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FOREWORD

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This paper proposes a framework for projecting public health and long-term care expenditures. It considers demographic and other (non-demographic) drivers of expenditures. The paper extends demographic drivers by incorporating death-related costs and the health status of the population. Concerning health care, the projections incorporate income and the effects of technology cum relative prices. For long-term care, the effects of increased labour participation, reduction of informal care and Baumol's cost disease *are taken into account. Using this integrated approach, public health and long-term care expenditures are projected for all* OECD *countries. Alternative scenarios are simulated, together with sensitivity analysis. Depending on the scenarios, total* OECD *health and long-term care spending is projected to increase in the range of* 3.5 *to* 6 *percentage points of* GDP *for the period* 2005-50.

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The common indicator to assess fiscal power of sub-central governments is the share of sub-central to total tax revenue. But this indicator says nothing about the true discretion sub-central jurisdictions have over tax rates and the tax base, and it skips revenue from intergovernmental grants entirely. The main purpose of this paper is to develop and analyse a set of more refined indicators that assess the true autonomy sub-central governments have over fiscal resources. In sum, fiscal autonomy is considerably lower than the simple ratio suggests. About 60% *only of own tax revenue is under full or partial control of sub-central governments, and again* 60% *only of transfer revenue is unconditional. Moreover, contrary to the allegations of fiscal federalism theory, much sub-central tax revenue comes from mobile income taxes and is prone to tax erosion. The new database can help assess how fiscal autonomy affects policy outcomes such as public sector efficiency, equity in access to public services or the long-term fiscal stance.*

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TAXATION AND BUSINESS ENVIRONMENT AS DRIVERS OF FOREIGN DIRECT INVESTMENT IN OECD COUNTRIES

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INTRODUCTION

How important are differences in corporate taxation for the investment decisions of multinational enterprises (MNEs)? Over the past decade, interest in this issue has been growing in parallel with the increasing mobility of capital and internationalisation of businesses. Standard models of the MNEs predict that corporate taxation can influence foreign direct investment (FDI) by creating a wedge between the pre- and post-tax returns on investment. The relevant tax wedge, however, depends on whether MNEs' investment is incremental or involves the creation of entirely new plants. Moreover, the size of the wedge depends on the whole set of tax policies implemented by the home and host countries – including, for instance, exemption or credit regimes for foreign source income, withholding taxes on repatriated profits or dividends and FDI-specific tax incentives. Recent studies have also shown that MNEs may *de facto* close the wedge implied by international corporate taxation by implementing "triangular" strategies that exploit cross-country differences in tax policies to defer or avoid tax obligations (Grubert, 2004; Altshuler and Grubert, 2003). Given the uncertainty surrounding the relevant tax wedges and the response of MNEs to them, a large number of studies have explored the issue empirically.[1]

While empirical studies generally find that FDI choices are significantly affected by various measures of corporate taxation, many of them focus on just a few countries (often bilateral relations between the United States and its partners),[2] use tax variables that do not cover important dimensions of bilateral tax regimes (such as the tax treatment of foreign income) and, most importantly, omit to control explicitly for other policies that are likely to be relevant for MNEs' choices – such as border barriers and the domestic business environment. Omission of these variables is likely to bias the estimated tax elasticities because taxation regimes and other domestic policies are often correlated over time and across countries.

This paper looks at the effects of corporate taxation on bilateral FDI stocks in 28 investing countries and their partners, focusing on the OECD area over the 1990s, contributing to previous panel data analyses of the tax/FDI nexus in two main ways. First, the paper relates bilateral FDI with new estimates of tax wedges that include many relevant aspects of FDI-specific taxation. These estimates are based on tax codes and provide marginal effective tax rates (METRs) and average effective tax rates (AETRs) on FDI for each OECD country pair. Second, the paper controls for a large set of additional factors that may affect the attractiveness of a

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country for international investors. These include openness to foreign trade and investment, the cost and regulation of labour, and policies that affect the degree of domestic market competition. Both tax and other policy indicators have a time-series dimension, covering changes that occurred over the sample period. This would seem to be the first analysis of the tax and FDI issue that embodies such a large set of countries and policies over a decade during which many changes were observed both in taxation and other policy regimes. The wide variation over time and across country pairs allows for a better identification of the elasticities of FDI to corporate taxation arrangements.

The empirical approach is novel also in other respects. It is based on Markusen's (2002) "unified approach" to the analysis of MNEs' cross-border investment, in which market size, distance, comparative advantage and scale factors may all drive FDI location choices. This accounts for both market access ("horizontal") and production fragmentation ("vertical") motives for creating or extending foreign affiliates in host countries. Moreover, following Erkel-Rousse and Mirza (2002), the paper is based on a semi-parametric estimation approach that allows to control for a number of unobserved effects (such as cultural or historical linkages between country pairs) possibly impinging on the choice of investment location by MNEs.

Consistent with previous findings, the regressions suggest that corporate taxation has a significant impact on FDI location choices, and that forward-looking measures based on tax codes – including bilateral arrangements and features of foreign income taxation – capture this impact more effectively than simple statutory rates. In keeping with the literature, the largest impact is recorded for AETRs, which account for taxation in infra-marginal investment. While a home country with an exemption system tends to encourage outward FDI, the impact of taxation on FDI is not affected by an exemption or credit system, *i.e.* the estimated elasticities are similar for both exemption and credit system countries.

The results indicate that omission of other policies that shape the business environment of host countries may lead to serious upward bias in tax elasticity estimates. Moving from a simple model specification including only tax policies to a wider one covering also other factors and policies affecting rates of return on FDI significantly lowers the estimated tax elasticities. As a result, the elasticity estimates are on the low side of the range covered by recent surveys of the empirical literature. Moreover, the impact of tax regimes on bilateral FDI appears to be quantitatively limited. On the whole, taxation would seem to be a relatively minor factor affecting the location choices of MNEs as compared with policies affecting the ease of entry for foreign firms, their labour costs and the functioning of product markets in the host country. These results appear to be robust to changes in model specification and estimation methods as well as to accounting for the possibility of FDI diversion from third countries.

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The remainder of the paper is organised as follows. First, the tax elasticities found in previous studies are reviewed. Then, the data and the empirical methodology are described, with a special focus on the indicators used to proxy for FDI taxation and other policies. The following section presents the regression results. Finally, policy implications and directions for future research are discussed.

TAXATION AND FDI: ISSUES AND PAST FINDINGS

Most theoretical and empirical models of MNEs' behaviour or FDI implicitly or explicitly draw upon the so-called OLI approach pioneered by Dunning (1977, 1981), which relates cross-border investment to three main motives – ownership, location and internalisation. In principle, taxation can affect each of them. For example, taxation may influence the incentive of MNEs to establish a foreign subsidiary by increasing or reducing the advantage associated with ownership (*e.g.* tax treatment of royalties, dividend repatriation). At the same time, the host-country corporate tax rate contributes to determine the comparative location advantage that it can offer to international investors relative to other destination countries. More generally, corporate taxation and the tax treatment of foreign corporate income are likely to affect the wedge between the pre-tax and post-tax rates of return on FDI. This will affect the extent to which MNEs can enjoy internalisation advantages relative to the alternatives of exporting or licensing their products in host countries.

A sizeable literature has been devoted to measuring the response of FDI to taxation since the mid-1980s. In their thorough review, de Mooij and Ederveen (2005) provide a useful analysis of these empirical studies that differ mainly by the type of FDI data, the type of sample, the type of tax indicators and the specification of the empirical models.[3] Their analysis explores how these differences in study characteristics affect the magnitude of the tax elasticities. The following subsections summarise their main findings. Table 1 reproduces the "typical" tax elasticities (and semi-elasticities) that they derive in their meta-analysis of studies that use different data and empirical approaches.[4] The general conclusion is that the magnitude of these elasticities varies considerably depending on the characteristics of the studies.

FDI *data*

FDI data are obviously crucial for the estimated tax elasticities. They can be based on cross-border financial flows (or stocks), real activity of foreign affiliates (*e.g.* property, plant and equipment) and count data on the location of subsidiaries. Data on real activity are considered to be more reliable than both count data and financial data for proxying the amount of real capital invested. Count data cannot account for the possible impact of taxation on the amount of investment in foreign

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Table 1. **Comparison of semi-elasticities and elasticities by de Mooij and Ederveen**[1]

	Country STR[2]	State STR[3]	METR[4]	AETR[5]	Micro ITR[6]	Macro ITR[7]	Mean
	Panel A – Average semi-elasticities						
Time Series	–0.8	–6.7	–2.2	–4.6	–0.8	–3.0	–3.0
Discrete choice	2.3	–3.6	0.9	–1.5	2.3	0.1	0.1
Panel data	–1.9	–7.9	–3.4	–5.8	–1.9	–4.1	–4.2
Cross section	–7.8	–13.8	–9.2	–11.7	–7.8	–10.0	–10.0
Mean	–2.1	–8.0	–3.5	–5.9	–2.0	–4.2	–4.3
	Panel B – Average elasticities						
	Country STR[2]	State STR[3]	METR[4]	AETR[5]	Micro ITR[6]	Macro ITR[7]	Mean
Time Series	–1.1	–1.1	–1.1	–1.8	–1.3	–1.3	–1.3
Discrete choice	–0.2	–0.2	–0.2	–0.9	–0.4	–0.4	–0.4
Panel data	–0.7	–0.6	–0.6	–1.3	–0.9	–0.9	–0.8
Cross section	–1.8	–1.8	–1.8	–2.5	–2.1	–2.1	–2.0
Mean	–1.0	–0.9	–0.9	–1.6	–1.2	–1.2	–1.1

1. Elasticities are obtained from a meta-analysis by de Mooij and Ederveen (2005) and are evaluated at the sample mean of tax indicators. The meta-analysis is based on elasticity estimates from studies using firm-level, sectoral and national data.
2. Country statutory tax rate.
3. State statutory tax rate.
4. Marginal effective tax rate.
5. Average effective tax rate.
6. Implicit tax rate computed using micro-level data.
7. Implicit tax rate computed using macro-level data.

Source: De Mooij and Ederveen (2005).

affiliates, while financial data mix real investments with mergers and acquisitions that are likely to respond quite differently to taxation.[5] Existing studies show that both tend to underestimate tax elasticities relative to real activity data. Nonetheless, financial flows are the only widely available data for cross-country (or cross-industry) and time-series analyses of bilateral FDI. Moreover, the available evidence suggests that the potential downward bias on elasticity estimates implied by these data is substantially smaller than the one implied by the use of count data.[6]

Type of sample

Sample types encompass analyses that are purely time-series, purely cross sectional and panel (either industry/time or bilateral/time). The majority of purely time-series and cross-sectional analyses focus on the United States and look at either aggregate FDI or the distribution of bilateral FDI from the United States to foreign countries or from foreign countries to the United States, in some cases distinguishing among destination states. A few similar studies have also looked at

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investments of German MNEs in the European Union. All these analyses have been made using data on real activity. By contrast, panel analyses generally use financial flows (or stock) data that are either aggregated by industry or by bilateral country pairs at the national level (often for relatively small subsets of OECD countries). Meta-analysis results suggest that the "typical" elasticities estimated using panel data are close to the mean elasticity values obtained from a survey of studies covering all data sources and sample types. Table 2, also drawn from de Mooij and Ederveen (2005), shows however that tax elasticity estimates obtained from panel data analyses vary widely across individual studies depending on precise model specifications.

