attempt to study the role of fiscal policy for resilience but rather as a robustness check on the previous findings. The latter are found to be robust to such sensitivity analysis.

Table 9. **Output gap equations with control for fiscal policy**

	1	2	3
	Model selected from statistical tournament	Model with synthetic indicators of labour and product market regulation alone	Model with synthetic indicators of labour and product market regulation and monetary factors
Persistence coefficients:			
φ	1.052	1.021	1.017
	[22.61]***	[21.47]***	[20.67]***
η	0.400	0.380	0.379
	[9.42]***	[8.49]***	[8.19]***
Effect of institutions on persistence: φ^j			
Labour and product market regulation[1]		0.100	0.080
		[3.49]***	[2.63]***
Household mortgage debt[2]			–0.508
			[1.80]*
EPL	0.128		
	[3.53]***		
Tax receipts as a share of GDP	0.044	–0.406	–0.064
	[0.13]	[1.01]	[0.14]
Effect of institutions on amplification of shocks: γ^k			
Labour and product market regulation[1]		–0.173	–0.184
		[2.49]**	[2.61]***
Household mortgage debt[2]			
PMR	–0.408		
	[3.90]***		
Tax receipts as a share of GDP	–0.906	0.040	0.504
	13.5	[0.03]	[0.41]
Country fixed effects	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	395	395	374
R^2	0.82	0.83	0.83

Note: Non-linear least squares. Absolute value of t statistics shown in parentheses.
*, ** and *** = significant at 10%, 5% and 1%, respectively.
1. Synthetic indicators calculated as the first component of a factor analysis performed on the following set of policies and institutions: unemployment benefit replacement rate, EPL, corporatism regime, collective bargaining coverage and PMR.
2. Time-invariant indicator (country average over period 1990-2002).
Source: Authors' estimates.

Assessing the overall degree of resilience of OECD countries

What the previous analysis implies for the analysis of the policy and institutional determinants of resilience is somewhat ambiguous. Overall, strict labour and product market regulations appear to reduce resilience to shocks by increasing output gap persistence. Strict mortgage regulations have a similar – albeit somewhat less robust – effect. At the same time, there seems to be an offsetting effect insofar as strict labour and product market regulations improve resilience by cushioning the initial impact of shocks in most specifications.

In order to determine which of these offsetting effects dominates in practice, it is possible to devise a number of resilience criteria, and then to simulate the "preferred" equation of Table 5 (column 5) for different values of policy and institutional indicators to see how the latter affect the score on each resilience criteria. Three alternative criteria for assessing resilience are defined: *i*) the time *T* needed for output to get back to potential in the aftermath of a 1 percentage point negative common shock to the output gap; *ii*) the

cumulative output loss between 0 and *T*; and, *iii*) the conditional volatility of output gaps, which unlike the other criteria is not derived from simulations but rather can be calculated from the equation for any value of policy and institutional indicators, under the assumption that only common shocks λ_t with standard deviation σ_λ occur.[31] The lower is the time needed for output to get back to potential, and/or the smaller is the cumulative output loss and/or the lower is the volatility of output gaps, the greater is the degree of resilience to common shocks. In practice, the simulations indicate that rigid labour and product markets delay output recovery and increase the cumulative output loss on the one hand, but reduce output gap volatility on the other. By contrast, on all three criteria, a flexible mortgage market strengthens resilience through its impact on output gap persistence.[32]

It is also possible to simulate the "preferred" equation for each OECD country, based on its current set of policy and institutional settings, to see how it is expected to score on each resilience criterion. Concretely, the analysis proceeds in two steps:

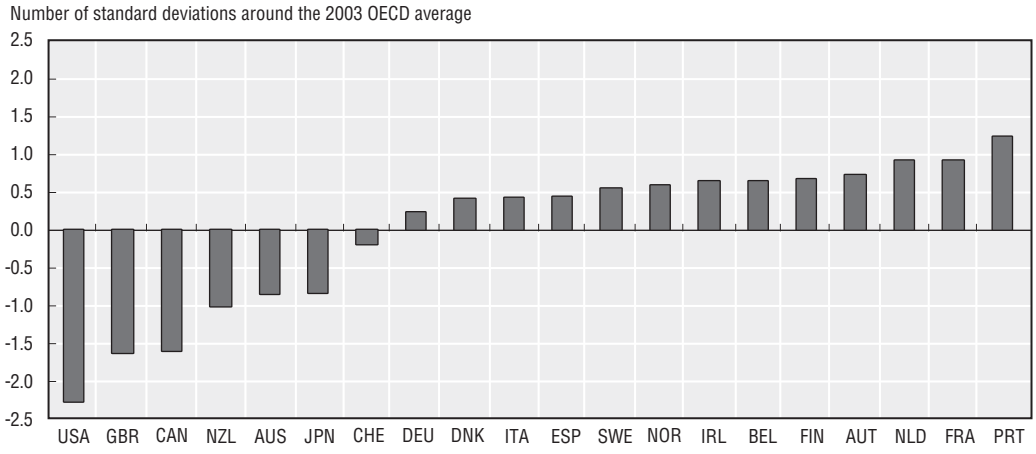
- First, a dynamic output gap equation is computed for each country, replacing the synthetic indicator of labour and product market regulation and the level of household mortgage debt by their most recent values in the "preferred" econometric regression. Three main groups of OECD countries emerge from these two indicators (Figure 1): most English-speaking countries (Australia, Canada, New Zealand, UK, US), which combine relatively flexible labour, product and mortgage markets; most continental European countries (Austria, Belgium, France, Italy, Spain and, to a lesser extent, Germany), where regulation remains comparatively stringent in all three areas; Northern European countries (Denmark, Netherlands, Norway and, to a lesser extent, Sweden) and Switzerland, which combine moderately regulated labour and product markets and well-developed mortgage markets. Japan is a special case, where labour and product markets are relatively flexible, while mortgage markets remain under-developed.
- These country-specific output gap equations are then used to simulate the impact of a (common) shock on output gap dynamics. Based on these simulations, illustrative cross-country comparisons of resilience are made according to each of the three resilience criteria defined above.

Impulse-response functions derived from these country-specific output gap equations are presented in Figure 2, and associated comparisons of the degree of resilience across OECD countries are summarised in Figure 3. The main cross-country patterns that emerge from these simulations are the following:

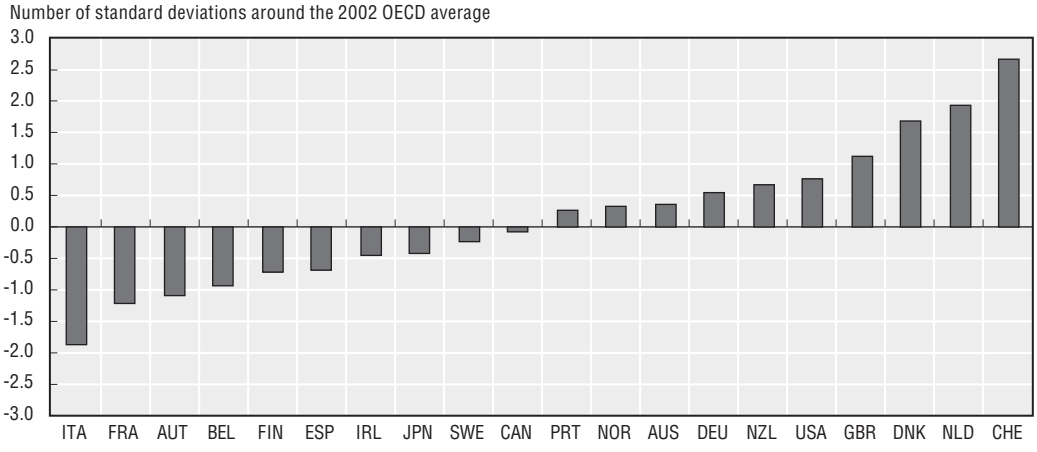
- Following a common shock, the time needed to get back to potential and the cumulative output loss appear to be relatively low in English-speaking countries with more flexible labour, product and/or mortgage markets (Figure 3, upper and middle panels). At the same time, however, output gap volatility tends to be comparatively high in this group of countries (Figure 3, lower panel). This reflects primarily their relatively flexible labour and product markets, which act in the direction of amplifying the initial shock.
- By contrast, some small European countries (Denmark, the Netherlands, and Switzerland) tend to perform relatively well on all accounts, reflecting their highly developed mortgage markets along with a moderate degree of labour and product market regulation. To a lesser extent, Germany appears to fall into this category.

Figure 1. **Cross-country comparison of the value of explanatory variables**

Synthetic indicator of labour and product market regulation, 2003



Household mortgage debt



Source: Authors' estimates. See text for details.

- Most other continental European countries perform poorly on all accounts, reflecting both their less-developed mortgage markets and the stringency of their labour and product market regulation.

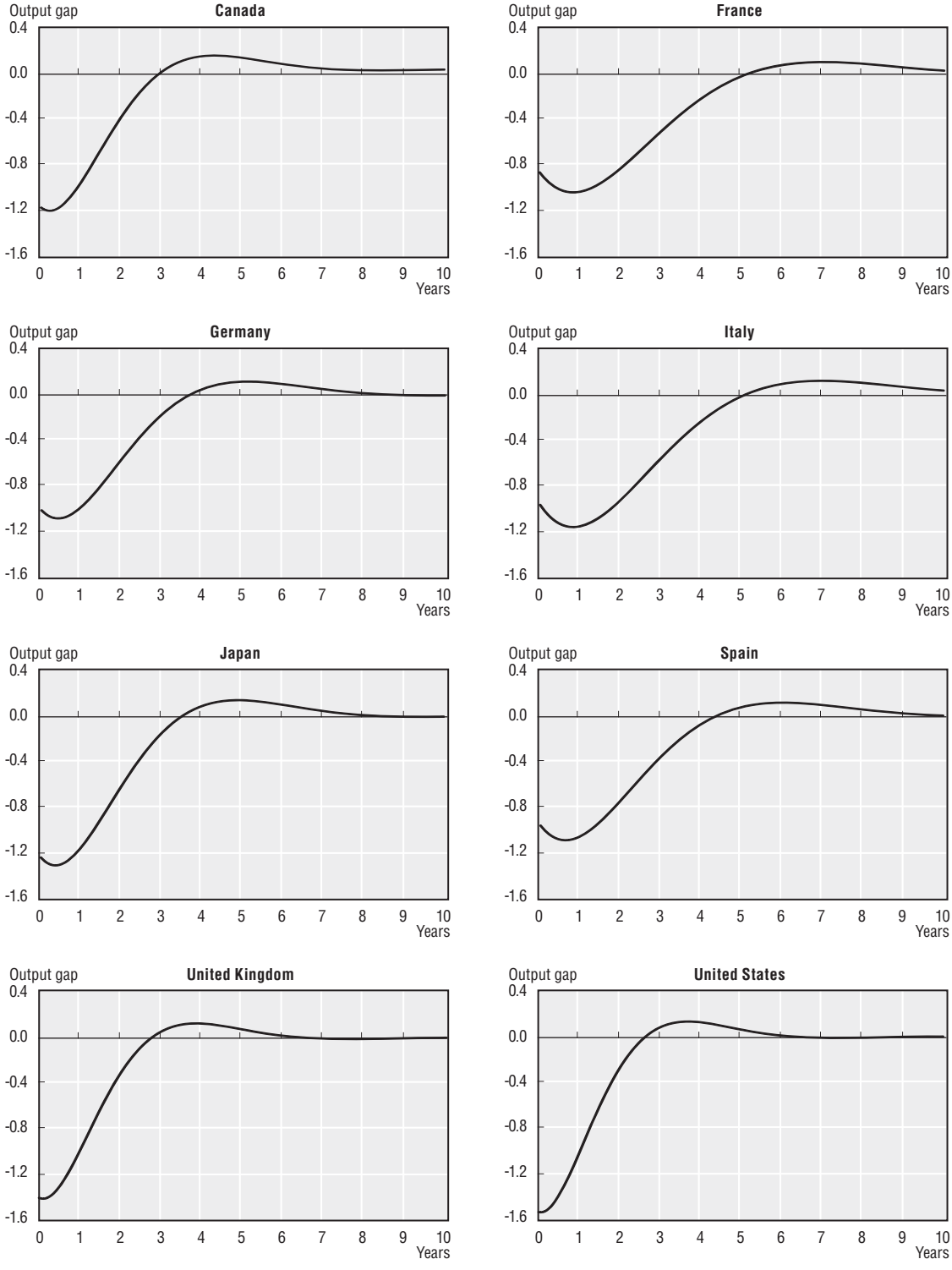
Summary and conclusions

While recent economic research shows that cyclical fluctuations have become smaller over the past three to four decades, it provides no strong evidence that cycles have become more synchronised across OECD countries, except perhaps among euro area countries. One possible explanation, which this paper focuses on, is that economies differ in their degree of resilience to otherwise similar shocks as a result of existing cross-country differences in labour, product and financial market regulation.

Resilience may be loosely defined as the ability to maintain output close to potential in the aftermath of shocks. This in turn hinges on the ability of the institutional framework to cushion the initial impact of exogenous shocks and to reduce the persistence of the ensuing gap between actual and potential output. Both of these components of resilience are likely to be undermined by stringent financial market regulation, insofar as the latter

Figure 2. **Impulse-response functions**

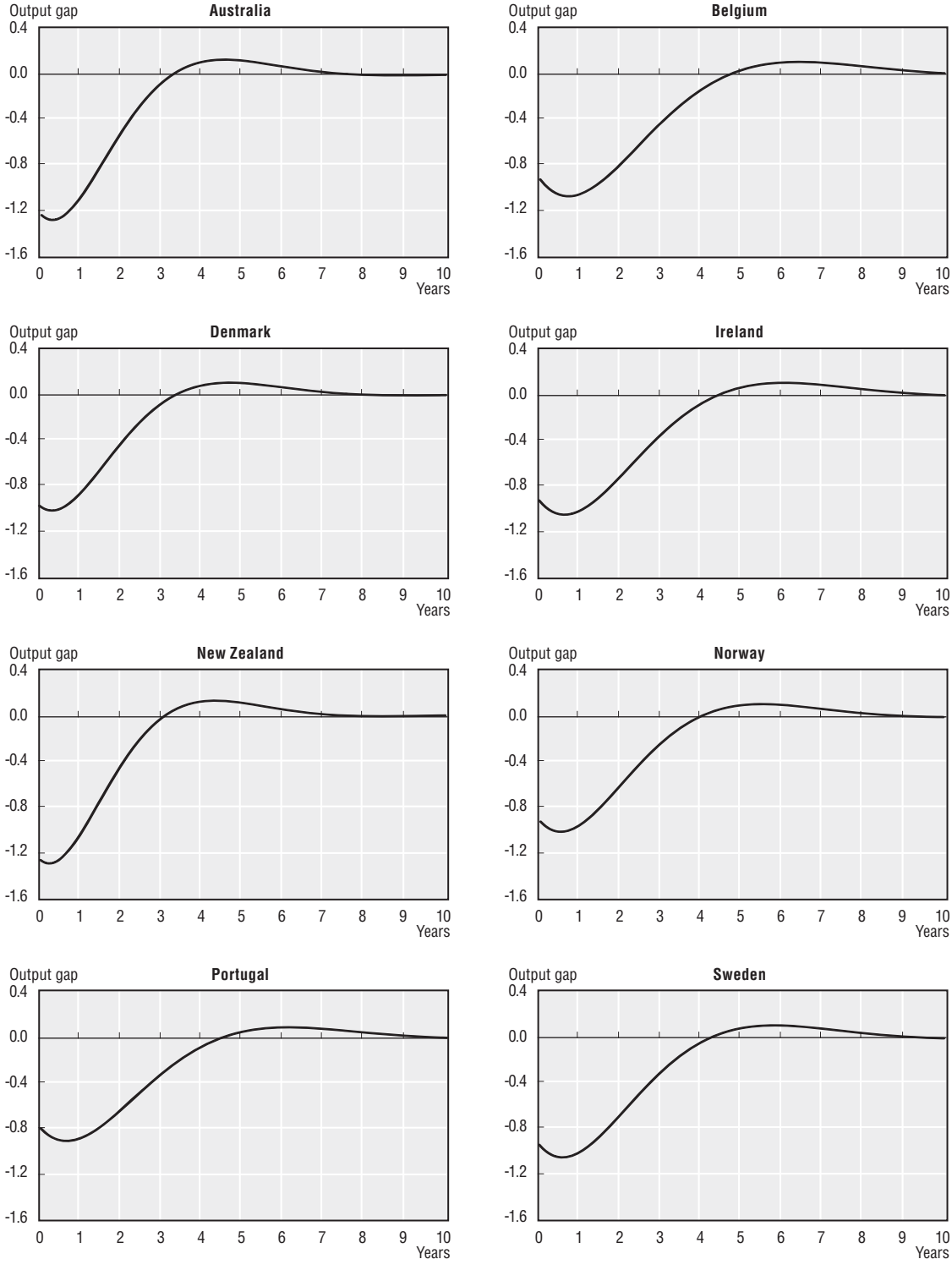
Assuming a 1 percentage point common negative shock to the output gap, based on Table 4, column 5



Source: Authors' estimates. See text for details.

Figure 2. **Impulse-response functions** *(cont.)*

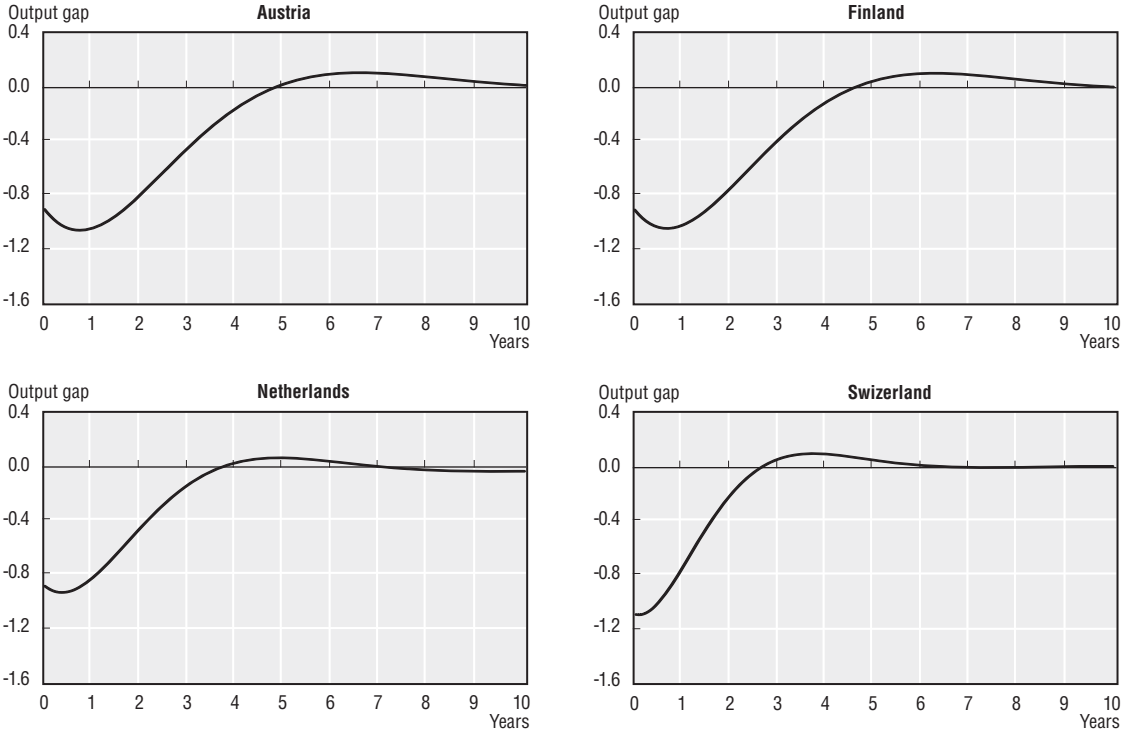
Assuming a 1 percentage point common negative shock to the output gap, based on Table 4, column 5



Source: Authors' estimates. See text for details.

Figure 2. **Impulse-response functions** *(cont.)*

Assuming a 1 percentage point common negative shock to the output gap, based on Table 4, column 5



Source: Authors' estimates. See text for details.

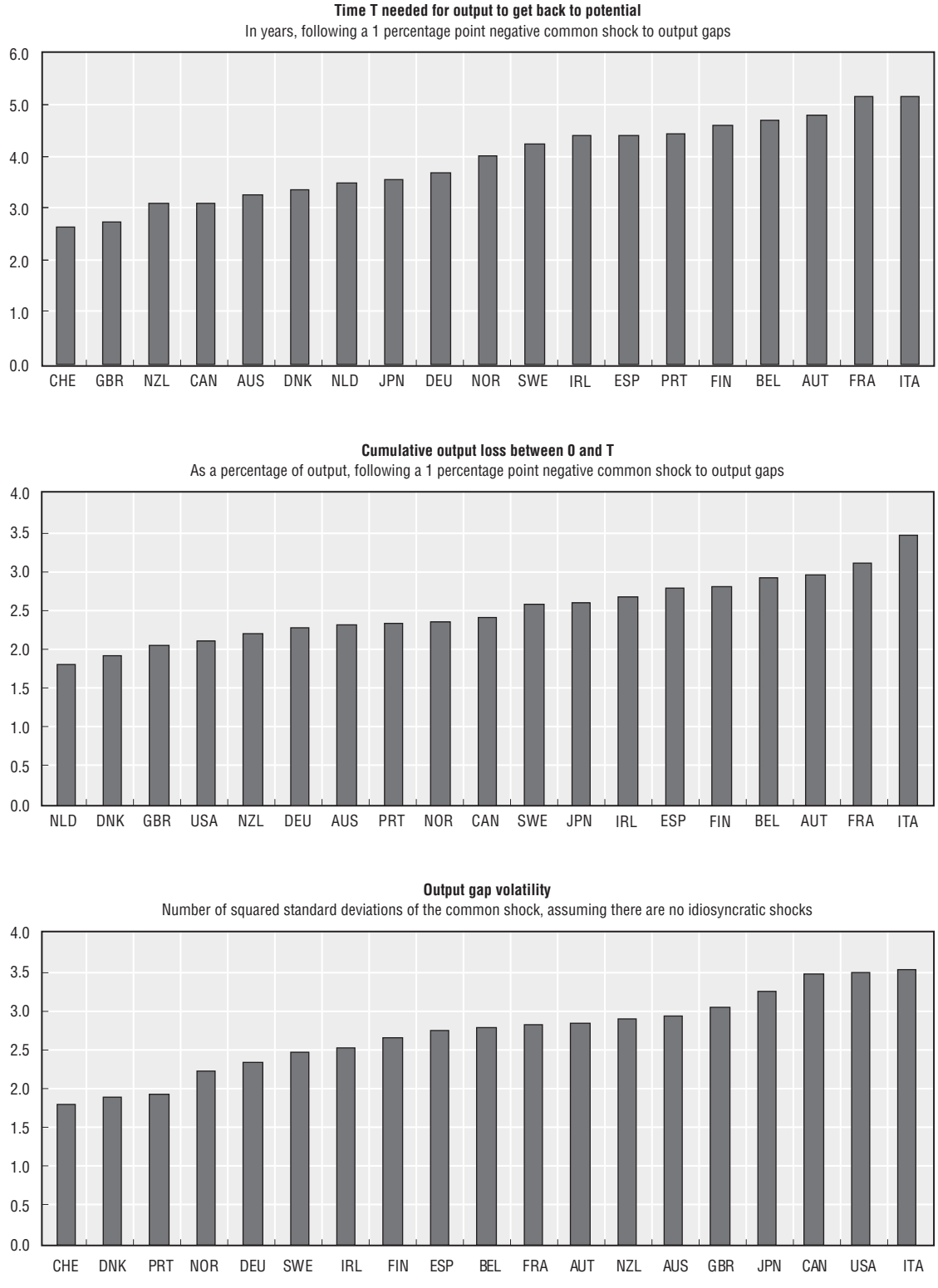
weakens the monetary policy transmission mechanism. By contrast, the resilience effects of labour and product market regulations are theoretically ambiguous and represent essentially an empirical issue.

The paper therefore presents a univariate econometric framework in which the determinants of both amplification and persistence aspects of economic resilience can be tested. Concretely, output gap equations are estimated for a panel of 20 countries over the period 1982-2003 in order to disentangle the effect of policies and institutions on the initial impact of (unobserved) common shocks from their effect on output gap persistence. The key findings are the following:

- Employment protection legislation is found to increase output gap persistence, while product market regulation appears to dampen the initial output gap effect of (unobserved) exogenous shocks. Other individual policy and institutional indicators are not robust across all specifications, making it difficult to draw clear conclusions regarding their effects. When instead of individual indicators a synthetic indicator of labour and product market regulation is used, the analysis provides strong evidence that heavy regulation dampens the initial impact of shocks but makes it more persistent.
- Household mortgage debt, which bears a negative relationship with mortgage market regulation and can be seen as an indicator of financial market flexibility, seems to reduce output gap persistence. This is consistent with the view that monetary policy transmission channels are stronger in less regulated financial markets.

Figure 3. **Simulated degrees of resilience according to three alternative criteria**

Based on Table 4, column 5, using 2003 values of policy and institutional indicators



Source: Authors' estimates. See text for details.

- Most of the above findings appear to be reasonably robust to the use of alternative output gap measures, to the analysis of both observed and unobserved shocks and to some control for the fiscal policy stance.

Insofar as strict labour and product market regulations may dampen the initial impact of shocks but make it more persistent, the implications for resilience are *a priori* unclear. In order to determine which of these offsetting effects dominates in practice, the preferred equation was simulated so as to assess the impact of policies and institutions on different resilience criteria. The simulations indicate that rigid labour and product markets lengthen the time it takes for output to return to potential following a shock and increase the cumulative output loss incurred over the period. However, economies with more flexible labour and product markets appear to exhibit greater output gap volatility. By contrast, whatever the resilience criterion used, strict mortgage market regulation reduces resilience by increasing output gap persistence.

Simulations of the preferred equation were also run in order to see how individual OECD countries are expected to score on these resilience criteria, based on their most recent policy and institutional settings. This exercise points to three main groups of countries:

- English-speaking countries with flexible labour and product markets and well-developed mortgage markets, where the time needed for output to get back to potential in the aftermath of a shock and the cumulative output loss are estimated to be among the lowest across the OECD, but where output gap volatility is comparatively high.
- Some small European countries with moderately stringent labour and product market regulation and well-developed mortgage markets, which according to the simulations perform relatively well on all of the resilience criteria. To a lesser extent, Germany also falls into this group.
- Most other continental European countries with comparatively strict labour and product market regulation and less-developed mortgage markets, which are estimated to be less resilient on all counts.

The purpose of this paper was to explore the reasons why in recent years a number of English-speaking and Nordic countries seem to have been more resilient than most continental European countries to a range of otherwise fairly similar shocks. Overall, the evidence linking resilience to rigidities in labour and product markets is somewhat ambiguous – both theoretically and empirically. By contrast, the analysis tentatively suggests that policy settings strengthening monetary policy transmission – such as the low degree of mortgage market regulation prevailing within the group of resilient countries – are unambiguously good for resilience. This result is in line with the conclusions drawn by Cotis and Coppel (2005) who, based on an analysis of recent cross-country business cycle patterns, suggest that financial market flexibility has been key to the strong resilience of certain OECD countries. However, it remains tentative insofar as it is not based on a detailed analysis of the policy and institutional determinants of monetary policy transmission. Furthermore, the univariate approach adopted here could only to a limited extent distinguish between different kinds of shocks hitting economies. It is possible that such a distinction could overturn some of the above conclusions. As well, the specifications assume symmetry in the way structural policies affect the response to positive and negative shocks. In practice, however, effects may differ depending on the direction of a shock. It is also conceivable that the impact of policies in labour, product and financial

markets on resilience could depend on the size of shocks. There is therefore ample scope for further research.

Notes

1. See *e.g.* Dalsgaard *et al.* (2002); Stock and Watson (2003).
2. See *e.g.* Bergman (2006); Camacho *et al.* (2006); Helbling and Bayoumi (2003).
3. See Cotis and Coppel (2005).
4. In principle, this could of course reflect reverse causation, *i.e.* reduced macroeconomic volatility facilitating structural reforms.
5. In principle, output could also be stabilised in response to demand shocks under a weak transmission mechanism but this would be associated with an instrument variability that might be unpalatable. In the face of supply shocks, the strength of the transmission mechanism might be irrelevant to the inflation and output pattern.
6. The exchange rate is part of the monetary transmission mechanism, but this aspect is not explicitly covered in the current analysis.
7. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
8. The choice of the time period is driven by the availability of policy and institutional indicators, in particular the OECD EPL index which starts in 1982.
9. F-stat = 0.88, p-value = 0.60.
10. Identifying these shocks would in principle require a fully-fledged, country-specific VAR analysis in a preliminary step, given that there is a two-way causal relationship between output gaps and such variables as interest rates, exchange rates or even oil prices.
11. Given the fairly wide cross-country variance in idiosyncratic components shown in the first section, one way to minimise this source of estimation bias would be to correct the variance-covariance matrix of the residuals for group-wise (country-wise) heteroskedasticity. However, this would entail a sizeable loss in the number of degrees of freedom and would make it more difficult for the non-linear estimation procedure to converge.
12. Against this background, following Bassanini and Duval (2006) and OECD (2004), observations for Finland, Germany and Sweden in 1990 and 1991 are removed from the sample, reflecting the view that large country-specific shocks had a major effect on output gap fluctuations during this period – the collapse of the Soviet Union, the unification and the banking crises, respectively – which were behind the upward shift in unemployment over this two-year period. However, sensitivity analysis (not reported here) shows that key findings from the analysis presented below do not hinge on whether these observations are excluded from the sample.
13. Note that not all these cross-country differences are statistically significant, however (see Table 1).
14. See appendix for full details on data sources and methods. These indicators are time-varying and available at an annual frequency, with the exception of collective bargaining coverage which is time-invariant (country average over 1980-2000) due to lack of data at an annual frequency.
15. This sector-based PMR indicator is used in this paper because it covers the whole sample period, unlike the OECD's economy-wide indicator which is available only for 1998 and 2003. One drawback is that changes in the indicator for non-manufacturing sectors do not incorporate all aspects of regulatory reforms that have been undertaken by a number of OECD countries in the past decades, such as administrative reforms affecting all sectors. As a result, the resilience effects of regulatory reforms may not be fully captured by the econometric estimates presented in this paper.
16. This variable is less imperfect than union density, not least because administrative extension practices – which remain in place in a number of continental European countries – extend collective agreements to the non-affiliated, providing unions with greater bargaining power in practice than union membership rates would suggest.

17. Lack of significance of the unemployment benefit measure – which combines initial replacement rate and unemployment duration components – is somewhat at odds with micro-econometric evidence showing spikes in job-finding rates around the end of unemployment spells.

18. The so-called "Kaiser rule" suggests that one should retain only factors with eigenvalues greater than one (Kaiser, 1960). Here, only the first component meets this criterion.

19. For example, the impact of a common oil-price shock depends not only on policy and institutional settings but also on the oil intensity of output, which may vary across countries.

20. Also apparent from [2] is the fact that policies and institutions enter the estimated equation in deviations from their sample means. One implication is that $\eta\varphi$ provides a measure of output gap persistence in the "average" OECD country.

21. The multicollinearity issue may not be extremely severe, however. The condition number of matrix X'X, where X is a (6 x 22) matrix containing all five policy and institutional variables above and the unit vector as column vectors, is about 9. Only values in excess of 20 have been suggested as indicative of an important multicollinearity problem (Belsley *et al.,* 1980).

22. Splitting the average unemployment benefit replacement rate into its initial replacement rate and benefit duration components yields similar results.

23. By construction, the values of both the EPL indicator and that of product market regulation for seven non-manufacturing industries range from 0 to 6. In 2003, their average values across the 20 countries included in the sample were equal to 1.84 and 2.1, and their standard deviations were equal to 0.87 and 0.55, respectively. For the "average" OECD country, a decline in EPL by two standard deviations would be equivalent to bringing it down to the stance observed in the some of the most liberal OECD countries (Canada and the United Kingdom, where EPL is estimated to be slightly more stringent than in the most liberal country, namely the United States). Likewise, a decline in PMR by two standard deviations would be equivalent to undertaking product market liberalisation of the same order of magnitude as that which has taken place in the average OECD country over the past ten years.

24. See Catte *et al*. (2004). Household mortgage debt is expressed as a share of GDP and is time-invariant (country average over 1990-2002), due to lack of data at an annual frequency for most countries over the sample period. See appendix for details.

25. This dummy variable takes value 1 if the country is not engaged in any fixed exchange rate agreement in year t and zero otherwise. See appendix for details.

26. For euro area countries, which according to the first section have seen an increased synchronisation of cycles, the common monetary policy may of course react to common shocks. The dummy variable is not able to capture such nuances, which could explain its lack of significance in the regressions discussed below. As well, it could be argued that what matters is the combination of monetary policy autonomy and the strength of the transmission mechanism, *i.e.* that the two variables should be interacted. However, such interactions (not reported here) were tested but appeared to be statistically insignificant.

27. See appendix. The value of trades in domestic shares is used as denominator because the main alternative, namely stock market capitalisation, does not measure the amount of funding available to firms but rather the discounted value of future earnings. Stock market capitalisation provides an indication of the size rather than the activity of stock markets. That said, it should be acknowledged that stock market value traded primarily captures turnover in stock markets and therefore is also an imperfect proxy for firms' access to capital.

28. It should be stressed that this variable is particularly robust since it would also survive the statistical tournament between labour and product market regulation indicators carried out in the previous section, and would therefore appear in the "final" model along with the other variables selected.

29. As discussed in Box 1, this assumption holds under optimal monetary policy.

30. One way at least to mitigate the endogeneity issue is to consider the country average of the fiscal policy variable over the sample period. In practice, however, using this time-invariant variable does not change the conclusions from Table 9.

31. The mathematical formula for the variance of a stationary second-order auto-regressive process can be found for instance in Hamilton (1994), p. 58.

32. However, it should be borne in mind that such simulations have no clear-cut normative implications, given that none of the three resilience criteria correspond to clear welfare measures.

For instance, in a so-called "New Keynesian" model of the business cycle model, the utility-based welfare loss function would combine both inflation and the output gap and would imply some trade-off between inflation and output stabilisation, at least for certain types of shocks. Welfare-based evaluations go beyond the scope of this paper, whose primary purpose is to shed some light on the policy and institutional determinants of business cycle patterns.

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Appendix: Data Sources and Methodology

OECD measure of the output gap:

Definition: OECD measure of the gap between actual and potential output as a percentage of potential output. The methodology followed by the OECD in order to estimate output gaps is based on a Cobb-Douglas production function with Harrod-neutral technological progress and is described in detail in Giorno *et al.* (1995). The approach may best be qualified as hybrid in the sense that it relies on both structural economic relationships to estimate NAIRUs (see Richardson *et al.*, 2000) – and univariate filters – mostly HP filters, to estimate trend participation rates, trend hours worked, trend capital services and trend total factor productivity.