Table 2. **Summary of results from panel data studies**[1]

	Semi-elasticity			Elasticity		
	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Swenson, 1994	1.3	2.7	4.3	0.4	0.8	1.0
Jun, 1994	–0.5	–1.3	3.2	–0.2	–0.4	1.1
Devereux and Freeman, 1995	–1.6	–1.6	0.1	–0.4	–0.4	0.0
Pain and Young, 1996	–1.5	–1.4	1.2	–0.8	–0.7	0.6
Shang-Jin Wei, 1997	–5.2	–5.0	0.6	–1.5	–1.5	0.2
Billington, 1999	–0.1	–0.1	0.0	0.0	0.0	0.0
Gorter and Parikh, 2000	–4.6	–4.6	4.3	–1.3	–1.3	1.2
Broekman and Vliet, 2001	–3.4	–3.5	0.8	–1.0	–1.1	0.2
Benassy-Quere *et al.*, 2001	–5.0	–5.0	3.0	–0.4	–0.4	0.2
Buettner, 2002	–1.5	–1.6	0.6	–0.4	–0.4	0.2
Benassy-Quere *et al.*, 2003	–5.4	–4.2	3.2	–1.6	–1.3	1.0
Desai *et al.*, 2004	–0.6	–0.6	0.0	–0.2	–0.2	0.0
Stöwhase, 2005	–5.3	–4.3	2.7	–1.5	–1.3	0.8
All	–2.9	–2.5	3.5	–0.8	–0.7	1.0

1. The table includes studies using both FDI flows and stock.
Source: De Mooij and Ederveen (2005).

E*mpirical specification*

Model specification issues involve the choice of both non-policy factors and policy factors (other than tax rates) that are included in the regression models. Concerning the former, recent analyses often tend to account for factors related to market size and distance (so-called gravity factors), factor proportions, and firm and/or plant-specific economies of scale; other controls include proxies for agglomeration and openness. Few studies, however, estimate specifications covering all these factors, as would be suggested by Markusen's (2002) "knowledge capital" or "unified" approach that formalises and extends the earlier OLI framework. Turning to tax policy factors, a widely debated empirical issue is whether home countries' different tax treatment concerning foreign-source income (exemption or credit systems) affects investors' responses to changes in host countries'

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taxation.[7] Most studies, however, do not find significant differences in the elasticity of FDI to host-country taxation under alternative foreign source income taxation regimes. Thus, the distinction between credit and exemption countries may not be important in practice, due among other things to excess foreign credit, tax deferral and other tax planning strategies of MNEs (see below).

Inclusion of policy influences other than tax rates or bilateral tax agreements is much less common. Yet, the range of policy controls accounted for in regressions may have an important bearing on the estimated tax elasticities, due to potential omitted-variable bias. This is of course particularly important for policies that are likely to be correlated with the FDI taxation variable, such as border barriers, labour income taxation and product market regulation. The meta-analysis of de Mooij and Ederveen (2005) shows for instance that omission of openness factors can artificially increase tax elasticity estimates.

Tax indicators

A major unresolved issue in this strand of research is the choice of the best indicator for measuring the tax burden on FDI. Three main measures have been proposed: the statutory corporate tax rate in the host country; the implicit tax rate computed using either macro data on corporate tax revenues or firm-level data on corporate tax payments; and the effective tax rate based on host and home country tax codes, bilateral arrangements concerning taxation of foreign income and economic assumptions (*e.g.* about the firm's typical financing and asset structure). As illustrated in the next section, effective tax rates can refer to either marginal or infra-marginal foreign investments.[8]

Apart from the degree of detail contained in these tax measures, they differ mainly in that those based on tax codes are *ex ante* or "forward looking", while those based on tax payments are *ex post*. From an empirical point of view, *ex post* measures have the advantage of reflecting the actual impact of tax codes on the FDI tax wedge. However, they are also likely to reflect other factors, possibly unrelated to taxes (*e.g.* economic conditions). Moreover, they are also likely to be endogenous to the amount and the location of FDI itself. Alternative, "forward looking" measures have opposite properties: they are less exposed to the endogeneity problem and identify mostly tax influences, but they may omit important features of the tax system.[9] These measures are derived from modelling firms' profit maximisation behaviour based on several assumptions on their investment decisions, such as types of assets and forms of financing FDI, which are unlikely to be uniform across countries and over time. However, these assumptions do not usually incorporate MNEs' business and/or fiscal strategies aimed at minimising their tax burden by taking advantage of the possibility to arbitrage among different tax regimes (so-called "tax planning" strategies, see Box 1).

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Box 1. **Tax planning**

Numerous studies have pointed out that tax planning has become an increasingly common phenomenon among the MNEs. International investors have access to alternative methods of financing FDI, arranging transactions between related parties located in different countries and changing the timing of repatriation of income to a parent company. The financial incentives of the MNEs to resort to these strategies are strong. For example, Weichentieder (1996) and Grubert (1998) confirmed a frequent reliance on intra-company loans for financing foreign affiliates in high corporate tax countries in order to exploit a favourable tax treatment for debt-financing. The phenomenon that firms manipulate prices used in intra-firm transactions with a view to reducing total tax liabilities has been confirmed by Grubert and Mutti (1991). Hines and Rice (1994), Harris (1993), Rousslang (1997) and Clausing (1998). Hines and Hubbard (1990) showed that multinationals also adjust the timing of their dividend repatriation from foreign subsidies.

While not accounting for these strategies would clearly tend to overstate the tax burden for MNEs (biasing upwards the forward-looking measures), further research in this area is needed to assess the precise way in which tax planning operates to lower home and host country tax burdens on FDI and the extent of measurement bias from omitting these strategies.* Recently Desai, Foley and Hines (2002), after reviewing affiliate-level data on the behaviour of US companies, suggested that the previous US evidence on the impact of taxation may underestimate the effect of taxation on the behaviour of multinationals. This was based on their empirical finding that the investment pattern of indirectly-owned affiliates of US multinationals was considerably more sensitive to local tax rates than was the investment pattern of directly-owned foreign affiliates.

At the same time, efforts have been made to curb aggressive tax planning activities of MNEs – such as the practice of allocating taxable profits to low-tax countries by manipulating prices in intra-firm transactions (transfer-pricing) and the practice of allocating company debt and the associated reduction for interest payments to subsidiaries in high-tax countries (thin capitalisation). In addition, many countries also responded to these issues by formulating very complex tax codes. Those include deferral of taxes on foreign-source income, apportionment rules of a parent's expenses and special rules on foreign sales corporations. See Gresik (2001) for details.

* See OECD (2007) for further discussion on the forward-looking tax measures and tax planning by MNEs.

Given the various factors at work, the potential bias on tax elasticity estimates implied by the use of the different indicators of tax burden on FDI is unclear *a priori*. Available evidence suggests that, independent of the FDI data and sample type used, estimated elasticities tend to be higher for average effective tax rates on

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infra-marginal investments (AETRs) and macro-based implicit tax rates than for statutory tax rates, effective tax rates on marginal investments (METRs) and micro-based implicit tax rates (Table 1).

Summing up

The results of previous studies provide insights that have several useful implications for the estimation strategy used in this paper. First, there is a consensus that data on real activity of foreign affiliates are ideally the most appropriate to gauge the effects of taxation on FDI. However, such data simply do not exist on a bilateral basis for a sufficiently large set of country pairs and periods. Moreover, the bias implied by the use of more widely available data on financial flows and stocks does not seem to be substantial. Second, within the spectrum of empirical approaches used in this kind of analysis, panel data studies seem to provide tax elasticities that are in the median range of available estimates. Third, from the point of view of obtaining unbiased estimates of tax elasticities, use of "forward-looking" measures would appear to be safer because they reflect only tax factors and reduce the potential endogeneity problems of other measures.[10] The inherent limitations of these measures suggest however to experiment also with other tax indicators. Finally, to obtain unbiased elasticity estimates, it is crucial to control not only for gravity and other factors but also for non-tax policies that influence comparative location advantages by shaping after-tax rates of return on FDI and the more general business environment in which foreign affiliates operate.

DATA, MODEL SPECIFICATION AND EMPIRICAL METHODOLOGY

Tax indicators

The choice of METR *and* AETR

The two most common forward-looking bilateral tax burden indicators for FDI are the marginal effective tax rate (METR) and the average effective tax rate (AETR). These indicators measure the wedge between the pre-tax rate of return on investment earned by a company and the post-tax rate of return earned by its foreign parent, taking into account three dimensions of tax policies: the domestic corporate tax systems of home and host countries, the taxation of cross-border flows of income, and the interaction of tax systems of home and host countries. The main difference between the two rates is that the METR applies to a marginal investment project that earns the minimum required rate of return after tax, whereas the AETR applies to an *infra-marginal* investment project that earns some economic rent, *i.e.* a project that earns after-tax pure profits. The AETR is determined as the difference between the pre- and post-tax economic rent per unit of investment for *a given pre-tax rate* of return divided by the net present value of pre-tax income. The METR is determined as the percentage difference between the

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cost of capital producing zero post-tax economic profit and the post-tax rate of return of an alternative investment as a proportion of the cost of capital.[11]

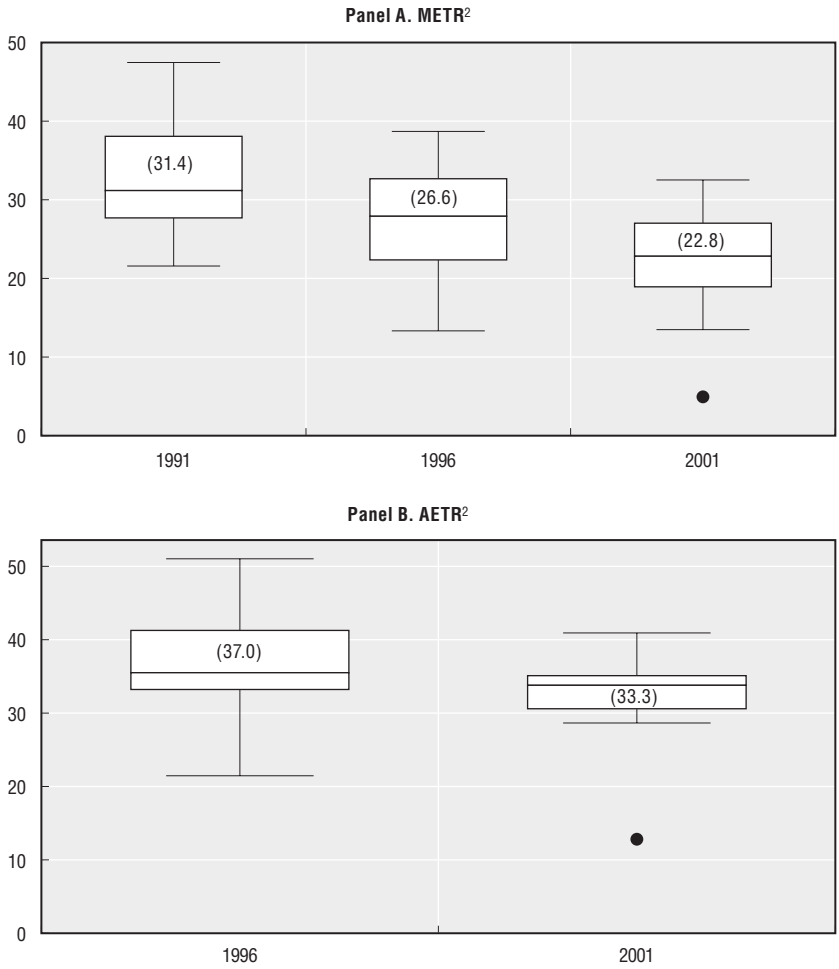
This paper uses recent estimates of these forward-looking indicators by Yoo (2003), who extended previous measures computed by OECD (1991) and the European Commission (2001). Yoo (2003) constructed METR and AETR for 1996 and 2001, and then used detailed information on tax reforms in individual OECD countries in various years to create time-series that change with the evolution of tax codes and bilateral or multilateral agreements. The two measures cover the 1991-2001 and 1996-2001 periods, respectively.[12] As noted by Devereux and Griffith (2002), the AETR tends to be a better measure of the tax burden on FDI than the METR, because the AETR is relevant for decisions regarding lumpy investment, investment in the presence of imperfect competition, or for location decisions of MNEs, which are the most common drivers of FDI.[13] However, both measures are used to test the robustness of the results and also because a longer time-series is available for the METR.

There has been significant change in the effective tax rates on FDI over the 1990s, reflecting tax reforms in many OECD countries. When measured by the METR on *inward* FDI (*i.e.* the METR faced in each host country by a foreign investor from the average OECD country), the tax burden on average fell by 8 percentage points (Figure 1, Panel A). The AETR followed a similar pattern over the second half of the past decade at the same time as tax wedges tended to converge across host countries (Figure 1, Panel B). Nonetheless, substantial variation in tax rates faced by the average investor in different host countries remained, with an approximate 30 (20) percentage points spread between the highest and lowest METR (AETR) in 2001. At the same time, the tax burden faced in each host country by investors from different home countries also varied considerably (Figure 2). For example, the spread between the highest and lowest AETR applying to foreign investors in a given host country (including outliers) ranged from around 10 (France and Belgium) to around 30 (Ireland and Iceland) percentage points. This is partly due to the cross-country differences in withholding tax rates on cross-border flows of dividends and interest income *vis-à-vis* partner countries and the interaction of home and host countries' tax systems.

It bears repeating that these tax indicators do not take into account the possibility of a multinational to reallocate taxable income across different countries with a view to minimising its tax burden. To the extent that tax-planning by MNEs reduces the tax wedges across host countries, the tax indicators will tend to overestimate the cross-country difference in tax burdens. Moreover, these indicators do not incorporate fiscal incentives to foreign investment that are specific to certain regions or spending categories (such as R&D or spending by SMEs). This can be another source of overestimation of the actual tax burden on FDI, especially in countries where entitlements to these incentives are widespread. Finally, the

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Figure 1. **The effective tax rates on inward FDI: Evolution over time of mean and variance across host countries**[1]

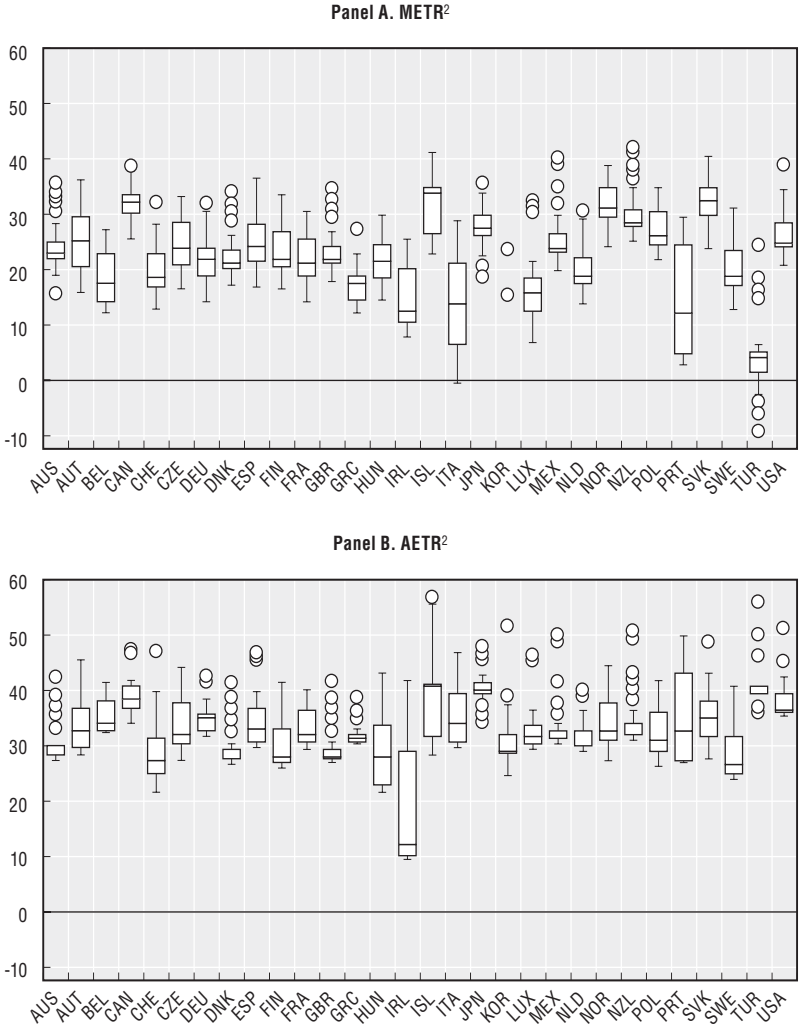


1. An effective tax rate on inward FDI refers to the rate applied to investors of the average investor country on income earned in a host country. A marginal effective tax rate applies to a marginal investment that earns the minimum rate of return after tax, while an average effective tax rate applies to an infra-marginal investment that earns some economic rent, *i.e.* a project that earns more than the minimum required after tax rate of return.
2. The box plot shows in each year the median OECD value of the effective tax rate imposed on inward FDI (the horizontal line in the box), the third and second quantiles of the cross-country distribution (the edges of each box) and the extreme values (the two whiskers extending from the box). Averages provided in parentheses. Dots identify outlier observations. 2001 figures are based on 4.5% inflation to ensure the consistency.

Source: Yoo (2003).

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Figure 2. **Variation across foreign investors of the effective tax rates on inward FDI applied by each host country, 2001**[1]



1. Effective tax rates on inward FDI refer to the rates applied to investors from different home countries on income earned in a host country. A marginal effective tax rate applies to a marginal investment that earns the minimum rate of return after tax, while an average effective tax rate applies to an infra-marginal investment that earns some economic rent, *i.e.* a project that earns more than the minimum required after tax rate of return.
2. The box plot shows for each host country the variation of METR or AETR imposed on the investment from other countries. The median value of the effective tax rate is depicted by the horizontal line in the box, the third and second quantiles of the cross-country distribution by the edges of each box and the extreme values by the two whiskers extending from the box. Dots identify outlier observations.

Source: Yoo (2003).

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tax burden indicators are based on economic assumptions that are tailored to manufacturing, though a large and increasing share of FDI actually concerns non-manufacturing industries.

Nonetheless, these forward-looking indicators are preferred over the measures of the implicit tax rate (ITR) for several reasons. The ITR is calculated as aggregate taxes paid to the host country relative to the pre-tax earning and profits earned in the host country, both of which are available from tax return or accounting data. While the micro-level ITR accounts to some extent for MNEs' "tax-planning" activities, recent evidence indicates that various tax-reducing alternatives to dividend repatriation, such as royalty payments to the parent and "triangular" or "multiple-tier" transactions between the parent and related foreign affiliates, cannot be captured in simple ITR measures.[14] In addition, the ITR reflects a wide range of investments of varying age, duration, asset composition and financing sources by construction. Moreover, international comparisons based on the ITR are made difficult by differences in accounting definitions and the timing of tax payments.

Diversion effects triggered by changes in tax policies in alternative investment locations

In a bilateral setting, FDI from an investor country to a given host country can be affected by changes in tax policies in other countries, which may divert investment to these other locations even though tax policy in the host country has remained unchanged. For this FDI "diversion" to occur, these other locations should be at least as attractive as the host country, abstracting from differences in tax policies. To account for this potential diversion effect, a variable summarising bilateral taxation regimes of the home country with other host countries that are sufficiently "similar" to induce potential crowding out (or crowding in) of FDI from the host country to those other countries (or *vice versa*) was constructed. A similarity index was computed taking into account all non-policy characteristics of host and home country pairs (over sample period averages). For each country pair, similar country pairs were defined as those whose similarity index deviates by no more than one standard error. For each country pair, the diversion variable was then computed as the (simple) average of bilateral METRs or AETRs over this subset of similar country pairs.

Model specification

Regressions are based on a specification derived from Markusen's (2002) reformulation of the OLI model of the MNEs. In this model decisions to export or invest abroad are taken jointly. Moreover, foreign investment decisions can be of the horizontal or vertical type, depending on whether the MNE wishes to access foreign markets or fragment production into different stages. Horizontal investment is usually undertaken to exploit firm-specific knowledge capital of the parent

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firm and plant-specific scale economies of duplicating production in host countries. Vertical investment is usually motivated by the wish to exploit the comparative advantages of the host country. The empirical implementation of Markusen's framework builds on the analysis in Nicoletti *et al.* (2003) but extends the model specification as regards tax indicators discussed above.