Source: OECD, *OECD Economic Outlook* 80, December 2006.

Aggregate unemployment rate:

Definition: unemployed workers as share of the labour force, in %.

Source: OECD, *Database on Labour Force Statistics*; OECD, *Annual Labour Force Statistics*.

Data adjustments: while the primary source is the OECD Database on Labour Force Statistics, Annual Labour Force Statistics – which are usually available over longer time periods – were also used in some cases to extrapolate unemployment rates backwards (under the assumption of similar percentage changes in unemployment rates in both sources).

Unemployment benefit replacement rate:

Definition: average unemployment benefit replacement rate across two income situations (100% and 67% of average production worker (APW) earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (1st year, 2nd and 3rd years, and 4th and 5th years of unemployment).

Source: OECD, *Benefits and Wages*.

Data adjustments: original data are available only for odd years. Data for even years are obtained by linear interpolation.

Employment Protection Legislation (EPL):

Definition: OECD summary indicator of the stringency of Employment Protection Legislation.

Source: OECD, OECD *Employment Outlook* 2004.

Product Market Regulation (PMR):

Definition: OECD summary indicator of regulatory impediments to product market competition in seven non-manufacturing industries:[1] gas, electricity, post, telecoms

(mobile and fixed services), passenger air transport, railways (passenger and freight services) and road freight.

Source: Conway, P. and G. Nicoletti (2006) "Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights", *Economics Department Working Paper* No. 530.

Degree of corporatism:

Definition: indicator of the degree of centralisation/co-ordination of the wage bargaining processes, which takes values 1 for decentralised and uncoordinated processes, and 2 and 3 for intermediate and high degrees of centralisation/co-ordination, respectively. The "low corporatism" dummy variable frequently used in this paper equals 1 when bargaining is decentralised and uncoordinated and 0 otherwise. The "high corporatism" dummy variable used in structural unemployment regressions equals 1 when bargaining is highly centralised and/or co-ordinated and 0 otherwise.

Source: OECD, OECD *Employment Outlook* 2004.

Data adjustments: original data are five-year averages and classify countries in each period along a 0-5 scale from least to most "corporatist" countries. In the present paper, annual data have been reconstructed based on various sources on the timing of past changes in centralisation and/or co-ordination of wage bargaining. Furthermore, the indicator has been rescaled along a 1-3 scale. In this process, it has been assumed that wage bargaining in France predominantly occurs at the intermediate level, while original data describe it as a mix of firm-level and industry-level bargaining. For other countries, values 1, 2 and 3 correspond to values 1-2, 3 and 4-5 in the original dataset, respectively.

Collective bargaining coverage:

Definition: share of workers covered by a collective agreement, in %. The variable used in the econometric estimates is the country average computed over the period 1980-2000.

Source: OECD, OECD *Employment Outlook* 2004. In the case of Ireland, the average bargaining coverage rate is taken from Belot, M. and J. Van Ours (2004).

Union density

Definition: trade union density rate, *i.e.* the share of workers affiliated to a trade union, in %.

Source: OECD, *OECD Employment Outlook* 2004.

Data adjustments: data for missing years are obtained by linear interpolation. Furthermore, original data are typically available until 2001 for most OECD countries. Extrapolations have therefore been made in order to expand data availability up to 2003. These are mainly based on national sources but, in some cases, an assumption of unchanged union densities over the period 2001-03 had to be made due to lack of data.

Labour tax wedge

Definition: tax wedge between the labour cost to the employer and the corresponding net take-home pay of the employee for a single-earner couple with two children earning 100% of APW earnings. The tax wedge corresponds to the sum of personal income tax and all social security contributions as a percentage of total labour cost.

Source: OECD, *Taxing Wages*.

Data adjustments: Austria: original data includes employers' social security contributions starting from 1997 only, thereby inducing an upward shift in tax wedge from this year; the tax wedge starting from 1997 is therefore recalculated based on the fact that employers' contribution rates to social security remained unchanged between 1996 and 1997. Netherlands: unlike other years, in 2002 and 2003 APW earnings are just above the threshold beyond which employers and employees do no longer have to contribute to the national health insurance plan (private medical insurance is typically provided instead), thereby inducing a temporary decline in the tax wedge; this issue is addressed by replacing the 2002 and 2003 observations by data obtained from linear interpolations between the 2001 and 2004 observations.

Monetary policy autonomy:

Definition: dummy variable which equals 1 when a country's (*de jure*) exchange rate regime is "floating" or "floating with discretionary intervention" and 0 otherwise.

Source: These data represent the *de jure* classification of IMF countries' exchange rate regimes, as collected and normalized by Ghosh, A., A-M. Gulde and H. Wolf, *Exchange Rate Regimes: Choices and Consequences*, The MIT Press, Cambridge, Massachussets, 2002.

Household mortgage debt:

Definition: Household mortgage debt as a share of GDP, in %. The variable used in the econometric estimates is the country average computed over the period 1990-2002. In the absence of available data for Switzerland before 2000, this country is excluded from all those regressions that include household mortgage debt among the set of explanatory variables. However, it is included in the illustrative impulse-response functions that are produced using the estimated regressions.

Source: Catte, P. *et al.* (2004) and, for Switzerland, Swiss National Bank (2004), *Swiss Financial Accounts*.

Financial intermediation:

Definition: Ratio of private credit by deposit money banks and other financial institutions to total stock market value traded – which is the value of the trades of domestic shares on domestic exchanges.

Source: World Bank, *Financial Structure Database*.

Total factor productivity shock:

Definition: deviation of the logarithm of Total Factor Productivity (TFP) from its trend calculated by means of a Hodrick-Prescott (HP) filter (smoothing parameter λ = 100). The calculation proceeds in three steps. First, growth in the Solow residual in the business sector is calculated as: $\Delta \log(TFP) = [\Delta \log(Y) - \alpha \Delta \log(N) - (1-\alpha)\Delta \log(K)]/\alpha$, where Y refers to real business sector GDP, N to total employment, K to the gross capital stock and α to labour income as a share of business sector income. Second, an index log(TFP) of the logarithm of TFP is obtained by cumulating the annual values of Δlog(TFP). Finally, the TFP shock variable is computed as the difference between log(TFP) and its HP filtered trend.

Source: Bassanini and Duval (2006), Annex 2.

Terms of trade shock:

Definition: logarithm of the relative price of imports weighted by the share of imports in GDP, *i.e.* terms of trade shock = $(M/Y) * \log(P_M / P_Y)$, where M and Y denote total imports and GDP in nominal terms, respectively, and (P_M / P_Y) is the ratio of the deflator of total imports to the GDP deflator.

Source: Bassanini and Duval (2006), Annex 2.

Real interest shock:

Definition: difference between the 10-year nominal US government bond yield (in %) and the annual change in the US GDP deflator (in %).

Source: Bassanini and Duval (2006), Annex 2.

Labour demand shocks:

Definition: logarithm of the labour share in business sector GDP purged from the short-run influence of factor prices.

The methodology follows Blanchard, O. and J. Wolfers (2000). First, measures of real wages and employment in efficiency units are computed as $W_{\text{efficiency units}} = (W / P_Y) / TFP$ and $N_{\text{efficiency units}} = N * TFP$, respectively. The simplest possible measure of labour demand shocks would be the negative of the sum of the logarithm of the ratio of labour input in efficiency units to real output in the business sector, on the one hand, and the logarithm of real wages in efficiency units, on the other hand: $-[\log(N_{\text{efficiency units}} / Y) + \log(W_{\text{efficiency units}})] = -\log[(N * TFP) / Y] - \log[(W / P_Y) / TFP] = -\log[(W * N) / (P_Y * Y)] = -$ (labour's share of business sector income). However, this simple measure of labour demand shocks is accurate only to the extent that the production function is Cobb-Douglas and factor proportions adjust instantaneously to changes in factor prices. Insofar as the latter assumption is unlikely to be verified in the short-run, changes in the labour share reflect both genuine labour demand shocks and the lagged adjustment of factor proportions to changes in factor prices.

Therefore, it is necessary to purge the labour share from the short-run influence of factor prices. For simplicity and comparative purposes, this is done here by following the same methodology as Blanchard (1998). Concretely, a wage measure which takes into account the gradual adjustment of factor proportions is computed as: $\log(W_{\text{adjusted}}) = \lambda * \log(W_{\text{adjusted}}) + (1-\lambda) * \log(W_{\text{efficiency units}})$, where the value of parameter λ is set equal to 0.8 in line with estimates on annual data provided by Blanchard. The labour demand shock is then constructed as $-[\log(N_{\text{efficiency units}} / Y) + \log(W_{\text{adjusted}})]$. The negative sign implies that an increase in this variable should be interpreted as an adverse labour demand shock. Finally, this variable is set equal to zero in 1970 (or in the first year of data availability for those countries where long time series are unavailable).

Source: Bassanini and Duval (2006), Annex 2.

Cyclically-adjusted primary fiscal surplus:

Definition: Primary fiscal surplus adjusted for cyclical factors.

Source: OECD, *OECD Economic Outlook* 80.

Note

1. Details on the broader PMR indicator for the whole economy – which is available only over the period 1998-2003 and therefore is not used in this paper – can be found in Conway, P., V. Janod and G. Nicoletti (2005), "Product Market Regulation in OECD Countries: 1998 to 2003", *OECD Economics Department Working Paper* No. 41.

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The Incidence of Carbon Pricing: Norway, Russia and the Middle East

by
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Introduction 240
Fossil fuels, energy efficiency and diversification 242
Impact of changing fossil energy costs 244
A global carbon dioxide tax 244
The ENV-Linkages model 245
Quantitative results 245
Middle East 246
Russia 247
Norway 248
"Subsidies" in Russia and the Middle East 250
Information asymmetries and climate change negotiations 252
Conclusion 253
Notes 254
Bibliography 254
Annex: The ENV-Linkages Model 257

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Introduction

One of the factors complicating ongoing negotiations to mitigate greenhouse gas (GHG) emissions is the heterogeneity that exists amongst countries. It has long been recognised that there is asymmetry both with respect to the potential impacts of global warming on individual countries, as well as with the economic impacts on countries of abatement regimes (Schelling, 1991). On the economic side, a strong source of heterogeneity is found in the highly varied distribution of endowments of hydrocarbon resources. The world's deposits are not uniformly located across all countries: some countries have them in abundance, while other countries import virtually all of their domestic use.

For countries that have deposits, high demand creates rents that governments can control and can allocate to serve policy objectives. Rent allocation, however, is not always free of impacts on economic efficiency. In extreme cases, Wintrobe (2000) observes that natural resource wealth can create conflict among social groups who are vying for control of the rents.[1] In less extreme cases, the rent allocation may take the form of government policy that regulates pricing of domestic hydrocarbon products at relatively low levels. Both of these cases lead to economic inefficiencies.

Below we explore differences in how three economies with large hydrocarbon deposits will respond to policy that increases the price of carbon dioxide emissions. Those responses are shown to vary widely and are largely related to policies concerning domestic use of hydrocarbons. We note that, to the extent that the differences are not widely understood, information asymmetries exist and may create the conditions underlying the results of Mailath and Postlewait (1990). Those asymmetries will make it difficult to conclude negotiations to coordinate global policy to mitigate carbon dioxide emissions.

The three countries/regions that are studied are: Russia, Norway and the Middle East.[2, 3] For perspective, Table 1 illustrates the relative magnitudes of production shares and export earnings from oil and gas in these regions. The first row (share of oil and gas) is shown in comparison to all other economic sectors. This value can be understated since, unlike the next row, it is calculated at prices in the domestic economy – *i.e.* the oil and gas are not valued at international prices. It also does not include transport and other related services that deliver the products to users. Nonetheless, the high fraction of oil and gas production in economic output in these regions/countries makes them important, if not dominant, sectors. The second row illustrates the importance of oil and gas to the well-being of each region's citizens – clearly they make major contributions to incomes, so policies that distort the oil and gas sector can have important implications for the economy as a whole.

How the rents from export sales are allocated may alter the domestic market for oil and gas, and thus affect the magnitude of a country's response to climate change mitigation policies. A simple case is where use of domestic oil and gas is subsidised through prices that are mandated to be low by government policy. In that case, the export

Table 1. **Output share and export earnings from oil and gas, 2005**

	Russia	Norway	Middle East
Share of oil and gas in gross output	19%	10%	21%
Estimated export earnings per capita[1]	$1 030	$14 450	$1 900
Population (million)	144	4.6	187

1. For natural gas, Middle East includes only the value of exports to OECD countries.
Source: Authors' calculation from IEA (2007), OPEC (2006), Central Bank of Russia (2005), Statistic Norway (2007), GTAP database version 6.

price is the opportunity cost of the oil and gas, so economic inefficiencies exist. New policies related to climate change would increase prices to consumers of the subsidised goods and reduce the distorting impact. What happens on the producer side will depend on how the policy is implemented. If the tax is implemented without changing the producer price, then the efficiency gain will come only from reduced demand. If, however, the producer price is allowed to be market driven, then it may increase even with the tax – in which case the efficiency gains from the policy will be even larger.

IPCC (2007) documents the contribution of anthropogenic sources of greenhouse gases (GHG) to potential changes in climate. An important finding of the work was that the climate may be more sensitive than previously thought to increased concentrations of GHGs. A doubling of GHGs above pre-industrial levels may lead to a greater change in temperature than was previously thought, and could thus be more disruptive for natural processes and human societies. Indeed, studies such as those surveyed by IPCC (2007b) suggest that marginal costs for carbon dioxide emissions (often referred to as the *social cost of carbon*) are between $4 and $95 per tonne – with $25 serving as a central value. In other words, a carbon dioxide tax of $25 might be justified for abating emissions.[4]

Policies to impose those costs on emissions will lead to the cost of fossil fuels increasing significantly. In fact, the consumer price of fossil fuel-based products will increase, while the producer price will decrease. Thus the resource rents will decrease, even while the consumer price of oil and gas are increasing. Pricing carbon dioxide emissions globally is thus likely to impact on the income that Norway, Russia and the Middle East receive from exports. Equally important, however, is the impact on domestic use of oil and gas for consumption and production. Each region listed in Table 1 has its own domestic prices for oil products and natural gas that reflect policy objectives of its government (the differences in cost of production are small compared with the differences in final demand prices). Table 2 illustrates two prices for energy sources in those countries.

Table 2. **Domestic tax-inclusive energy prices ($), 2005**

	Russia[1]	Norway	Middle East
Natural gas (per million BTU)	1.20	~6	<1.20[2]
Unleaded gasoline (premium/litre)	0.54	1.67	<0.25

1. Russia's gas prices have been changing recently and in 2008 are expected to reach $2.40 (Troika Dialogue, 2007). These prices are still well below the level in other countries so while they impact on the magnitude of the results below, the qualitative explanation remains the same. Gasoline prices in Russia are also significantly below that of European countries, while being a little higher than in the US.
2. IEA (2007) reports gas feedstock prices in some individual countries as ($ per million BTU): Iran, 0.35; Saudi Arabia 0.75; Oman 0.80; United Arab Emirates 1.00. An exact average for the region was not available, but the essential point of the table is made by illustrating that it is low relative to the others – especially Norway.
Source: IEA (2006) and American Chemistry Council (2005).

As Table 2 shows, there is a good deal of heterogeneity in the domestic energy prices of each country/region. IEA (2006b) reports that the economic value of energy subsidies in Russia in 2005 were equivalent to $40 billion in the then-current exchange rate. Saudi Arabia and Iran together were reported as having subsidies of $57 billion. Those calculations were based on the difference between the domestic price of various energy sources, and a measure of the globally-traded price. They were thus not precise measures of actual government budget outlays, as they may include the effects of elements not considered to be subsidy-related; *e.g.* health and safety regulatory frameworks.

Of particular interest for this paper is the impact of a policy that would place a price on carbon dioxide emissions. Since fossil fuels have a high carbon content (though natural gas also has considerable hydrogen), a carbon dioxide tax would increase their costs to users. For illustration, a $100 tax per metric tonne of carbon dioxide emitted would amount to a $0.24 tax on a litre of gasoline (or almost $1 per US gallon), and a $5.31 tax per 1 million BTUs of natural gas.[5]

Of course, for any given tax, the price impact will depend on the demand elasticity of the product, as well as on the initial price. If we assume a given elasticity applies in all three regions, then the largest impact of a particular tax will be expected in the Middle East, followed by Russia, then Norway – this is because Norway has the highest prices, followed by Russia and the Middle East.[6] This paper shows that this simple intuition is incomplete. It does so by highlighting a variety of impacts that carbon pricing would cause. It then notes what these impacts imply for future diversification strategies.

We begin with some background on each region.

Fossil fuels, energy efficiency and diversification

The differences between these regions are significant in ways that are worth noting further. The use of fossil fuels per person and per unit of GDP is more intense in Russia than in the other two economies, as implied in Table 3 from CO_2 emissions. All three regions, however, are considerably higher than the world average in emissions per capita, but Norway is considerably lower in emissions per unit of GDP.

Table 3. **CO_2 emissions from energy, 2005**

	Norway	Russia	Middle East	World
Emissions (tonne) per capita	8.0	10.8	6.6	4.2
Emissions per GDP[1]	0.20	4.41	1.57	0.75

1. Kilogram per $ (in year 2000) of GDP.
Source: IEA (2007).

To see how those emissions are allocated, Table 4 breaks them into four categories. Final demand uses of energy are contained, in part, in the Transport and Other categories. The table makes clear the heterogeneity between the regions. Table 3 above shows that Russia has the highest emissions per capita of these countries, Table 4 now shows that a large share of those emissions come from energy transformation sectors. In particular, Russia uses a large share of its fossil fuels for the generation of heat and electricity in Heat Plants and Combined Heat and Power Plants (IEA, 2006d). These activities are directly supporting industrial and commercial activity so they are important as intermediate inputs into the economy.

Table 4. **Sectoral share of energy-related CO_2 emissions, 2005**

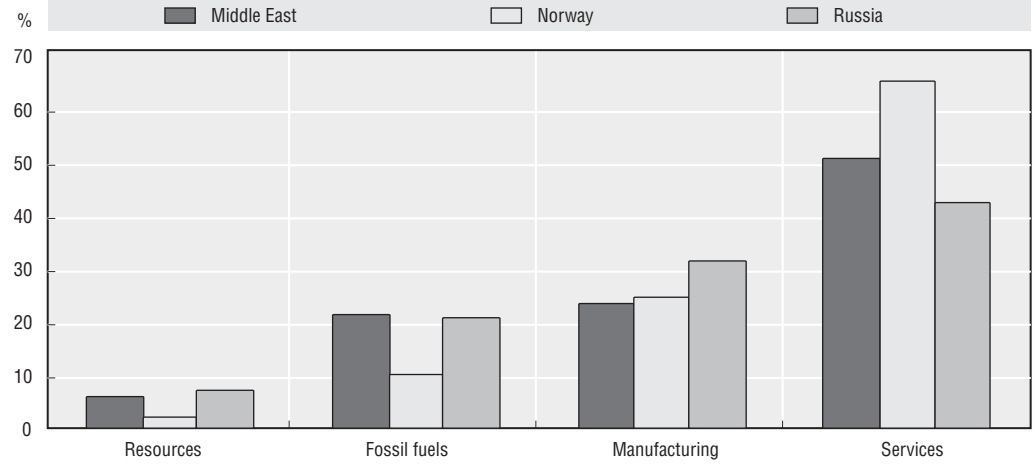
Per cent

	Energy transformation	Manufacturing	Transport	Other
Norway	26	20	34	10
Middle East	43	22	22	13
Russia	60	13	13	12

Source: IEA (2006).

Another perspective on differences between these regions is in economic diversification. Norway has a highly diversified economy that would be indistinguishable from other European economies without its oil assets. Figure 1 shows the sectoral share of four aggregates in gross output. It uses a System of National Accounts (SNA) definition of a sector so it is not directly comparable to Table 4, where an activity-based definition of a sector is used. Norway's service sector produces 65% of gross output compared with 43% in Russia (in 2001). The Middle East is the region with the lowest share of gross output in manufacturing: 23% compared with 31% for Russia.

Figure 1. **Sectoral share in gross output (2005)**



Source: GTAP Database version 6.

The results shown in Tables 3 and 4, as well as Figure 1, are directly linked to the prices shown in Table 2. Through taxation, Norway forces final consumers to be very fossil fuel efficient – they face European prices for energy and thus have European levels of emissions per unit of income. Russia, on the other hand regulates domestic prices for natural gas, and has only a little taxation of domestic transport fuels. Most countries in the Middle East keep domestic prices for fossil fuels low by not taxing the use of fossil fuels, and a few sell refined petroleum products domestically at prices below their international value. Unlike Russia, however, Middle Eastern countries do not have extensive domestic industries that are dependent on low-cost fossil fuels – though some are used in chemicals industries. Norway is thus one of Europe's carbon-efficient economies in spite of its large fossil fuel sector. Its carbon dioxide emissions per unit of GDP are less than half that of the United States, and low even by European standards. Norway can thus be seen as a country that produces large quantities of fossil fuels, but does not consume very much itself.

Russia's economic growth over the past few years has been fuelled primarily by energy exports, given the increase in Russian oil production and relatively high world oil prices (Russian Economic Report, 2006). Roughly 72% of crude oil production and 32% of natural gas production was exported in 2004 (IEA, 2006d). Russia's heavy dependence on oil and natural gas exports make it vulnerable to fluctuations in world prices. Typically, a $1 per barrel change in oil prices will result in a $1.4 billion change in Russian revenues in the same direction. Russia has recently been increasing its exports of refined petroleum products in an attempt to increase the value-added in energy-related exports.

The Middle East is the region most dependent on oil and gas resources. Some attempts have been made to diversify away from that economic base, but these have often also been based on the use of cheap energy sources – particularly in the Gulf states and Iran. Petrol-chemicals have been one area where attempts have been made at diversification; aluminium smelting has been another since the cost of electricity is a major component in the cost of producing aluminium. More recently, liquefied natural gas (LNG) plants/facilities, gas-fired electricity and desalination plants have been developed. Indeed, recent demand has been growing strongly enough that in the future the distinction between Russia and the Middle East may be largely eliminated.

In the past, the low levels of diversification and demand for natural gas caused it to be routinely flared off. The United Arab Emirates with its manufacturing and services sectors (financial/banking especially) is perhaps the most successful example of diversification. Nonetheless, for the oil-rich countries as a whole, diversification to the extent it has happened, has generally meant developing industries around their oil and gas wealth to expand employment and blunt the impact of demand fluctuations for crude oil. Most of the Middle East's oil production is exported – 81% of crude oil production. A much smaller proportion of its natural gas is exported – 15% (IEA, 2006d).

Impact of changing fossil energy costs

Given the different contexts that the three economies face, one can expect considerable heterogeneity across them in response to changes in the prices of fossil fuels. It is clear, and uninteresting, that each would stand to lose from a fall in the producer price of crude oil and natural gas. Russia's moves to process crude oil domestically and export refined petroleum products has little, if any, impact on its losses from such price decreases because refining margins are generally not much impacted by input prices since competitive markets leave little room for retail price control.

More interesting would be a change in the price of fossil fuels that is induced by policy to deal with climate change. Using a Pigouvian tax,[7] there would be a rise in the consumer price while the producer price declined. Intuitively, one would expect that all three regions would incur adverse consequences from such a policy, but that the Middle East might be more adversely impacted given its heavy reliance on fossil fuels as a source of national income. As we now see, some additional factors make the outcome of a carbon dioxide tax more interesting.

A global carbon dioxide tax

A global carbon dioxide tax is admittedly simplistic. It would require all countries to implement one, so the negotiations around such a tax would be difficult to conclude. It would also have to be accompanied by additional policies that would help achieve burden

sharing since a tax would be unfairly burdensome for developing regions (Chichilnisky and Heal, 1994).[8] It is nonetheless useful for illustrating the impacts of a comprehensive climate change policy. It also has some characteristics that are attractive from fiscal policy and other perspectives (Cuervo and Ghandi, 1998; and Shah and Larsen, 1992; Cooper, 2005). Indeed, a number of countries implemented an energy or carbon tax in the early 1990s (see Shrum, 2007, for a brief survey), and in the US the Clinton Administration proposed a BTU tax in 1993 that never reached implementation. Finland began applying a carbon dioxide tax in 1990 that was equal to € 18.05 per tonne in August of 2007. Sweden also began applying a tax in 1991 whose value in August 2007 was equal to € 150 per tonne. Sweden's tax however, exempts electricity and only requires industries to pay 50% – an explicit attempt to avoid disadvantaging its industries in domestic and international markets. Great Britain began applying an energy levy in 2001 that is intended to reduce its use (with reduction of carbon dioxide emissions as an important ancillary objective). Other countries, such as Norway, apply energy taxes that are related to carbon content, but whose coverage is limited and thus have only a small impact on emissions.

Given the mounting scientific evidence of the need for climate change mitigation policies (IPCC, 2007), understanding their differential impacts, and especially the sources of those impacts, may facilitate negotiation and implementation of climate change polices. To study the detailed impacts of a carbon dioxide tax, a useful tool is a numerical model that uses actual data to calculate responses. The kind of partial-equilibrium based discussion above already suggests that we would expect the differences between the three regions to be significant in response to a carbon dioxide tax. To move beyond that intuitive discussion and examine how important the differences between regions are would require a more complete framework. A general equilibrium model would illustrate the differences in considerable detail and permit a more in-depth analysis. A numerical general equilibrium model also has the advantage of being based on estimates of behavioural parameters (such as various demand and substitution elasticities), while simultaneously accounting for other sources of heterogeneity across these regions.

The ENV-Linkages model

ENV-Linkages is a recursive dynamic neo-classical general equilibrium model that has been developed for policy analysis within the OECD. It is a global economic model built primarily on a database of national economies. The model represents the world economy in 34 countries/regions, each with 26 economic sectors. Each of the 34 regions is underpinned by an economic input-output table (usually sourced from national statistical agencies). Those tables identify all the inputs that go into an industry, and identify all the industries that buy specific products. Since the main interest for this work is in three specific regions, we will not focus much on the other 31 regions. Nonetheless, having that regional detail implies that inter-linkages through trade are well represented. More detail concerning the model is provided in the annex.

Quantitative results

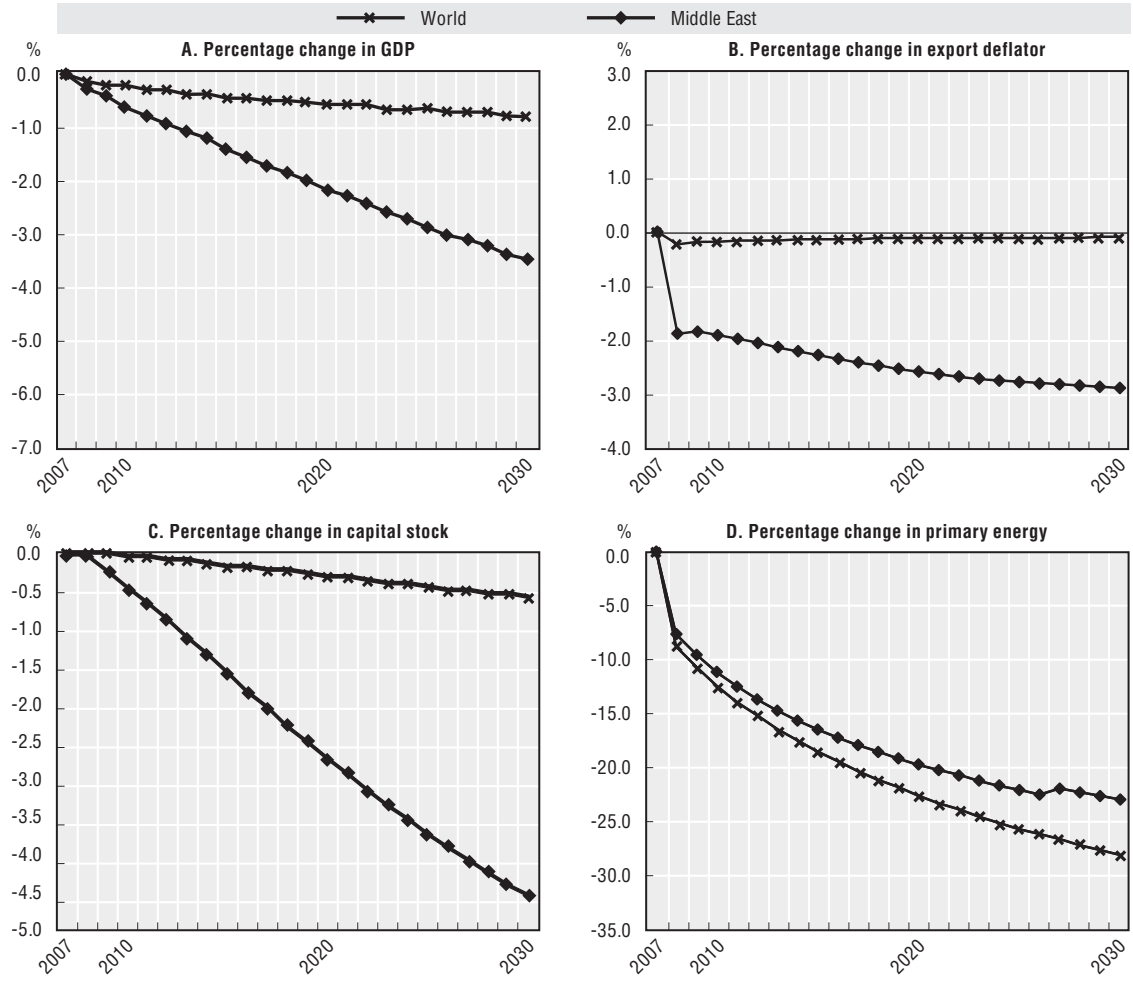
The experiment undertaken for this analysis is an illustrative $25 tax per tonne of carbon dioxide emitted that is increasing relative to the real value of all produced goods by 0.5% per year.[9] The amount of the tax is chosen arbitrarily, but the results reported below would scale up or down with changes in the tax rate. This is imposed on inputs of fossil fuels in all economic sectors, including final demand by government and consumers. The

database that the model uses (GTAP version 6) incorporates IEA data and supplementary information to reflect the user price of fossil fuels (Burniaux and Truong, 2002). The heterogeneity in prices illustrated above is captured in the model's reference case. The impact of the tax will differ by energy types given their carbon dioxide emissions – it distinguishes between emissions (per unit of input) of each sector's energy use. The tax is global so all countries are directly impacted. What is key in the results reported below is the impact that the tax has on domestic use. Since the tax adds a fixed cost to a litre of gasoline or a million BTU of natural gas, the percentage increase in price is dependent on the pre-tax cost of gasoline or natural gas. Regions that have low pre-tax prices will thus see a larger impact of climate change mitigation policy.

Middle East

The response in the Middle East region to the carbon dioxide tax is of a reduction in exports due to reduced demand, and thus a fall in export prices (Figure 2B). The loss of export markets translates directly into a loss of GDP which is approaching 4% by 2030, compared with a global GDP loss of 1% (Figure 2A).

Figure 2. **Middle East**



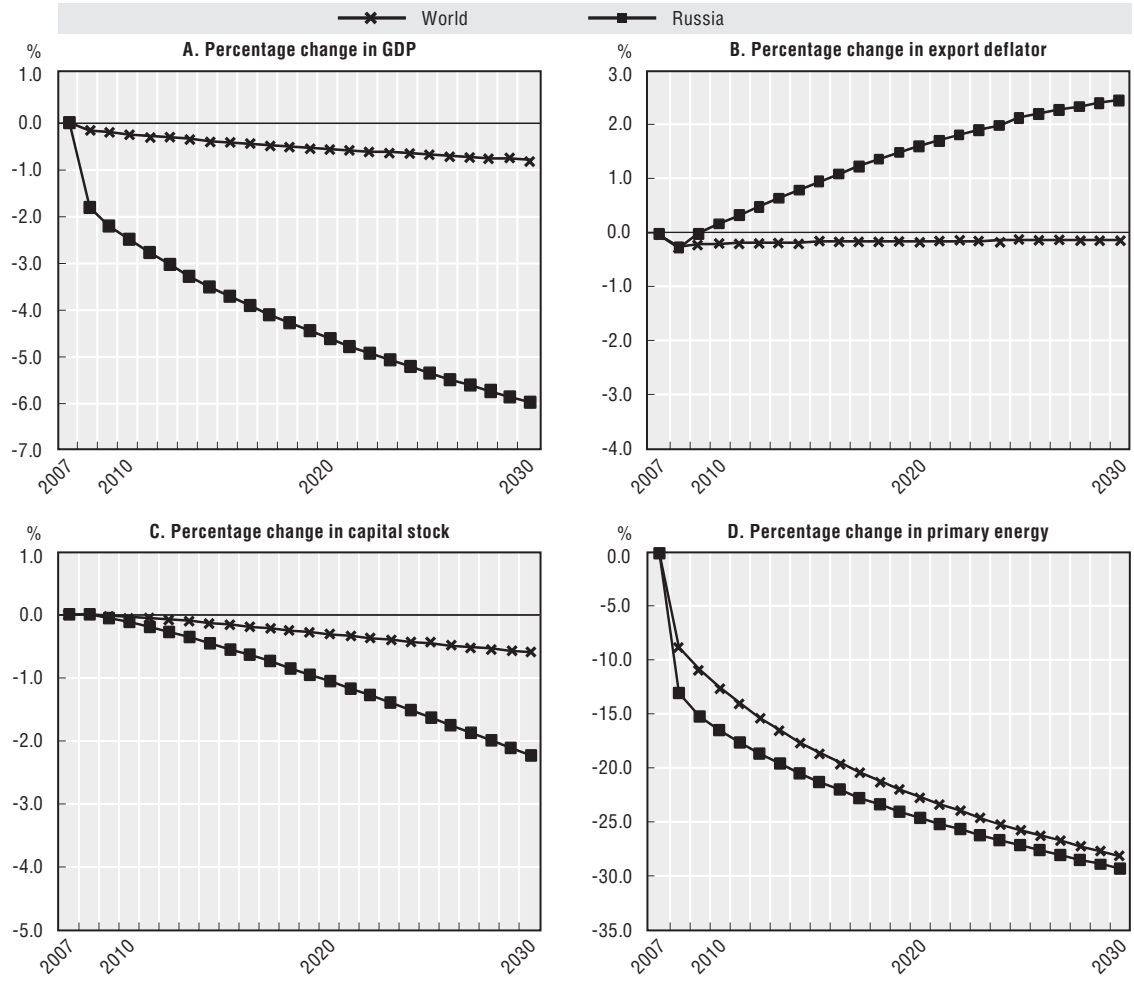
Source: ENV-Linkages results.

The reduction in production is associated with a reduction of capital (Figure 2C) as investment slows in the fossil fuel sector. Since most of the fossil fuels produced are exported, the reduction in primary energy (Figure 2D) largely matches the international reduction in energy used.