Policy and non-policy influences

To subsume both the trade *versus* investment choice by the MNEs and the horizontal *versus* vertical investment motives, the estimated model specification relates bilateral FDI to an array of non-policy factors. These reflect the effects of *i*) gravity and economies of scale (combined market size, distance and transport costs); *ii*) factor proportions (dissimilarity in capital-labour ratios and human capital endowments); and *iii*) plant-specific economies of scale (market size similarity). In constructing gravity variables, market size is proxied by the sum of home and host country GDP and transport costs are computed as the moving average of the difference between the value of imports in the host country and value of exports by the home country.[15] Due to data limitations, the difference between the log per capita GDP in home and host countries is used to construct the factor dissimilarity index proxying the relative differences in the factor endowments of the two countries. Differences in factor proportions are also measured using a dissimilarity index of human capital endowments taking into account the share in population by different education levels and average years of schooling in each level. The size similarity of the two countries is described by an index built in Nicoletti *et al.* (2003). This index captures the relative size of the countries.[16]

Particular care was taken in identifying and measuring policy factors other than bilateral taxation that may have a bearing on FDI by affecting the host-country's business environment and rates of return on investment in foreign affiliates. These factors cover three broad areas: border barriers, domestic product market regulation and labour market arrangements. Border barriers are proxied by the indicator of FDI restrictions of Golub (2003) and by a dummy for participation (of both home and host countries) in any free trade area. Labour market arrangements are captured by two indicators: tax wedges on labour income (from OECD's *Taxing Wages*) and the OECD indicator of employment protection legislation, EPL (OECD, 2004). Product market settings are described by the product of two sets of OECD indicators of anti-competitive regulation: the simple average of the time-series indicators of regulation in seven non-manufacturing industries (Conway and Nicoletti, 2006) and the economy-wide indicator of product market regulation for 1998 (Conway *et al.*, 2005). These indicators measure in complementary ways the extent of barriers to entry and regulatory hurdles faced by firms in the host (or home) country domestic markets. Combining the two indicators allows for a full

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use of available information on product market regulation over the sample period.[17]

Most of these policy variables can be thought to affect the MNE's choice between trade and FDI as well as the type and location of FDI. For example, FDI restrictions can twist decisions towards exporting goods or services, while participation in free trade areas can encourage horizontal FDI that takes advantage of ease of access to and economies of scale of a larger market. Domestic restrictions to competition, regulatory hurdles or high labour costs (as implied by tax wedges or strict employment protection) can deter FDI in a particular location.[18] Given that the MNEs' decision to invest abroad is often driven by a relative location advantage of the host country *vis-à-vis* the home country (*e.g.* in comparing the costs of producing at home and export to local markets *versus* the costs of producing in the local market, or in comparing costs in the home and host country for the purpose of fragmenting production), the variables proxying for domestic product and labour market arrangements in host countries were expressed as a ratio to the corresponding variables in the home country.

FDI

The FDI data used in regressions are drawn from OECD's I*nternational* D*irect* I*nvestment* S*tatistics* Y*earbook* and covers 28 OECD countries over the 1991-2000 period.[19] Regressions are semi-logarithmic and focus on bilateral stocks of FDI between country pairs. Regressions for FDI flows were also run for robustness purposes and yielded similar results.

E*mpirical approach*

Denoting by y the log of the FDI stock, by X a vector of non-policy controls, by P a vector of (non tax) policy indicators, by T the indicator for the relevant tax rate, by α an unobserved component and by u the error term, the general empirical specification of the bilateral FDI model is as follows:

$$y_{ijt} = \sum_{x} \beta_x X_{ijt} + \sum_{P} \beta_P P_{ijt} + \beta T_{ijt} + \alpha_i + \alpha_j + \alpha_t + \alpha_{it} + \alpha_{ij} + \alpha_{jt} + u_{ijt}$$

where i indexes the home country, j indexes the host country and t is the time period. It should be noted that some variables will be specific either to the home or to the host country (*e.g.* FDI restrictions) and will lack the bilateral dimension.

Panel data methods allow controlling for unobserved heterogeneity that is specific to each home and host country, home-host country pair, as well as, for time-varying factors that are common to all countries and specific to home and host countries. The presence of these unobserved influences is particularly likely in bilateral FDI models because country interactions can be affected by institu-

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tions, culture, language, cyclical synchronicity, financial market linkages, *etc*. However, estimating a model capturing all these unobserved effects with a standard fixed effects approach may be problematic due to the extensive number of parameters to be estimated and the associated loss of degrees of freedom. To address this problem, two complementary estimation approaches are used. First, a simplified fixed effect model is estimated, in which the bilateral unobserved components are dropped:

$$y_{ijt} = \sum_x \beta_x X_{ijt} + \sum_z \beta_z P_{ijt} + \beta T_{ijt} + \alpha_i + \alpha_j + \alpha_t + u_{ijt} \qquad \text{FE}$$

Recognising that estimates of this simplified model may suffer from omitted-variable bias, the analysis adopts the "transformed least square" (TLS) methodology introduced by Erkel-Rousse and Mirza (2002) in the context of empirical trade modelling. This approach expresses all variables in terms of deviations from an average home or host country. Thus, for any given variable Z_{ijt} at time *t* the operators Δ_i and Δ_j are defined such that:

$$\Delta_i Z_{ijt} = Z_{ijt} - \frac{1}{I}\sum_i Z_{ijt}$$

$$\Delta_j Z_{ijt} = Z_{ijt} - \frac{1}{J}\sum_j Z_{ijt}$$

Using this approach the two following (home country and host country, respectively) equations can be derived from the general model above:

$$\Delta_i y_{ijt} = \sum_x \beta_x \Delta_i X_{ijt} + \sum_P \beta_P \Delta_i P_{ijt} + \beta \Delta_i T_{ijt} + \Delta_i \alpha_i + \Delta_i \alpha_{it} + v_{ijt} \qquad \text{TLS home country}$$

$$\Delta_j y_{ijt} = \sum_x \beta_x \Delta_j X_{ijt} + \sum_p \beta_p \Delta_j P_{ijt} + \beta \Delta_i T_{ijt} + \Delta_j \alpha_j + \Delta_j \alpha_{jt} + v'_{ijt} \qquad \text{TLS host country}$$

where $\Delta_i\alpha_i$ and $\Delta_j\alpha_j$ represent deviations from the mean (home and host country) fixed effects, $\Delta_i\alpha_{it}$ and $\Delta_j\alpha_{jt}$ indicate home and host country specific deviations that vary over time (proxied in empirical analysis by trends that are specific to the home or host country). Note that the residuals are now re-defined to include both the random errors *and* the deviations of bilateral fixed effects from their means, which are assumed to be i.i.d. random errors.[20]

In the TLS home country specification bilateral FDI stocks and all the explanatory variables are expressed as deviations from the mean of home countries whereas in the TLS host country specification FDI stocks and the explanatory variables are expressed as deviations from the mean of host countries. The advantage

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of the TLS specifications and related assumptions is that in the home (host) country equation all unobserved host (home) country-specific effects as well as common time trends are captured in a non-parametric way before estimating the equation. Thus, only home (host)-specific country effects and home (host)-specific trends need to be estimated. This greatly reduces the number of parameters to be estimated, while leaving the properties of the relevant coefficient estimates unchanged. Thus, the advantage of the TLS home country and TLS host country equations is that the estimated parameters (β_x, β_p, β) are the same as in the general specification and (under the null of i.i.d. random errors) their estimates should also be similar in the two regressions.

REGRESSION RESULTS

In this section regression results are reported for several model specifications that vary mostly according to the number of policy variables used to describe the business environment in the home and host countries. Tax elasticities are estimated, using both the AETR and METR indicators, as well as the host country corporate tax rate. The time period for the panel regressions is restricted to either 1991-99 (METR and corporate tax rate) or 1996-99 (AETR) because the AETR were not available for the whole period. Hence, estimates for the METR and AETR indicators are not strictly comparable because the number of observations differs substantially across regressions. Following the discussion in de Mooij and Ederveen (2005) and Bénassy-Quéré *et al.* (2003), some regressions include a dummy variable describing alternative (exemption or credit) tax schemes in the home country to test whether tax elasticity estimates are influenced by these tax regimes. This variable takes a value of one if an exemption scheme is in operation in a home country and zero if a credit scheme is in operation. Finally, some regressions also include the tax variable expressing bilateral tax policies in other potential investment locations to account for possible FDI "diversion" effects. These effects are usually ignored in empirical studies of tax and FDI and this omission could be a possible source of bias in tax elasticity estimates. In all regression specifications, results are shown for the TLS home country, TLS host country and FE estimation approaches to check the robustness of the estimates to different estimation methods.

Before discussing tax elasticity estimates in the various model specifications reported in Tables 3-6, it is useful to comment on regression results for the basic non-policy variables whose coefficients are remarkably stable across most equations. As already found in Nicoletti *et al.* (2003), coefficient estimates for variables reflecting market size, transport costs, economies of scale (size similarity) and factor proportions are generally significant and signed according to priors. Taken together, the findings of a positive effect of market size similarity and a negative effect of factor dissimilarity support the conjecture that FDI is driven mainly by horizontal (market access) motives among the OECD countries covered by the

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sample. It is also worth noting that, in all specifications, the null of no country or time effects is strongly rejected by the data, pointing to a significant influence of unobserved factors on the intensity of bilateral FDI among country pairs.

Tables 3-5 focus on tax elasticity estimates in the simple model in which no other policies shaping the business environment are included. The results for the AETR and METR computed by Yoo (2003) suggest that effective corporate tax rates have a significant negative effect on FDI decisions by MNEs (Tables 3-4). Depending on the estimation approach, the estimated semi-elasticities suggest that, on average, a one percentage point increase in the METR leads to a 2 to 4.5% fall in the stock of FDI invested in a host country. As expected, the semi-elasticities computed for AETR are larger, with one percentage point increase leading to a 3.5 to 5.5% fall in FDI. The corresponding elasticities are 0.6-1.2 for the METR and

Table 3. **The effect of the AETRs on FDI stocks – years 1996-1999**[1]

	Outward FDI outstock-taxation						
	TLS		FE	TLS		FE	
	Home	Host		Home	Home		
	A	B	C	D	E	F	G
Total GDP	4.508	1.776	0.697	4.532	4.552	0.690	0.679
	[4.22]***	[1.72]*	[0.85]	[4.26]***	[4.29]***	[0.85]	[0.83]
Size similarity	2.505	1.053	0.549	2.521	2.530	0.551	0.544
	[4.76]***	[2.09]**	[1.33]	[4.80]***	[4.83]***	[1.34]	[**1.32**]
Factor dissimilarity	–0.245	–0.335	–0.314	–0.253	–0.250	–0.322	–0.318
	[2.95]***	[4.20]***	[3.69]***	[3.05]***	[3.01]***	[3.78]***	[3.73]***
Human capital	–3.213	–3.685	–3.256	–3.130	–3.120	–3.149	–3.151
dissimilarity	[6.72]***	[7.83]***	[7.08]***	[6.54]***	[6.54]***	[6.89]***	[6.89]***
Transport costs	–0.422	–0.170	–0.363	–0.418	–0.416	–0.359	–0.357
	[2.27]**	[0.77]	[1.63]*	[2.26]**	[2.26]**	[1.62]*	[1.62]*
AETR[2]	–0.057	–0.036	–0.042	–0.053		–0.038	
	[5.38]***	[3.52]***	[4.81]***	[4.76]***		[4.18]***	
TAX exempt				0.418		0.465	
				[1.35]		[1.81]*	
TAX exempt*AETR					–0.051		–0.036
					[4.52]***		[3.90]***
TAX credit*AETR					–0.061		–0.046
					[5.55]***		[5.14]***
Constant	0.082	–0.901	3.797	–0.168	–0.300	3.333	3.907
	[0.02]	[0.40]	[0.16]	[0.04]	[0.07]	[0.14]	[0.17]
Observations	1 609	1 624	1 607	1 609	1 609	1 607	1 607
R-squared	0.774	0.624	0.8471	0.774	0.774	0.848	0.848

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level.
28 home and host countries included.

1. Absolute value of t-statistics in brackets.
2. Average effective tax rate on FDI.

Source: Authors' calculations.

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Table 4. **The effect of the METRs on FDI stocks – years 1991-1999**[1]

	Outward FDI outstock-taxation											
	TLS		FE	TLS				FE			TLS	FE
	Home	Host		Home	Home	Home	Host				Home	
	A	B	C	D	E	F	G	H	I	J	K	L
Total GDP	4.344	1.891	0.885	4.413	4.366	3.829	2.317	0.893	0.885	0.861	3.832	0.861
	[7.18]***	[3.36]***	[2.66]***	[7.30]***	7.22]***	[6.29]***	[4.20}***	[2.68]***	[2.66]***	[2.65]***	[6.29]***	[2.65]***
Size similarity	2.542	1.194	0.681	2.580	2.554	2.238	1.357	0.689	0.682	0.616	2.240	0.616
	[8.62]***	[4.36]***	[4.02]***	[8.76]***	[8.67]***	[7.54]***	[5.01]***	[4.06]***	[4.02]***	[3.72]***	{7.54]***	[3.72]***
Factor	−0.266	−0.358	−0.258	−0.275	−0.267	−0.309	−0.389	−0.265	−0.259	−0.328	−0.311	−0.328
dissimilarity	[4.02]***	[5.35]***	[3.70]	[4.16]***	[4.05]***	[4.67]***	[5.95]***	[3.79]***	[3.70]***	[4.64]***	[4.70]***	[4.64]***
Human capital	−2.463	−2.691	−2.723	−2.372	−2.425	−2.318	−2.600	−2.617	−2.704	−2.411	−2.282	−2.407
dissimilarity	[8.69]***	[9.66]***	[9.38]***	[8.39]***	[8.59]***	[8.27]***	[9.13]	[9.04]***	[9.36]***	[8.66]***	[8.19]***	[8.68]***
Transport costs	−0.603	−0.585	−0.801	−0.596	−0.595	−0.808	−0.823	−0.794	−0.798	−0.959	−0.797	−0.958
	[4.24]***	[3.85]***	[5.88]***	[4.20]***	[4.21]***	[6.04]***	[6.13]***	[5.85]***	[5.86]***	[7.84]***	[5.96]***	[7.82]***
METR[2]	−0.046	−0.027	−0.022	−0.044		−0.038	−0.022	−0.020		−0.017		
	[7.01]***	[5.36]***	[5.37]***	[6.54]***		[5.79]***	[4.39]***	[4.91]***		[4.21]***		
TAX exempt				0.412				0.411				
				[2.25]**				[2.61]***				
TAX					−0.043				−0.021		−0.035	−0.016
exempt*METR					[6.06]***				[4.63]***		[4.93]***	[3.73]***
TAX credit*METR					−0.048				−0.023		−0.041	−0.017
					[7.15]***				[5.17]***		[5.89]***	[3.83]***
EMTR elsewhere						0.015	0.014			0.009	0.016	0.009
						[2.20]**	[2.31]**			[1.49]	[2.38]**	[1.51]
Constant	−1.032	0.885	−2.712	−1.279	−1.159	0.021	0.803	−3.378	−2.739	−1.819	−0.111	−1.827
	[1.10]	[1.41]	[0.30]	[1.35]	[1.23]	[1.35]	[1.30]	[0.38]	[0.43]	[0.21]	[0.12]	[0.21]
Observations	3 099	3 103	3 083	3 099	3 099	2 960	2 960	3 083	3 083	2 935	2 960	2 935
R-squared	0.743	0.639	0.840	0.743	0.743	0.759	0.617	0.840	0.840	0.851	0.759	0.851

N*otes:* * significant at 10% level; ** significant at 5% level; *** significant at 1% level.
28 home and host countries included.

1. Absolute value of t-statistics in brackets.
2. Marginal effective tax rate on FDI.

Source: Authors' calculations.

Table 5. **The effect of corporate tax rates on FDI stocks – years 1991-1999**[1]

	Outward FDI outstock-taxation				
	TLS Host	FE	FE		
	A	B	C	D	E
Total GDP	1.716	0.848	0.861	0.850	0.859
	[3.03]***	[2.53]***	[2.57]***	[2.54]***	[2.39]**
Size similarity	1.111	0.676	0.687	0.685	0.681
	[4.03]***	[3.96]***	[4.02]***	[4.01]***	[3.73]***
Factor	–0.369	–0.275	–0.282	–0.271	–0.275
dissimilarity	[5.48]***	[3.91]***	[4.01]***	[3.84]***	[3.89]***
Human capital	–2.848	–2.884	–2.736	–2.781	–2.885
dissimilarity	[10.26]***	[9.96]***	[9.49]***	[9.65]***	[9.96]***
Transport costs	–0.585	–0.791	–0.782	–0.792	–0.791
	[3.84]***	[5.80]***	[5.77]***	[5.90]***	[5.80]***
Corporate tax rate[2]	–0.000	–0.004	–0.004		–0.003
	[0.02]	[0.40]	[0.40]		[0.38]
TAX exempt			0.523		
			[3.38]***		
TAX exempt*Corporate				0.001	
tax				[0.07]	
TAX credit*Corporate tax				–0.010	
				[1.07]	
Tax elsewhere					0.007
					[0.10]
Constant	0.682	–2.424	–3.296	–2.653	–3.014
	[1.09]	[0.27]	[0.36]	[0.29]	[0.27]
Observations	3103	3083	3083	3083	3083
R-squared	0.635	0.838	0.839	0.839	0.838

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level.
1. Absolute value of t-statistics in brackets.
2. Statutory corporate tax ratel.
Source: Authors' calculations.

0.9-1.5 for the AETR. Comparison with the results reported in Tables 1 and 2 suggests that these estimated elasticities are in line with recent studies using a range of indicators of the tax burden on FDI.

Tables 3 and 4 also explore the impact of credit or exemption systems and the possibility of FDI diversion due to changes in tax regimes in similar host countries (from the point of view of the home country).[21] Consistent with priors, results suggest that *ceteris paribus* moving to an exemption system tends to increase the stock of bilateral FDI. However, in line with previous findings by Slemrod (1990) and Bénassy-Quéré *et al.* (2003), there is no evidence that the response of FDI to changes in either METR or AETR differs across countries that enjoy credit or exemption systems.[22] As to diversion effects, a significant positive coefficient is found for the variable that proxies for taxation in alternative but similar host countries, suggesting that increases in the METR in these countries will tend to divert

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FDI towards the host country (and *vice versa*).[23] Interestingly, taking diversion into account reduces the value of the estimated tax elasticities. Hence, omission of this variable in previous studies may have led to overestimates of tax elasticities.

As previously discussed, one criticism of studies using AETRs and METRs is that they may lead to biased elasticity estimates because these indicators are unable to account for MNEs' strategies aimed at minimising tax burdens (Swenson, 1994). For instance, MNEs can rely on thin capitalisation of high-taxed subsidiaries, defer tax payment in various ways and rely on triangular structures that provide multiple tax advantages.[24] These features are very difficult to model within standard AETR or METR frameworks. An alternative way to capture the importance of tax planning is to assess the direct impact of statutory tax rates on FDI. If tax planning strategies are effective, then these tax rates become more relevant tax indicators for MNEs than the bilateral measures of the tax burden.[25] This conjecture is tested in Table 5, by replacing the METR and AETR with the host country corporate tax rate in the regressions. The results show that the estimated effect of the statutory tax rate is statistically insignificant, suggesting either that this procedure is not capturing the potential impact of tax planning or that tax planning is not so extensive as to fully eliminate the impact of home country taxation and the impact of interaction between the tax systems of both home and host country.

As already mentioned, host country tax rates and bilateral tax arrangements are only two of the policy factors that may affect the attractiveness of a host country for international investors. The regressions in Table 6 extend the basic tax and FDI model to cover a number of other policies that are potentially important for MNEs' location choices, focusing on border barriers, product market regulation and labour market arrangements. Regression results show that the estimated effects of these policies correspond to priors. Increasing openness by participating in a free trade area tends to increase FDI stocks in the host country. The effect of easing FDI restrictions is less clear-cut and lacks robustness across estimation approaches and model specifications, perhaps reflecting insufficient in sample variability of this indicator, especially in AETR regressions. Both relatively high employment protection and labour tax wedges tend to curb FDI stocks and the same is true for anticompetitive regulations. Most of these effects are significant at very high levels and are robust across estimation methods and model specifications. The exception is employment protection, which loses significance in the AETR equations, probably reflecting the fact that very few changes in the indicator have occurred over the 1996-99 period.