Russia

By contrast, Russia suffers a larger GDP loss than the Middle East, even though the change in its capital stock is smaller – the GDP loss is almost twice as big.

Figure 3. **Russia**



Source: ENV-Linkages results.

Figure 3B illustrates that Russia's export deflator is rising even though energy prices for its export market have fallen. Underlying this is the fact that Russia uses more energy (heat and electricity) for domestic industry than does the Middle East. This increase in the price of exports shows that relative to the rest of the world, the price of all exports from Russia increase – thus causing some loss of markets. The price of exports is increasing relative to the rest of the world because domestic energy prices are lower than in the rest of the world. If Russia's energy prices were equal to those in the rest of the world, the relative price of exports would have to fall given the decline in fossil fuel export prices.

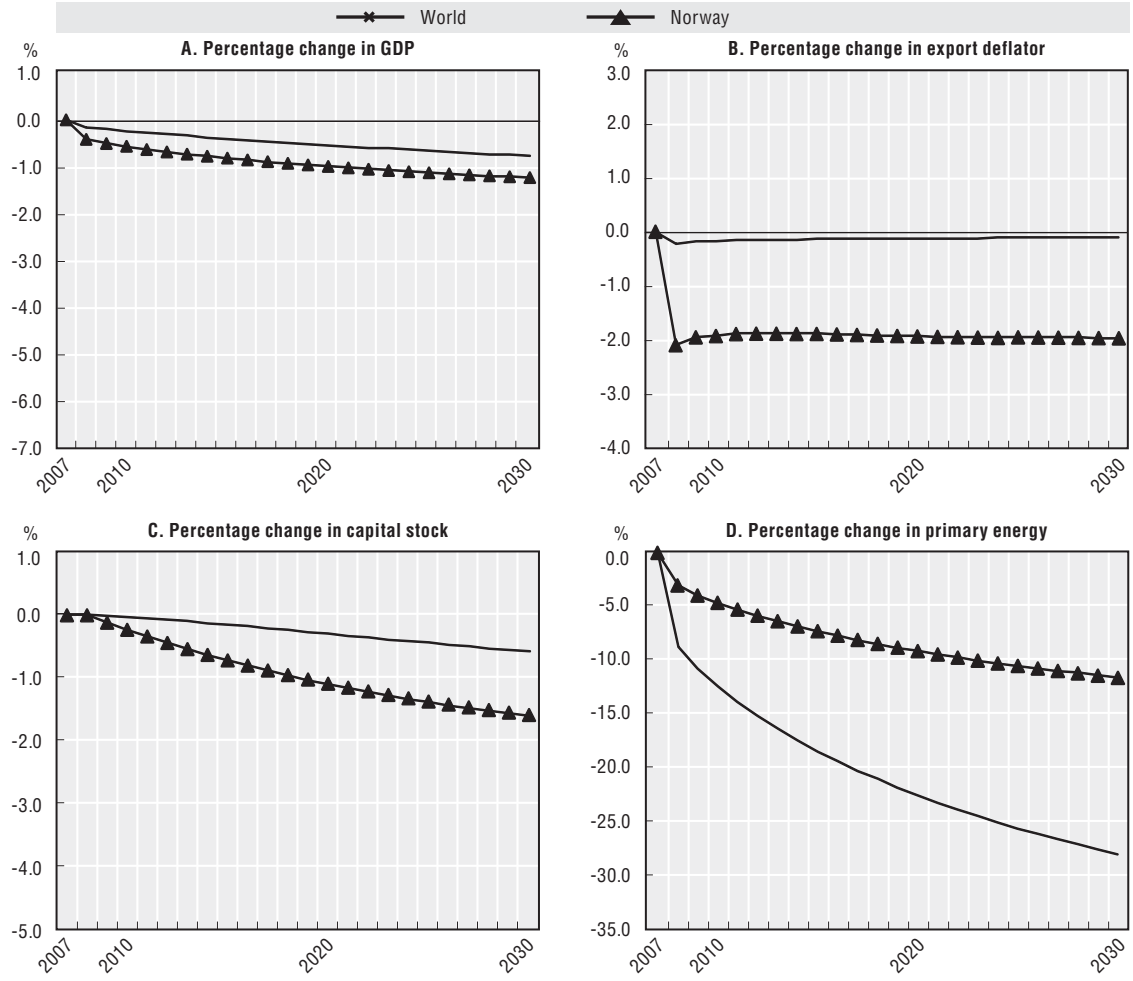
Finally, as Figure 3D illustrates, there is a decline in energy use in Russia that is larger than elsewhere. Again, this is caused by the larger percentage increase in energy prices in the domestic market.

This result offers an interesting lesson to Middle Eastern countries that are attempting to diversify away from heavy reliance on fossil fuel exports. In the past, countries in that region have discussed expanding chemical industries and aluminium manufacturing that would provide value-added to their energy sources and act to dampen energy demand cycles that heavily impact on the region's economic activity. Because activity in these industries would be correlated to fossil energy prices, the region would actually increase the domestic impact of climate change policy – it would make itself more like Russia. True economic diversification would require establishing industries that were largely unaffected by energy prices, and thus would not be impacted strongly by a carbon dioxide tax.

Norway

Norway's experience with the carbon dioxide tax (Figure 4) shows a well-known phenomenon that is put into reverse: *Dutch Disease*.[10] The loss in GDP is small – almost

Figure 4. **Norway**

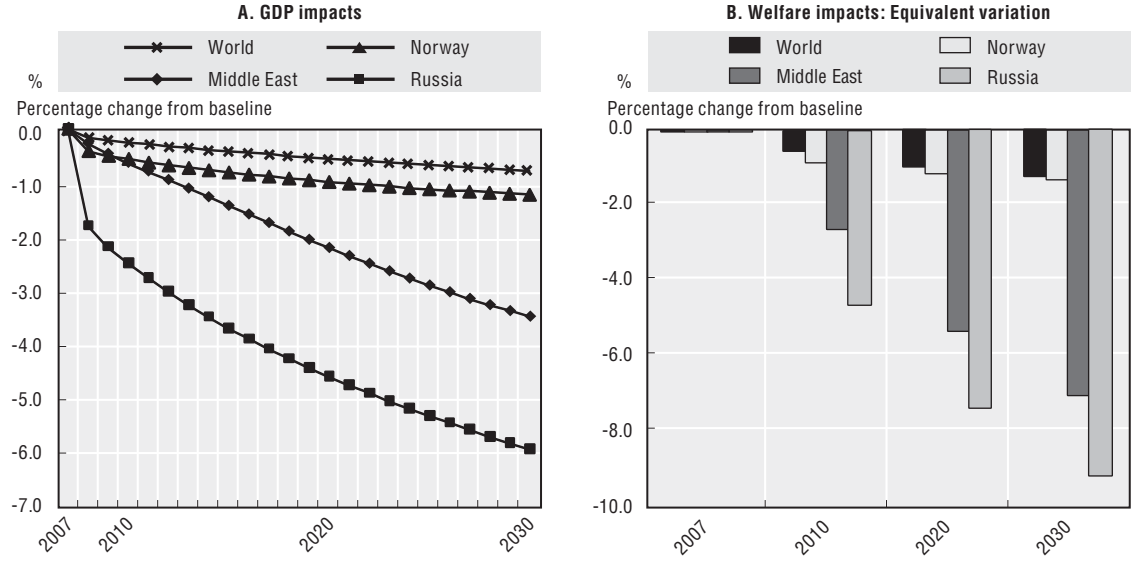


Source: ENV-Linkages results.

identical to that of the rest of the world – because the price of all exports *falls* with the loss of petroleum markets. In other words, losing markets in one area creates the opportunity to gain markets in other areas. This is reinforced by the fact that Norway's domestic energy price is already similar to that of other European countries, and higher than non-European countries – meaning that the percentage increase in domestic energy prices is smaller than the world average.

Comparison of GDP between the three regions is illustrative of relative impacts. Global GDP impact is presented in Figure 5A for reference. Any comparison of GDP to other regions and countries needs to be done carefully since a major export product will be decreasing in value. There is a potential deterioration in the terms of trade for the three regions. Indeed, when we examine the terms of trade we see the Middle East's terms of trade down by 2.5% and Norway's down by a comparable 1.9% in 2030. Perhaps not surprisingly given the observations made above, the terms of trade in Russia improved by about 3% in 2030. This should have been predictable looking panel B in each of the previous three figures. The export deflator is down in Norway and the Middle East, but since Russia uses a lot of energy in producing its exports, its export deflator increases. For each region, import prices are only mildly changed so the terms of trade move with export prices.

Figure 5. **Comparative GDP and welfare impacts**



Source: ENV-Linkages results.

Figure 5B gives the equivalent variation[11], which shows little difference between Norway and the world as a whole, but very large losses for the Middle East and Russia – in spite of Russia's improvement in its terms of trade. The difference between the regions is very strong and the magnitude of the impact on the Middle East and Russia stands in sharp contrast to Norway.

Recent trends in the Middle East, however, suggest that it may be becoming more like Russia. The export market demand for natural gas is extremely strong – Qatar is expanding its exports from projections of nearly 31 million tonnes of LNG in 2007 to an anticipated 77 million tonnes by 2011-12. In addition there is very strong domestic demand growth in nearly all of the Gulf States – such that it can't currently be met from existing supplies. As a result Oman is

having problems finding sufficient feedstock for a new LNG plant at Qalhat. Kuwait, Bahrain, and the United Arab Emirates all have tight natural gas markets, as does Saudi Arabia. This is quite a change from earlier periods and represents a deepening of demand markets. Even oil has seen demand surge – a combination of cheap transport fuel prices and increased incomes from increasing exports. All this suggests that to some extent, the region is making itself more vulnerable to the kind of impacts illustrated above for Russia.

"Subsidies" in Russia and the Middle East

The prices of oil and gas illustrated in Table 2 were important factors in the results illustrated above (price elasticities were assumed to be similar in each region). Given their importance, a few additional observations are warranted concerning Russia and the Middle East.

When Russia began its transition to a market economy in the early 1990s it had an infrastructure for exporting oil and gas that was significantly developed. Oil and gas were, however, sectors that were troubled by difficulties from communist-era management (IEA, 2002). Economic restructuring during the early 1990s led to dislocation on a large scale – OECD estimates of the economic contraction from 1992 to 1998 are on the scale of 38% of GDP. As part of an effort to offset the impact on consumers, the government lowered (already low) electricity and natural gas prices in the late 1990s. This likely gave a short-term boost to industry. Oil products were not considered part of basic energy needs, and were thus not subjected to similar controls. By the early 2000s – with world oil prices recovering, the rouble devalued, and reforms coming out of the financial crisis taking effect – Russia's industrial sector and particularly its oil industry were in sharp recovery. Its natural gas sector, however, was still under domestic price controls.

Those controls did not extend to exports. In general, the price of natural gas exports was set by international market forces – though for some export markets, notably former Soviet Union countries, prices were lower. This created an incentive for maintaining and developing a capacity to transport natural gas to external markets while neglecting domestic markets. Indeed, natural gas exports increased by 5% (measured in energy terms) between 1992 and 1998 even while domestic production decreased by 11% – though it is likely that the sharp economic decline contributed to the domestic decrease. An export transport monopoly was (and is) held by its largest natural gas producer Gazprom. Since even larger increases in capacity for exports were not built during this period, it may well have been the case that Russia (Gazprom) was behaving strategically as a price-setter.[12] The Bluestream Pipeline from Russia to Turkey has been viewed as an attempt by Gazprom to protect its status as a price setter in the European market by limiting the ability of Caspian-area competitors to access Europe (Tsereteli, 2005). Given the results above, an interesting question arises concerning the appropriate prices that should have been set domestically.

Given Russia's very large reserves, it is not clear what its domestic price should have been: domestic long term marginal cost, or the export price. If Russia feared that technological developments in the future might make its gas reserves worth much less than today, then its current domestic price should not necessarily be equal to its export price. This would be the case if there was a possibility that a future energy technology might have marginal cost lower than the marginal cost of its natural gas while it still had substantial reserves. Indeed, with reserves that could sustain some 80-odd years worth of

consumption at current rates, future technological change creates substantial uncertainty for the value of those reserves. In those circumstances, Russia's best strategy would be to export as much as possible at whatever price those markets will bear, but to keep the domestic price near long term marginal cost (*i.e.* the cost that included incentives to maintain as well as expand infrastructure, and to continue with further exploration of new sources of natural gas).

The price in European markets may not have been appropriate for Russia domestically in the past, but there is some evidence that the actual domestic price was too low. IEA (2006c) reports that the average price for all domestic users was $31 per thousand cubic metres in 1998 (which was roughly 90% of the export price – in fact that domestic price was often not paid by domestic users since many bartered trades or refused to pay). That domestic price was on a downward trend that reached a low of $11 in 1999/2000 (roughly 10% of the export price in those years). The price from 1999 to 2002 was even below the apparent marginal cost of $22 per thousand cubic metres.[13] After 2002, the price rose above marginal cost and has been increasing since (with a higher proportion of customers actually paying for natural gas). Tarr and Thomson (2004) also argue that an optimal strategy for Russia would be a dual pricing structure that had Russia (Gazprom) behaving strategically in international markets while pricing at long run marginal cost in domestic markets. They estimated Russia's long run marginal cost to be around $40 per thousand cubic meters. Recent increases in production costs associated with increases in labour and capital costs, as well as depletion of its low-cost reserves would put its long run marginal cost closer to $60 per thousand cubic meters – still well below the export price, and prices in most industrialised countries.[14] Ahrend and Tompson (2004) come to similar conclusions and argue that reform of Russia's gas markets should lead only to the domestic price being set at long term marginal cost – which they acknowledge is well below the export price. These observations suggest that recent price increases for natural gas could remove completely any implicit subsidy given to domestic consumers and still leave Russia vulnerable to the kinds of results noted above. This is because domestic prices would remain below that of its industrial competitors.

With Russian ratification of the Kyoto Protocol, however, a new factor has now been added to the determination of the domestic price for natural gas. It should be above current marginal (and long term marginal) cost irrespective of the size of its reserves (even if Russia had virtually limitless supplies of natural gas). This is because a GHG abatement regime would force Russian energy costs to increase, thereby narrowing the difference between Russia's domestic price and the prices of industrial competitors and trading partners. Given the results illustrated above, there is a strong case for slowly moving domestic prices closer to that of its trading partners; that is, doing it on its own timetable would be preferable to having to move more abruptly in a subsequent internationally-negotiated GHG abatement regime.

In the Middle East region, many countries subsidize their domestic consumption. GTZ (2007) reports retail gasoline prices in Iran, Saudi Arabia and Kuwait at $0.09, 0.16, and 0.22, respectively. In Iran subsidies were estimated to be worth 16% of GDP in 2000 (Tarki, 2004) and rising rapidly with increasing oil prices. Iran only refines about half its domestic demand. Since the other half is imported from abroad, subsidies automatically rise with increasing oil prices. Moreover, the subsidies encourage illegal re-exports of cheap gasoline: implying that the Iranian treasury finances re-export activity and subsidizes its neighbours' gasoline consumption. Von Moltke *et al.* (2003) report that annual growth in

energy use (encouraged by subsidies) was 5.4% between 1990 and 2000 – enough to increase energy use by 72%. More recently, between 2001 and 2006, oil consumption grew in Iran and Saudi Arabia at over 5% annually and at more than 7% in Kuwait. These rates of growth are sufficient to call into question the region's capacity to increase exports in response to high export prices. They also lead directly to the region's sensitivity to climate change abatement policy by making consumers dependent on cheap energy.

Information asymmetries and climate change negotiations

The results reported here may lead to the disquieting conclusion that the Middle East and particularly Russia have little incentive to join a climate change mitigation regime. Indeed, given these results one would ask why Russia ratified the Kyoto Protocol at all. Buchner and Dall'Olio (2002) show that the circumstances for Russia's ratification were somewhat unique in that other issues (side-agreements) induced Russia into signing. Even so, Russia and the Middle East have strong incentives to participate in order to avoid some of the particularly adverse consequences of climate change – such as melting of the polar ice caps (Schellnhuber, 2006). Unrestricted indefinite emissions of greenhouse gases raise the possibility of such outcomes. The question is thus not "if" these regions should join, but rather "under what circumstances".

A substantial literature on information asymmetries suggests that if the types of heterogeneities highlighted here were not accounted for, negotiations to reach an accord for the post-2012 period would be difficult. Kennan and Wilson (1993) highlight that information asymmetries cause long (and sometimes painful) negotiations to occur just to get participants to reveal their preferences so that mutually acceptable solutions can be explored. In negotiations between firms and labour unions, strikes and lockouts are means of revealing information concerning bargaining positions (Fisher, 2001).

The provision of GHG mitigation is a public good that requires collective action through negotiation, but the set of feasible outcomes becomes restricted under asymmetric information. Indeed, Mailath and Postlewaite (1990) show that as the number of agents becomes large, the probability of finding an acceptable solution under information asymmetries approaches zero. This happens even when there is a clear net benefit to be had from collective action.

Our argument here is that when that result is combined with unknown degrees of heterogeneity – *i.e.* that individual country circumstances are not well understood by everyone participating in the negotiations – then the range of possible outcomes that could be agreed upon may become vanishingly small. This is arguably the case with a problem such as climate change, where the free-rider incentive is evident and thus suspicion of strategic behaviour may greet each claim of special circumstance. It may be the case that global negotiations cannot reach agreement with a large number of countries participating until there is broader understanding of what the impacts of a changing climate and mitigation policy will be on individual countries.

This line of analysis is different from the currently dominant approach to looking at climate change policy as a game-theoretic problem (*e.g.* Finus, 2002 a,b). In the current literature, as long as a welfare-improving negotiated outcome exists, there is an assumption that it will be found. The problem in that work is seen as ensuring that the institutional arrangements that facilitate, monitor, and enforce outcomes will be put in place. Failure to get an agreement is seen as a failure to put in place the right institutions

(*e.g.* international governance). Mailath and Postlewaite (1990), however, show that the problem may be much deeper in the presence of information asymmetries; *i.e.* you may never get a solution without removing the asymmetries.

Rigorous quantitative analysis is thus necessary for each major country/region participating in the negotiation to remove, as much as possible, information asymmetries and subject claims of exceptions to rigorous scrutiny. The work that has been reported here is a step in that direction.

Conclusion

The contrast between the three regions that we considered is striking in how strong the different responses are, even though all three regions are heavy fossil-fuel exporters. While all three are (economically) adversely impacted by the global carbon dioxide tax, Norway is the least impacted. This comes about largely because the government has made it a national policy not to make Norway dependent on its fossil-fuel reserves for its economic well-being, with energy prices in Norway being well above the global average. Since a tax on carbon dioxide emissions raises the price of a fossil fuel by a fixed amount in all countries, those with already high prices will see a smaller percentage increase, and thus are less impacted.

The lessons for the Middle East that come from this work are twofold. On the one hand, it makes the obvious point that the region stands to be adversely impacted by global GHG-abatement policies. On the other hand, it also suggests that diversification strategies that rely on inputs of cheap fossil fuels will only deepen the consequences of such policies. True diversification requires developing sectors that are at best anti-cyclical to fossil-fuel industries, or at least neutral with respect to cycles in those industries.

Russia has already acknowledged the need to reform its domestic energy prices. An international carbon dioxide tax would increase the price of Russian oil and gas to consumers (foreign and domestic), while lowering the price that suppliers receive. It is thus in Russia's interest to follow through, and even accelerate, its domestic energy reforms so that domestic consumers of energy are impacted by GHG abatement policy no more adversely than Europe's consumers, or its other industrial competitors.

A message from this work is evident for other countries as well. Vulnerability to climate change abatement policies is partially a function of current and past policies regarding energy and sources of carbon dioxide emissions. If dealing with climate change is going to be a policy objective, then it will be best to start moving sooner to energy prices that are closer to that of other major economies.

A final message from this work is that lack of widespread understanding of impacts of climate change mitigation policy creates information asymmetries that will make reaching global agreement difficult. Rigorous quantitative analysis is thus necessary for each major country/region participating in the negotiation – to remove, as much as possible, information asymmetries and subject claims of exceptional circumstances to rigorous scrutiny. The work that has been reported here is a step in that direction.

Notes

1. Sachs and Warner (1995) noted a correlation between high natural resource abundance and slow economic growth.
2. The Middle Eastern region here is defined as Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen and Occupied Palestinian Territories. The limitations of source data precluded further disaggregation. Norway is also combined with Iceland and Liechtenstein.
3. Pricing carbon dioxide emissions would also impact on coal, but only a little coal is consumed in Norway and the Middle East. Russia, on the other hand, has 11% of its gross (pre-export) energy production coming from coal (IEA, 2006). In the results reported below, coal emissions are priced, but coal does not substantially explain the differences between regions.
4. Although a tax of $25 is studied below, it is not intended to be justified on the basis of cost-benefit. The economic costs of carbon dioxide emissions are not well enough understood to use the $25 estimate for cost-benefit analysis.
5. Using US Energy Information Administration data on emission factors (*http://www.eia.doe.gov* /oiaf/1605/coefficients.html). The same tax would add $269 to the cost of a tonne of bituminous coal.
6. Since the tax would be expected to be permanent, long-term price elasticities would apply. A survey of transport elasticities by Hanly, *et al.* (2005) show a fairly robust long-term response, with the average price elasticity around 0.64 for transport fuels.
7. A tax that exactly internalises non-markets transaction, or externalities (Pigou, 1920).
8. An international tradable permit scheme can facilitate burden sharing through the allocation of permits, but has some drawbacks in requiring periodic re-negotiation of the permit allocation – which will transfer very large sums of money between countries.
9. The model does not account for the impact of productivity growth on consumer prices for individual goods (only prices of aggregate goods are represented). Therefore, these prices would be increasing more rapidly over time in real consumer prices. That is, in an aggregate sector, productivity increases imply that output of that sector represents more individual units of goods and services. A consumer price index of the model's goods and services should account for that change and keep the units constant over time. One can infer from this that the growth in the tax rate would be higher relative to consumer prices.
10. See McKibbin and Wilcoxen (1998) for an analysis of Dutch Disease induced by the creation of tradable permits for carbon dioxide emissions.
11. Defined here as the change in real income relative to baseline income. See Fane and Ahammad (2004) for a discussion of measures of equivalent variation in a modelling context.
12. With recent increases in export capacity to Europe by Norway and the Middle East, Russia may be losing any ability it may have had to influence European natural gas prices.
13. The price of $22 is inferred from a contracted price that Gazprom negotiated with Lukoil in 2003 (IEA, 2006c).
14. Personal communication with Isabel Murray of the International Energy Agency.

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Annex: The ENV-Linkages Model

The ENV-Linkages model is a recursive dynamic neo-classical general equilibrium model that has been developed for policy analysis within the OECD. It is a global economic model built primarily on a database of national economies. The model represents the world economy in 34 countries/regions, each with 26 economic sectors. Each of the 34 regions is underpinned by an economic input-output table (usually sourced from national statistical agencies). Those tables identify all the inputs that go into an industry, and identify all the industries that buy specific products. Since the main interest for this work is in three specific regions, we will not focus on the other 31 regions. Nonetheless, having that regional detail implies that inter-linkages through trade are well represented.

Income generated by economic activity ultimately reflects demand for goods and services by final consumers. ENV-Linkages represents consumers as being largely similar at a very aggregated level of consumption. As such, the model postulates a representative consumer who allocates disposable income according to preferences: among consumer goods and saving. In this version of the model, consumers purchase goods and services as produced by firms (a *transition matrix* to map produced goods into specific consumer goods is not implemented). The consumption/saving decision is static instead of forward-looking: saving is treated as a "good" and its amount is determined simultaneously with the demands for the other goods, the price of saving being set arbitrarily equal to the average price of consumer goods. This means that consumers are saving a constant proportion of their income and not adjusting savings to reflect future events that may impact on income.

Formally, a representative consumer maximises well-being (utility) subject to resource constraints:

$$Max\ \ U = \sum_i \mu_i \ln(C_i - \theta_i) + \mu_s \ln(\frac{S}{P_s}) \qquad subject\ to \quad \sum_k P_k C_k + S = Y, \quad and \quad \sum_k \mu_k + \mu_s = 1$$

where U represents utility, C is a vector of consumer goods, P_k represents consumer prices, S represents the value of saving, P_s the relevant price of saving, and Y is total income (completely allocated between consumption and savings). The parameter, θ, is the floor level of consumption – its main function is in making the utility function non-homothetic (see Dowrick, *et al.* 2003). Both the floor level of consumption and the share parameters, μ, are calibrated to a given set of *initial* consumption shares and income elasticities. Since consumers are not represented with forward-looking behaviour, some care needs to be exercised in studying policies that consumers may reasonably be expected to anticipate – either the policy itself or its consequences. Analysis of tax changes, or any other event, that are announced today but not enacted until the future would not be appropriate with this modelling framework.

For each country, the consumer's objective function thus gives rise to household private consumption and savings (letting *k* represent individual goods),

$$C_k = Pop\theta_k + \frac{\mu_k}{P_k^c} Y^*, \qquad where \quad Y^* = Y^c - Pop\sum_k P_k^c \theta_k \qquad \text{(consumption)}$$

$$S = Y^c - \sum_k P_k^c C_k \qquad \text{(savings)}$$

where *Pop* represents population, Y^c represents household disposable income and Y^* is a *supernumerary* income (*i.e.* income above the subsistence level).

Production

Firms in all sectors in ENV-Linkages minimise the cost of producing the goods and services that are demanded by consumers and other producers (domestic and foreign). Production is represented by constant returns to scale technology, though diminishing costs can be achieved through fixed costs.

Figure 6 illustrates the nesting of the model's principle sectors (the agriculture sectors have a slightly different nesting, but that is not important for this analysis).

In this model, each node is represented by a constant elasticity of substitution (CES) production function. This gives marginal costs and represents the different substitution (and complementarity) relations across the various inputs in each sector. There are material inputs – including energy – that are used by all sectors in the economy, and, as well, there are the value-added factor inputs, capital and labour. In some sectors the material inputs include natural resources, *e.g.* trees in forestry, land in agriculture, *etc.* The material inputs generate the input/output tables of each economy represented in the model.

The top-level production nest has final output that is produced as a combination of aggregate intermediate demand and value added. For each good or service, output is produced by different production streams which are differentiated by capital vintage (old and new). Capital that is implemented contemporaneously is new – thus investment impacts on current-period capital; but then becomes old capital (added to the existing stock) in the subsequent period. Each production stream has an identical production structure, but with different technological parameters and substitution elasticities. Letting $X_{i,v}$ represent gross output of sector *i* using capital of vintage *v*, the equations representing production are derived from first order conditions of the firm's profit maximization objective:

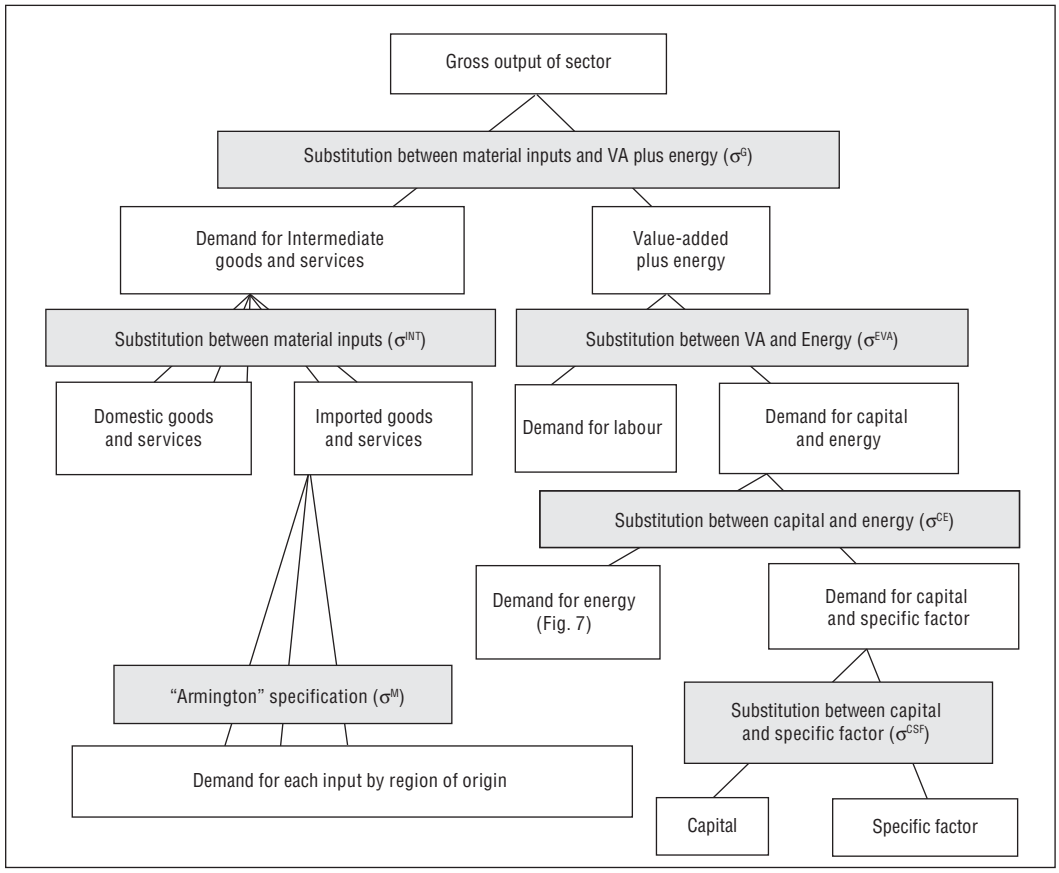
$$INT_i = \sum_v \alpha_{i,v}^{INT} A_{i,v}^{\sigma_{i,v}^G - 1} \left(\frac{VC_{i,v}}{P_i^{INT}}\right)^{\sigma_{i,v}^G} X_{i,v} \qquad \text{(intermediate demand)}$$

$$VA_{i,v} = \alpha_{i,v}^{VA} A_{i,v}^{\sigma_{i,v}^G - 1} \left(\frac{VC_{i,v}}{P_i^{VA}}\right)^{\sigma_{i,v}^G} X_{i,v} \qquad \text{(value added)}$$

$$VC_{i,v} = \frac{1}{A_i}\left[\alpha_{i,v}^{INT} P_i^{INT\,1-\sigma_{i,v}^G} + \alpha_{i,v}^{VA} P_i^{VA\,1-\sigma_{i,v}^G}\right]^{(1/(1-\sigma_{i,v}^G))} \qquad \text{(variable costs)}$$

where *INT* is intermediate demand (P^{INT} its price), *VA* represents value-added (P^{VA} its price), *VC* is unit variable cost (average costs include the cost of capital), *A* is the technical change term. In these equations, the subscript v denotes the vintage of the capital stock used in production (v equals *old* or *new*). In order to determine the industry-wide cost that includes both capital vintages, there is an averaging (weighted) of variable costs across the two vintages. The model allows the production technology to be something other than constant returns to scale through the inclusion of fixed capital or labour costs, whose costs

Figure 6. **Structure of production in ENV-Linkages**



are then added to variable cost *VC* to determine the unit output price. A markup is also possible in determining output prices – which allows the representation of non-competitive markets.

The model includes adjustment rigidities. An important feature is the distinction between old and new capital goods. In addition, capital is assumed to be only partially mobile across sectors, reflecting differences in the marketability of capital goods across sectors. The specification of partial mobility, however, does not impact on the usefulness of capital. There is homogeneity in the use of old and new capital.

Variable costs (*VC*) focus on intermediate inputs and value-added because, in each period, the supply of primary factors (*i.e.* capital, labour, and land) is usually predetermined (except, as noted above, for the influence of contemporaneous investment on capital). Energy is also in value-added, giving it an added degree of variability. On the right hand side of the tree in Figure 6 value-added is shown as being composed of a labour input along with a composite capital/energy bundle.

$$L_i = \sum_v \alpha_{i,v}^{L} \left(\frac{P_{i,v}^{VA}}{W_i}\right)^{\sigma_{i,v}^{EVA}} VA_{i,v} \lambda^{\sigma_{i,v}^{EVA}-1} \qquad \text{(labour demand)}$$

$$KE_{i,v} = \alpha_{i,v}^{KE} \left(\frac{P_{i,v}^{VA}}{P_{i,v}^{KE}}\right)^{\sigma_{i,v}^{EVA}} VA_{i,v} \qquad \text{(capital-energy demand)}$$

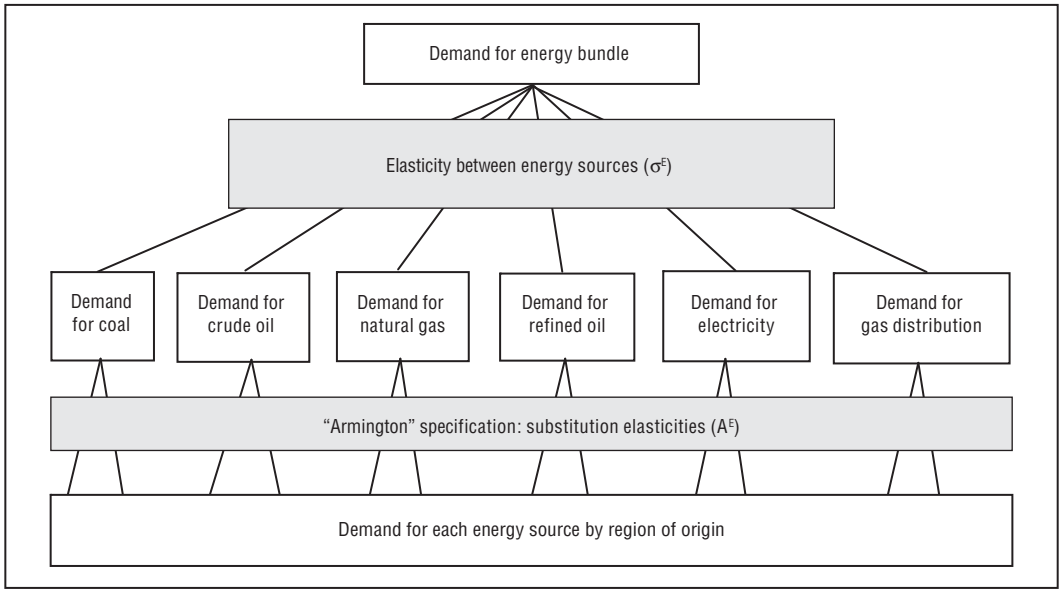
where *L* represents labour (*W* its price), and *KE* is the capital-energy bundle (P^{KE} its price), *VC* is unit variable cost (average costs include the cost of capital). The price of the value-added bundle is:

$$P_{i,v}^{VA} = \frac{1}{A_{i,v}}\left[\alpha_{i,v}^{KE} P_{i,v}^{KE^{1-\sigma_{i,v}^{EVA}}} + \alpha_{i,v}^{L}\left(\frac{W_i}{\lambda_i}\right)^{VA^{n\,1-\sigma_{i,v}^{EVA}}}\right]^{(1/(1-\sigma_{i,v}^{EVA}))} \qquad \text{(price of value-added)}$$

Value-added (*VA*) is a sub-component of the top level node that produces sectoral output X_i. Similar sub-components also exist in formulating the capital and energy bundle. In fact, as shown in Figure 6 (bottom right node), the capital represented here is bundled with a sector-specific resource when one exists and energy is itself a bundle of different energy inputs.

The energy bundle is of particular interest for the analysis of climate change issues. Energy, as reported in Figure 7, is a composite of fossil fuels and electricity. Given the dual streams of production (from old and new capital), there is a high degree of substitutability between energy sources when capital is new (elasticity of 2), but after one year it becomes a sunk cost and falls to a low level of substitutability (elasticity of 25). Moreover, in the sectors that produce fossil fuels (such as natural gas), there is no substitutability between energy inputs (so the model does not allow coal liquefaction beyond its share in the base year).[1] The low level of substitutability of energy when old capital is present is consistent with empirical findings by Arnberg and Bjorner (2007) that look at plant level changes in energy intensity. However, since this model includes the possibility of changes in industry composition, our overall responsiveness to energy price changes will be higher than they found at plant levels.

Figure 7. **Structure of energy demand in ENV-Linkages**



Once a sector's optimal combination of inputs is determined from relative prices, sectoral output prices are calculated assuming competitive supply (zero-profit) conditions.

A fixed mark-up exists in the model to allow examination of alternative specifications of competitive behaviour – though it was not used for the analysis here.

Total output (supply) of any good or service consists of an Armington combination of domestic production and imports. This must equal total demand, consisting of demand from domestic firms, domestic consumers and exports.

Technical change

ENV-Linkages features technical change that is exogenously specified. In the baseline of the model (to 2030), labour productivity has been assumed to globally follow a trajectory that leads to convergence in growth rates to 1¾ per cent per year (see OECD, 2008 for more information). In the simulations, however, there is no explicit mechanism that would connect that to changes of aggregated labour productivity in response to a carbon dioxide tax. Indeed, the model does not link policy instruments of any kind to labour productivity – though a link can be introduced (by changing the exogenous rate of productivity growth along with the introduction of a policy instrument). At a practical level, the technical change parameters of the CES production function are exogenously set. This limitation in the model's representation of technological change means that some may view the results as somewhat pessimistic.

Nonetheless, a CES representation of production features some technological change as firms and industries respond to price changes. Indeed, when the price signal is strong enough a CES production technology predicts that new technology will be forthcoming that does not currently exist. Since the elasticities in the model are taken from an empirical literature that covers periods of technological change in response to price changes, there is a degree of consistency with empirical evidence. In fact, any attempt to introduce an explicit representation of endogenous technological change would have to adjust the substitution elasticity so as not to over-represent the impact of new technologies.

For the simulations reported above, if policy were implemented in a manner that accelerated technical change, it would reduce the impact on each region of the carbon dioxide tax. It should not, however, change the main result of this paper; *i.e.* the heterogeneity of the regional responses. In order to change the main issue addressed in the paper, technological change in response to the policy would have to be unique to each region.

Investment

This version of the model does not include an investment schedule that relates investment to interest rates.[2] Investment is equal to domestic saving in each period; *i.e.* investment is equal to the sum of government savings, consumer savings and net capital flows from abroad induced by trade imbalances. The differences in sectoral rates of return determine the allocation of investment. Sectors with higher investment, therefore, are more able to adapt to changes than are sectors with low levels of investment. Indeed, declining sectors whose old capital is less productive begin to sell capital to other firms (which they can use after incurring some cost for modifications).

Foreign trade

World trade in ENV-Linkages is based on a set of regional bilateral flows. The basic assumption is that imports originating in different regions are imperfect substitutes;

i.e. different countries may produce similar goods, but they are never identical (though some goods, such as crude oil, are very similar). Therefore in each region, total import demand for each good is allocated across trading partners according to the relationship between their export prices. This specification of imports – commonly referred to as the Armington specification – formally implies that each region faces a reduction in demand for its exports if domestic prices increase. The Armington specification is implemented using two CES nests. At the top nest, domestic agents choose the optimal combination of the domestic good and an aggregate import good consistent with the agent's preference function. At the second nest, agents optimally allocate demand for the aggregate import good across the range of trading partners *r*.

$$M_i = \beta_i^m \left(\frac{P_i^A}{P_i^M}\right)^{\sigma_i^m} X_i^A \quad \text{(import demand: 1st level CES nest)}$$

$$P_i^M = \left[\sum_r \beta_{i,r}^W P_{i,r}^{M\,1-\sigma_{i,r}^w}\right]^{(1/(1-\sigma_i^w))} \quad \text{(price of imports)}$$

where M is import of a particular good or service (P^M its price) and X^A represents Armington-based aggregate demand, which gives the demand for imports (P^A is its price).

The bilateral supply of exports is specified in parallel using a nesting of constant-elasticity-of-transformation (CET) functions. This specification complicates the determination of aggregate output since it is no longer a simple addition of domestic demand plus exports. At the top nest (where CET is used), domestic suppliers optimally allocate aggregate supply across the domestic market and the aggregate export market. At the second nest, aggregate export supply is optimally allocated across each trading region as a function of relative prices (analogous to the import specification above).

$$X_i = \left[\alpha_i^{-1/\sigma_i^X} X_i^{D\,(\sigma_i^X+1)/\sigma_i^X} + \alpha_i^{-1/\sigma_i^X} E_i^{D\,(\sigma_i^X+1)/\sigma_i^X}\right]^{(1/(1-\sigma_v^X))} \quad \text{(gross ouput: 1st level CES nest)}$$

where X is gross output, X^D is domestic demand, and E^D is the demand coming from abroad.

Trade measures are fully bilateral and can include both export and import taxes/subsidies. Trade and transport margins can also be included; in which case world prices would reflect the difference between FOB and CIF pricing.

Prices

ENV-Linkages is fully homogeneous in prices, *i.e.* only relative prices matter and the model only solves for relative prices. The price of a single good, or of a basket of goods, is arbitrarily chosen as the numéraire of the price system. In this version of the model, an index of OECD manufacturing exports has been chosen to anchor prices, and is set to one in both the base year and all subsequent years. From the point of view of the model specification this has an impact on the evaluation of international investment flows. They are evaluated with respect to the price of the numéraire good. Therefore, one way to interpret the foreign investment flows is as the quantity of foreign saving which will buy the average bundle of OECD manufacturing exports.

The domestic producer price in the model is defined as the variable cost (*VC*) plus a mark-up and taxes. The consumer price is a composite of individual industry Armington prices, which are based on domestic output prices and import prices.

Government and long-term closure

Government collects income taxes, indirect taxes on intermediate and final consumption (*e.g.* carbon taxes), production taxes, tariffs, and export taxes/subsidies. Aggregate government expenditures are linked to real GDP, so government programmes grow with the rest of the economy. Since predicting corrective government policy is not an easy task, the real government deficit is exogenous. Closure of the model to ensure reasonable long-term properties therefore implies that some fiscal instrument is endogenous – in order to anchor the given government deficit. The fiscal closure rule in ENV-Linkages is that the marginal income tax rate adjusts to offset changes that may arise in government expenditures, or as a result of other taxes. For example, a reduction or elimination of tariff rates is compensated by an increase in household direct taxation, *ceteris paribus*. If change in the long-term deficit is desired as a result of the tariff change, the deficit can be changed exogenously by the amount of the decreased revenues – so there is no offsetting change in income taxes.

Each region runs a current-account surplus (or deficit), which is fixed (in terms of the model numéraire basket of goods). Closure on the international side of each economy is achieved by having a counterpart of these imbalances result in a net outflow (or inflow) of capital, which is subtracted from (added to) the domestic flow of saving. In each period, the model equates gross investment to net saving (which is equal to the sum of saving by households, the net budget position of the government and foreign capital inflows). Given the rules for government and international closure, this final particular closure rule implies that investment is driven by saving.

Dynamic features and calibration

The ENV-Linkages model has a simple recursive dynamic structure as agents are assumed to be myopic and to base their decisions on static expectations concerning prices and quantities. Dynamics in the model originate from three sources: *i)* accumulation of productive capital; *ii)* the putty/semi-putty specification of technology; and *iii)* productivity changes.

Capital accumulation

In the aggregate, the basic capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. However, at the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. In this case, the sector contracts over time by releasing old capital goods. Consequently, in each period, the new capital vintage available to expanding industries is equal to the sum of disinvested capital in contracting industries plus total saving generated by the economy, consistent with the closure rule of the model.

The putty/semi-putty specification

The substitution possibilities among production factors are assumed to be higher with the *new* than with the *old* capital vintages – technology has a putty/semi-putty specification. Hence, when a shock to relative prices occurs (*e.g.* tariff removal), the demands for production factors adjust gradually to the long-run optimum because the substitution effects are delayed over time. The adjustment path depends on the values of

the short-run elasticities of substitution and the replacement rate of capital. As the latter determines the pace at which new vintages are installed, the larger is the volume of new investment, the greater the possibility to achieve the long-run total amount of substitution among production factors.

Dynamic calibration

The model is calibrated on exogenous growth rates of population, sector-specific and aggregate labour productivity growth. The residual autonomous energy efficiency improvement in energy use (known as the AEEI factor) is dynamically calibrated in order to reproduce *IEA World Economic Outlook* (2006) prospects concerning energy demand. There are various alternatives for calibrating the key growth parameters in the baseline scenario. The model uses labour productivity growth to project forward a changing composition of economic output, and uses and aggregate labour productivity growth to achieve some convergence in long-term productivity *growth*. In aggregate, the regions converge at a rate given by Sala-i-Martin (1996) to 1.75. Since convergence is very slow (2% closing of the productivity gap per year), none of the regions have converged within the horizon used for the analysis below (to 2030).

The GTAP database version 6 (Dimaranan, 2006) provides much of the data necessary for simulation. For use with the model, the database is aggregated globally to 26 sectors and 34 regions.

Notes

1. On-going work to estimate these parameters using Bayesian techniques (Robinson, Cataneo, and El-Said, 2001) may change these elasticities in future versions of the model.
2. A *maquette* version of ENV-Linkages has been developed that links investment to rates of return and is being used for studying intertemporally optimal dynamic paths.

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Fiscal Equalisation

by
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Introduction and summary 266
Why fiscal equalisation? 266
Regional disparities 267
A snapshot of fiscal equalisation arrangements 269
Size and institutional design of fiscal equalisation 269
Taxonomy of fiscal equalisation 269
Fiscal equalisation and equity 271
The disparity-reducing effect of fiscal equalisation 271
Contributors and receivers vary from country to country 271
Incentives in revenue equalisation 273
Revenue equalisation design 273
Revenue equalisation can reduce a jurisdiction's tax effort 273
... and open a development trap for poorer regions 275
Incentives in cost equalisation 275
Cost equalisation design 276
Cost equalisation can inflate expenditure needs 276
... and invite rent seeking 277
Cost equalisation and (dis)economies of scale in service production . . . 277
Earmarking of cost equalisation grants 279
Sustainability and stability of fiscal equalisation 280
Fiscal equalisation can put pressure on the budget 280
... and can be pro-cyclical 281
Main findings and conclusions 282
Notes 283
Bibliography 285

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Introduction and summary

Fiscal equalisation is a transfer of fiscal resources across jurisdictions with the aim of offsetting differences in revenue raising capacity or public service cost. Its principal objective is to allow sub-central governments to provide their citizens with similar sets of public services at a similar tax burden even if incomes differ across areas. Fiscal equalisation can be seen as the natural companion to fiscal decentralisation as it aims at correcting potential imbalances resulting from sub-central autonomy. Distinct fiscal equalisation arrangements first emerged during the 1940s and 1950s in a number of federal countries, and today most OECD Member countries run redistributive programmes to reduce fiscal disparities. The significance of fiscal equalisation is highlighted not only by its extensive use in both federal and unitary countries, but also by the fact that its objectives and procedures are often laid down in the constitution and form a central pillar of national fiscal policy.

This article aims at analysing fiscal equalisation issues that are common to all countries. The article first presents the rationales for fiscal equalisation and an overview on regional disparities within OECD countries and then provides a few stylized facts on fiscal equalisation arrangements. The following sections deal with policy outcomes: the extent to which fiscal equalisation systems reduce fiscal disparities across jurisdictions; the extent to which both revenue and cost equalisation provide incentives for SCGs to develop their economic and fiscal base; and the extent to which equalisation contributes to a balanced budget and fiscal stability. Most information contained in this article was collated from the responses to a questionnaire distributed to members of the OECD Network on Fiscal Relations across Levels of Government in spring 2006.[1]

Why fiscal equalisation?

Fiscal equalisation aims at reducing or eliminating differences in net fiscal benefit, *i.e.* the benefits that the public sector provides otherwise identical households residing in different jurisdictions.[2] Net fiscal benefit is the difference between the utility households derive from consuming public services and the taxes they pay for producing these services, standardised to take differences in preferences and tax rates into account (see Box 1 for key terms used in this article). Unlike interpersonal redistribution, fiscal equalisation is not concerned with differences in individual household income but with differences in access to public services in a geographical sense. Although both redistributive arrangements interact to some extent – *e.g.* through the progressivity of national taxes or the level of social assistance programmes – their purpose is not the same, and indeed countries have adopted quite different patterns of individual and spatial redistribution.

Fiscal policy distinguishes three roles of fiscal equalisation, albeit not uncontested, that are related to equity, efficiency and stability of public finance:

- *Equity*: the primary objective of fiscal equalisation is horizontal equity among the residents of different jurisdictions, *i.e.* ensuring that, subject to local preferences, all persons or firms in a country can obtain comparable public services at comparable tax rates.

- *Efficiency*: fiscal equalisation may correct for inefficiencies that might arise if households or firms choose their location based on fiscal rather than productivity considerations. However, equalisation may also reduce labour mobility and SCG's incentives to develop their economic and fiscal base.
- *Stability*: fiscal equalisation may help support macroeconomic stabilization and insure regions against asymmetric shocks they may not be able to cope with if left alone. However, fiscal equalisation can also exacerbate cyclical movements and jeopardise fiscal stability.

Questionnaire responses suggest that the main driver for fiscal equalisation is to guarantee equal access to public services. It is thus safe to say that fiscal equalisation's main objective is equity but that it has to be set against its impact on efficiency and fiscal stability.[3]

Box 1. **Key terms**

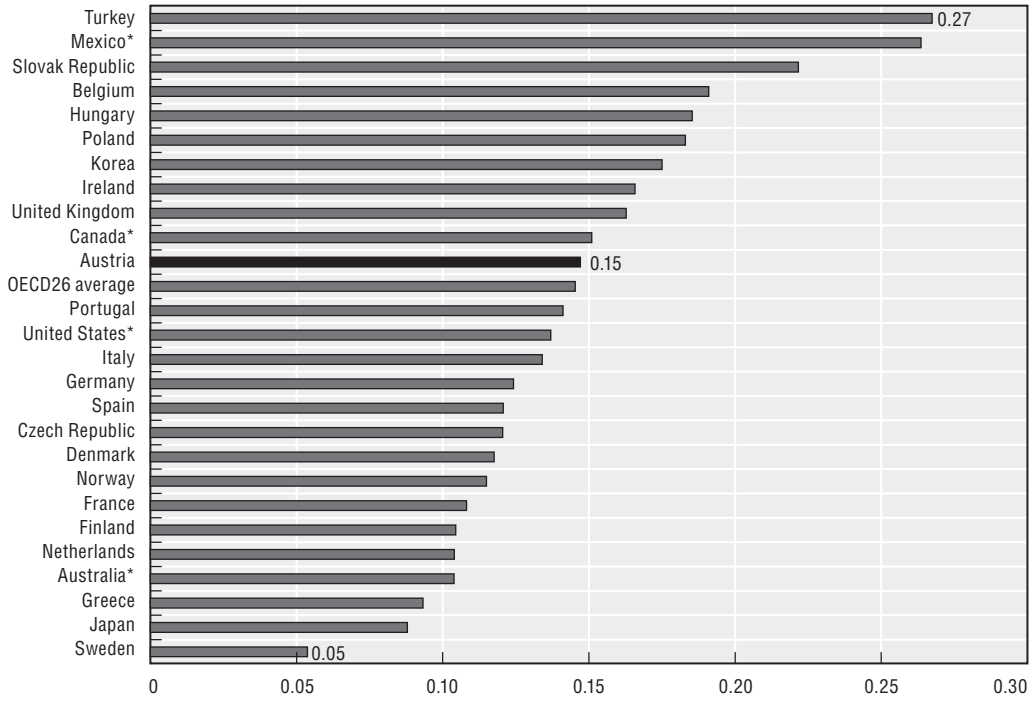
- Revenue raising capacity – the potential ability of a region to raise revenue. Also called "fiscal capacity".
- Expenditure needs – the potential cost for a jurisdiction to provide a given set of services.
- Fiscal disparity – the differences in revenue raising or fiscal capacity across regions.
- Net fiscal benefit – the difference between the benefit a household derives from public services and the cost in terms of taxes to produce them.
- Revenue equalisation – a transfer of fiscal resources to reduce differences in a jurisdiction's per capita revenue raising capacity.
- Cost equalisation – a transfer of fiscal resources to reduce differences in a jurisdiction's per capita cost of providing a standard set of public services.
- Horizontal equalisation – the transfer of fiscal resources between units at the same level of government.
- Vertical equalisation – the transfer of fiscal resources from the central government to sub-central governments.
- Vertical fiscal imbalance – the difference between own tax revenue and own expenditure of a jurisdiction.
- Fiscal gap – the difference between revenue raising capacity and expenditure needs.

Regional disparities

Fiscal equalisation is usually justified to address disparities across sub central governments. The differences in sub-central GDP per capita which can serve as a proxy for fiscal or revenue-raising disparities[4] are often substantial and have evolved little during the last decades, although they may depend on how "sub-central governments" are defined statistically (Figure 1).[5] While the Gini index, which measures disparities between the regions in a country, shows relatively low regional inequalities in GDP per capita for Sweden, Greece and Japan (less than 0.10), it is relatively marked for Turkey, Mexico and the Slovak Republic (more than 0.20). The average Gini index for 26 OECD countries is 0.15 (OECD, 2007). What is even more interesting is that regional disparities tend to be persistent. Analysis of the evolution of the coefficient of variation in regional GDP per

capita from 1980 to 2002 shows that, with the exception of some central European countries and Germany in the aftermath of reunification which exhibit a peak of regional disparities, the level of disparity has fluctuated around the same country-specific value over the whole period (Blöchliger *et al.*, 2007), suggesting that regional disparities have remained basically unchanged in many countries over a period of more than 20 years.

Figure 1. **Gini index of inequality of GDP per capita across regions within each country, 2003**



* Data are estimated for TL3 regions, except for countries marked with an asterisk (*) which indicates that data are for TL2 regions.

Source: OECD (2007), *Regions at a Glance*.

Regional disparities also arise with respect to the costs of providing public goods in different regions of the same country. Differences in geographic location, population size, demographic trends, welfare status as well as path-dependency after economic shocks are responsible for differences in public service cost across a country.[6] One important feature affecting the cost of services is a region's size and the concentration of the population. More populous regions tend to benefit from economies of scale and agglomeration. Certain services (*e.g.* hospitals, motorways) can be produced efficiently only beyond a minimum scale and their provision in scarcely populated areas tends to be either more expensive or undersized. In fact, there is a high degree of concentration of population in OECD countries. On average about half of the OECD population (46%) lives in predominantly urban regions and in particular in the Netherlands (85%), Belgium (83%), and the United Kingdom (70%). By contrast, in places such as Ireland, Finland, and Sweden, at least half of the population lives in predominately rural and dispersed regions (OECD, 2007), leading to marked cost differences between concentrated and dispersed areas.

The cost of services across regions also varies due to differences in demographic characteristics. For example, in all OECD countries the elderly population has increased

over the last 30 years. As elderly people tend to be concentrated in few areas within each country, a small number of regions will have to face the social and economic challenges associated with an ageing population, such as provision of health care services, affordable housing, and accessible transportation. Similarly, if the welfare of residents varies across regions, expenditure needs can also be expected to vary. For example, unemployment rates vary significantly within regions of OECD countries. The Gini index shows that in 2003, Italy was the country with the largest disparity in unemployment rates (the Gini value was 0.43) whereas the Netherlands boasted the lowest disparity in the unemployment rate (0.09). The average for OECD countries was 0.19 (OECD, 2007).

A snapshot of fiscal equalisation arrangements

This section deals with the main features of fiscal equalisation. The section first shows size and design of fiscal equalisation and then applies a taxonomy that helps distinguishing between revenue and cost equalisation as well as between horizontal and vertical equalisation.

Size and institutional design of fiscal equalisation

The central features of fiscal equalisation systems can be assessed using a few key variables (Dafflon and Vaillancourt, 2002). These include the size of transfers relative to GDP, government expenditure, intergovernmental transfers or population; the type of disparity or inequality the systems is tackling, *i.e.* differences in revenue or in cost; or to what extent fiscal equalisation is part of the wider fiscal federal framework such as tax sharing arrangements. Table 1, based on the questionnaire discussed above, provides information on all arrangements that explicitly provide greater per capita-transfers to sub-central governments with below-average tax revenue-raising capacity, or greater per capita-transfers to sub-central governments with above-average public service cost.

With an average of 2.3% of GDP or 4.8% of government expenditure, fiscal equalisation has a considerable impact on both central and sub-central public finance, roughly comparable to what sub-central governments spend on health care (Table 1). The size of equalisation varies considerably across countries, pointing both at the varying degree of sub-central revenue autonomy and the political weight given to equal public services access. Most countries operate arrangements for both revenue and cost equalisation, with three out of 18 countries operating cost equalisation arrangements only and one country operating revenue equalisation only. Most equalisation transfers are closed-ended, *i.e.* total amounts are either determined institutionally (*e.g.* a fixed share of overall tax revenue), or through an *ex ante* central government budget decision. Quantitative and qualitative statistics could be slightly distorted as some countries clearly separate equalisation from other transfers while others use "compound" arrangements where funding and equalisation are combined.

Taxonomy of fiscal equalisation

The variety of equalisation arrangements can be best captured by a taxonomy reflecting the direction of equalisation transfers – horizontal *versus* vertical – and the type of disparity equalised – revenue *versus* cost equalisation.

- The first distinction is between horizontal and vertical equalisation. In horizontal equalisation arrangements payments are transferred between sub-central governments, while in vertical or "gap filling" arrangements equalisation payments are transferred from the central government to sub-central governments.

Table 1. **Main features of fiscal equalisation, 2004**

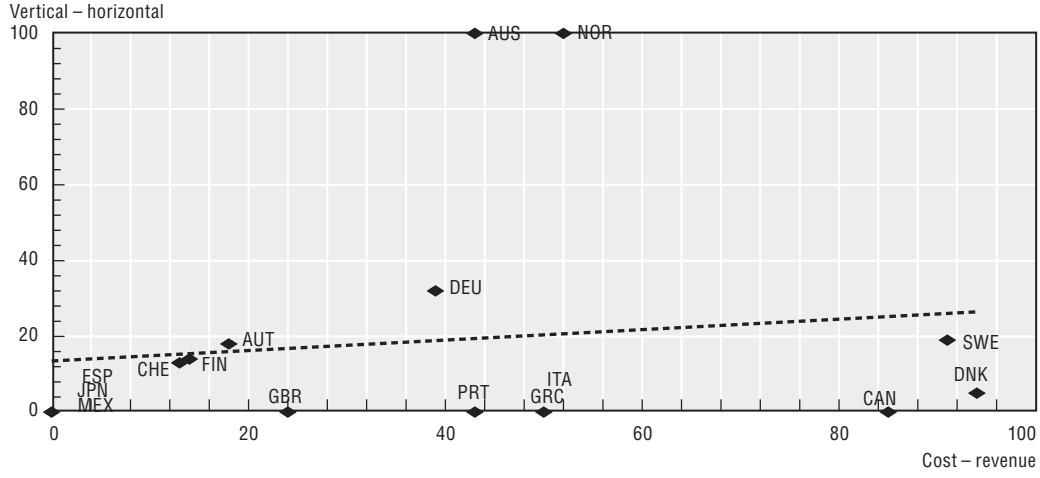
	Size			Number of transfers	Cost and revenue equalisation	Subnational equalisation	Per cent of closed-ended transfers
	Per cent of GDP	Per cent of government expenditure	Per capita (PPP-USD)				
Federal/regional countries							
Australia	0.5	1.4	110	1	Joint	Yes	100
Austria	3.8	7.6	1 227	15	Separate	No	64
Canada	1.0	2.5	326	2	Separate	Yes	84
Germany (2005)	2.0	4.2	569	13	Separate	Yes	60
Italy	3.0	6.3	849	5	Separate	No	91
Mexico	3.7	n.a.	384	8	Cost equalisation only	No	23
Spain	3.0	7.6	768	1	Cost equalisation only	No	100
Switzerland	3.0	8.2	1 035	7	Separate	Yes	56
Unitary countries							
Denmark	2.8	5.1	907	n.a.	Separate	No	n.a.
Finland	3.8	7.4	1 129	4	Separate	No	100
Greece	1.2	2.4	257	10	Separate	No	100
Japan	4.0	11.0	1 244	3	Cost equalisation only	No	100
Norway	0.5	1.2	220	2	Separate	No	100
Poland	n.a.	n.a.	n.a.	10	Separate	No	n.a.
Portugal	1.8	4.0	343	4	Joint	No	100
Sweden	2.6	4.6	813	4	Separate	Yes	100
Turkey	1.1	n.a.	794	2	Revenue equalisation only	No	0
United Kingdom (England)	n.a.	n.a.	530	1	Separate	Yes	100
Unweighted average	2.3	4.8	641	5			78

- The second distinction is between revenue and cost equalisation. Revenue equalisation aims at reducing differences in a jurisdiction's per capita revenue raising capacity, while cost equalisation aims at reducing differences in the per capita cost of providing a standard set of public services. Cost difference can be differentiated into whether they are due to needs (a higher level of a particular service is required per capita) or higher unit cost (a particular service is more expensive per unit in one jurisdiction than another).

In practice, "pure" systems hardly exist, and most countries today use all types of equalisation. Figure 2 shows the pattern of equalisation arrangements that developed within and across countries. The horizontal axis depicts the percentage of revenue equalisation to total equalisation (the higher the value, the more "revenue-oriented" the system), and the vertical axis depicts the percentage of horizontal equalisation to total equalisation (the higher the value, the more "horizontal" the system).

The figure hints at a wide variety of equalisation models and arrangements across countries. A closer look at the picture shows that vertical equalisation is more important than revenue equalisation. Across countries as well as within a country revenue equalisation tends to be horizontal while cost equalisation tends to be vertical – shown by the rising line – but this picture is qualified by several countries (Canada and Italy have vertical revenue equalisation arrangements, and Sweden has horizontal cost equalisation). Whether a country is constitutionally federal or not has surprisingly little influence on equalisation models: although federal/regional countries tend towards horizontal revenue equalisation while unitary countries favour vertical cost equalisation, differences are small and variation within a country group is larger than variation between the two groups.

Figure 2. **Taxonomy of fiscal equalisation, 2004**



Source: National sources.

Fiscal equalisation and equity

This section shows to what extent equalisation reduces inter-regional disparities and then shows which types of regions benefit most from equalisation.

The disparity-reducing effect of fiscal equalisation

Fiscal equalisation is first and above all evaluated on how it reduces fiscal disparities. Table 2 gives an overview of the revenue raising capacity of OECD sub-central governments before and after equalisation.[7] The table is divided into two sections, one for federal countries or countries that provided data for the regional level, and another for unitary countries. For federal/regional countries the indicators are calculated for the state/regional level and include every single jurisdiction. For unitary countries, local governments are grouped into deciles (or "tenths") ranked in increasing order of fiscal capacity before equalisation. Both sections of the table show the variation and Gini coefficients of fiscal capacity across sub-central governments, and the maximum and minimum fiscal capacity before and after equalisation. Given the different statistical procedures to calculate fiscal capacity indices, results for federal/regional and unitary countries are not comparable.

In most countries the effect of equalisation is substantial (Table 2). On average disparities, as measured by the coefficient of variation of fiscal capacity before and after equalisation, decrease by almost two thirds, from 29% to 10%; similar effects are shown by the Gini coefficient.[8] In some countries such as Australia, Germany and Sweden revenue raising disparities are virtually eliminated. Horizontal equalisation has a slightly stronger equalisation effect per GDP used than vertical equalisation (not shown in the table). Post-equalisation fiscal disparities are clearly below economic disparities as measured by regional GDP, *i.e.* public services are more equally distributed across jurisdictions than economic wealth. The results of Table 2 are in line with analyses for selected countries (Chernick, 2003).

Contributors and receivers vary from country to country

The redistributive pattern of fiscal equalisation across types of jurisdictions depends on sub-central revenue sources, the character of decentralised public services, and the

Table 2. **Fiscal disparities and disparity reducing effect of fiscal equalisation, 2004**

	Before equalisation (in per cent)				After equalisation (in per cent)				Equalisation effect (difference pre/post-equalisation, percentage points)	
	Variation coefficient	Gini coefficient	Highest capacity	Lowest capacity	Variation coefficient	Gini coefficient	Highest capacity	Lowest capacity	Variation coefficient	Gini coefficient
Federal/regional countries										
Australia	16.8	5.0	103.8	79.8	0.0	0.0	100.0	100.0	16.8	5.0
Austria					4.2	2.0	106.9	93.2		
Canada	29.8	10.0	177.1	75.0	20.1	7.0	156.9	92.9	9.7	3.0
Germany (2005)	13.0	6.0	116.5	67.2	2.7	2.0	104.5	97.4	10.3	4.0
Italy	39.0	21.0	146.0	24.0	6.0	10.0	115.0	89.0	33.0	11.0
Spain	26.5	15.0	142.2	67.2	10.1	4.0	117.4	83.7	16.4	11.0
Switzerland	31.8	15.0	173.0	46.0	23.2	11.0	159.0	64.0	8.7	4.0
Unitary countries										
Denmark	16.0	8.0	134.0	62.0	6.0	4.0	175.4	86.4	10.0	4.0
Finland	17.7	11.0	143.0	78.8	4.2	3.0	104.8	95.3	13.4	8.0
Japan	36.0	20.0	183.0	58.0						
Norway	23.0	13.0	142.0	64.0	8.0	5.0	118.0	93.0	15.0	8.0
Portugal	90.0	34.0	331.0	26.0	28.0	14.0	138.0	65.0	62.0	20.0
Sweden	10.0	6.0	118.0	84.0	0.0	0.0	103.0	91.0	10.0	6.0
Turkey	39.0	22.0	130.0	2.0	14.0	6.0	107.0	64.0	25.0	16.0
Average	29.9	14.3	156.9	56.5	9.7	5.2	123.5	85.8	19.2	9.1

Source: National sources.

design of the equalisation formula. Revenue equalisation usually leads to redistribution from urban to rural areas in view of their lower revenue raising capacity. Cost equalisation based on geographic indicators reinforces redistribution towards rural areas. Cost equalisation based on socio-economic need indicators weakens this redistributional effect, but urban areas usually remain net contributors since higher revenue raising capacity and lower geographical need indicators outweigh socio-economic need indicators (Sweden, Finland, Norway, Japan, Korea and in the future Italy).[9] In a few countries equalisation benefits urban areas, especially if they have few own resources and if cost equalisation leans strongly towards equalising socio-economic needs (Netherlands, England). Some equalisation arrangements appear bi-polar: they tend to favour the low and high end on the fiscal capacity scale relatively at the expense of intermediate-revenue jurisdictions (Germany, Switzerland).

Equalisation does not always adequately address fiscal disparities, and, in some cases, can even exacerbate them. First, a few equalisation formulae leave out substantial revenue sources in their fiscal capacity definition, portraying jurisdictions much "poorer" than they actually are. In Canada and Norway, the non-inclusion of natural resource income is likely to have undesired equity effects. Second, a number of equalisation arrangements take an indicator of fiscal effort into account (Japan, Turkey, and formerly Switzerland), giving equalisation grants a matching character. To the extent that a sub-central government raises its taxes it can get relatively more of the equalisation grant[10] (see also the section on cost equalisation). Whether some cost equalisation arrangements have undesirable effects is less easy to say since the "true" cost of service delivery across jurisdictions is difficult to assess.

Incentives in revenue equalisation

This section deals with revenue equalisation, the indicators it is based on, and the potential disincentives it may create for SCGs to develop their economic and tax base.

Revenue equalisation design

Revenue equalisation addresses differences in sub-central tax raising capacity. An account of revenue equalisation is given in Table 3. Most revenue equalisation systems are of the horizontal or "solidarity" type. In general Representative Tax Systems (RTS) with a standardised tax base are used to assess revenue raising capacity, but in a few countries actual tax revenue is used. Most transfers are closed-ended, *i.e.* there is a ceiling on the total amount of grants, or total funds are determined by tax sharing formulas. The "marginal equalisation rate", (or "equalisation tax", "tax back" or "compensation rate"), *i.e.* the amount of equalization grants a SCG looses if it increases its own tax revenue, varies considerably across countries; however, on average sub-central jurisdictions have to dedicate more than 70% of additional tax revenue to equalisation.[11]

Revenue equalisation can reduce a jurisdiction's tax effort…

The "equalisation tax rate", *i.e.* the rate at which a sub-central government's additional revenue is equalised away, is one of the most debated issues in fiscal equalisation. Strong equalisation, with a rate reaching 100% in some cases, may dampen sub-central governments' efforts to increase their fiscal base and to go for regional growth. There is evidence on a negative relationship between equalisation and economic and fiscal effort (OECD, 2006b; Wurzel, 2003). Moreover, sub-central governments have an incentive to increase tax rates in order to reduce the tax base and to obtain higher equalisation grants, resulting in strategic tax rate setting and an overall increase of taxation levels (for Australia: Dahlby and Warren, 2003; for Canada: Smart, 2007, for Germany: Büttner, 2006). Since many fiscal equalisation formulas do not or only partially capture all sub-central taxes, governments are tempted to avoid taxes that enter the formula and select taxes that do not, resulting in a distorted sub-central tax structure.[12] Lenient tax effort, especially if tax administration is under sub-central control, may also be a result of high equalisation rates (Spahn, 2001).

However, equalisation can be designed to maintain incentives for sub-central fiscal effort. Many countries have moved towards comprehensive RTS or a central/federal tax to assess sub-central revenue raising capacity, thereby leaving sub-central jurisdictions less leeway to play with the fiscal base. Imposing tax rate ceilings and floors may also contain sub-central strategic behaviour. Equalisation formulae that fully include all major sub-central taxes reduce strategic behaviour and can help achieve a given equity objective with lower equalisation rates. Whether fiscal equalisation has a negative effect on tax effort also depends on the wider economic framework within which sub-central governments operate. Depending on their power to shape economic policy, sub-central constituencies may opt for growth-oriented strategies – since they increase total disposable income – even if additional tax revenue is entirely equalised away (Schneider, 2002). The constituency may accept such a fiscal zero-sum game under the condition that firms grow, that people get jobs or that new residents settle in the jurisdiction.