These extended regressions can address two questions: What is the effect of including broader measures of the business environment on estimated tax elasticities? What is the relative importance of tax and other policies in determining the FDI attractiveness of a country? The answers they provide are very instructive for tax and FDI analyses and may also have broader policy implications. The results

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Table 6. **The effect of the METRs and AETRs on FDI stocks**[1]

	Outward FDI outstock-full model							
	TLS		FE[2]	TLS		FE[2]	TLS	FE[2]
	Home[2]	Host[2]		Home[2]	Host[2]		Host[2]	
	A	B	C	D	E	F	G	H
Total GDP	5.177	1.428	0.688	8.113	0.094	1.542	1.332	0.644
	[7.86]***	[2.40]**	[2.20]**	[5.48]***	[0.07]	[1.62]	[2.23]**	[2.05]**
Size similarity	3.019	0.956	0.603	4.258	0.119	0.907	0.910	0.594
	[9.50]***	[3.30]***	[3.77]***	[5.94]***	[0.19]	[1.90]*	[3.13]***	[3.69]***
Factor	–0.068	–0.370	–0.206	0.374	–0.104	–0.041	–0.361	–0.197
dissimilarity	[0.57]	[2.57]***	[1.44]	[1.85]*	[0.44]	[0.18]	[2.50]**	[1.37]
Human capital	–1.422	–2.290	–2.110	–3.241	–4.078	–3.377	–2.358	–2.231
dissimilarity	[4.37]***	[6.89]***	[6.46]***	[4.72]***	[7.18]***	[5.97]***	[7.12]***	[6.89]***
Transport costs	–0.453	–0.469	–0.753	0.068	–0.294	–0.241	–0.456	–0.747
	[2.92]***	[3.25]***	[5.32]***	[0.32]	[1.35]	[1.23]	[3.14]***	[5.20]***
METR[3]	–0.020	–0.011	–0.015					
	[2.70]***	[2.12]**	[3.34]***					
AETR[4]				–0.028	–0.007	–0.019		
				[2.22]**	[0.54]	[2.21]**		
Corporate tax							0.012	0.002
rate[5]							[1.02]	[0.19]
Free trade area	0.637	0.547	0.536	0.778	0.432	0.759	0.573	0.565
	[7.99]***	[7.47]***	[7.35]***	[5.12]***	[2.75]***	[5.20]***	[7.84]***	[7.66]***
FDI		–0.039	0.008		–0.086	0.069	–0.047	0.005
restrictions[6]		[1.75]*	[0.97]		[0.83]	[1.46]	[2.05]**	[0.61]
EPL ratio[7]	–0.044	–0.032	–0.049	0.015	–0.009	0.008	–0.029	–0.045
	[2.97]***	[2.07]**	[3.29]***	[0.62]	[0.30]	[0.28]	[1.88]*	[3.00]***
Wedge ratio[7]	–2.598	–3.842	–3.109	–3.828	–4.618	–3.767	–3.923	–3.180
	[12.53]***	[14.02]***	[14.02]***	[8.13]***	[9.80]***	[8.87]***	[14.29]***	[14.30]***
Regulation	–0.098	–0.078	–0.081	–0.074	–0.055	–0.070	–0.076	–0.079
ratio[8]	[5.73]***	[4.50]***	[4.89]***	[3.50]***	[2.46]**	[2.96]***	[4.48]***	[4.86]***
Constant	0.633	–3.127	8.406	1.772	–4.963	–13.617	–3.462	9.296
	[0.69]	[3.95]***	[0.99]	[0.4]	[2.53]***	[0.52]	[4.35]***	[1.10]
Observations	2 366	2 362	2 349	1 015	1 014	1 008	2 362	2 349
R-squared	0.719	0.683	0.844	0.762	0.680	0.867	0.682	0.843

N*otes*: * significant at 10% level; ** significant at 5% level; *** significant at 1% level.

1. Absolute value of t-statistics in brackets.
   Period 1991-99 for METR and 1996-99 for AETR.
2. 21 home and host countries (excluded: The Czech Republic, Hungary, Iceland, Korea, Mexico, Poland and Turkey).
3. Marginal effective tax rate on FDI.
4. Average effective tax rate on FDI.
5. Statutory corporate tax rate.
6. It increases with the intensity of restrictions.
7. Ratio of the EPL and labour wedge indicators in the host and home countries. The ratios increase as EPL or the labour tax wedge in the host country becomes relatively more restrictive.
8. Ratio of indicators of lack of liberalisation in the host and home countries. The ratio increases as product market regulation in the host country becomes relatively more restrictive.

S*ource*: Authors' calculations.

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Table 6. **The effect of the METRs and AETRs on FDI stocks**[1] (*cont.*)

	Outward FDI outstock-full model				
	TLS	FE[2]	TLS		FE[2]
	Home[2]		Home[b]	Host[2]	
	I	J	K	L	M
Total GDP	5.183	0.689	4.818	1.367	0.713
	[7.86]***	[2.20]**	[7.16]***	[2.26]**	[2.27]**
Size similarity	3.025	0.607	2.822	0.923	0.614
	[9.50]***	[3.80]***	[8.69]***	[3.13]***	[3.83]***
Factor dissimilarity	–0.075	–0.207	–0.125	–0.429	–0.196
	[0.63]	[1.45]	[1.05]	[2.89]***	[1.37]
Human capital dissimilarity	–1.356	–2.056	–1.394	–2.271	–2.107
	[4.20]***	[6.30]***	[4.23]***	[6.70]***	[6.45]***
Transport costs	–0.441	–0.744	–0.449	–0.443	–0.754
	[2.85]***	[5.27]***	[2.93]***	[3.07]***	[5.33]***
METR[3]			–0.018	–0.010	–0.015
			[2.38]**	[1.86]*	[3.24]***
TAX exempt*METR	–0.016	–0.017			
	[-2.11]**	[3.56]***			
TAX credit*METR	–0.022	–0.013			
	[2.99]***	[2.65]***			
EMTR elsewhere			0.004	0.002	0.035
			[0.45]	[0.34]	[1.38}
Free trade area	0.632	0.534	0.611	0.521	0.534
	[7.95]***	[7.33]***	[7.43]***	[6.89]***	[7.32]***
FDI restrictions[4]		0.008		–0.047	0.007
		[0.95]		[2.07]**	[0.90]
EPL ratio[5]	–0.044	–0.049	–0.042	–0.030	–0.049
	[2.93]***	[3.24]***	[2.88]***	[2.00]**	[3.28]***
Wedge ratio[5]	–2.620	–3.139	–2.596	–3.789	–3.109
	[12.63]***	[14.09]***	[12.51]***	[13.94]***	[14.00]***
Regulation ratio[6]	–0.099	–0.082	–0.097	–0.078	–0.082
	[5.75]***	[4.91]***	[5.72]***	[4.50]***	[4.94]***
Constant	0.503	8.459	0.949	–3.337	6.452
	[0.54]	[0.99]	1.03	[4.17]***	[0.75]
Observations	2 366	2 349	2 315	2 312	2 349
R-squared	0.719	0.844	0.7224	0.6799	0.8445

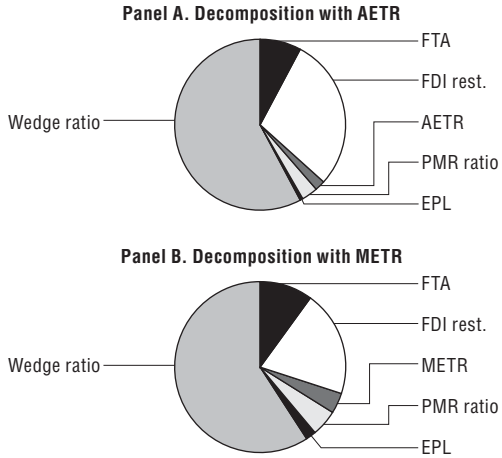
N*otes*: * significant at 10% level; ** significant at 5% level; *** significant at 1% level.

1. Absolute value of t-statistics in brackets.
   Period 1991-99 for METR.
2. 21 home and host countries (excluded: The Czech Republic, Hungary, Iceland, Korea, Mexico, Poland and Turkey).
3. Marginal effective tax rate on FDI.
4. It increases with the intensity of restrictions.
5. Ratio of the EPL and labour wedge indicators in the host and home countries. The ratios increase as EPL or the labour tax wedge in the host country becomes relatively more restrictive.
6. Ratio of indicators of lack of liberalisation in the host and home countries. The ratio increases as product market regulation in the host country becomes relatively more restrictive.

S*ource*: Authors' calculations.

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Figure 3. **Contributions of policy factors to the deviations in FDI**[1]



1. Figures summarise the contributions of different policies to deviations in FDI. Due to illustrative purposes, the contributions of non-policy related factors, as well as home and host country specific effects and time effects are not shown. Contributions are based on the results of host country equations (B) and (E) in Table 6 and are computed taking the average over the estimation period and investor countries.

Source: Authors' calculations.

show that including other policy variables more than halves tax elasticity estimates, suggesting that most empirical studies of the tax and FDI link suffer from a serious omitted-variable bias that grossly overstates the response of FDI to taxes.[26] More importantly, regression results suggest that, while taxation appears to have had a small but significant negative effect on FDI, this effect is dwarfed by the effect of other policies. By way of illustration, Figure 3 shows the average contributions of policy factors to explaining the changes in FDI.[27] Taken together, policies seem to have had a substantial effect on FDI: around 40% of the country-specific deviations of FDI from OECD average are explained by policy factors and 60% by non-policy related factors, as well as home and host country-specific effects and time-fixed effects. However, the decomposition of policy influences confirms that taxation contributes relatively little to explaining FDI compared with other policies. These results, if confirmed by further analysis, would tend to tone down the public debate around the relevance of cross-country differences in corporate tax policies for FDI. Incidentally, this would seem to be in line with business surveys that usually do not put host country taxation at the top of MNEs' concerns when choosing locations. Nonetheless, the fact that there is a tendency for both convergence and decline over time of corporate tax rates calls for further research in this area.

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CONCLUDING REMARKS

There is a growing consensus that taxation matters for FDI, but the extent to which it does so has been subject to debate, and different studies produce varying tax elasticities of FDI. While these studies use a range of tax indicators, most of them concentrate exclusively on taxation ignoring the potential effect of other policies that affect the business environment in the host country where foreign affiliates operate. Empirical studies also generally ignore the possibility that bilateral FDI responds not only to home and host country tax policies and bilateral arrangements, but also to tax policies of countries that would represent valid alternatives as FDI locations for the home country MNEs, because they are similar in economic structure and in other (non-tax) policies.

In this paper, these issues are addressed using a panel of OECD countries over the 1990s to estimate a fairly general model of bilateral FDI. The model includes new forward-looking tax indicators that subsume home and host country tax policies as well as bilateral arrangements governing the tax treatment of foreign source income. The main results, which are summarised in Table 7, can be stated very simply: focusing only on taxation in home and host countries and omitting other policies or diversion effects may lead to a serious overestimation of tax elasticities and their relevance for policy. The simple model including only the tax

Table 7. **Summary table of the estimated semi-elasticities and elasticities of tax rates**

	Basic model (only bilateral tax policies)					
	Home country		Host country		FE	
	Semi-elasticity	Elasticity	Semi-elasticity	Elasticity	Semi-elasticity	Elasticity
METR (1991-2000)	–4.6	–1.2	–2.7	–0.7	–2.2	–0.6
AETR (1996-2000)	–5.7	–1.5	–3.6	–0.9	–4.2	–1.1
	Basic model + tax diversion effects					
	Home country		Host country		FE	
	Semi-elasticity	Elasticity	Semi-elasticity	Elasticity	Semi-elasticity	Elasticity
METR (1991-2000)	–3.8	–1.0	–2.2	–0.6	–1.7	–0.4
	Full model (including non-tax policies effecting the business environment)					
	Home country		Host country		FE	
	Semi-elasticity	Elasticity	Semi-elasticity	Elasticity	Semi-elasticity	Rlasticity
METR (1991-2000)	–2.0	–0.5	–1.1	–0.3	–1.5	–0.4
AETR (1996-2000)	–2.8	–1.0	–0.7	–0.2	–1.9	–0.5

Notes: Elasticities are evaluated at the sample mean of METR and AETR.
Source: Authors' calculations.