Table 3. **Revenue equalisation, 2004**

	Direction	Revenue base	Percentage of closed-ended transfers	Equalisation rate	Per cent of GDP	Frequence of changes to the distribution formula	Conditionality attached
Federal/regional countries							
Australia	Horizontal	Potential tax raising capacity, payroll, property sales, land values, mining activities	100%	n.a.	1.98	Every five years	
Austria	Horizontal	Tax sharing system, actual tax revenue collected	100%	0% for *Länder* above average fiscal capacity, 88% for *Länder* below	2.66	Every four years	
Canada	Vertical	Representative Tax System with 33 different taxes	100%	0% for provinces above average fiscal capacity, 70-100% for provinces below	0.91	Formerly every five years, currently more frequent	
Germany	Both horizontal and vertical	Tax sharing system, actual tax revenue collected, RTS	85%	n.a.	0.76	Less often than every five years	
Italy	Vertical	Representative Tax System	100%	55% to 90%	2.91	Less often than every five years	
Mexico		(No revenue equalisation)				n.a.	
Spain		(No revenue equalisation)					
Switzerland	Both horizontal and vertical	Actual tax revenue, tax rates, household income	100%	n.a.	0.96	Less than every five years	Some earmarked
Unitary countries							
Denmark	Horizontal	n.a.	n.a.	85% for metropolitan municipalities, 90% for poor municipalities, 58% for others	n.a.	Less often than every five years	
Finland	Horizontal	Representative Tax System (Personal Income Tax, Corporate Income Tax, Property Tax)	100%	40% for municipalities above 90% of average fiscal capacity, 100% for municipalities below	0.53	Minor changes every two to five years	
Greece	Vertical	Actual tax revenue	100%	n.a.	1.19		Some earmarked
Norway	Horizontal	Potential tax revenue (all local governments set the same tax rate)	100%	55% for municipalities above 90% of average fiscal capacity, 90% for municipalities below	0.28	Less often than every five years	
Poland	Vertical	Representative Tax System (Personal Income Tax, Corporate Income Tax, actual tax revenue)	n.a.	n.a.	n.a.	Every two to five years	Some earmarked
Portugal	Vertical	Actual tax revenue	100%	0% for municipalities above average fiscal capacity, 100% for municipalities below	0.80	Less often than every five years	60 current, 40 capital expense
Sweden	Horizontal	Potential tax revenue	100%	85% for municipalities above 115% of average fiscal capacity, 95% for municipalities below	2.39	Every two to five years	
Turkey	Vertical	Per capita	0%	n.a.	0.71	Nine changes in the last 20 years	
United Kingdom	Vertical	Actual tax revenue	100%	0-100% according to property tax brackets	n.a.	Every two to five years	

Source: OECD, *National Accounts*, and national sources.

... and open a development trap for poorer regions

In some cases, fiscal equalisation can open a development trap for poorer jurisdictions. Most arrangements ensure a minimum fiscal capacity to all sub-central governments, *i.e.* jurisdictions whose capacity falls below a certain threshold are fully compensated. Jurisdictions below the minimum threshold face a marginal equalisation tax rate of 100%, while jurisdictions above face a smaller tax rate that can be as low as 0%, depending on equalisation design (see Box 2). Such equalisation creates asymmetric incentive effects, with a stronger disincentive for poorer than for richer jurisdictions to develop their economy. Fiscal equalisation may hence slow down regional economic convergence, and regional inequalities may harden.[13] Individual country evidence suggests a negative relationship between the size of equalising transfers and regional growth performance (Garnaut and FitzGerald, 2002, Baretti, Huber and Lichtblau, 2000), although the direction of causality is not obvious.

Box 2. **Equalisation tax rates in Austria**

Several Austrian municipalities with weak fiscal capacity face equalisation tax rates exceeding 100%. The comprehensive and complex Austrian fiscal equalisation is embedded in a tax sharing system that covers both the state and the municipal level. The sub-central share of the shared taxes are distributed across the *Länder* according to population and a factor representing past tax shares, and to the municipalities according to various criteria such as fiscal capacity, expenditure needs and a scale factor favouring larger municipalities. Altogether five distinct equalisation arrangements govern the allocation of the equalisation grant to the individual municipality, each with different tax and expenditure bases. As the equalisation formulas interact, a municipality's overall loss in equalisation grants may in some cases be greater than its gain in additional tax revenue resulting from development efforts. Since the disincentive is larger for poorer than for wealthier municipalities, and since policy makers at the *Länder* level tend to favour development in municipalities with a low equalisation tax rate (Schneider, 2002), Austrian municipal equalisation may actually exacerbate economic and fiscal disparities.

Central governments have responded in some cases and tackled these disincentives. In several equalisation systems only a part of sub-central tax revenue enters the equalisation formula. The Canadian government, conceding that equalisation could impede resource development in the poorer Atlantic Provinces, set up accords endorsing that a part of natural resource revenue does not enter the equalisation formula (Canada Department of Finance, 2006). However, such arrangements increase the pressure on existing taxes and may again give room for strategic tax setting (OECD, 2006a). Regional policy may also offset the negative incentives of fiscal equalisation, particularly if entitlements are based on policy results rather than a jurisdiction's wealth. Italy has set up regional development programmes where a part of investment support is linked to a region's performance in selected policy areas (Busillo, 2006). Lowering the minimum fiscal capacity threshold reduces the number of jurisdictions facing a 100% equalisation tax rate, but such a measure could raise equity concerns. The trade-off between equity and efficiency cannot be entirely avoided.

Incentives in cost equalisation

This section provides an account of cost equalisation, the indicators it is based on, and the effects it could potentially have on expenditures of sub-central governments

Cost equalisation design

Cost equalisation addresses two forms of cost differences. The first refers to the *unit cost* for providing a certain service – *e.g.* maintaining one road kilometre is more expensive in the mountains than in the plain – and the second refers to *needs* – *e.g.* more elderly care is required in a jurisdiction where the population is older. The two sources of cost variations are sometimes difficult to distinguish, as both finally lead to differences in the per capita cost for service provision. Most countries have developed cost indicator systems that take both differences in unit cost and differences in need into account, usually distinguishing between "geographic indicators" – reflecting unit cost differences due to topography – and "socio-economic indicators", reflecting differences in need due to a SCG's social structure.

Cost equalisation covers around 1.4% of GDP (Table 4). Unlike revenue equalisation, cost equalisation is vertical in most countries, *i.e.* central government often fine-tunes sub-central public service delivery. While most countries today use standard cost type equalisation formulae, in several countries equalisation is based on historical or actual expenditure. In most unitary countries cost equalisation is closed-ended while in many federal countries it is open-ended, and indeed cost equalisation tends to occupy a larger share of government expenditure in the latter than in the former. While countries usually indicated that cost equalisation was not earmarked, a frequent practice is to attach regulatory strings on services that are co-financed by central funds.

Cost equalisation can inflate expenditure needs…

Cost equalisation can give SCGs considerable leeway to influence expenditure needs and lead to inflated equalisation payments. First, since the spending side is more decentralized than the revenue side, cost equalisation is potentially more prone to budget drift than revenue equalisation. Second, given that sub-central governments are responsible for many policy areas and that sub-central public services are very heterogeneous, cost equalisation tends to be complex and difficult to manage. Although on average cost disparities are much lower than revenue disparities, amounting to one third to one fourth of the latter only, cost equalisation is slightly larger than revenue equalisation in terms of the GDP ratio.[14] Large cost equalisation schemes may point at insufficient own-source revenue (Japan, Mexico, formerly Italy) or at distorted fund allocation in the past (Spain).[15]

The extent to which cost equalisation can withstand spurious demand while addressing true expenditure needs depends on how needs are assessed. Cost equalisation that relies on actual spending gives sub-central governments an incentive to inflate the budget.[16] Cost equalisation based on past (historical) expenditure reduces budget drift but perpetuates initial biases in public service delivery. Today most countries use standard or norm cost approaches that separate "avoidable" from "unavoidable" expenditures and account only for features that are beyond sub-central control, while voluntary service improvements or inefficiencies in service delivery do not enter the equalisation formula.[17] Standard or norm cost approaches require a set of need criteria: while some countries operate with only a few broad-based needs indicators, others use relatively complex indicator systems that are regularly amended.[18] Cost equalisation arrangements based on a few indicators not only tend to be more transparent, they also cause less statistical headaches when annual equalisation entitlements have to be determined (OECD, 1981, Lotz, 2006a).[19]

Table 4. **Cost equalisation, 2004**

	Direction	Cost base	Percentage of closed-ended transfers	Size in % of GDP	Frequency of changes to the distribution formula
Federal/regional countries					
Australia	Horizontal	Average/Standard cost	100	0.28	Every five years
Austria	Vertical	Average/Standard cost, actual expenditure	37	3.11	Every four years
Canada	Vertical	Average provincial expenditure growth	0	0.16	Formerly every five years, currently more frequently
Germany	Vertical	Global lump sum contributions, actual expenditures	45	1.21	Less often than every five years
Italy	Vertical	Actual expenditure	n.a.	0.09	Less often than every five years
Mexico	Vertical	Unit cost, historical expenditure	17	3.75	n.a.
Spain (2005)	Vertical	Historical expenditure	100	1.48	Between every two to five years
Switzerland	Vertical	Actual expenditure	28	2.04	Between every two to five years
Unitary countries					
Denmark	Vertical	Average/Standard cost	n.a.	n.a	Less than every five years
Finland	Vertical	Average/Standard cost, actual expenditure	100	3.26	Every two to five years
Greece		(No cost equalisation)			
Japan	Vertical	Average/Standard cost	100	11.01	Every year
Norway	Horizontal	Average/Standard cost	100	0.26	Every two to five years
Poland	Vertical	Per capita	Some closed-ended	n.a.	n.a.
Portugal	Vertical	Average/Standard cost	100	1.05	Less than every five years
Sweden	Horizontal	Average/Standard cost	100	0.44	Every two to five years
Turkey		(No cost equalisation)			
United Kingdom	Vertical	Average/Standard cost	100	n.a	Every year

Source: National sources.

... and invite rent seeking

Since cost equalisation is often complex, it is prone to rent seeking and pressure from special interest. While revenue equalisation leaves little room for special interest – a tax base has to be selected and the equalisation rate determined – the margin for error and interpretation is larger in cost equalisation: criteria explaining cost differences have to be selected, their weight has to be established and the associated data have to be collected. There is evidence that in some countries political economy pressure has a strong influence on the equalisation formula and/or on individual entitlements (Box 3). Rent seeking can also put pressure on the budget. As shown above, total cost equalisation almost equals total revenue equalisation although disparities in expenditure needs are much smaller. Again, cost equalisation with a few broad-based indicators can reduce rent seeking behaviour.

Cost equalisation and (dis)economies of scale in service production

Expenditures for public service not only depend on need factors but also on production function characteristics such as (dis)economies of scale and scope.[20] As noted in the section on regional disparities, population dispersion as well as density may affect the unit cost of service delivery. Smaller municipalities are more expensive to run since schools, hospitals and other public facilities exhibit fixed costs. On the other hand, services

Box 3. **The political economy of equalisation transfers**

The political economy of grants and tax shares looks at the effects of political factors that should not affect the equalisation policy of a country, but actually do. Various sources of such effects and measures to limit undue political economy pressures are presented below.

- In the US, party affiliation between federal and states politicians increases the per capita dollar amount of grants made to a state, as does the size of its bureaucracy and union membership (Grossman, 1994). Party affiliation and per capita representation also play a role in Japan where over-represented prefectures received higher per capita transfers than under-represented ones (Meyer and Naka, 1999). Similar effects have been analysed for Mexico by Kraemer (1997) who showed that transfers allocated in 1992 favoured states that remained loyal to the dominant party during the previous 1988 presidential election. In Portugal, grants increase in election years, and the longer a mayor has been in office, the more funds are transferred to his municipality (Gonçalves Veiga and Pinho, 2005). Clearly, a political bias is particularly strong if grants are not formula-determined. For Sweden, Johansson (2003) showed that municipalities with many swing voters receive larger grants than other ones. Sorensen (2003) also found persistent disparities in Norwegian local government grants that cannot be accounted for by regional policy or equity objectives. Lobbying powers are underlined by Merk (2006) for the Netherlands where cost equalisation gets evaluated regularly except for the four largest cities that were never subject to evaluation.
- Countries have developed various measures to limit undue special interest influence. Several countries established agencies and other arms' length independent bodies that help contain and channel transfer increases (Denmark, Australia). Independent agencies leave less room for political bargaining; allocation of equalisation money is defined as a technical exercise. In order to do justice to different circumstances, a fine-tuned allocation model tends to be used. Recent research confirms that independent agencies are less prone to political influence than ministries (Khemani, 2003).* In some countries a two-stage budget procedure, whereby the overall budget for equalisation is determined *before* the distribution formula is negotiated among sub-central governments, successfully limits rent-seeking pressure (*e.g.* Norway). The process of adjusting equalisation formulas can also be organized to reduce rent seeking pressure. In many countries not only the opinion of local governments is taken into account, but also civil servants, politicians and experts can be involved. Finally, the most promising way to limit rent seeking is a simple, transparent and easy-to-understand equalization formula with few indicators covering the main fiscal disparities of a country.

* An agency brings a principal-agency-problem: the agency might have an interest to make its work more complex than necessary so as to ensure its existence and to enlarge the scope of its work. Moreover, it might lead to an increase in transaction costs. Shah tries to confirm this by pointing out that the Australian grants commission has a large staff and the Australian equalisation system a massive set of criteria and data required to feed in the model (Shah, 2005). However, there seems to be a large variety in the amount of staff in a ministry occupied with equalisation. This can range from one staff member (in the case of Sweden) to 17 in the case of Korea. An independent agency does not necessarily have to have more staff than the number of people in a ministry occupied with equalisation.

such as security or fire protection bring about higher per capita expenditures in urban areas. Infrastructure is often based on capital-intensive network industries such as energy or transport systems, exhibits strong economies of scale and unit cost decrease considerably over a wide range of population size and density. In most countries, per capita expenditures are U-shaped with respect to jurisdictional size, with very small and very large settlements having higher per capita expenditure,[21] although it is unclear to what extent this is linked to scale (dis)economies. (Lotz, 2006b).

Many countries have implicit or explicit arrangements to take (dis)economies of scale and scope into account and operate with need indicators that are adjusted for municipal size or for density and dispersion. However, to take the industrial organisation of public services into account for determining equalisation entitlements is risky and is likely to preserve inefficient public service operation. Equalisation payments favouring small municipalities could prevent them from amalgamating or from finding other forms of joint provision that would help increase quality. In the long run, differentiated payments could also reduce service providers' search for cost-saving technologies. In some cases adjustments for jurisdictional size and related features in equalisation formulas cause awkward outcomes.[22]

Earmarking of cost equalisation grants

In a few countries, equalisation transfers are earmarked, and sub-central governments perform public services under explicit financial control of the central government. Such arrangements raise considerable efficiency concerns. Earmarking is an input rather than an output- or outcome-related strategy. It brings about considerable administrative burden and compliance cost for both the central and sub-central governments. Earmarking reduces sub-central choice and can lead to distorted sub-central budget allocation, especially if grants cover many small budget items. Moreover, if earmarked grants are matching sub-central spending – so-called matching grants – their equalising effect is likely to be weak or even negligible (see Box 4). If central government is

Box 4. **Earmarked matching grants in the United States and Switzerland**

Both the Unites States and Switzerland have for some time been using earmarked matching grants to reduce fiscal disparities across states. Medicaid, the US medical insurance programme for low-income people and by far the largest intergovernmental programme in the US, is an open-ended earmarked matching grant with the matching rate varying between 50 and 77% inversely related to state income per capita (Laubach, 2005). Most US states also use earmarked grants to finance local school districts with a matching rate inversely related to the districts' tax raising capacity. In Switzerland, cost equalisation is composed of around 350 earmarked grants with a matching rate between 40 and 95%, inversely related to cantonal fiscal capacity. By using earmarked matching grants for equalization purposes, governments implicitly assume high price elasticity and low income elasticity for public goods.

The experience after decades of earmarked equalisation is mixed, however. While state and local governments indeed tend to spend more on subsidized services, the disparity reducing effect is quite small. The US Medicaid programme does little to reduce disparities precisely because poor states tend to spend less on health care (Levitt and Poterba, 1994). The states' educational grants are estimated to have reduced the large fiscal inequalities among school districts only by 19 to 34% (Evans, Murray and Schwab, 1998), and have reduced spending of high-spending districts rather than increased spending of low-spending districts (Hoxby, 2001) With around 3%, Switzerland's earmarked equalizing grants have an even lower disparity reducing effect (Frey *et al.*, 1994). Both the US and Swiss experience show that although poorer regions get a higher matching rate, they are also less willing or able to put up their own funds, so the resulting equalizing effect is at best weak. The disappointing outcome of earmarked matching grants led the Swiss government to thoroughly overhaul its fiscal equalisation system as from 2006 on (Blöchliger and Reschovsky, 2003).

to retain control over the proper use of equalisation funds, it can do better through appropriate public service regulation such as minimum standards or output and performance indicators, while leaving operation and management of fiscal resources at the discretion of local and regional governments (Bergvall *et al.*, 2006).

Sustainability and stability of fiscal equalisation

Fiscal equalisation can put pressure on the budget…

Fiscal equalisation, in particular vertical cost equalisation, can put pressure on the central budget. Many countries ensure that their sub-central governments have a minimum fiscal capacity or fully cover expenditure needs without setting a ceiling to total payments. In Ireland, Portugal and Spain, jurisdictions have grandfather rights even if the distribution formulae would call for a reduction in annual transfers.[23] Several countries regularly adapt and extend cost indicators in order to account for newly emerging needs, inviting rent seeking that may result in a soft sub-central budget constraint (Goodspeed, 2002). Analysis for two countries for which detailed data is available (Mexico, Switzerland) suggests that central government at least partially gives in to sub-central pressure (OECD, 2003b and OECD, 2004), leading to above-average transfer growth. That not only damages the central government's fiscal stance, but it is also likely to reduce overall effectiveness of equalisation, as the disparity-reducing effect of various indicators could be mutually cancelled out.[24]

Institutional constraints to contain budget drift vary across countries. Horizontal equalisation tends to be less prone to budget drift than vertical equalisation since central government is not involved financially (*e.g.* Germany). Some countries set transfer caps irrespective of sub-central financial needs (*e.g.* Canada). Other countries determine total equalisation payments as a share of total tax revenue or total expenditure (Japan, Korea, Portugal), thereby limiting expenditure increases, although occasional increases of the sub-central governments' share undermine the limit's credibility. A neat way to reduce budget drift is to concatenate different equalisation transfers: In Switzerland's post-2007 equalisation system vertical revenue equalisation will be determined – within a range – as a percentage of horizontal revenue equalisation, thereby forging political coalitions between the federal and cantonal governments against expenditure increases. Finally, several countries established agencies and other arms' length independent bodies that help contain and channel transfer increases (Denmark, Australia). While strong institutional constraints are likely to cap central budget drift, they could lack the necessary flexibility in reacting to legitimate sub-central needs.

An adequate set of rules on how budgets are drafted, approved and implemented can also help better align equalisation needs with budgetary resources. There is some evidence that improved budget management leads to greater fiscal discipline (Ahmad, Albino-War and Singh, 2006). Several countries present detailed and binding medium-term budget projections for equalisation payments and their growth (Canada, Denmark). In a few countries fiscal equalisation is linked to other transfer mechanisms and scattered over several budget lines, reducing transparency and complicating a general view of the true cost of equalisation (Switzerland until 2006), but most central budgets today report a few broad equalisation line items only or even report equalisation as a single distinct transfer (*e.g.* Canada or Germany).[25] In some countries a two-stage budget procedure, whereby the overall budget for equalisation is negotiated *separately* from the distribution formula, thereby successfully limiting rent-seeking pressure (*e.g.* Norway). Put together, fiscal equalisation embedded in a stable fiscal framework helps contain budget drift.

... and can be pro-cyclical

Business cycles may also pose a problem when allocating equalisation payments. Rapid adjustments to changes in sub-central tax capacity or expenditure needs can exacerbate cyclical movements and destabilise aggregate fiscal policy, especially for vertical transfers.[26] In some countries, equalisation payments are frequently and rapidly adjusted to changes in sub-central tax capacity, and these adjustments can exacerbate annual fluctuations in total sub-central revenue, particularly if sub-central fiscal behaviour is in itself pro-cyclical. There is some evidence that in Canada and Germany vertical equalisation increased the volatility of sub-central revenues, while German horizontal equalisation tends to act as an automatic stabiliser (Boadway and Hayashi, 2002, and von Hagen and Hepp, 2000). Moreover, business cycles and equalisation payment fluctuations have an asymmetric effect on sub-central behaviour: in an upswing expenditures are increased while in a downturn tax rates are increased (Rattso and Tovmo, 1998).

Some countries harness equalisation as an automatic stabiliser, by linking equalisation payments to lagged fiscal capacity indicators or by applying moving averages, thereby avoiding excessive sub-central revenue volatility. Canada, where fluctuations in equalisation transfers have been a concern for both the federal and provincial governments for decades, in 2005 thoroughly overhauled both the procedure to determine the overall equalisation budget and the distribution formula (see Box 5). Nevertheless, equalisation that reacts slowly to the cycle may put sub-central budgets at risk, particularly

Box 5. **Ensuring budget stability for both central and sub-central governments: The case of Canada**

The search for a balance between fiscal stability at the federal level and budget predictability for the provinces is an ongoing concern in Canada. Unlike in most other federations, revenue equalisation is not horizontal but vertical, *i.e.* the federal government is entirely responsible for equalisation payments. The standard to which provinces are equalized has changed several times and is currently set by five middle-income provinces. Provinces below this average receive equalisation payments; provinces above the standard are not affected by equalisation.

Since their introduction in 1957, fluctuations in equalisation payments have been large, making budgeting difficult for both the federal government and for provinces. Ceiling and floor provisions have been used in the past to attempt to limit fluctuations. In 2004, a new formula was introduced which replaced ceiling and floor provisions with a 3-year moving average approach to determine entitlements. This approach would have limited fluctuations in payments substantially; however it did not set a limit to the global equalisation budget and thus still posed a certain threat to fiscal stability.

The formula was superseded in autumn 2004 by a new funding framework. Whereas funding levels for equalisation had previously been endogenously determined (or open-ended), total payments under the new framework are "fixed" (pre-set by fiat or closed-ended). The new rules eliminate budgetary uncertainty and the risk of fiscal drift for the federal government since total payments – for all provinces combined – are set and known in advance of each fiscal year. They also substantially reduce – though not eliminate – year-to-year fluctuations in payments to individual provinces through ceiling and floor provisions, making budgeting easier for provincial governments. Total equalisation is now set at $10.9 billion for 2005-06, with 3.5% annual growth thereafter.

if the revenue base – such as local business taxes – is highly volatile (Finland). There is hence a certain trade-off between the stability and the insurance objective of equalisation: central governments may compensate sub-central governments for fluctuations at the risk of exacerbating business cycles, or use sub-central governments as automatic stabilisers at the cost of undermining their budget security.

Main findings and conclusions

Most OECD countries have established fiscal equalisation arrangements in the last decades. Their objective is to allow sub-central governments to provide their citizens with similar sets of public services at a similar tax burden. Fiscal equalisation is an explicitly redistributive programme and as such may conflict with objectives such as efficient sub-central expenditure or sub-central tax effort. Fiscal equalisation arrangements are very country specific and often form part of the institutional backbone, so any comparative analysis must be taken with great care. However, a few general findings and conclusions can be made, and these can be summarised as follows:

- *Fiscal equalisation makes up around 2.3% of GDP.* Across countries, the size of equalisation transfers varies between 0.5 and 3.8% of GDP, between 1.2 and 7.2% of government expenditures, or between $110 and $1 200 per capita. A part of the difference is due to the difficulty of obtaining detailed data for intergovernmental transfers, however. Fiscal equalisation is more transparent if it is institutionally or statistically separated from other transfer mechanisms
- *Equalisation significantly reduces disparities.* Disparities in fiscal capacity are reduced by roughly two thirds on average. Most country arrangements have roughly similar equalising effect, but in a few countries disparities are virtually reduced to zero. Horizontal fiscal equalisation has a slightly stronger equalising effect per GDP per cent used than vertical fiscal equalisation.
- *Revenue equalisation can reduce tax and development effort, especially in poorer regions.* A high "equalisation tax" – the rate at which additional tax revenue must be dedicated to equalisation – can reduce a jurisdiction's effort to develop its fiscal base and can slow down regional convergence. Poor regions are more affected since their equalisation tax is usually higher, often reaching 100% and beyond. The disincentive is only partially offset by the constituency's desire to increase its disposable income.
- *Cost equalisation is prone to rent seeking and can become ineffective.* Cost equalisation is more important than revenue equalisation in terms of GDP, although cost disparities are much smaller than revenue disparities. Since true sub-central expenditure needs are difficult to define, cost equalisation tends to become complex and prone to pressure from special interests. A way to reduce rent seeking and budget drift is to base cost equalisation on a few broadly defined need indicators that are difficult to manipulate.
- *The choice of standardised revenue or cost bases can mitigate disincentives.* Many countries use Representative Tax Systems covering all major sub-central taxes to determine revenue raising capacity and thereby reduce undesired equity effects or negative incentives for tax collection. Some countries also use sophisticated methods to calculate standard cost of service provision, in order to vitiate sub-central governments' incentive to inflate expenditures.
- *Equalisation can pose a problem for budget stability.* Fiscal equalisation can jeopardise budget stability. To cope with budget drift, some countries set equalisation transfers as a

fixed percentage of total tax revenue and/or introduced budget ceilings. Horizontal systems are less likely to create budget problems since central government is financially not involved. Fiscal equalisation can also be pro-cyclical. To cope with pro-cyclicality, countries often link entitlements to lagged indicators, thereby neglecting legitimate sub-central budget needs however.

Notes

1. Eighteen countries (Australia, Austria, Canada, Denmark, Finland, Germany, Greece, Italy, Japan, Mexico, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, and United Kingdom) responded fully or partially to the questionnaire. Additional input was provided by an expert workshop on fiscal equalisation held in Zaragoza, Spain, in June 2006.
2. The concept of net fiscal benefit goes back to Buchanan (1950). The concept is further elaborated in Boadway (2001) and Garnaut and FitzGerald (2005)
3. Besides fiscal equalisation, other government fiscal activities have intended or unintended re-distributional effects. Per capita transfers or transfers using demographic indicators are usually equalising, particularly if financed through progressive taxes, and it is often difficult to separate equalisation in the strict sense from other transfers. National taxes – that help, among other things, fund equalisation – change the relative fiscal positions of sub-central jurisdictions. Moreover, through direct investment, public employment or public procurement in policy areas such as education, energy, transport, health care or defence, central government is also able to affect the distribution of fiscal resources across jurisdictions. Finally, in some countries, regional policy and fiscal equalisation closely interact. While the interaction between fiscal equalisation and other public sector policies should not be neglected, a deeper analysis is beyond the scope of this paper.
4. The link between GDP per capita and tax-base depends on the tax base of sub-national governments, the regional composition of GDP, and the link between GDP and the actual tax-base. The development of GDP per capita and the effect on the tax-base depends on the composition of GDP and the parts of GDP that are growing, as tax rates usually differ between different components of GDP. Generally, GDP per capita can be assumed to be a good indicator of revenue raising capacity. While GNP may also be a useful measure of regional fiscal capacity, these data are not readily available.
5. Figure 1 presents GDP data using an OECD territorial classification on the basis of two territorial levels (TLs) (see Spiezia, 2003). Using administrative boundaries is likely to produce different statistical results and show different levels of variation as compared with using regions defined by economic and demographic factors. A TL2 region is a higher level of aggregation (335 macro regions in the OECD database) than TL3 (1 679 micro-regions) which can lead to differences in the ability to detect sub national heterogeneity. Differences between administrative boundaries and OECD regional classification should also be kept in mind when comparing information supplied by ministries in charge of equalisation policy and data generated by the OECD to facilitate the comparison of regional economies.
6. It is important to point out that disparities in the cost of public service provision pose a problem for sub-central governments and require fiscal equalisation only if the sub-central entity is responsible for delivering services in the respective policy area.
7. Revenue raising capacity is used here as a proxy for fiscal capacity since most countries only provide revenue raising capacity but not cost disparity indicators, necessary to construct an overall fiscal capacity indicator.
8. The Gini coefficient is population-weighted while the variation coefficient is not. Small jurisdictions with very high or very low revenue raising capacity therefore affect the coefficient of variation more than the Gini coefficient.
9. See *OECD Territorial Reviews* of Finland (2005), Stockholm (2006), Seoul (2005) and DeWit (2004).
10. Sharing of taxes generated at the place of origin can also interfere with an equalisation arrangement. In some countries part of the local revenue comes from a share of the taxes that are generated locally. The idea is that richer areas, usually large urban areas, should be able to profit from the wealth that they themselves create. Metropolitan municipalities in Turkey, for example, are allowed to keep 5% of the general tax revenues collected within their boundaries. This is in addition to the allocation of the general revenue share to municipalities, which is based on a per

capita-criterion. The result is that the richer, metropolitan areas get relatively more of the revenue share: almost 70% of the budget of Istanbul consists of the revenue share, whereas municipalities on average get 50%.

11. Marginal equalisation rates are extremely difficult to calculate and values should be taken with care. Statutory and effective equalisation rates may vary considerably because tax bases interact and because equalisation formulas fully or partially omit some tax bases. Often the effective rate is endogenously defined, as the total amount to be disbursed is decided first, followed by a calculation of the equalisation rate for each jurisdiction. Also the *marginal* equalisation rate must be carefully distinguished from the *average* long-run reduction in SCG fiscal disparity. Both indicators may vary considerably. In Germany, around 50% of the long run differences in state tax revenue are offset by equalisation (Von Hagen and Hepp, 2000), in the United States less than 50% of differences in education spending are eliminated (Evans, Murray and Schwab, 1997). In France, national grants reduce inequality among municipalities by 30% only (Gilbert and Guengant, 2002).
12. In Canada, some natural resource taxes do not enter the equalisation formula. In Germany or Austria, only a part of municipal business taxes enters the equalisation formula.
13. The relatively larger public sector and therefore the political economy of equalisation-dependant jurisdictions might reinforce this effect. Economic underperformance and long standing disparities are often seen as the result of development-discouraging policies and attitudes linked to equalisation (Poschmann and Tapp, 2005).
14. To calculate revenue and cost disparities, figures on pre- and post-equalisation tax revenue and expenditures for each state/region or municipal decile were used. Using these proxies, disparities in revenue raising capacity appear to be larger than cost disparities for all countries.
15. In some countries cost equalisation is based on historical expenditure, perpetuating the inefficiencies in public expenditure of the past. Moreover, the equalisation could have perverse effects in that it could change the ranking order of regional fiscal capacity before and after equalisation (Ruiz Huerta, 2006)
16. The former cost equalisation in Switzerland, in force until 2006, was based on actual spending by the cantons.
17. Strictly speaking, it means separating a sub-central jurisdiction's "preferences" from its "needs".
18. Denmark and Norway each use around 15 socio-economic indicators to assess expenditure needs (Mau Pedersen, 2007). Switzerland uses 4 indicators for geographic and six indicators for socio-economic needs (Fischer, 2007). The Netherlands uses 24 indicators to assess needs. Sweden uses 10 different models for cost equalisation (Tingvall, 2007). On the other hand, the Australian system operates with more than 40 indicators, while the Korean system has around 50 indicators, still less than the UK (Spasojevic, 2007, Ponsford, 2007). The French equalisation system consists of seven programmes with dozens of indicators (OECD, 2007; Gilbert and Guengant, 2003).
19. Statistical procedures on how to determine the true cost of service provision are shortly described in Blöchliger *et al*, 2007.
20. For a detailed presentation of this issue, see the Proceedings of the Experts' Meeting on "Efficiency of Sub-central Public Spending" held in the Ministry of Economy and Finance, Paris, France, May 2006.
21. The shape of the curve much depends on the country. In general, settlements below 10 000 and above 250 000 inhabitants exhibit higher than average expenditures. Too many people or firms can cause congestion, resulting in diseconomies of agglomeration and negatively affecting the cost of service delivery.
22. Australia, Denmark, the Netherlands, Norway, Sweden and the UK operate arrangements explicitly taking the cost of "density" and "dispersion" into account. Cost equalisation in Austria and the Czech Republic favours smaller municipalities. This could explain the fierce resistance of Czech municipalities to merge and the increase in the number of municipalities in Austria. In Korea, the number of administrative districts and government officials enters into the local tax share formula, causing the public sector to grow. The Portuguese equalisation system until 2006 used the number of *freguesias* (parishes or municipal sub-units) as an indicator for a municipality's entitlements, so municipalities tended to divide themselves further up; the Local Finance reform of 2007 now provides incentives for mergers of *freguesias*.
23. In Portugal, where total transfers are a fixed share of national tax revenue, the "minimum guarantee" offsets the formula-based allocation for around 100 out of 385 municipalities. With the Local Finance reform of 2007, this grandfather clause was abolished.

24. France's municipal equalisation scheme reduces fiscal disparities by one third only. High levels of complexity and rent seeking at the local government level appear to be responsible for the relatively weak performance of the French transfer system (Gilbert and Guengant, 2003).

25. Until 2006, vertical fiscal equalisation in Switzerland was attached to various other transfer mechanisms and scattered over more than 300 different budget lines, making planning virtually impossible. In 2007, vertical equalisation became a single budget line, thereby considerably increasing transparency of the budget.

26. "Pro-cyclical" is meant in the sense that the volatility of total post-equalisation revenues of sub-central governments is larger than the volatility in pre-equalisation revenues.

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The Contribution of Economic Geography to GDP per Capita

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Introduction and main findings 288
General empirical framework 290
The basic determinants of GDP per capita 290
Benchmark specification and empirical results 291
Economic distance 293
Why proximity matters 293
The distance of OECD countries to world markets 295
Empirical analysis: Augmented Solow model and proximity 299
Transport costs 301
Evolution of transport and telecommunications cost indices 303
Impact of transport costs on openness to trade and GDP per capita 307
Overall economic impact and policy implications 310
Overall impact 310
Policy implications 311
Conclusions 315
Notes 316
Bibliography 318
Annex: The Augmented Solow Model 320

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Introduction and main findings

Over the past several years, the OECD has quantified the impact of structural policies on employment, productivity and GDP per capita (*e.g.* OECD, 2003, 2006). The results from these studies, which have built on a vast academic literature, have contributed to a better understanding of the main channels linking policies to labour and product market outcomes in OECD countries. In doing so, they have also underscored the limits to the understanding of economic growth: only a limited part of the cross-country dispersion in GDP levels and growth rates can be explained by quantifiable policy levers, at least on the basis of standard macro-growth regression analysis.

This paper examines how much of the cross-country dispersion in economic performance can be accounted for by economic geography factors. To do so, an augmented Solow model is used as a benchmark. The choice is motivated by the fact that this model has served as the basic framework in previous work on the determinants of growth, thereby ensuring some continuity. It has long been recognised, however, that while providing a useful benchmark to assess the contributions of factor accumulation as a source of differences in GDP per capita, the basic Solow growth model ignores potentially important determinants. For instance, it leaves a large portion of growth to be explained by the level of technology, which is assumed to grow at a rate set exogenously.

In order to bridge some of the gaps, extensions of the model in the literature have generally taken four types of (partly related) directions: *i*) R&D and innovation, *ii*) goods market integration and openness to international trade, *iii*) quality of institutions, and *iv*) economic geography. The focus of this paper is on economic geography, although this is not totally independent from the other factors, in particular international trade. More specifically, for the purpose of this study, the concept of economic geography is examined through the proximity to areas of dense economic activity.

The key point of this aspect of geography is the recognition that proximity may have a favourable impact on productivity, through various channels operating *via* product and labour markets. In the case of product markets, one of the key channels is that proximity induces stronger competition between producers, thus encouraging efficient use of resources and innovation activity. Another is that an easy access to a large market for consumers and suppliers of intermediate goods allows for the exploitation of increasing returns to scale. Furthermore, the presence of large markets allows for these scale effects to be realised without adversely affecting competition. The scope for exploiting higher returns to scale is hampered by distance to major markets, both within and across countries, due to transportation costs. Transportation costs also reduce the scope for specialisation according to comparative advantage, another important driver of gains from trade along with the ability to reap scale economies.

While the economic geography literature focuses mainly on trade linkages, a parallel literature on urban and spatial economics puts more emphasis on agglomeration externalities as a benefit from operating in an area of dense economic activity. Such

externalities may include economies of scale related to infrastructure and other public services, as well as the potential gains associated with the access to a large pool of workers, and localised knowledge spillovers. In principle, it is possible to provide some quantification of these benefits, using standard measures of economic density, such as the share of population living in cities. In practice, such measures are highly endogenous to economic development and finding appropriate instruments to address the endogeneity problem is beyond the scope of this paper. As a result, this aspect is only examined in a very tentative way in the final section of the paper.

The empirical strategy pursued in the paper is as follows. In the next section, the augmented Solow model, which is used as the basic framework, is first briefly described and estimated both in level and in error-correction forms, over a sample of 21 OECD countries over the period 1970-2004. The influence of proximity to major markets on GDP per capita is then investigated in the following section, introducing in the benchmark model various indicators of distance to markets, such as measures of market potential, market and supplier access, as well as the sum of distances to world markets and population density. The various measures of distance to markets are all found to have a statistically significant effect on GDP per capita, with the exception of population density. The estimated economic impact varies somewhat across specifications, but it is far from negligible. For instance, the lower access to markets relative to the OECD average could contribute negatively to GDP per capita by as much as 11% in Australia and New Zealand. Conversely, the benefit from a favourable location could be as high as 6-7% of GDP in the case of Belgium and the Netherlands.

Later in the text, the impact of distance is alternatively examined *via* the more specific channel of transportation and telecommunication costs. To this end, broad indicators of weight-based transportation costs covering maritime, air and road shipping have been constructed for 21 OECD countries over the period 1973-2004, along with an indicator of the cost of international telecommunications. Based on these indicators, there is little evidence that the importance of distance in the transportation of goods has diminished during the past two or three decades (though transport costs may have fallen relative to the value of transported goods). In contrast, the cost of international telecommunications has fallen in all countries to the point where it is basically no longer significant anywhere. Overall, transportation costs are found to have a negative and significant effect on GDP per capita through their effect on international trade. Based on these estimates, differences in transport costs relative to the OECD average contribute to reduce GDP per capita by between 1.0% and 4.5% in Australia and New Zealand. At the other end, the lower transport costs for Canada and the United States contribute to raise GDP per capita relative to the average OECD country, but only by a small margin varying between 0.5% and 2.5%. The quantitatively smaller effects than those found on the basis of measures of economic distance are consistent with transportation costs being only one aspect of costs related to distance.

Most of the geography factors discussed in this paper cannot be influenced by policy or are only affected by policy in indirect ways. Nevertheless, a number of policy issues are addressed in the penultimate section, which also provides a summary of the combined economic impact of the geographic variables used in the empirical analysis.

General empirical framework

A basic empirical framework is required in order to assess the importance of economic geography in determining GDP per capita. Against the background of earlier OECD analysis in this area, this section briefly reviews the basic determinants of GDP per capita, discusses alternative specifications in terms of levels and changes over time, and reports the results of an empirical analysis using only the basic determinants. The remainder of the paper will then examine whether economic geography variables can account for some of the variance in GDP per capita left unexplained by the basic determinants.

The basic determinants of GDP per capita

The empirical framework used to assess the influence of economic geography determinants is the Solow (1956) model augmented with human capital. The model has been widely used in the empirical growth literature, owing largely to its simplicity and flexibility. For instance, despite being derived from a specific framework, the empirical version of model is sufficiently general to be consistent with some endogenous growth models (Arnold *et al.*, 2007).

The Solow model has been widely used as a theoretical framework to explain differences across countries in income levels and growth patterns. The model is based on a simple production function with constant returns-to-scale technology. In the augmented version of the model (Mankiw, Romer and Weil, 1992), output is a function of human and physical capital, as well as labour (working-age population) and the level of technology. Under a number of assumptions about the evolution of factors of production over time, the model can be solved for its long-run (steady-state) equilibrium whereby the path of output per capita is determined by the rates of investment in physical and human capital, the level of technology, and the growth rate of population (see Annex for a detailed derivation). In the steady-state, the growth of GDP per capita is driven solely by technology, which is assumed to grow at a (constant) rate set exogenously in the basic model.

The long-run relationship derived from the augmented Solow model can be estimated either directly in its level form, or through a specification that explicitly takes into account the dynamic adjustment to the steady state. Estimates of the long-run relationship in static form have been used in the literature (*e.g.* Mankiw, Romer and Weil, 1992; Hall and Jones, 1999; Bernanke and Gürkaynak, 2001), in particular in studies focusing on income level differentials across countries. However, since the model has often been used in the empirical growth literature to examine issues of convergence, some form of dynamic specification has been more common. The two types of specification – static or dynamic – can be expected to yield similar results if countries are not too far from their steady states or if deviations from the latter are not too persistent.

In principle, a dynamic specification is preferable, even when the interest is mainly on the identification of long-run determinants. This is because persistent deviations from steady state are more likely to lead to biased estimates of the long-run parameters in static regressions, especially when the time-series dimension of the sample is relatively short. In practice, estimating dynamic panel equations is also fraught with econometric problems (Durlauf and Quah, 1999). Furthermore, a major drawback with the most common techniques based on dynamic fixed-effect estimators is that only the intercepts are allowed to vary across countries, implying that all countries converge to their steady-state at the same speed, an assumption unlikely to hold even among developed countries.[1]

To address the latter issue, previous studies have relied on the Pooled Mean Group (PMG) estimator, which allows for short-run coefficients and the speed of adjustment to vary across countries, while imposing homogeneity on long-run coefficients (OECD, 2003). However, even though the PMG estimation technique is intuitively appealing and perhaps the most suitable under some conditions, it is not without limitations especially when such conditions are not met. For instance, due to the large number of parameters and the non-linear constraints, the maximum likelihood estimation technique is prone to problems of convergence on local optima. And, experience suggests that parameter estimates can be particularly sensitive in presence of multi-collinearity among regressors, with some parameter values being in such cases too large (and unstable) to be plausible.

For the purpose of this study, the model is first re-estimated with only the basic determinants included in the specification, *i.e.* proxies for investment in physical and human capital, population growth and technical progress. Then, a number of determinants are added to the benchmark specification throughout the rest of the paper, but the set of additional variables is limited to those related to economic geography factors. One exception is the measure of exposure to international trade which, given the importance of geography on trade, is used to assess the impact of transportation costs on GDP per capita (see later in the text). The reason for leaving other potential variables out is essentially one of parsimony, *i.e.* to limit the number of specifications, which quickly runs up as each additional determinant is considered.[2] However, this implies that potentially significant control variables are not included, with the risk that this entails in terms of biases and robustness of the results as regards the determinants of economic geography. In order to minimise those risks, all specifications include various combinations of country and year fixed-effects and/or linear time trends, all of which are introduced in part to capture omitted variables.

Benchmark specification and empirical results

The empirical version of the augmented-Solow model is re-estimated over a panel data set comprising 21 countries and 35 years of observations (1970-2004). In what will serve as the reference model for the rest of the paper, the level of GDP per working-age person in country i and year t (y_{it}) is regressed on the rate of investment in the total economy ($s_{K,it}$), the average number of years of schooling of the population aged 25-64, which is used as a proxy for the stock of human capital (hc_{it})[3] and the growth rate of population (n_{it}) augmented by a constant factor introduced as a proxy for the sum of the trend growth rate of technology and the rate of capital depreciation ($g + d$), with all variables expressed in logs.[4] Technological progress is captured alternatively by a linear time trend or time dummies.

The results presented in this paper are based on both a level specification, using a least-square estimator (that corrects for heteroskedasticity and contemporaneous correlations), and an error correction specification, using the pooled mean group (PMG) estimator. Due to persistence in the series, control for first-order serial correlation is systematically made when the level specification is estimated. The functional forms of the

equations estimated in level and error-correction forms are respectively specified as follows (see Annex for derivation):

Level specification (AR1)

$$Log\ y_{it} = \alpha.Log\ s_{K,it} + \beta.Log\ hc_{it} + \varphi.\Delta Log\ hc_{it} + \gamma.Log(n_{it} + g + d) + \varsigma_i t + e_i + e_t + u_{it}$$
$$u_{it} = \rho.u_{it-1} + \varepsilon_{it} \quad , \quad \varepsilon_{it} \ \ i.i.d. \tag{1}$$

Error-correction specification (Pooled Mean Group)

$$\Delta Log\ y_{it} = -\lambda_i.\left[Log\ y_{it-1} - \left(\alpha.Log\ s_{K,it} + \beta.Log\ hc_{it} + \gamma.Log(n_{it} + g + d)\right)\right] + a_{0i}.\Delta Log\ s_{K,it} + a_{1i}.\Delta Log\ hc_{it} + a_{2i}.\Delta Log(n_{it} + g + d) + e_i + \varsigma_i.t + \varepsilon_{it} \tag{2}$$

where e_i and e_t are country and year fixed-effects, respectively, and t is a linear time trend. The parameters α, β, γ, and ζ are the long-run parameters on the three basic determinants and the time trend. The parameter σ is the first-order autocorrelation coefficient used in the level specification.[5] The other parameters capture short-run dynamics and will not be reported in the table of results. Finally, u_{it} and ε_{it} are the residuals.

The results from re-estimating the empirical version of the augmented-Solow model are presented in Table 1. The first three columns refer to the level specification and the last two are based on the error-correction specification. Focusing on the level specification, the

Table 1. **Basic framework: Regression results**

Augmented-Solow model[1]

Dependant variable GDP per capita	Level AR(1)	Level AR(1)	Level AR(1)	Error correction PMG	Error correction PMG
	(1)	(2)	(3)	(4)	(5)
Common parameters					
Physical capital	0.184***	0.156***	0.199***	0.292***	0.572***
	(0.019)	*(0.024)*	*(0.017)*	*(0.030)*	*(0.059)*
Human capital	0.334***	0.792***	–0.063	0.861***	–0.006
	(0.127)	*(0.053)*	*(0.156)*	*(0.199)*	*(0.189)*
Population growth[2]	–0.006	–0.016	–0.003	–0.392***	–0.661***
	(0.018)	*(0.028)*	*(0.018)*	*(0.067)*	*(0.101)*
Time trend					0.015***
					(0.002)
Rho[3]	0.884	0.911	0.775		
Country-specific parameters					
Lambda[4]				–0.190***	–0.086***
				(0.025)	*(0.017)*
Time trend	No	No	Yes	Yes	No
Fixed effects					
Country	Yes	No	Yes	Yes	Yes
Year	Yes	Yes	Yes	No	No
Sample size					
Total number of observations	696	696	696	695	695
Number of countries	21	21	21	21	21

Note: Standard errors are in parentheses. *: significant at 10% level; ** at 5% level; *** at 1% level.

1. The functional forms corresponding to the "level" and "error-correction" specifications are reported earlier in the text. In the level specification, standard errors are robust to heteroscedasticity and to contemporaneous correlation across panels. In the error-correction specification, only long term parameters are reported.
2. The population growth variable is augmented by a constant factor $(g + d)$ designed to capture trend growth in technology and capital depreciation. This constant factor is set at 0.05 for all countries.
3. *Rho* is the first-order auto-correlation parameter.
4. The parameter *lambda* is the average of the country-specific speed adjustment parameter, λ_i.

coefficient on human capital is quite sensitive to the control for fixed effects and or time trends. In particular, it comes out significantly higher when country fixed effects are excluded (column 2), suggesting that an important part of the information contained in the average number of years of schooling is related to differences in average levels across countries. Moreover, it completely drops out when country-specific time trends are included in the regression in addition to country- and year-fixed effects (column 3).

Turning to the error-correction specification, the results shown in the fourth column are similar to those obtained in the earlier OECD analysis based on an almost identical specification (with country fixed effects and country-specific parameters on the time trend) and the same estimation method (PMG).[6] The speed of adjustment parameter suggests rapid convergence to the steady-state, a result which is influenced by the introduction of country-specific time trend parameters.[7] Also, the parameter estimate on human capital suggests a strong effect, with one extra year of schooling leading to an increase in GDP per capita by around 8% in the long run for the average OECD country. However, here again, the significance of the human capital coefficient depends on whether or not the trend is assumed to be common or country specific (column 5).[8]

Figure 1 presents the contribution of physical capital, human capital and fixed effects to the gap in GDP per capita relative to the average OECD country and on average over the 2000-04 period.[9] The results presented in the two panels are based on the specifications shown in columns 1 and 4, respectively. Not surprisingly, the contribution of physical and human capital is small relative to that of the fixed effects. Indeed, the latter account for 72% and 87% of the GDP per capita variance (over this average period) for the level and the error correction specification respectively. Some of the highest fixed effects are in both specifications recorded for Norway and, to a lesser extent, the United States and Sweden. Portugal, Greece, New Zealand and Japan have the largest negative effects. The position of Ireland and Switzerland is particularly sensitive to whether common or country-specific time trends are introduced.

The rest of the paper investigates whether some of these large fixed effects can be accounted for by indicators of economic geography and, more generally, the extent to which such indicators can explain part of income levels which is not explained by the usual determinants.

Economic distance

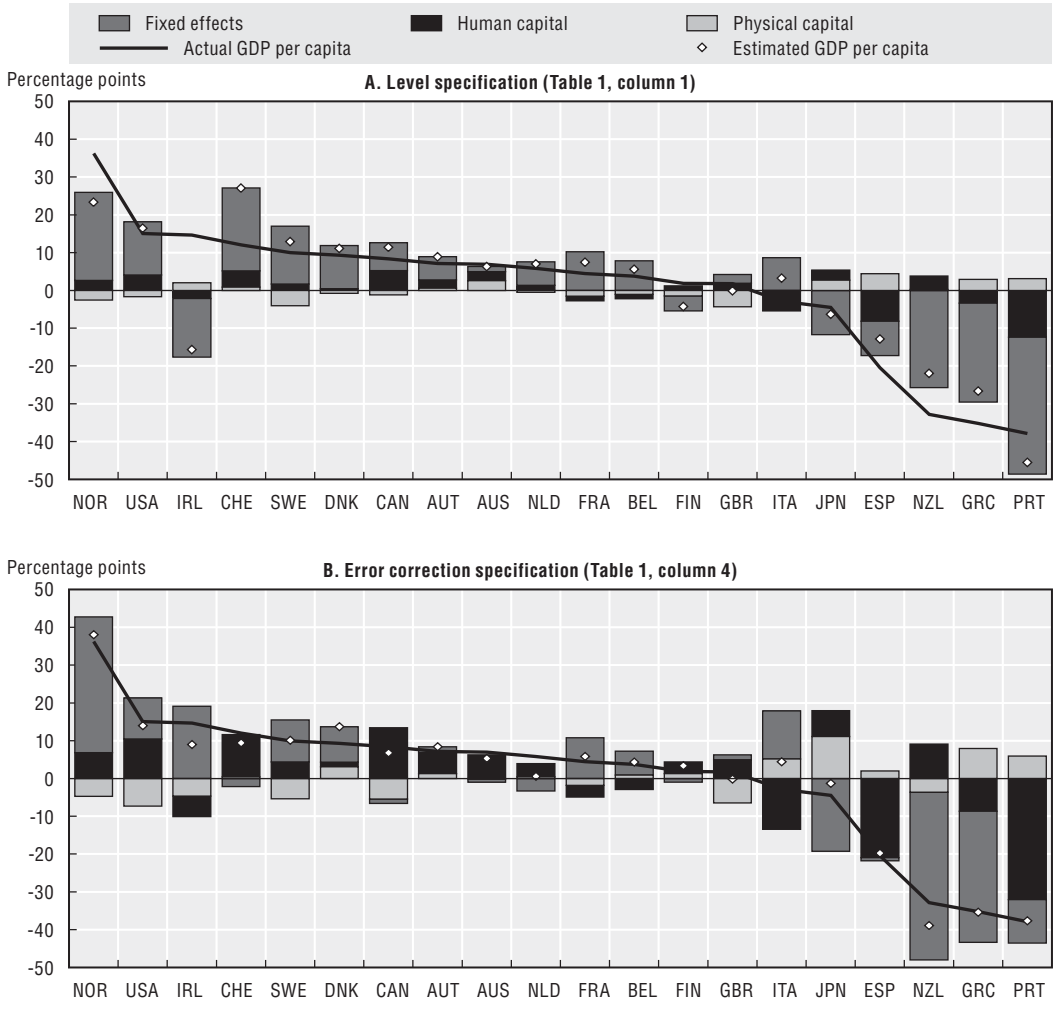
In this section, different measures of proximity to markets or centrality are introduced and tested in the empirical analysis as potential determinants of GDP per capita. Some of them are simple measures based on GDP, country size, population and distances *vis-à-vis* other countries. The others are model-based measures derived from bilateral trade flows.

Why proximity matters

The role of geographic distance and the influence of neighbouring countries have largely been neglected in traditional growth theory which relies essentially on national characteristics, *e.g.* factor endowments and technological progress. Yet, the clustering of economic activities is a well-known phenomenon that raises questions about the extent to which the proximity to high-income neighbours matters for a country's own income. The development process might indeed be hindered in countries that are distant from centres of economic activities.

Figure 1. **Basic framework: Contributions of explanatory variables**[1]

Difference to average country, 2000-2004



1. These charts show the contribution of each explanatory variable to GDP per capita based on Table 1. The contributions are computed as differences to the average country and on average over the period 2000-04. The contribution of fixed effects is the sum of country and year fixed effects in Panel A, and the sum of country fixed effects and country specific time trends in the Panel B. For Norway and Panel A, as an example, the chart reads as following: On average between 2000-04, Norway had a GDP per capita which was 36% above the average across countries, whereas the estimated difference to the average is 23% based on Table 1, column 1. These 23% are broken down according to the contribution of fixed effects (23%), physical capital (–3%) and human capital (3%). Because of a break in the series due to the reunification, data for Germany were used only for the period 1970-89. Therefore, Germany is not included in the figure.

Distance can affect productivity and income levels through various channels, including trade, foreign investment and technology diffusion. There is ample evidence showing the importance of distance for trade and FDI flows (*e.g.* Nicoletti *et al.*, 2003), as well as for technology spillovers (Keller, 2002). Furthermore, trade and FDI are obvious channels of knowledge spillovers (Eaton and Kortum, 1994 and 1996), which reinforces the impact of distance on productivity.

Focusing on the trade channel, distance directly raises transport and other trade costs and is an obstacle to both domestic and foreign trade. There are a number of inter-related ways through which this channel affects productivity. Greater proximity to world markets

increases the opportunity to concentrate resources in activities of comparative advantage. It also encourages specialisation of firms that can attain efficient scale and more generally exploit increasing returns in specific fields of production. Moreover, stronger competition pressures force companies to use available inputs efficiently and encourage them to innovate and maintain a competitive advantage.

In addition to influencing GDP per capita *via* its impact on technical efficiency, distance can also affect external terms of trade. A relatively remote and sparsely populated country has to internalise transport costs into producer prices of tradeable goods in order to remain competitive in world markets or otherwise suffer lower sales. Because, by definition, the factor prices of mobile factors tend to be equalised across locations, the costs of remoteness are born by the immobile factors, *i.e.* mostly labour in an international perspective. Indeed, even if technologies are the same everywhere, firms in more remote countries can only afford to pay relatively lower wages (Redding and Venables, 2004).

In addition to its direct impact on incomes, geography might have an influence through other factors such as physical or human capital. Returns to physical and human capital might be higher in countries having a better access to large markets (Redding and Scott, 2003). In turn, a high return to skills increases the incentive to invest. As regards human capital, Redding and Scott provide some evidence that the world's most peripheral countries have relatively low levels of education, a feature found also in the case of European regions (Breinlich, 2007).

The distance of OECD countries to world markets

In this section, four measures of proximity to markets or centrality are constructed and compared. The first one is population density. The second one depends solely on distances between countries. The third one is a simple measure based on distances *vis-à-vis* other countries and the size of their GDPs, and the last one is a model-based measure derived from bilateral trade flows. The next section is specifically dedicated to the effects of economic distance measured by transport costs.

Population density, sum of distances and market potential

Population density, defined as the ratio of population to surface area, is an indicator of proximity to the domestic market. The higher the density the lower the aggregated domestic transport costs. However, the critical shortcoming of this measure is its failure to take into account the effective access to foreign markets.

A simple measure of distance to markets that does so is one based on bilateral distances. From the perspective of empirical analysis, this measure is attractive because it is based on exogenous characteristics of geography. Although the sum of the distances of each country to Tokyo, Brussels and New York has been commonly used in the empirical literature, the choice of these three locations is arbitrary and creates issues of endogeneity.

Hence, a better alternative is to sum the distances to all countries (Head and Mayer, 2007):

$$Distsum_i = \sum_j d_{ij} \tag{3}$$

In order to compute ***Distsum***, the world was divided in 32 areas: Africa, Australia, Austria, Belgium, Brazil, Canada, China, CIS countries, Denmark, Eastern Europe, Finland, France,

Germany, Greece, Ireland, Italy, Japan, Korea, Latin America (other than Brazil and Mexico), Mexico, the Middle East, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States and Asia (other that the countries already included). Pure distance measures, however, fail to take into account the size of markets. Moreover, this measure depends on how geographic areas are constructed. For example, a different picture would be obtained if the European Union was considered as one entity or, alternatively, the North America was disaggregated into states/provinces.

Therefore, a more refined measure of proximity to markets is market potential, which is defined as the sum of all countries' GDP weighted by the inverse of the bilateral distance (Harris, 1954):

$$Market\ Potential_i = \sum_j \frac{GDP_j}{d_{ij}} \tag{4}$$

The market potential measure must take into account, for a given country, the domestic market and include its own GDP weighted by the inverse of internal distance. Because the internal distance is generally smaller than external distances, it is associated with a greater weight and is therefore a sensitive parameter for measures of centrality. The most commonly used distance indicators combine geodesic capital-to-capital distances between countries and internal distances based on surface areas.[10] It follows that market potential is likely to be positively correlated with population density due to the domestic component.

Market and supplier access

Although it is an intuitive indicator of centrality, market potential is an *ad-hoc* way of capturing the influence of distance to markets. In particular, the weighting of foreign markets in the market potential computation is based solely on distances, regardless of the true accessibility of these markets. In that respect, market *potential* is a very crude measure of market *access*. Indeed, accessibility depends, in addition to distance, on trade policy and cultural relationships, among other determinants. A better approach consists in looking not only at the *potential*, but rather at the *actual* accessibility to countries' markets.

A measure based on such an approach has been proposed in the new economic geography literature, which has revived the concept of proximity to markets and formalised the role of economic geography in determining income. Using the methodology proposed by Redding and Venables (2004) and described in Box 1, measures of market and supplier access have been derived from bilateral trade equations estimated over the period 1970 and 2005 for the 32 countries/areas covering 98.5% of world trade flows in goods (see Boulhol and de Serres, 2008, for details).

Comparison of the different measures

The various measures of centrality discussed in the previous sub-section have been computed for most OECD countries and Table 2 reports the computed values for 2005, plus the average of the country ranking over the different measures. To facilitate the comparison, each of these measures is scaled such that the average across countries is 100 for each year. The cross-country pattern is reasonably close across indicators. Linear correlation is especially high, at around 95%, between market potential, market access and supplier access (and the average ranking). Ranking the countries enables to distinguish five

Box 1. **Construction of market access and supplier access measures**

Market and supplier access measures are derived from the estimation of a gravity-like relationship. As is common in the literature, trade costs in the bilateral trade specification are assumed to depend on three variables: bilateral distance, common border and common language. Noting X_{i-j} as the export from country i to country j and d_{ij} the bilateral distance, the following equation is estimated for each year t:

$$Log\ X_{i\to j,t} = s_{it} + a_t.Log\ d_{ij} + b_t.Border + c_t.Language + m_{jt} + v_{ijt}$$

where the so-called freeness of trade (ϕ), which is inversely related to trade costs, is given by $Log\ \phi_{ijt} = a_t.Log\ d_{ij} + b_t.Border + c_t.Language$. The estimates of "intra-country" freeness of trade, ϕ_{iit}, are computed based on the same formula applied to internal distance, common border and common language. s_{it} and m_{jt} are unobserved exporter and importer characteristics, respectively. For each year, they are proxied by country fixed effects. According to the model (see Boulhol and de Serres, 2008, for details), these effects capture some characteristics of the countries related to the number of varieties, expenditures on manufactures, price indices, etc. Market and supplier access, respectively MA and SA are then constructed from the estimated parameters of the bilateral equation according to:

$$MA_{it} = \sum_k m_{kt} \cdot \phi_{ikt}\ ;\ SA_{it} = \sum_k s_{kt} \cdot \phi_{ikt}$$

For all the countries, market access (supplier access respectively) is computed as a weighted sum of unobserved importer characteristics m_j (exporter characteristics s_i respectively) of all countries. Only the weights put on each partner change across countries, with these weights being a function of estimated trade costs. If a given country k has a large market capacity m_k, countries having low trade costs with country k, *i.e.* a high freeness of trade, put a high weight on m_k and tend to have a high market access. A similar argument applies to supplier access for countries having low trade costs with partners having a large export capacity. Note that this is the same principle as that applied to market potential, whose computation boils down to weighting all countries' GDP by the inverse of the bilateral distances.

groups, in ascending order and Figure 2 represents this clustering using market potential for illustration purposes:

- The remote and sparsely populated countries: Australia and New Zealand.
- Low-income peripheral countries.
- High-income peripheral countries, Korea and North America.
- Continental Europe, the United Kingdom and Japan.
- The centrally located and dense economies of Belgium and the Netherlands.

As expected, access measures are negatively correlated to the sum of distances and positively correlated to population density, suggesting that market and supplier access encompasses these different geographical dimensions. Besides, population density is an important factor explaining the position of Japan and Korea at or above what could be expected from the pure sum-of-distances measure.[11]

Given the size of its own market, the relative position of the United States in terms of market potential or market access might look surprising. As shown by the first column in Table 2 which gives the simplest measure of proximity, one reason is that the United States is much further from markets than European countries. Another reason is that the size of

Table 2. **Measures of proximity/distance to markets, 2005**

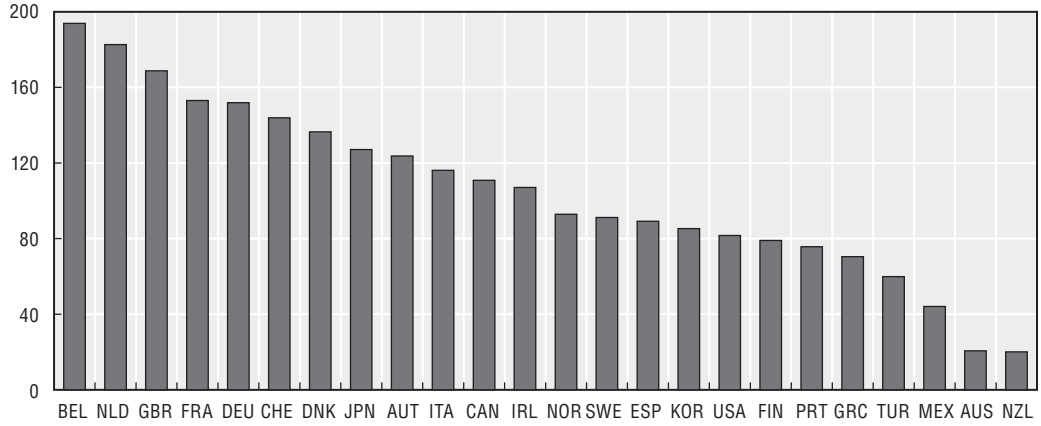
	Average across countries = 100 for each indicator					Average ranking[1]
	Sum of distances (*Distsum*)	Market potential	Market access	Supplier access	Population density	
Australia	214	21	25	23	2	1.4
Austria	69	124	116	123	78	16.2
Belgium	69	194	236	222	113	21.8
Canada	113	111	126	86	3	10.6
Denmark	68	136	119	130	97	18.0
Finland	72	79	66	74	12	8.0
France	70	153	145	137	84	18.2
Germany	68	152	154	172	197	21.6
Greece	76	70	61	55	63	7.2
Ireland	73	107	100	101	46	11.8
Italy	72	116	115	110	150	15.2
Japan	139	127	111	163	266	15.6
Korea	131	85	104	154	406	14.2
Mexico	149	44	44	33	43	4.0
Netherlands	69	183	221	199	308	22.8
New Zealand	234	20	26	25	14	2.2
Norway	70	93	76	80	11	9.8
Portugal	81	76	73	59	90	8.4
Spain	77	89	96	73	67	10.0
Sweden	70	91	75	84	15	10.6
Switzerland	70	144	136	147	143	18.8
Turkey	78	60	52	52	75	6.6
United Kingdom	70	169	158	136	189	19.4
United States	119	82	92	64	27	7.6
	Linear correlation coefficient					
Sum of distances		–0.69	–0.57	–0.52	–0.17	–0.62
Market potential			0.96	0.92	0.50	0.97
Market access				0.93	0.53	0.92
Supplier access					0.71	0.95
Density						0.62

1. All the countries are ranked based on each of the five indicators, 1 standing for the most remote country and 24 for the most central one. The average ranking is the average of these five rankings.

the domestic market is not in itself an adequate indicator of market potential or access to markets. To see this more closely, Table 3 breaks down market potential and market access into their domestic and foreign components, respectively. Looking for example at market potential, it is true that the domestic component represents two thirds of the total for the United States whereas that share is only 22% for the Netherlands and 4.5% for Canada. Still, the domestic market potential for the United States is only 30% greater than that for the Netherlands, even though its GDP is 20 times bigger. This is because the internal distance of the United States is 15 times bigger. What matters is not the size of the total domestic market, captured here by the GDP, but that size relative to internal distance.[12] In any case, these considerations have very limited consequences for the econometric analysis that follows, since they refer essentially to the levels of the proximity measures and most of the regressions include country fixed effects.

Figure 2. **Market potential, 2005**[1]

Average across countries = 100



1. Market potential is defined in equation (4).

Table 3. **Domestic and foreign components of market potential and market access, 2005**

Base: "World" = 100

	Market potential			Market access			Internal distance[1] Km
	Total	Domestic	Foreign	Total	Domestic	Foreign	
Australia	21	4	17	25	9	17	1 043
Austria	124	14	110	116	13	103	109
Belgium	194	27	166	236	69	167	68
Canada	111	5	106	126	7	120	1 188
Denmark	136	17	120	119	16	103	78
Finland	79	4	75	66	6	60	218
France	153	39	114	145	32	113	278
Germany	152	63	89	154	73	81	225
Greece	70	8	62	61	9	52	136
Ireland	107	10	97	100	12	88	100
Italy	116	43	73	115	54	61	206
Japan	127	99	28	111	83	28	231
Korea	85	34	52	104	61	43	119
Mexico	44	7	37	44	10	34	528
Netherlands	183	41	142	221	96	126	77
New Zealand	20	3	17	26	9	18	195
Norway	93	7	86	76	6	70	214
Portugal	76	8	68	73	12	62	114
Spain	89	21	68	96	40	55	268
Sweden	91	7	84	75	8	68	252
Switzerland	144	24	120	136	19	117	76
Turkey	60	6	54	52	6	46	332
United Kingdom	169	60	109	158	65	93	186
United States	82	54	28	92	64	28	1 161

1. The underlying assumption behind the internal distance $d_{ii} = 2/3\sqrt{area_i/\pi}$ is that a country is a disk where all suppliers are located in the centre and consumers are located uniformly over the area.

Empirical analysis: Augmented Solow model and proximity

The impact of access to markets on GDP per capita has been tested in different contexts and all these studies find that proximity has an important impact on GDP per

capita.[13] However, none of them has focused on developed countries despite their widely varying access to markets. In a broad sample covering both least and most developed countries, Australia and New Zealand generally appear to have overcome the "tyranny of distance" (Dolman, Parham and Zheng, 2007). However, this inference might be misleading if the data do not enable to account for important country specificities. Focusing on a more homogenous group over a large period using panel techniques should therefore lead to a more reliable estimate.

This sub-section assesses the impact of the different measures of proximity/distance on GDP per capita when added to the usual explanatory variables in the augmented Solow framework.[14] Table 4 presents a first set of results obtained from the GDP per capita level specification. In order to identify the sum-of-distances and population density measures, country fixed effects have to be removed and, therefore, the first two columns include country effects, whereas the last two do not.[15] This first set of results indicates that the effect of proximity is robust to the various measures. Market potential, the weighted sum of market and supplier access, and the sum of distances are all highly significant with the expected sign, with only population density not having any strong link to GDP per capita.[16] This confirms that, as expected from the previous section, population density is a much weaker indicator of proximity to markets than the other three. Based on the estimates related to the sum of distances (which do not control for country fixed effects), an increase of 10% in the distances to all countries triggers a decrease of 2.1% in GDP per capita.[17]

Table 4. **Basic framework with proximity variables**[1]

Dependant variable GDP per capita	Level AR(1)			
	(1)	(2)	(3)	(4)
Physical capital	0.178***	0.174***	0.178***	0.156***
	(0.020)	*(0.019)*	*(0.020)*	*(0.024)*
Human capital	0.313***	0.317***	0.928***	0.813***
	(0.115)	*(0.122)*	*(0.070)*	*(0.051)*
Population growth[2]	–0.003	–0.005	–0.006	–0.014
	(0.018)	*(0.018)*	*(0.023)*	*(0.028)*
Market potential	0.086***			
	(0.023)			
Weighted sum market and supplier access		*0.056****		
		(0.015)		
Sum of distances			–0.210***	
			(0.023)	
Population density				0.008
				(0.005)
Rho[3]	0.863	0.882	0.946	0.913
Fixed effects				
Country	Yes	Yes	No	No
Year	Yes	Yes	Yes	Yes
Sample size				
Total number of observations	696	696	696	696
Number of countries	21	21	21	21

Note: Standard errors are in brackets. *: significant at 10% level; ** at 5% level; *** at 1% level.