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indicators shows tax elasticities and other related results (*e.g.* the lack of sensitivity of elasticity estimates to exemption or credit systems) that are in line with previous studies. However, when proxies are included for a range of border, product and labour market policies or for "tax diversion" of FDI to similar host countries, the results are at variance with the mainstream literature: much smaller tax elasticity estimates were found. Moreover, estimates imply that the effects of taxation on FDI are quantitatively much less relevant than the effects of other policies that contribute to make a location attractive to international investors, such as openness, labour costs and regulatory hurdles. If these results were confirmed using other kinds of data (*e.g.* on activity of foreign affiliates) and tax indicators (*e.g.* backward-looking indicators such as average tax rates), it would mean that empirical analyses that omit these factors are likely to provide a distorted picture of the response of FDI to tax policies and, by grossly overstating such response, would run the risk of misleading the policy debate.

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Notes

1. Hines (1999) and de Mooij and Everdeen (2001, 2005) provide comprehensive overviews of these studies.
2. Devereux and Freeman (1995), Hines (1997), Mayer and Mucchielle (1999), Gropp and Kostial (2000) and Bénassy-Quéré *et al.* (2003, 2005) are recent exceptions.
3. Previous surveys include Hines (1997, 1999).
4. The typical elasticities are obtained using the fitted values for elasticities obtained from regressing elasticity estimates of various studies on a set of study characteristics. The elasticities used as dependent variables in the meta-analysis are computed using the coefficients of the studies reviewed and evaluated at the mean value of the FDI variables and tax rates.
5. Moreover, financial flows may be geographically biased due to MNEs' use of strategically-located holdings to intermediate their real investments.
6. In the meta-regressions of de Mooij and Ederveen (2005), which control for other sources of bias, "typical" elasticity estimates based on count data are significantly lower than those estimated using total financial FDI data.
7. Under the exemption scheme repatriated profits from foreign affiliates are exempt from corporate taxation in a home country and are taxed only according to the host-country tax rate whereas under the credit scheme MNEs are allowed to deduct taxes paid abroad by their foreign affiliates from their tax payments in the home country. Hence, *ceteris paribus* under credit and exemption systems, host country taxes exert different incentives for parent companies to undertake FDI. A multinational residing in a credit-system country could in principle offset the increase in the host-country tax burden and leave its net tax burden unaffected by claiming foreign tax credits in the home country, while a multinational residing in an exemption-system country would not be able to avoid the rise in the host-country tax burden, implying a one-to-one rise in the overall tax burden.
8. All these measures focus on the corporate sector and ignore the possible role played by household taxation regimes.
9. An additional advantage of these measures is that they can be used to simulate the effects of changes in single elements of tax regimes on FDI tax wedges, which is clearly impossible with *ex post* measures.
10. Although in the long run even the forward-looking measures of tax burden may be endogenous as tax codes can be affected by international influences in several ways. For example, competitive pressures from foreign investors may strengthen the incentives for domestic firms to seek reform in tax policies that put them at a competitive

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disadvantage *vis-à-vis* foreign investors. For further discussion of political economy influences and structural policies, see *e.g.* Høj *et al.* (2006).

11. The METR was originally constructed by King and Fullerton (1984) and OECD (1991) for domestic and cross-border investment respectively. The AETR was developed by Devereux and Griffith (1999) and extended by the European Commission (2001) for cross-country comparisons of tax burdens on FDI. The construction of these indicators also incorporates a number of assumptions concerning the financing and asset structure of firms, asset-specific depreciation rates and inflation rates.

12. See Yoo (2003) for a detailed methodology and a description of the tax data used to estimate the METR and AETR.

13. A common reason for an MNE to create a foreign affiliate is to earn an economic rent by exploiting some firm-specific advantage (Markusen, 2002). Due to economies of scale in production, it will choose to build one plant among alternative locations.

14. See, for example, Grubert (1998), Grubert and Mutti (1991), and Altshuler and Grubert (2003).

15. In the sensitivity analysis, the market size was proxied by the product of both home and host country GDP and the results were robust to this change in variable.

16. Other non-policy variables were included in regressions but were dropped in the final specification due to lack of significance, among these R&D intensity, infrastructure endowments, bilateral exchange rates and exchange rate variability.

17. Other policy variables originally included in regressions but subsequently dropped for lack of significance or multicollinearity includes the Ginarte and Park (1997) indicator of intellectual property rights and an indicator of tariff and non-tariff barriers.

18. Alternatively, MNEs may be attracted by a weakly competitive environment to exploit market power.

19. To construct a balanced panel, some missing data were filled by setting (missing) outward FDI stocks from country *i* to country *j* equal to inward FDI stocks of country *j* from country *i*.

20. In other terms:
$v_{ijt} = \Delta_i u_{ijt} + \Delta_i \alpha_{ij}$
$v'_{ijt} = \Delta_j u_{ijt} + \Delta_j \alpha_{ij}$
This is the same assumption made by Erkel-Rousse and Mirza (2002).

21. Specifications assessing the impact of tax exemption *versus* credit system are reported only for home country and fixed-effects specifications since this is a home country characteristic and using the TLS methodology such characteristics are, by definition, captured in a non-parametric way in the host country specification. For further discussion, see the previous section and Erkel-Rousse and Mirza (2002).

22. As suggested by Tanzi and Bovenberg (1990) and Altshuler and Newlon (1993), excess foreign credit positions and tax planning strategies of MNEs may make the distinction between credit and exemption countries unimportant in practice.

23. Unfortunately, the sample period is too short to estimate the corresponding effect on AETR regressions.

24. See OECD (2007) for a long list of such strategies in both exemption and credit systems.

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25. Alternatively, if deferral was the main form of tax planning, the relevant tax variables could be AETR and METR of the host country alone (excluding taxation in the home country).

26. The results concerning credit and tax exemption schemes as well as the variable capturing possible FDI diversion are relatively robust to the inclusion of other policy variables, although the statistical significance of the FDI diversion variable is reduced.

27. Contributions are based on the results of host country equations (B) and (E) in Table 6, and are computed taking averages over the estimation period and home countries.

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PRODUCT MARKET REGULATION AND PRODUCTIVITY CONVERGENCE

Paul Conway, Donato de Rosa, Giuseppe Nicoletti and Faye Steiner

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INTRODUCTION

Product market regulation in the OECD area has generally become less restrictive of competition over recent years. This has lead to a degree of convergence in regulatory policies, but nonetheless, the productivity performance of OECD countries has become increasingly disparate. Indeed, according to some measures, the growth rates and levels of labour productivity have recently begun to diverge. Recent developments in the theory and empirics of growth suggest that cross-country productivity patterns may partly reflect differences in the policy and institutional environment (Acemoglu *et al.*, 2004; Aghion and Griffith, 2005; Nicoletti and Scarpetta, 2003).

Against this background, this paper investigates the link between anti-competitive product market regulations and the international diffusion of productivity shocks using a productivity model that relates productivity growth to improvements in the global technology frontier and the speed of the catch up process (Griffith *et al.*, 2004). As well as looking at the *prima facie* evidence of a link, the paper also investigates two channels through which regulations that curb competition might affect the diffusion of best practice production techniques. In particular, building on the work of Gust and Marquez (2004) and Nicoletti *et al.* (2003) the influence of anti-competitive regulation on the adoption of information and communications technology (ICT) and the location decisions of multi-national enterprises is assessed. Depending on data availability, the analysis is conducted at both the aggregate business sector and sectoral levels.

The empirical results indicate that restrictive product market regulation slows the process of adjustment through which positive productivity shocks diffuse across borders and new technologies are incorporated into the production process. In some of the more restrictive OECD countries the loss of adaptability that occurs as a result of anti-competitive regulation can be sizeable. For example, estimates suggest that the improvement in domestic labour productivity that arises in these countries as a result of a one-off positive shift in the world productivity frontier can be up to 25% smaller than in a country in which product market regulation in non-manufacturing sectors is the least restrictive in the OECD. In all the countries included in the study the detrimental effect of anti-competitive regulation is larger in sectors that produce or use ICT intensively. This is because the regulatory barriers to diffusion tend to be higher in these sectors in comparison to the rest of the economy. As a result, the gap in productivity improvement in

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restrictive countries following a shift in the world productivity frontier can be as high as 40% in these sectors, relative to the most liberal countries.

Because relatively liberal countries benefit from improvements in the world productivity frontier more quickly than countries with more restrictive policy regimes, the cross-country dispersion of productivity levels is found to increase in the wake of a positive global productivity shock. In times of rapid improvements in the productivity frontier the positive effect of pro-competitive regulations on the speed of catch-up is amplified, increasing the dispersion of productivity levels across countries in which the stringency of product market regulation differs. These results imply that the emergence of new general-purpose technologies over the 1990s could partially explain divergent productivity trends, despite a degree of recent convergence in product market regulation across countries.

The results of simulating the productivity model suggest that the gains from further product market reform may be considerable, especially in countries that operate at some distance from the world productivity frontier. For example, if OECD countries had aligned regulation in non-manufacturing sectors on that of the least restrictive OECD country, the increase in annual productivity growth due to faster catch-up over the period 1995 to 2003 is estimated to range from 0.2 percentage points in the United Kingdom – which has one of the least restrictive regulatory environments according to OECD indicators – to 1.8 percentage points in Greece. In a number of countries, the average increase in annual productivity growth over this period given a liberal regulatory environment is estimated to be greater than 0.75 percentage points, implying substantial long-run gains in the level of productivity and a continuation of the process of productivity convergence. The gains from further product market reform are estimated to be largest in ICT-intensive sectors, where product market regulation is also found to have a direct impact on labour productivity growth.

The analysis in the second part of the paper finds that the link between product market regulation and productivity catch up can be traced to two factors. Overall, product market regulation is found to be a significant determinant of investment in ICT, with relatively liberal countries more successful at incorporating ICT into the production process than relatively restrictive countries. In the United States since the mid-1990s, for example, ICT investment as a share of total investment is estimated to have been more than four percentage points above the OECD average of 15% as a direct result of the relatively liberal regulatory environment. On average across countries for which data exist, estimates suggest that ICT investment as a share of total investment would increase by around 2.5 percentage points if countries adopted the regulatory stance of the least restrictive OECD country in each sector. For some countries the additional investment in ICT that would result from such a move represents a substantial increase in the existing stock.

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Confirming previous findings (Nicoletti *et al.*, 2003) there is also evidence that a restrictive regulatory stance curbs the establishment of foreign affiliates of multinationals, which is also likely to inhibit the international diffusion of technology. Ongoing reform of product market and foreign direct investment regulation is estimated to considerably increase the activity of foreign affiliates in some countries.