1. The functional form corresponding to the "level" specification is reported earlier in the text. Standard errors are robust to heteroscedasticity and to contemporaneous correlation across panels.
2. The population growth variable is augmented by a constant factor ($g + d$) designed to capture trend growth in technology and capital depreciation. This constant factor is set at 0.05 for all countries.
3. *Rho* is the first-order auto-correlation parameter.

In order to test the robustness of the proximity effects across specifications, the following results focus on the indicator that rests more firmly on sound theoretical grounds, *i.e.* market and supplier access. The first three columns of Table 5 add the weighted sum of market and supplier access to the specifications shown in columns 1 to 3 of Table 1, respectively. Market and supplier access is always highly significant, being robust to the inclusion of country and year dummies, as well as country specific time trends. Moreover, the estimate for the access variable is around 0.06-0.07 in all cases, while the parameters for human and physical capital are mostly unchanged compared with Table 1.[18] This result suggests than the impact of centrality to markets acts on top of these usual determinants. Also, the fact that excluding the country effects does not alter the parameter significantly means that the access effect is identified by the variation through time as well as across countries.

The estimated effect of access is fairly robust to the treatment of physical capital, human capital and the access variables as being potentially endogenous (column 4).[19] Finally, in the last column, the error correction specification is tested using the pooled mean group estimator. Here again, the impact of centrality seems to be orthogonal to the other dimensions, although the level of the parameter is somewhat higher.

Figure 3 presents the contribution of market and supplier access to GDP per capita for the 2000-04 period, based on the estimates in columns 1 and 5, which are representative of the level and error-correction specifications respectively. Unsurprisingly, Australia and New Zealand are the big losers from their geographic position. To a lesser extent, Greece, Portugal and Finland suffer compared with the average country. The beneficiaries are core European countries, especially Belgium and the Netherlands. As noted above, the order of magnitude of the geography effects varies substantially depending on the specifications. For example, market and supplier access is estimated to penalise Australia and New Zealand by around 11% of GDP in the level specification. The effect would be almost three times as large based on the error-correction specification, which is hardly plausible. Conversely, Belgium and the Netherlands benefit by around 6-7% compared with the average country in the level framework and by 16-18% in the error correction one.

Transport costs

In this section, the influence of proximity to large markets on GDP per capita is examined through the working of a direct channel: transportation costs. The cost of transporting goods is obviously closely linked to distance. However, shifts in modes of transport, technological improvements in long-distance shipping and changes in fuel costs have influenced the relationship between geographic distance and economic distance. To some extent, the impact of transport costs was implicitly captured in the measures of market and supplier access derived in the previous section. Nevertheless, the development of indicators of transport costs allows for assessing directly their impact on trade and GDP per capita, separately from other factors affecting market access, such as variations in the degree of openness to trade across various foreign markets as well as over time.

Transport costs constitute only one source of total trade costs, albeit an important one. According to recent estimates, broadly defined trade costs of "representative" goods expressed in *ad valorem* tax-equivalent terms can be as high as 170% in industrialised countries (Anderson and van Wincoop, 2004) with transport costs amounting to 21%, the rest being accounted for by border-related trade barriers (44%) and retail and wholesale

Table 5. **Sensitivity of proximity effects across specifications**[1]

Dependant variable GDP per capita	Level AR(1)	Level AR(1)	Level AR(1)	Level AR(1)	Error correction model
	(1)	(2)	(3)	(4)	(5)
Common parameters					
Physical capital	0.174***	0.166***	0.188***	0.171***	0.307***
	(0.019)	(0.019)	(0.017)	(0.060)	(0.032)
Human capital	0.317***	0.750***	–0.069	0.855***	0.902***
	(0.122)	(0.075)	(0.149)	(0.208)	(0.186)
Population growth[2]	–0.005	–0.008	–0.002	0.005	–0.411***
	(0.018)	(0.022)	(0.018)	(0.019)	(0.067)
Weighted sum of market and supplier access	0.056***	0.066***	0.064***	0.091**	0.131**
	(0.015)	(0.009)	(0.016)	(0.044)	(0.054)
Rho[3]	0.882	0.952	0.820	0.868	
Country-specific parameters					
Lambda[4]					–0.176***
					(0.024)
Time trend	No	No	Yes	No	Yes
Fixed effects					
Country	Yes	No	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	No
Sample size					
Total number of observations	696	696	696	696	695
Number of countries	21	21	21	21	21
First stage regressions[5]					
Hausman test				$\chi^2(4) = 12.4$	
				(*P = 0.015*)	
Hansen J-stat				$\chi^2(29) = 5.87$	
				(*P value = 1.00*)	
Physical capital				Shea $R^2 = 0.059$	
				(*P value = 0.238*)	
Human capital				Shea $R^2 = 0.182$	
				(*P value = 0.000*)	
Weighted sum of market and supplier access				Shea $R^2 = 0.092$	
				(*P value = 0.002*)	

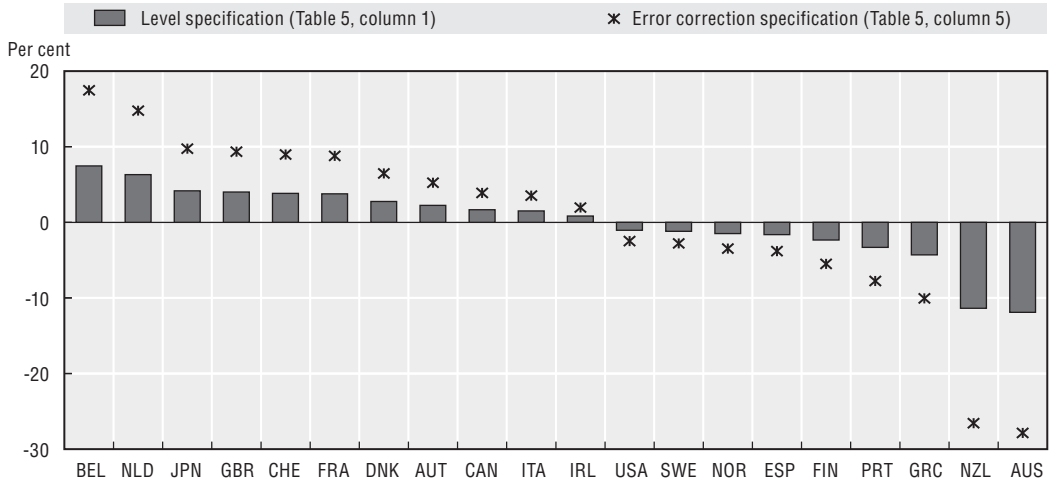
Note: Standard errors are in parentheses. *: significant at 10% level; ** at 5% level; *** at 1% level.

1. The functional forms corresponding to the "level" and "error-correction" specifications are reported earlier in the text. In the level specification, standard errors are robust to heteroscedasticity and to contemporaneous correlation across panels. In the error-correction specification, only long term parameters are reported.
2. The population growth variable is augmented by a constant factor ($g + d$) designed to capture trend growth in technology and capital depreciation. This constant factor is set at 0.05 for all countries.
3. *Rho* is the first-order auto-correlation parameter.
4. The parameter *lambda* is the average of the country-specific speed adjustment parameter, λ_i.
5. The instruments used in column (4) are $Z_{it} = Distsum_i.h_t$ where the h_t are time dummies. The tests reported for the Instrumental Variables estimator read as following. The Hausman test is a joint test of exogeneity of physical capital, human capital and market and supplier access. Exogeneity is rejected and this is due to human capital only (this is seen when including residuals from the first-stage regressions in the main equation). The over-identification test is the Hansen test. It is computed without the AR(1) process for the residuals. For first-stage regressions, Shea partial R^2 (*i.e.* based on the excluded instruments only) are reported for each potentially endogenous regressor, along with the *P-value* of the F-test. These statistics reveal that weak instruments could be an issue for physical capital only.

distribution costs (55%).[20] Excluding distribution, transport costs would on the basis on these estimates account for about one-third of international trade costs. This covers the contribution of both direct (freight charges including insurance) and indirect (holding cost for transit, inventory costs, *etc.*) transport costs. The empirical analysis presented in this section is based on estimates of freight charges for air, maritime and road transportation

Figure 3. **Estimated impact of market and supplier access on GDP per capita**[1]

Deviation from average OECD country in 2000-04



1. Contributions of market and supplier access to GDP per capita are based on Table 5. They are computed as differences to the average country and on average over the period 2000-04. For example, based on the estimate from the level specification, the favourable access to world markets that Belgium benefits from compared with the average country would contribute to as much as 6.7% of its GDP. Because of a break in the series due to the reunification, data for Germany were used only for the period 1970-89. Therefore, Germany is not included in the figure.

of merchandise. Indirect costs, which are usually inferred from trade flow regressions rather than directly observed, are not covered. In addition, the cost of international telecommunications is considered insofar as it affects trade in services and, to a lesser extent, trade in goods *via* its impact on back-office operation, financing, etc.

The rest of the section provides some details on the construction of an index of overall transport costs and its three main components, as well as the cost of international telecommunications, for the 21 OECD countries included in the empirical analysis reported in the previous sections. Given the limited availability of data covering both the time-series and cross-section dimensions in a consistent and comparable fashion, a number of key assumptions are required in order to build a comprehensive dataset. The impact of transport costs on GDP per capita is then examined both *via* its impact on exposure to cross-border trade and directly as an added determinant in the basic framework used in earlier sections.

Evolution of transport and telecommunications cost indices

Methodology and data sources

The construction of an aggregate index of transportation costs covering air, maritime and road components requires information about the costs for shipping goods between bilateral locations for each mode of transport, with the respective costs measured in the same units to allow for aggregation. In addition, the construction of country-specific indices requires that the respective costs be weighted so as to reflect the relative importance of each trading partner as well as of each mode of transport. In principle, trade flow data could be used to construct weights that are consistent with the actual distribution of goods shipped according to the mode of transport and bilateral destinations. Doing so, however, would make the aggregate index endogenous to the individual costs and is therefore avoided. The indicators of transportation costs used in

this paper are taken directly from Golub and Tomasik (2008), which provides details regarding raw data availability, sources, assumptions made and results. The main features can be summarised as follows:

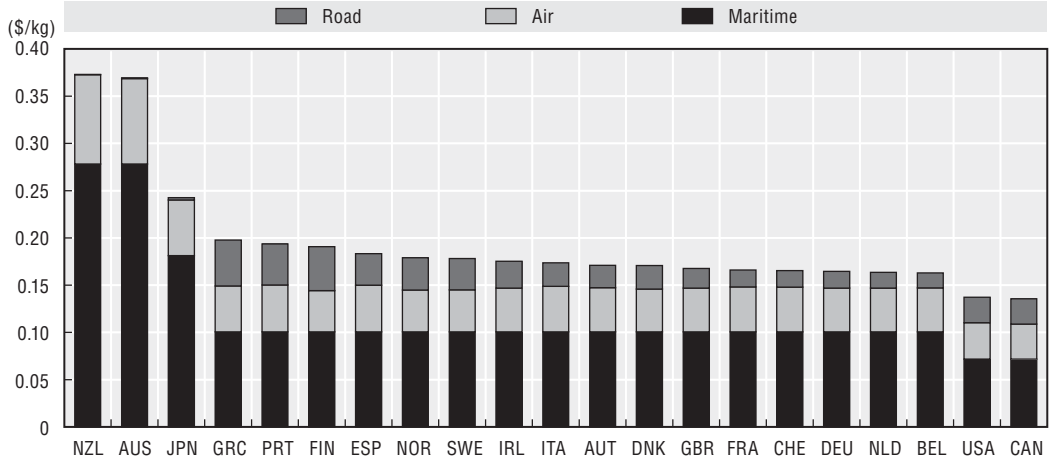
- The basic cost of each mode of transportation between any two locations is measured in US dollars per kilogramme shipped, and the cost of maritime shipping is assumed to be the same for countries within a broad region (*e.g.* for all EU countries *vis-à-vis* other broad regions).
- For each country, the costs of shipping goods to each bilateral destination are aggregated on the basis of GDP weights of partner countries (including a country's own GDP), as was the case for the indicator of market potential discussed in the previous section. The main reason for preferring GDP weights as opposed to actual trade weights is to avoid the endogeneity of trade patterns with respect to trade costs.
- The relative importance of each mode of transport in moving goods across locations is based on a mixture of assumptions and hard data that are available for a few countries. The key assumption made in this context is that all trade between "neighbours" is assumed to take place *via* road transportation.
- The nominal aggregate index of transport cost, expressed in dollars per kilogramme, is deflated using either the US GDP deflator or the US price index of manufacturing goods.

Results

The overall indicator of transport costs over the period 2000-04 is shown in Figure 4 for 21 OECD countries. The figure also provides the contribution of each of the three main sub-components to the overall cost. Individual countries can be regrouped into four blocks on the basis of their overall costs. Not surprisingly, transport cost is highest for Australia and New Zealand with a cost over 2½ times that observed in North America. This is followed by Japan which forms a group on its own, but at a level that is substantially lower than observed for the first group. The indicator shows similar costs for European countries, with only slightly higher values observed in peripheral countries, reflecting higher road transport costs. At the other end, transport costs are lowest in Canada and the United States, owing largely to a lower contribution from maritime freight charges. In fact, the

Figure 4. **Overall transport costs and contribution from three sub-components**

Deflated by US GDP deflator (2000 = 1), average 2000-04

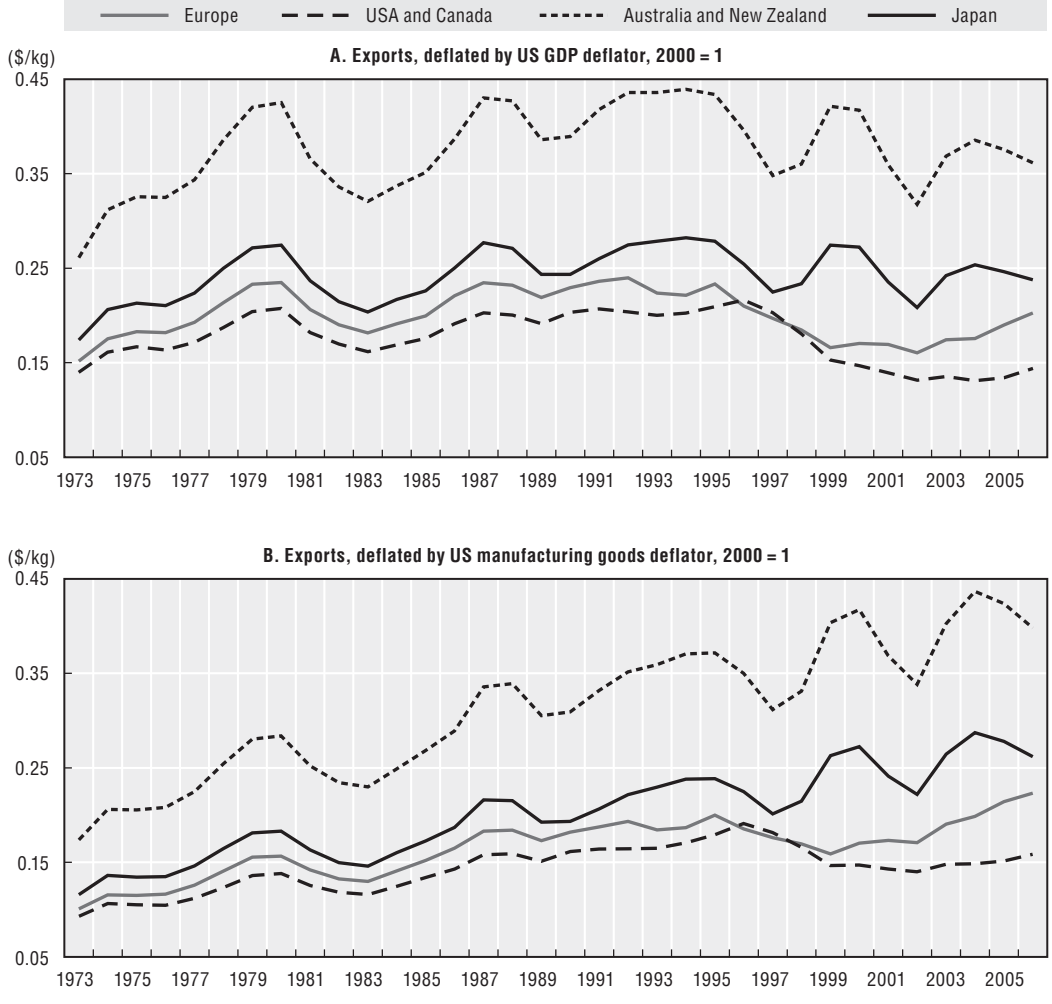


Source: Golub and Tomasik (2008).

maritime component accounts for the largest portion of the variation in the overall costs across the four groups of countries.

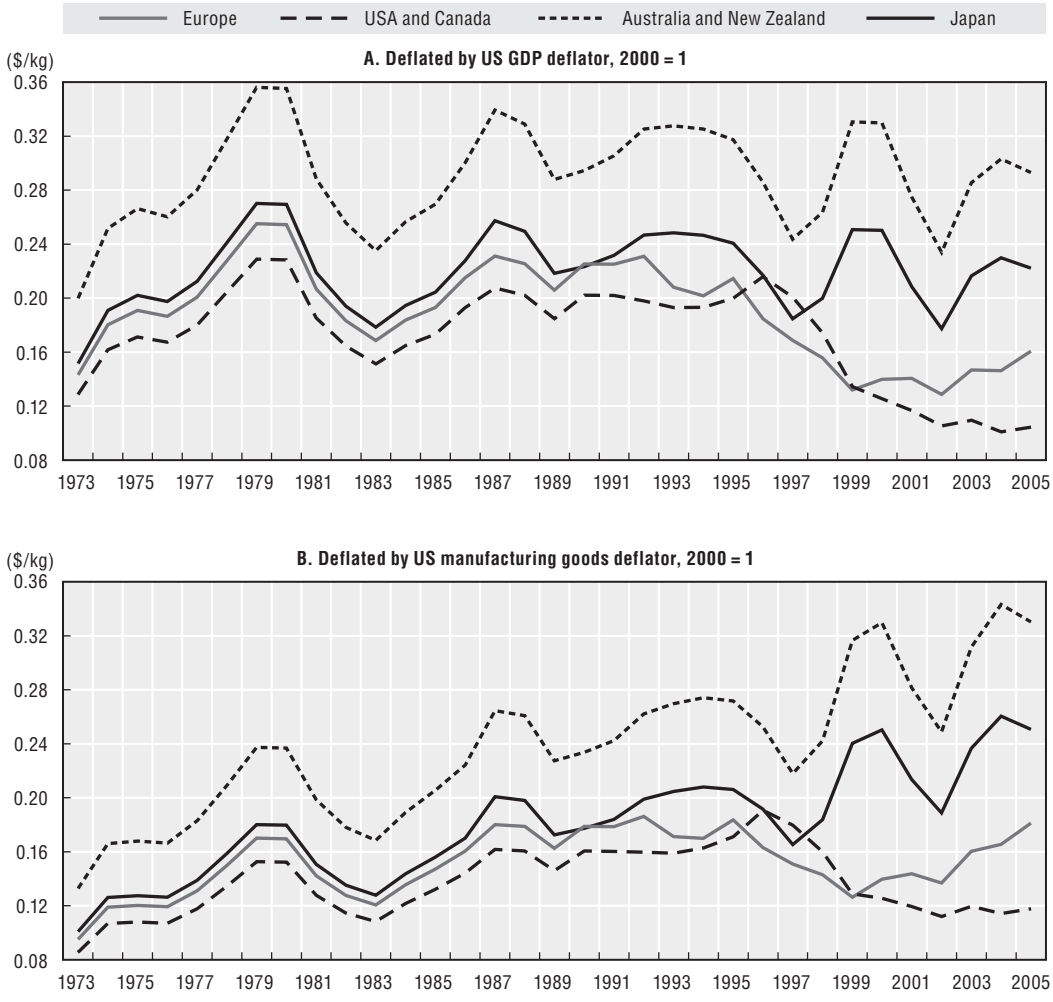
As regards the evolution of overall transport costs over time, a different picture emerges depending on whether the series are deflated by the US GDP deflator or by the US price index of manufacturing goods. On the latter basis, there is a clear upward trend in the four groups of countries throughout the sample period – though with somewhat different slopes – whereas no clear trend appears for the series based on the broader deflator, at least not since the 1970s (Figure 5). In both cases, the profile reflects to a large extent the contribution from maritime shipping costs (Figure 6). Looking more closely at the profile of maritime transport costs what stands out is the widening discrepancy since the mid-1990s between the cost for shipping goods from Asia, which have gone up in real terms, and those for goods shipped from Europe or North America, which have fallen. The break from the earlier pattern which saw the costs in the three zones moving roughly together coincides with the emergence of large trade imbalances. The sharp rise in exports from East Asia has led to capacity bottlenecks in the major ports of that region while containers are returned to Asia half empty.

Figure 5. **Total average transport cost**



Source: Golub and Tomasik (2008).

Figure 6. **Average maritime transport cost**



Source: Golub and Tomasik (2008).

To summarise, the perception that the relative influence of costs related to distance is fast diminishing is not supported, at least not by recent trends in international shipping costs.[21] This apparent puzzle was already noted in earlier studies (in particular Hummels, 2006). In the case of maritime transport, special factors such as rising fuel prices and port charges may have played a role in offsetting the gains from technological improvements. Moreover, studies based on micro data (Blonigen and Wilson, 2006) that compare prices for shipping similar goods and similar maritime routes but *via* different modes (*i.e.* using containers or not), suggest that the benefit from containerisation may not be as large as presumed (all else being equal).

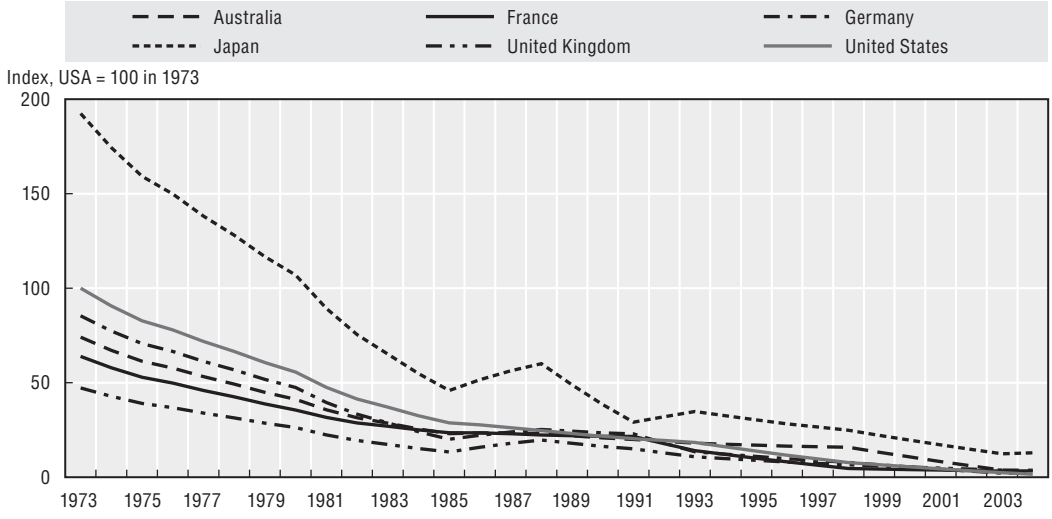
In any case, firm conclusions in this area need to be qualified due to limitations of data availability and measurement. It is not clear how data on road transport, for instance, reflect the gains in quality terms such as those from the use of global positioning systems which allows for precise tracking of the material in transit. In a similar vein, measured price indices for ocean shipping may not adequately reflect improvement in the service provided, for instance time savings brought about by containerisation. And, the importance of time as a trade barrier has been stressed in earlier studies (Hummels, 2001; Nordås, 2006; Nordås *et al.*,

2006). More generally, all transportation modes have benefited from progress in information and communication technology as well as from a better integration *via* intermodal systems. Taken at face value, the absence of a decline in the weight-based measures of real cost of transport (*i.e.* nominal costs deflated by the manufacturing price index) suggests that there may have been less technological progress in transportation than in manufacturing. However, due to innovations outside the transport sector, the composition of traded goods has changed significantly over the past decades, and many valuable goods are now relatively light, *e.g.* electronic chips. Consequently, transport costs may well have fallen relative to the value of transported goods.[22]

One area where the presumed death of distance does not seem to be at all exaggerated is international telecommunications since costs in this area have fallen in all countries to the point where they are no longer significant anywhere (Figure 7). In fact, historical data indicate that the substantial cross-country variations that still prevailed in the early 1970s had largely disappeared by the late 1980s, and since then the downward trend has continued, bringing costs to basically zero during the early 2000s. It should be noted, however, that this indicator only captures one type of telecommunications and therefore the treatment of this aspect of distance is covered too narrowly for firm conclusions to be drawn.[23] Nonetheless, this result would suggest that countries that are particularly affected by their distance to market may wish to ensure that their ICT networks are particularly well developed – not least by getting their regulatory frameworks right – so as to fully exploit the benefits from trading in the types of services where physical distance matters little.

Figure 7. **Real cost of one minute international telephone call from selected origin countries**

Deflated by US GDP deflator



Source: Golub and Tomasik (2008).

Impact of transport costs on openness to trade and GDP per capita

The impact of transport costs on GDP per capita is assessed both indirectly *via* their effects on individual countries' exposure to international trade and more directly as an additional determinant in the basic growth equation. The first set of regressions examines the impact of transportation costs through their effect on international trade openness (Table 6). This approach is based on the presumption that transportation costs matter for

Table 6. **Basic framework with openness to trade**[1]

Costs of transport and international communications used as an instrument for trade openness

Dependant variable GDP per capita	Level AR(1)	Level AR(1) IV	Level AR(1)	Level AR(1) IV	Level AR(1)	Level AR(1) IV
	(1)	(2)	(3)	(4)	(5)	(6)
Physical capital	0.175***	0.171***	0.164***	0.218***	0.208***	0.196***
	(0.020)	(0.022)	(0.023)	(0.030)	(0.021)	(0.022)
Human capital	0.234*	–0.273	0.740***	0.724***	0.210*	0.221**
	(0.122)	(0.324)	(0.058)	(0.068)	(0.112)	(0.112)
Population growth[2]	–0.016	–0.018	–0.038	–0.033	–0.028	–0.044*
	(0.023)	(0.025)	(0.031)	(0.029)	(0.025)	(0.026)
Trade openness	0.035*	0.029	0.048***	0.107***	0.068***	0.106***
	(0.020)	(0.061)	(0.017)	(0.040)	(0.020)	(0.039)
Rho[3]	0.886	0.890	0.941	0.954	0.844	0.855
Time trend	No	No	No	No	Yes	Yes
Fixed effects						
Country	Yes	Yes	No	No	Yes	Yes
Year	Yes	Yes	Yes	Yes	No	No
Sample size						
Total number of observations	633	633	633	633	633	633
Number of countries	21	21	21	21	21	21
	First stage regressions for the Trade openness variable[4]					
Excluded instruments						
Overall transport costs		–0.473**		–0.683***		–0.144**
		(0.233)		*(0.065)*		*(0.062)*
Costs of international communications		0.023		–0.148***		–0.009
		(0.024)		*(0.030)*		*(0.027)*
Sum of distances (average through time)		–0.018***		–0.004**		–0.027***
		(0.004)		*(0.002)*		*(0.002)*
Statistical tests						
Hausman test		$?^2(1) = 2.76$		$?^2(1) = 3.57$		$?^2(1) = 5.10$
		(P = 0.096)		*(P = 0.059)*		*(P = 0.024)*
Hansen J-stat		$?^2(31) = 23.8$		$?^2(31) = 10.3$		$?^2(31) = 31.2$
		(P value = 0.820)		*(P value = 1.000)*		*(P value = 0.458)*
Partial R^2		Shea $R^2 = 0.062$		Shea $R^2 = 0.152$		Shea $R^1 = 0.190$
		(P value = 0.917)		*(P value = 0.000)*		*(P value = 0.000)*

Note: Standard errors are in parentheses. *: significant at 10% level; ** at 5% level; *** at 1% level.

1. The functional form corresponding to the "level" specification is reported earlier in the text. Standard errors are robust to heteroscedasticity and to contemporaneous correlation across panels.
2. The population growth variable is augmented by a constant factor ($g + d$) designed to capture trend growth in technology and capital depreciation. This constant factor is set at 0.05 for all countries.
3. *rho* is the first-order auto-correlation parameter.
4. The instruments used in columns 2, 4 and 6 are overall transport costs, costs of international communications and $Z_{it} = Distsum_i.h_t$ where the h_t are time dummies. The tests reported for the Instrumental Variables estimator read as following. The Hausman test is a test of exogeneity of the trade variable. The over-identification test is the Hansen test. It is computed without the AR(1) process for the residuals. For first-stage regressions, Shea partial R^2 (*i.e.* based on the excluded instruments only) is reported for the potentially endogenous regressor, along with the *P-value* of the F-test.

GDP per capita only insofar as they matter for openness and that trade contributes to GDP. In order to assess the contribution of international trade to GDP per capita, a measure of exposure to international trade (trade openness) is first added as a determinant in the augmented-Solow model.[24]

The results appear in columns 1, 3 and 5 of Table 6, where the specifications vary only according to the combination of fixed-effects and/or time trend included. The coefficient on trade openness is positive and significant in all three cases – albeit only at the 10% level in the first case – and varies from 0.035 when both year and country fixed-effects are included (column 1) to twice that size when a time trend is included instead of year fixed-effects (column 5). The coefficients on the other variables do not vary much across specifications, except in the case of human capital, where the coefficient shows the same sensitivity to the treatment of fixed effects as reported in previous sections. A comparison of Table 6 with the first three columns of Table 1 also shows that adding the trade variable does not have much impact on the parameter values of physical and human capital.

Taken at face value, these results provide evidence that greater openness to trade leads to higher GDP per capita. However, it has long been recognised that given the uncertainties as regards the direction of causality, the introduction of trade as an additional determinant in the Solow model cannot be used as conclusive evidence of a positive influence on GDP per capita, regardless of the apparent size and statistical significance of the estimated parameter.

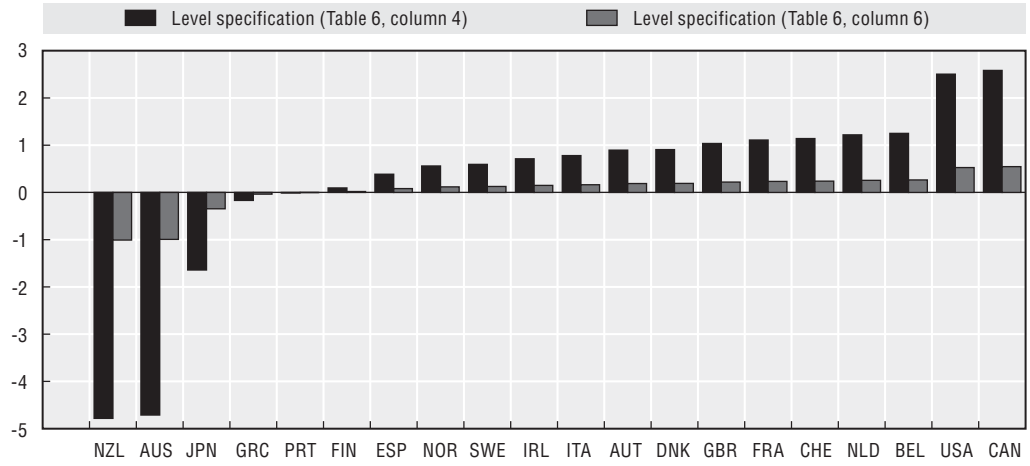
To address the endogeneity problem, an instrumental variable (IV) procedure is adopted, allowing for the indicator of overall transport costs and the cost of international telecommunications to be used as instruments for the measure of openness to international trade in the augmented Solow model. The sum of distance, defined in the previous section, is also used as an instrument.[25] The procedure is similar to that used in the third section and the results are reported in columns 2, 4 and 6 of Table 6. The estimated effect of (instrumented) trade openness on GDP per capita (second stage reported in the top panel) is significant in two of the three specifications (columns 4 and 6), and the estimated coefficient is in these cases higher than when actual trade openness is used (columns 3 and 5). However, this result no longer holds if one controls for both country and year fixed effects, where the coefficient on trade openness is not significant (column 2).[26] As for the results from the first-stage regression (bottom panel), they show that overall transport costs have a significant (negative) impact on trade openness in all three IV specifications, although with large variations in the parameter estimates.

Overall, these results indicate that transportation costs contribute to reduce the exposure to international trade and that in turn the latter appears to have a significant impact on GDP per capita. In contrast, the effect of international telecommunications on trade openness is significant only when country fixed effects are not included, and therefore the evidence is much weaker. The results from the IV procedure provides some evidence that trade openness may have a causal influence on GDP per capita, consistent with earlier findings (*e.g.* Frankel and Romer, 1999).

Against this background, the contribution of transport costs to GDP per capita is reported in Figure 8. In order to provide a range of estimates, the contribution is calculated on the basis of coefficients obtained from two specifications based on Table 6 (columns 4 and 6, respectively). On this basis, high transport costs relative to the OECD average are found to reduce GDP per capita by between 1.0% and 4.5% in Australia and New Zealand, where the effect is largest. At the other end, the lower transport costs for Canada and the United States contribute to raise GDP per capita by between 0.5% and 2.5%.

Figure 8. **Estimated impact of transportation costs on GDP per capita**[1]

Deviation from average OECD country in 2000-04



1. Contributions of market and supplier access to GDP per capita are based on Table 6. They are computed as differences to the average country and on average over the period 2000-04. Because of a break in the series due to the reunification, data for Germany were used only for the period 1970-89. Therefore, Germany is not included in the figure.

Overall economic impact and policy implications

Overall impact

In order to summarise the contribution of proximity to markets to GDP per capita over the whole period, Table 7 uses the parameters estimated from the preferred specification, *i.e.* column 1 of Table 5. In each case, the contribution is measured relative to the average country, and is reported both as an average over the period 2000-04 and as a change since 1970.

Three main results emerge from these calculations. First, as mentioned earlier, the order of magnitude of the impact of remoteness is important, ranging from around –11% of GDP for Australia and New Zealand to +6% for Belgium and the Netherlands. Second, these effects have not changed much over the period, reflecting that geographic factors are generally stable over time. Nevertheless, it seems that the unfavourable position of Oceanic countries has deteriorated somewhat over time, while economic integration has moved Spain, Portugal and Canada closer to central markets.

An alternative way to assess the explanatory power of the geography variables is to compare the standard deviation of the fixed effects before and after the inclusion of these variables. In the augmented Solow model, these country fixed effects account for 72% of the cross-country variance in GDP per capita (Table 8).[27] When geography variables are included, the variance explained by the fixed effects is reduced from 72% to 60%.

The country fixed effects may in this regard be interpreted as the estimated difference in productivity levels relative to the average country and on average over the whole period of estimation. Based on the standard augmented-Solow model (*i.e.* ignoring geography), the estimated country fixed effects put Australia slightly above the average country, while New Zealand lags by 25%. Once geography is controlled for, Australia moves 13% ahead, suggesting that it has managed to overcome the effect of its unfavorable location, whereas New Zealand remains behind the average country, but only by 14%. Taking geography determinants into account does not change the relative position of the United States, which lies 15% ahead of the

Table 7. **Impact of market and supplier access on GDP per capita**[1]

In per cent

	Market and supplier access	
	Difference to average country in 2000-04	Change since 1970
Parameter	*(0.056)*	*(0.056)*
Australia	–11.8	–1.6
Austria	2.1	–0.5
Belgium	7.5	0.2
Canada	2.4	1.3
Denmark	2.5	0.6
Finland	–2.7	–0.7
France	3.8	0.2
Greece	–4.1	0.1
Ireland	0.7	–0.6
Italy	1.4	0.0
Japan	3.3	1.1
Netherlands	6.3	1.0
New Zealand	–11.3	–1.1
Norway	–1.7	–0.2
Portugal	–3.0	1.3
Spain	–1.4	1.5
Sweden	–1.5	–0.8
Switzerland	3.6	–1.2
United Kingdom	4.2	–1.1
United States	–0.3	0.5
Minimum	*–11.8*	*–1.6*
Maximum	*7.5*	*1.5*
Average	*0.0*	*0.0*

1. In order to evaluate the impact of access to markets on GDP per capita, the parameters used are those obtained from Table 5, column 1. Based on these estimates, and taking Australia as an example, the table should be read as follows: compared with the average country in the sample, the distance to markets of Australia contributes to lowering its GDP per capita by 11.8% on average over the 2000-04 period. This is an addition of 1.6 points relative to the same contribution calculated for 1970. Because of a break in the series due to the reunification, data for Germany were used only for the period 1970-89. Therefore, Germany is not included in the table.

average country. Also, the estimated favorable fixed effects for Belgium and Netherlands in the augmented-Solow framework appear to be almost entirely due to centrality.[28]

Policy implications

The economic-geography effects discussed above imply that GDP-per-capita or productivity gaps cannot on their own be used as a measure of unfinished business of policy. Adopting best practice policy across all policy areas will not allow some countries to attain best performance because they are penalised by their location; others may be able to attain very high levels of performance without aligning their policies on best practice. This section briefly reviews some of the policy issues linked to unfavourable geographical location: how best to minimise the costs due to distance and whether the effectiveness of some structural policies are affected by remoteness.

Minimising the cost of distance

The high cost of distance, up to 10% of GDP, raises the question of whether public subsidies to transportation are warranted to reduce shipping costs for companies and individuals. Indeed, if distance has negative externalities, there would seem to be a

Table 8. **Size of country fixed effects and share of variance explained by fixed effects**[1]

	Average GDP per capita, 1970-2004 (deviation from the OECD average)	Fixed effects Augmented-solow Table 1, column 1	Fixed effects Augmented-Solow + geography Table 5, column 1
Australia	7.9	1.9	13.3
Austria	8.5	5.2	2.8
Belgium	4.0	7.3	–0.5
Canada	12.2	7.2	5.4
Denmark	11.3	10.8	8.1
Finland	–3.5	–4.1	–2.0
France	7.6	9.5	5.3
Greece	–30.8	–26.0	–22.5
Ireland	–20.6	–13.0	–14.2
Italy	0.2	6.9	4.9
Japan	–4.2	–13.2	–16.2
Netherlands	6.5	7.0	0.7
New Zealand	–21.1	–24.6	–13.7
Norway	27.9	22.7	24.0
Portugal	–44.6	–36.3	–33.6
Spain	–21.1	–10.1	–9.0
Sweden	13.7	15.4	16.1
Switzerland	29.1	21.9	17.8
United Kingdom	–0.4	3.0	–2.0
United States	17.5	14.6	15.2
Standard deviation	*0.191*	*0.161*	*0.147*
Variance	*0.036*	*0.026*	*0.022*
Share of variance		*0.716*	*0.599*

1. Because of a break in the series due to the reunification, data for Germany were used only for the period 1970-89. Therefore, Germany is not included in the table.

prima facie case for public intervention to correct such externalities. Budgetary subsidies for urban passenger transportation are common in many OECD countries, but are rare for long-distance, notably cross-border, transportation of goods. However, long-distance transportation already benefits from large implicit subsidies. Most importantly, many transportation activities result in environmental damage, and transportation companies and their clients are not charged for this degradation. This is notably the case for air pollution and greenhouse gas emissions in some modes of transportation where regulations on emissions are lax and fuel use is lightly taxed, air and maritime transportation being prime examples. In most countries, road transportation also benefits from not having to pay for the congestion it causes and free access to the road network. Any decisions to provide additional subsidies to transportation would also have to take into account the cost of raising funds for this purpose, and the risk of failure in managing such subsidies.

The authorities can also ensure that prices of transportation services are not inflated by regulations that reduce efficiency and increase costs. Traditionally, transportation sectors have been heavily regulated and exempted from standard competition legislation with adverse effects on costs. Over the past decades, regulations in domestic markets have been eased substantially, especially in road and air transportation (Conway and Nicoletti, 2006). However, cross-border freight transportation is still subject to extensive regulations. Competition pressures in international air routes often remain fairly weak due to restrictive bilateral air service agreements and limits to ownership of national carriers.

Road transportation on many international routes is hampered by lack of "cabotage" rights. And international scheduled maritime freight services are still operated as price-setting cartels on many key routes, reflecting that this activity is exempted from national competition legislation in many OECD countries. Moreover, port efficiency varies widely across countries and affects shipping costs significantly, in part due to regulatory restrictions hampering competition in port services (Clark, Dollar and Micco, 2004).

Distance and the effectiveness of structural policies

Remoteness can in principle influence the effectiveness of some structural policy measures, with implications for policy choices. A possible interaction between policy and distance is that a given policy change to strengthen competition in domestic product markets may have a weaker influence in remote countries than in countries close to large markets, even if such reforms are arguably more needed in the former group of countries as they have limited alternatives to enhance competition. In countries at a large distance from world markets, there may not be room for many competitors in some sectors if the efficient scale of operation is close to the size of the market. In such circumstances the lifting of statutory entry barriers may not stimulate entry, as the size of the market will *de facto* restrict the number of competitors. On the other hand, if legal entry barriers are the binding constraint on entry as seems more likely in countries close to world markets, then lowering such barriers should stimulate competition. Notwithstanding the intuitive appeal of such arguments, no evidence that distance significantly interacts with a measure of competition-restraining regulations could be found on the basis of an admittedly crude empirical investigation. Indeed, the first three columns of Table 9 show, first, that both product market regulation and access to markets remain significant when they are jointly included in the basic equation and, second, that the interaction between regulation and proximity is not significant.

Another area where the effectiveness of policies might be expected to vary depending on distance is R&D spending.[29] Such activity is likely to involve significant fixed costs and thus be subject to economies of scale. With distance limiting the size of the market, the unit cost of innovation can be expected to be higher in remote countries than in countries close to large markets where fixed costs can be spread more widely. Another related channel is the reduced incentives for large multinational firms to establish a commercial presence in remote markets, due to the limited development possibilities. Since multinational firms are the main carriers of innovation to other markets, the impact of domestic R&D spending on growth in foreign markets is limited by their absence in smaller remote markets. Hence, a given increase in public and/or private R&D spending is likely to have a greater leverage and therefore a greater GDP-per-capita impact in countries with short distance to markets than in more remote countries. Furthermore, insofar as the effectiveness of public and/or private R&D can be influenced by the strength of industry and science linkages or by close interactions between researchers from various institutions, the impact of R&D on GDP per capita may vary according to the extent of urban concentration within a country.

These possibilities are examined *via* the introduction in the estimated equation of two interaction terms, one between private R&D and distance and the other between private R&D and the share of the country population living in cities of more than 1 million inhabitants (urban concentration). A measure of R&D intensity (business R&D as a ratio of GDP) is first introduced as an additional determinant in the augmented Solow model

Table 9. **Geography and the effectiveness of structural policies**[1]

Dependant variable GDP per capita	Level AR(1)	Level AR(1)	Level AR(1)	Level AR(1)	Level AR(1)	Level AR(1)	Level AR(1)	Level AR(1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Physical capital	0.209***	0.199***	0.199***	0.222***	0.213***	0.221***	0.218***	0.222***
	(0.021)	*(0.021)*	*(0.021)*	*(0.023)*	*(0.023)*	*(0.023)*	*(0.023)*	*(0.022)*
Human capital	0.240***	0.263***	0.231***	0.203**	0.223**	0.366***	0.469***	0.579***
	(0.087)	*(0.086)*	*(0.088)*	*(0.090)*	*(0.095)*	*(0.115)*	*(0.118)*	*(0.134)*
Population growth[2]	–0.031	–0.027	–0.028	0.018	0.019	–0.009	–0.012	–0.011
	(0.021)	*(0.021)*	*(0.028)*	*(0.035)*	*(0.035)*	*(0.022)*	*(0.023)*	*(0.023)*
Weighted sum market and supplier access		*0.054****	*0.052****		0.041**	*0.038***	*0.048***	*0.041***
		(0.018)	*(0.018)*		*(0.021)*	*(0.019)*	*(0.020)*	*(0.020)*
PMR[3]	–0.035*	*–0.038**	*–0.035**					
	(0.019)	*(0.020)*	*(0.020)*					
PMR * Population density		0.007						
		(0.007)						
PMR * Weighted sum market and supplier access			–0.003					
			(0.010)					
Business R&D[4]				0.027*	0.031*			
				(0.015)	*(0.016)*			
Business R&D * Urban concentration					0.114**			
					(0.056)			
Business R&D * Weighted sum market and supplier access					0.007			
					(0.009)			
Human capital * Urban concentration[5]						0.927***		1.341***
						(0.193)		*(0.251)*
Human capital * Population density[6]							–0.129***	–0.219***
							(0.035)	*(0.047)*
Time trend	0.017***	0.017***	0.017***	0.020***	0.020***	0.018***	0.017***	0.017***
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
Rho[7]	0.843	0.844	0.861	0.857	0.853	0.831	0.827	0.846
Fixed effects								
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample size								
Total number of observations	595	595	595	344	344	696	696	696
Number of countries	21	21	21	21	21	21	21	21

Note: Standard errors are in parentheses. *: significant at 10% level; ** at 5% level; *** at 1% level.

1. The functional form corresponding to the "level" specification is reported earlier in the text. Standard errors are robust to heteroscedasticity and to contemporaneous correlation across panels. All interaction variables are constructed from the demeaned respective variables. That way, the estimated parameters on the non-interacted variables still measure the average effect of these variables.
2. The population growth variable is augmented by a constant factor ($g + d$) designed to capture trend growth in technology and capital depreciation. This constant factor is set at 0.05 for all countries.
3. PMR is the product market regulation index which is built in a 0-6 scale. It is introduced in logs.
4. Due to limitations in data, the sample for regressions involving R&D spending is substantially reduced. This is because data on R&D are generally only available from 1981 to 2003/04, and 6 of the 21 countries do not have sufficiently long series to be included. Note also that private R&D is entered in the regression with one lag.
5. Urban concentration is the share of the country population living in cities of more than 1 million inhabitants.
6. Population density measure is the ratio of population to surface area.
7. *Rho* is the first-order auto-correlation parameter.

(column 4), where it comes out significant (although at the 10% confidence level). The specification with the two interaction terms is then shown in column 5 of Table 9, where the results suggest that the effectiveness of private R&D intensity is significantly influenced by the degree of urban concentration, but not by distance to major markets.[30]

A third policy area where geographic factors might be important is human capital formation. In this case, however, the relevant geographic factor is not distance to world

markets but rather economic density, in particular the degree of agglomeration. A hypothetical benefit of agglomeration is that there are strong knowledge spillovers associated with proximity, whereby "tacit" or informal knowledge is transmitted *via* face-to-face contact. To the extent that such kind of knowledge is related to cognitive skills acquired during formal schooling, reforms that strengthen educational performance may have stronger productivity raising effects in densely populated urban centres than in areas where population density is lower. If this were to be the case, countries where the population is concentrated in large urban areas would benefit more from educational reforms than countries where the population settlement is more dispersed. The preliminary empirical evidence, as reported in the last three columns of Table 9, is inconclusive. Taking the estimates at face value, the impact of human capital on GDP per capita seems to be strengthened by urban concentration, whereas the opposite result is obtained when the density measure is the ratio of population to surface area.

Conclusions

This paper examines how much of the dispersion in economic performance across OECD countries can be accounted for by economic geography factors. More specifically, the proximity to areas of dense economic activity has been examined. To do so, various indicators of distance to markets and transportation costs have been added sequentially as determinants in an augmented Solow model, which is used as a benchmark.

Three measures of distance to markets are found to have a statistically significant effect on GDP per capita: the sum of bilateral distances, market potential and the weighted sum of market access and supplier access. And the estimated economic impact, which varies somewhat across specifications, is far from negligible. For instance, the lower access to markets relative to the OECD average could contribute negatively to GDP per capita by as much as 11% in Australia and New Zealand. Conversely, the benefit from a favourable location could account for as much as 6-7% of GDP in the case of Belgium and the Netherlands. The impact of transport costs on GDP per capita is also found to be statistically significant, albeit less so in economic terms. For instance, differences in transport costs relative to the OECD average contribute to reduce GDP per capita by between 1.0% and 4.5% in Australia and New Zealand. At the other end, the lower transport costs for Canada and the United States contributes to raise GDP per capita relative to the average OECD country, but only by a small margin varying between 0.5% and. 2.5%. These quantitatively smaller effects are consistent with transportation costs being only one aspect of distance-related costs.

Considering the substantial estimated effect that distance/proximity to major markets has on GDP per capita, one issue is whether there is a role for public authorities to subsidise international transport, at least in the most remote countries, so as to partly compensate for additional trade costs incurred. Against this, it can be argued that transport is already subsidised in many ways, if only because transport industries only partly bear the cost of negative externalities such as pollution and road congestion. Moreover, subsidisation involves well-known issues of government failure. Less controversial, public policies can also contribute to reduce the cost of transportation by strengthening competition in transport industries, which have in the past been heavily regulated. However, considering that since the mid-1980s domestic regulation has been eased to some extent, at least in air and road transport, further gains in this area may come

from reductions in regulatory barriers to cross-border freight transport, an area where less progress has been achieved.

Insofar as distance or remoteness may affect the effectiveness of policy, another policy issue is whether the possibility that what constitutes "best practice" in a particular area may differ across countries. Some tentative estimates of these effects have been conducted with respect to product market regulation, human capital and R&D spending. The preliminary results do not provide strong evidence of an impact of remoteness on the effectiveness of policy in these areas. However, there is some evidence that spending on R&D and human capital might have a stronger effect on GDP per capita in countries with higher urban concentration.

Notes

1. The implications of imposing invalid homogeneity restrictions on slope parameters in the context of dynamic panel estimates are discussed in Lee, Pesaran and Smith (1997).
2. The reason is that the number of determinants that can be jointly estimated is limited by available degrees of freedom and risks of multi-collinearity. Hence, the variables can only be tested sequentially with the number of possible permutations rising exponentially with the set of determinants. Sala-i-Martin *et al.*, (2004) have proposed a bayesian method to deal with this standard problem in empirical growth analysis.
3. In principle, a measure of investment in human capital should be used to be consistent with the treatment of physical capital in the basic Solow model. In practice, a proxy for the stock – average number of years of schooling – is used due to the absence of an adequate measure of the flow. However, to ensure consistency with the theoretical model, the measure of stock is introduced both in level and first-difference forms, even in the "level" specification.
4. Following a standard approach in the literature, this constant factor ($g + d$) is set at 0.05 for all countries (Mankiw *et al.*, 1992).
5. Doing so makes it close to a growth rate or error correction model specification, with constraints imposed on the short-term dynamics (see Beck and Katz, 2004, for further details). In that sense, one minus the first-order correlation parameter can be compared with the annual speed of convergence.
6. For a direct comparison, see the results reported in OECD (2003), Table 2.4, second column, on page 81.
7. In fact, the inclusion of specific trend parameters distorts the notion of convergence, since it should then be interpreted as convergence to a different steady-state growth rate across countries (Lee, Pesaran and Smith, 1997, and Islam, 1998). It is therefore not surprising that in such case the estimated speed of convergence of around 19% per annum is higher than when parameter homogeneity is imposed across countries.
8. The sensitivity of human capital to the treatment of the time trend in either level or error-correction specifications can be partly explained by the fact that it is proxied by a variable (average number of years of schooling) that is characterised by a very smooth upward-trend profile over time.
9. In order to minimise the number of determinants shown separately on the graph, the contribution of population growth is lumped with that of physical capital and the contribution of fixed effects cover both year and fixed effects in the top panel and country fixed effects and time trend in the lower panel.
10. The underlying assumption behind the internal distance $d_{ii} = 2/3\sqrt{area_i/\pi}$ is that a country is a disk where all suppliers are located in the center and consumers are located uniformly over the area. An alternative measure consists in using the largest cities in each country both for external and internal distances. This entails some differences depending on the size of the countries. However, the results in this paper proved to be robust to the choice of the distance definition.
11. When variables are compared in yearly changes over the whole panel rather than in levels, the correlation is still very significant, but falls to 50% and 36% between market potential, on the one hand, and market and supplier access, respectively, on the other hand.

12. In that context, the higher calculated total market potential for Canada than for the United States reflects the specific capital-to-capital measure of distance. Whereas the internal distance for the United States is 1 161 km, the capital-to-capital distance between the two countries is 737 km. Hence, this measure of distance gives the US GDP a greater weight for Canada than for the United States itself. This feature disappears when the distance measure takes into account not only the capital but also the biggest cities in each country (see Boulhol and de Serres, 2008).

13. Redding and Venables apply their framework to a cross-section of 101 countries, while Breinlich (2007), highlighting that regional income levels in the European Union display a strong core-periphery gradient, tests the impact of market access using a panel of European regions over 1975-97. Head and Mayer (2007) conduct a similar exercise based on European sectoral data over a shorter period. Concurrently, Hanson (2005) develops a model assuming labour mobility and tests it using data covering US counties. Combes and Overman (2004) present a survey of studies replicating Hanson's approach for various European countries.

14. Based on a cross-section of 148 countries, an earlier study showed that proximity (market potential) explains a significant fraction of the income pattern even after controlling for the usual determinants in Solow-type regressions (Hummels, 1995).

15. As in the second section (Table 1), the human capital parameter is very sensitive to whether country fixed effects are included.

16. Due to the strong correlation between market and supplier access, the specific effect of each indicator cannot be identified. However, the explanatory variable in the model is a weighted sum of the two indicators, the weights being given by structural parameters; see Boulhol and de Serres (2008) for details.

17. This would imply, for example, that the relatively large distance of Australia from world markets compared with the United States accounts for a GDP-per-capita gap of around 12 percentage points (given the values of the sum-of-distances measure reported in Table 3, 0.21.ln(214/119) ≈ 0.12).

18. These estimates are consistent with those shown in Boulhol and de Serres (2008) based on the pure Redding and Venables model in which market and supplier access are the only determinants of GDP per capita, once time and country fixed effects are controlled for.

19. In order to try to overcome the potential endogeneity bias, the sum of distances variable, *Distsum*, is an ideal instrument. Taking advantage of the panel dimension of the data, the effect of this time-invariant instrument is allowed to vary through time. In other words, a set of instruments, $Z_{it} = distsum_i.h_t$, are used where the h_t are time dummies.

20. The overall cost is computed as 1.21 * 1.44 * 1.55 – 1 = 1.7. Border-related costs include policy barriers (tariffs and non-tariffs), information and enforcement costs, as well as costs due to the use of different currencies, rules and legal frameworks.

21. A clear downward trend in the relative price of merchandise transportation appears in the case of air transport, but only if the series is deflated by the GDP deflator rather than the narrower index of manufacturing goods prices.

22. According to Hummels (2007), the weight/value ratio of traded goods has fallen especially for the United States, since the early 1990s: $1 (in real terms) of traded merchandise weighs much less today than in the 1970s. Hummels reports that the real value of trade grew 1.5% per year faster than its weight since 1973. Because the measures above refer to the costs in dollar per kg, and have been constructed on the basis of an unchanged weight/value ratio over time, they underestimate relative the decline in *ad valorem* transport costs.

23. For telecommunications, an alternative approach would have been to look at measures of "distance" such as, for instance, the total outbound international network capacity in each country, either in absolute or per inhabitant. Unfortunately, such measures are typically not available before the 1990s.

24. Trade openness is measured as the average of export and import intensities (*i.e.* as a ratio of GDP) and is adjusted for country size. The adjustment is made by regressing the raw trade openness variable on population size and by taking the estimated residual from that panel regression as the measure of trade exposure that is included as an additional determinant in the augmented Solow specification.

25. Even though the variable does not have a time-series dimension, its estimated impact is allowed to vary over time. The value reported in the bottom panel of Table 6, is the average of all parameter estimates.

26. The statistical tests reported at the bottom of Table 6 indicate that when both year and country fixed-effects are included (column 2), the instruments add little information and are therefore considered as weak.

27. The dispersion across countries of the average (log of) real GDP per capita over the period is 0.191, whereas the standard deviation of the country fixed effects in the estimated steady-state (Table 1, column 1) is 0.161 and $(0.161/0.191)^2 = 72\%$.

28. A similar exercise cannot be replicated concerning the impact of the transport costs variables. The reason is that, as shown in the previous section, the effects of transport costs are robust only *via* their impact on international trade. The fixed effects obtained from a specification that includes trade openness as a determinant of GDP per capita could have been reported, but these would be misleading as transport costs are one of the determinants of trade only.

29. R&D spending was left out from the specifications in previous sections because limitations in data availability would have led to a substantial reduction in sample size (from nearly 600 to around 350 observations), and also because the focus of the study is on economic geography determinants.

30. In this specification, the ratio of R&D spending to GDP is used as a proxy for investment in innovation. Although in absence of knowledge depreciation, a decline in the R&D intensity should not lead to a fall in GDP per capita, the specification implies that a switch to a steady-state corresponding to a lower R&D intensity would entail moving to a path with a lower GDP per capita.

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ANNEX

The Augmented Solow Model

The augmented Solow model in empirical analysis

The Solow (1956) model has been widely used as a theoretical framework to explain differences across countries in income levels and growth patterns. The model is based on a simple production function with constant returns-to-scale technology. In the augmented version of the model (Mankiw, Romer and Weil, 1992), output is a function of human and physical capital, as well as labour (working-age population) and the level of technology. Under a number of assumptions about the evolution of factors of production over time, the model can be solved for its long-run (steady-state) equilibrium whereby the path of output per capita is determined by the rates of investment in physical and human capital, the level of technology, and the growth rate of population. In the steady-state, the growth of GDP per capita is driven solely by technology, which is assumed to grow at a (constant) rate set exogenously in the basic model.

In an earlier analysis, summarised in OECD (2003), a wide range of variables were added to the basic model as potential determinants. For instance, in the specifications based on economy-wide data, the set of additional variables included measures of inflation, indicators of government size and financing, measures of R&D intensity, as well as proxies for financial development and exposure to international trade. Given the large number of potential determinants, as well as their heterogeneity in terms of country coverage and time-series availability, the additional variables were never introduced all at once but rather by groups through various specifications. However, the three basic determinants of the augmented-Solow model – physical capital, human capital and population growth – were systematically included in all specifications. And, the coefficient estimates on these core variables appeared fairly robust to the sequential inclusion of the additional variables.

The long-run relationship derived from the augmented Solow model can be estimated either directly in its level form, or through a specification that explicitly takes into account the dynamic adjustment to the steady state. Estimates of the long-run relationship in static form have been used in the literature (*e.g.* Mankiw, Romer and Weil, 1992; Hall and Jones, 1999; Bernanke and Gürkaynak, 2001), in particular in studies focusing on income level differentials across countries. However, since the model has often been used in the empirical growth literature to examine issues of convergence, some form of dynamic specification has been more common. The two types of specification – static or dynamic – can be expected to yield similar results if countries are not too far from their steady-states or if deviations from the latter are not too persistent.

In principle, a dynamic specification is preferable, even when the interest is mainly on the identification of long-run determinants. This is because persistent deviations from steady-state are more likely to lead to biased estimates of the long-run parameters in static regressions, especially when the time-series dimension of the sample is relatively short, as is the case for this study (maximum length 1970-2004). In practice, estimating dynamic panel equations is also fraught with econometric problems (Durlauf and Quah, 1999). Furthermore, a major drawback with the most common techniques based on dynamic fixed-effect estimators is that only the intercepts are allowed to vary across countries, implying that all countries converge to their steady-state at the same speed, an assumption unlikely to hold even among developed countries.[1]

To address the latter issue, the previous OECD analysis relied essentially on the Pooled Mean Group (PMG) estimator, which allows for short-run coefficients and the speed of adjustment to vary across countries, while imposing homogeneity on long-run coefficients. However, even though the PMG estimation technique is intuitively appealing and perhaps the most suitable under some conditions, it is not without limitations especially when such conditions are not met. For instance, due to the large number of parameters and the non-linear constraints, the maximum likelihood estimation technique is prone to problems of convergence on local optima. And, experience suggests that parameter estimates can be particularly sensitive in presence of multi-collinearity among regressors, with some parameter values being in such cases too large (and unstable) to be plausible.

Formal presentation of the model[2]

The underlying growth framework is the neoclassical growth model augmented with human capital (Mankiw, Romer and Weil, 1992). The production function is Cobb-Douglas:

$$Y(t) = K(t)^{a} H(t)^{b} (A(t)L(t))^{1-a-b}$$

where Y, L, K and H are output, labour, physical and human capital, respectively, and is the level of technology. L and A are assumed to grow exogenously at rates n and g. s_k and s_h being the investment rates in physical and human capital respectively, the dynamics of the reproducible factors are:

$$\dot{k}(t) = s_k(t) A(t)^{1-a-b} k(t)^{a} h(t)^{b} - (n(t)+d) k(t)$$

$$\dot{h}(t) = s_h(t) A(t)^{1-a-b} k(t)^{a} h(t)^{b} - (n(t)+d) h(t)$$

where $k \equiv K/L$ and $h \equiv H/L$ denote the stocks of capital per unit of labour and d is the time-invariant depreciation rate. Under the assumption of decreasing returns to physical and human capital ($a + b < 1$), this growth model generates the following steady states, denoted by *, where $y \equiv Y/L$:

$$Log\, k^{*}(t) = Log\, A(t) + \frac{1-b}{1-a-b} Log\, s_k(t) + \frac{b}{1-a-b} Log\, s_h(t) - \frac{1}{1-a-b} Log\left(g+d+n(t)\right)$$

$$Log\, h^{*}(t) = Log\, A(t) + \frac{a}{1-a-b} Log\, s_k(t) + \frac{1-a}{1-a-b} Log\, s_h(t) - \frac{1}{1-a-b} Log\left(g+d+n(t)\right)$$

$$Log\, y^{*}(t) = Log\, A(t) + \frac{a}{1-a}\left(Log\, s_k(t) - Log\left(g+d+n(t)\right)\right) + \frac{b}{1-a} Log\, h^{*}(t)$$

The steady-state of human capital in the last equation is unobservable, but a log-linearisation leads to:

$$Log\, h^{*}(t) = Log\, h(t) + \xi.\Delta Log\, h(t)$$

ζ being a function of the technological parameters (a,b). Consequently, the income steady-state is given by the following level equation:

$$Log\ y^*(t) = \frac{a}{1-a} Log\ s_k(t) - \frac{a}{1-a} Log\left(g+d+n(t)\right) + \frac{b}{1-a} Log\ h(t) + \frac{b}{1-a}\xi\ \Delta Log\ h(t) + Log\ A(0) + gt$$

(level equation)

The level equation ignores the dynamics to the steady state. A linear approximation of the transitional dynamics can be expressed as follows:

$$Log\ y(t) = (1-\lambda) Log\ y(t-1) + \lambda\ Log\ y^*(t) \quad \Leftrightarrow$$

$$\Delta Log\ y(t) = -\lambda\left[Log\ y(t-1) - \left(\frac{a}{1-a} Log\ s_k(t) - \frac{a}{1-a} Log\left(g+d+n(t)\right) + \frac{b}{1-a} Log\ h(t) + \frac{b}{1-a}\xi\ \Delta Log\ h(t) + g\,t + \psi \right) \right]$$

where $\lambda \equiv (1-a-b)(g+d+\overline{n})$ is the annual speed of convergence and $\psi = Log\ A(0) + g(1-\lambda)/\lambda$ is a constant. In order to obtain the error-correction form, short-run dynamics around the transition path has to be accounted for. Taking the maximum lag as being one, the following is obtained:

$$\Delta Log\ y(t) = -\lambda\left[Log\ y(t-1) - \left(\frac{a}{1-a} Log\ s_k(t) - \frac{a}{1-a} Log\left(g+d+n(t)\right) + \frac{b}{1-a} Log\ h(t) + \frac{b}{1-a}\xi\ \Delta Log\ h(t) + g\,t \right) \right]$$
$$+ a_0 + a_1 \Delta Log\ s_k(t) + a_2 \Delta Log\left(g+d+n(t)\right) + a_3 \Delta Log\ h(t) + a_4 \Delta^2 Log\ h(t)$$

(error correction equation)

The error correction equation could be estimated by imposing the homogeneity of all the coefficients across countries. Such restrictions are generally not supported by the data. An alternative specification, the Pooled Mean Group, proposed by Pesaran, Shin and Smith (1999) consists in allowing short-run coefficients, the speed of adjustment and error variances to differ across countries, while imposing homogeneity on long-run coefficients. Formally, the following specification is estimated:

$$\Delta Log\ y_i(t) = -\lambda_i\left[Log\ y_i(t-1) - \left(\frac{a}{1-a} Log\ s_{k_i}(t) - \frac{a}{1-a} Log\left(g+d+n_i(t)\right) + \frac{b}{1-a} Log\ h_i(t) + \frac{b}{1-a}\xi \Delta Log\ h_i(t) + g\,t \right) \right]$$
$$+ a_{0i} + a_{1i} \Delta Log\ s_{k_i}(t) + a_{2i} \Delta Log\left(g+d+n_i(t)\right) + a_{3i} \Delta Log\ h_i(t) + a_{4i} \Delta^2 Log\ h_i(t) + \varepsilon_{i}$$

ε_{i} i.i.d. across i and t , $Var(\varepsilon_{i}) = \sigma_i^2$

(error correction equation, PMG)

It is common to impose $(g + d)$ in $Log[g + d + n(t)]$ to be equal to 0.05. Based on the Cobb-Douglas production function, the physical and capital shares are equal to a and b, respectively. These two parameters should therefore be around 1/3. Consequently, the coefficients that are consistent with the model above should be close to 0.5 for both $Log\ s_k$ and $Log\ s_h$, with a speed of convergence of around $(1-a-b)(g+d+\overline{n}) \approx (1-1/3-1/3).(0.05+0.02) \approx 0.023$.

The empirical framework above is actually fairly general and consistent with various endogenous growth models, but with different interpretation of the parameters (Bernanke and Gürkaynak, 2001). In particular, the Uzawa-Lucas model generates the following steady state (Piras, 1997; Bassanini and Scarpetta, 2001):

$$Log\ y^*(t) = \frac{a}{1-a} Log\ s_k(t) - \frac{a}{1-a} Log\left(\widetilde{g}+d+n(t)\right) + Log\ h(t) + Log\ A(0) + gt$$

where $\widetilde{g} \equiv g + \gamma_{h^*}$ is the steady-state growth rate of GDP per capita, which is the sum of the exogenous growth rate, g, and of the equilibrium growth rate of human capital per effective unit of labour, γ_{h^*}. Therefore, one can still assume $\widetilde{g} + d = 0.05$. Thus, the steady-state equation is similar to that obtained in the augmented Solow model, but with

the prediction that the coefficient for human capital is equal to one. The transitional dynamics along the stable path is:

$$\Delta Log\ y(t) = -\tilde{\lambda}\left[Log\ y(t-1) - \left(\frac{a}{1-a} Log\ s_k(t) - \frac{a}{1-a} Log\left(\tilde{g} + d + n(t)\right) + Log\ h(t) + \xi\ \Delta Log\ h(t) + g\ t + \psi \right)\right]$$

with the speed of convergence given by: $\tilde{\lambda} \equiv (\tilde{g} + d + \overline{n})(1-a)/a$. There are two differences with the transitional dynamics in the augmented Solow model. First, the human capital coefficient is equal to one in the Uzawa-Lucas model instead of around 0.5 in the augmented Solow specification. Second, the speed of convergence is much faster in the Uzawa-Lucas approach, as a reasonable order of magnitude is $\tilde{\lambda} \approx (1-1/3)/(1/3).(0.05+0.02) \approx 0.14$ instead of 0.02 previously.

Notes

1. The implications of imposing invalid homogeneity restrictions on slope parameters in the context of dynamic panel estimates are discussed in Lee, Pesaran and Smith (1997).
2. This section borrows from Bassanini and Scarpetta (2001).

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TABLE OF CONTENTS

Publicly Provided Services and the Distribution of Households' Economic Resources
François Marical, Marco Mira d'Ercole, Maria Vaalavuo and *Gerlinde Verbist* 9

Improving the Efficiency of Health Care Spending: What Can be Learnt from Partial and Selected Analyses of Hospital Performance?
Espen Erlandsen 49

Globalisation and Employment in the OECD
Margit Molnar, Nigel Pain and *Daria Taglioni* 83

Globalisation and OECD Consumer Price Inflation
Nigel Pain, Isabell Koske and *Marte Sollie* 117

The Macroeconomic Policy Challenges of Continued Globalisation
Karine Hervé, Isabell Koske, Nigel Pain and *Franck Sédillot* 149

Economic Resilience to Shocks: The Role of Structural Policies
Romain Duval and *Lukas Vogel* 201

The Incidence of Carbon Pricing: Norway, Russia and the Middle East
Philip Bagnoli, Jean Château and *Yong Gun Kim* 239

Fiscal Equalisation
Hansjörg Blöchliger and *Claire Charbit* 265

The Contribution of Economic Geography to GDP per Capita
Hervé Boulhol, Alain de Serres and *Margit Molnar* 287

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