The rest of the paper is structured as follows. The second section briefly outlines recent developments in product market regulation and labour productivity in the OECD area. The model that is used to test the influence of product market regulation on productivity growth, the results of the estimation and some illustrative simulations are presented in the third section. In the penultimate section, additional panel data regressions are used to investigate the effect of product market regulation on the two potential transmission channels mentioned above. A final section suggests some steps for further research in this area.

PRODUCT MARKET REGULATION AND LABOUR PRODUCTIVITY IN THE OECD: CONVERGENCE AND DIVERGENCE?[1]

Regulation

In the empirical work that follows, two sets of indicators are used to measure product market regulation at the economy-wide and sectoral levels respectively:

- An aggregate indicator of regulatory conditions in seven non-manufacturing sectors – covering energy (gas, electricity), transport (airlines, railways, road freight) and communications (post and telecoms) – is used as a proxy for economy-wide product market regulation. While this indicator misses important aspects of economy-wide regulation, it includes some of the sectors in which anti-competitive regulation is concentrated in OECD countries, given that manufacturing sectors are typically lightly regulated and open to international competition. In addition, this indicator is highly correlated with a cross-section indicator of economy-wide product market regulation in the years in which they overlap, suggesting that the former is a reasonable proxy for the latter.[2] This indicator has been estimated for 21 OECD countries over the period 1975 to 2003 and is therefore well suited to time-series analysis.[3]
- At the sectoral level the time-series indicators of anti-competitive regulation discussed above, as well as cross-section indicators of regulation in retail distribution, banking and business services are used to compute indicators of the "knock-on" effects of regulation in non-manufacturing sectors. These indicators, called the regulation impact indicators, are predicated on the notion that anti-competitive regulations in non-manufacturing sectors not only have a direct influence on market conditions in these sectors, but also have a less visible impact on the cost structures faced by firms that use the output of non-manufacturing sectors as intermediate inputs in the production process.[4] For each sector in a particular country the

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regulation impact indicator is calculated as a weighted average of the indicators of regulation in non-manufacturing sectors. The weights used in the calculation are total input coefficients, derived from (harmonised) input-output tables, which measure the extent to which intermediate inputs from each of the non-manufacturing sectors are used in the final output of each sector in the economy (Yamano and Ahmad, 2006). These indicators exist for 39 ISIC rev. 3 sectors in 21 OECD countries over the period 1975 to 2003.

According to the aggregate indicators of regulation in transport, energy and communications sectors, product market regulation has become more conducive to market mechanisms in the OECD area in recent years as governments have liberalised potentially competitive markets, re-regulated natural monopoly markets establishing pro-competitive regulation where possible, and privatised previously state-owned assets. Given different starting points and patterns of reform, cross-country differences in the stance of product market regulation increased across the OECD in the 1980s and 1990s. From the late-1990s, however, the dispersion in policy stance has fallen in part because regulation in the Euro area and former transition countries has moved towards that of the more liberal countries (Conway and Nicoletti, 2006). Notwithstanding this convergence, however, product market regulation in the OECD area is still characterised by significant differences across countries (Conway *et al.*, 2005).

One feature of the sectoral regulatory indicators that is germane for the empirical results that follow is that the knock-on effects of anti-competitive regulation in non-manufacturing sectors is typically largest in sectors in which ICT is used intensively (Figure 1). This reflects the fact that these sectors tend to be more exposed to anti-competitive regulation in non-manufacturing sectors relative to other sectors. The impact of regulation on ICT-using sectors is particularly high in many continental EU countries, Japan and Canada. In addition, the cross-country variation in the regulation impact indicators is also largest in ICT-using sectors.

P*roductivity*

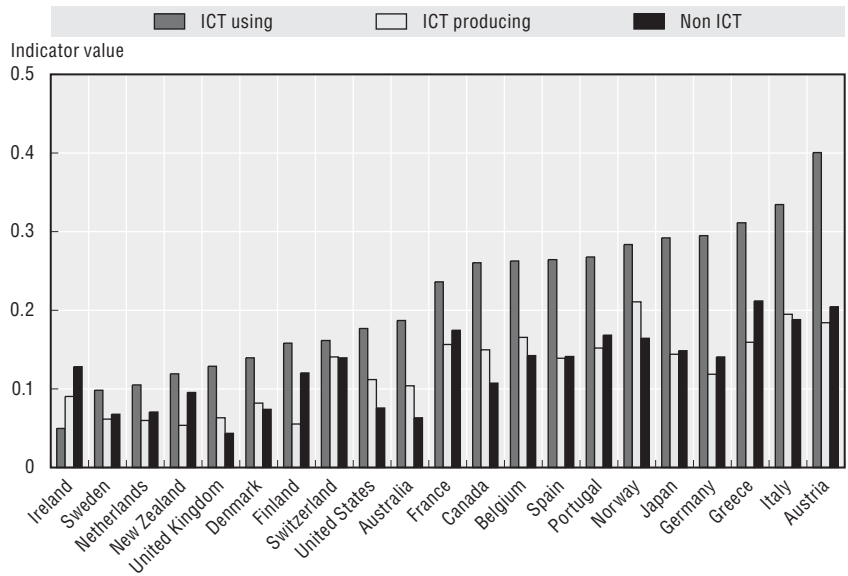
In the empirical work that follows, labour productivity at the aggregate level is calculated as the ratio of business sector GDP to business sector employment, while at the sectoral level labour productivity is calculated as value-added per person employed in each industry.[5] To ensure comparability across countries, the output values used to estimate labour productivity are converted into prices denominated in a common currency using purchasing power parities (PPP). For both the sectoral and business sector productivity estimates this has been done using aggregate PPPs.[6]

As illustrated in detail in OECD (2003a), productivity performances have varied markedly across countries over the past two decades and the process of catch-up

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Figure 1. **The impact of regulation on ICT-producing, ICT-using and non-ICT intensive sectors, 2003**[1]

The scale of the indicators is 0-1 from least to most restrictive



1. These data are the simple averages of the regulation impact indicators for the individual industries included in ICT-producing, ICT-using, and non-ICT intensive sectors in 2003. The classification of sectors as ICT-using, ICT-producing, and non-ICT intensive is discussed in the data annex. The data is ordered according to the indicator values for ICT-using sectors.

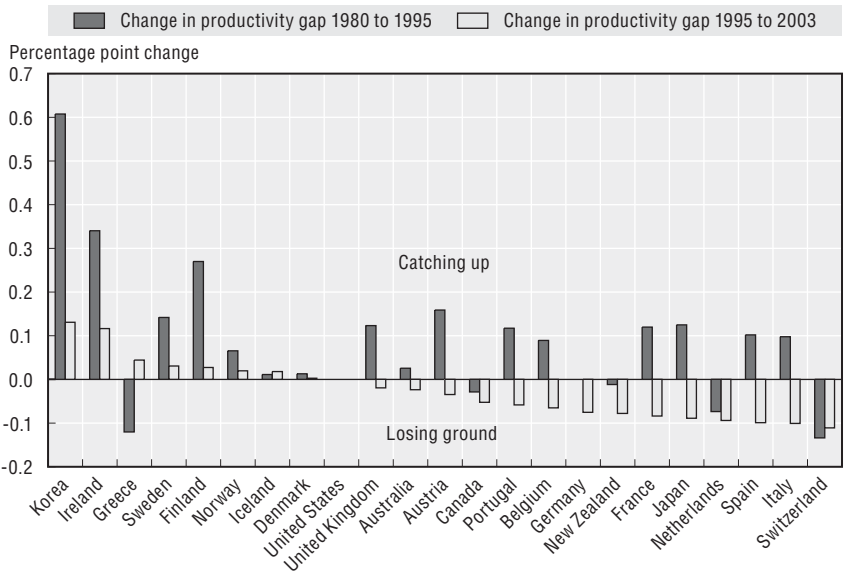
Source: OECD International Regulation Database.

has been stalling for several years. From 1995, only a few high-growth countries have continued to converge towards the productivity levels of the United States (Figure 2).

To some extent these disparities in productivity growth reflect differing degrees of adaptability across countries to recent technology shocks (OECD, 2003b). In the United States, a large proportion of the increase in labour productivity in the second half of the 1990s originated in sectors that either produce or intensively use ICT (Figure 3). A few other countries – for example, Ireland, Australia, Finland, Mexico, Portugal and the United Kingdom – also experienced accelerating productivity growth in these sectors in the second half of the 1990s. In a number of countries, however, the contribution of ICT-producing or using sectors to productivity growth has typically been smaller than in the United States and even declined in several of them over the 1990s.[7]

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Figure 2. **Change in productivity levels relative to the United States**[1]

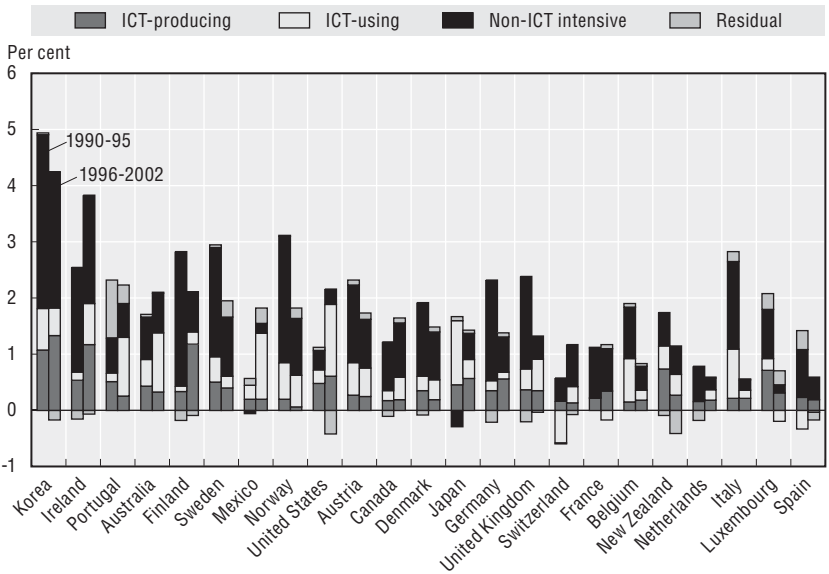


1. Based on cyclically-adjusted series of business sector output and employment (Hodrick-Prescott filter, lambda = 100, data extended to 2006 using OECD medium-term projections to mitigate the end-point problem inherent with this filter). The productivity gap is the (log) difference between business sector labour productivity per employee in each country and the United States. Countries are ordered according to the change in the productivity gap in the most recent period.

Thus, although ICT is a "general purpose" technology and readily available in worldwide markets, only a limited number of OECD countries have been reaping its significant potential benefits to the full. This hints at the potential role of policy and institutional factors in explaining the differing abilities of countries to produce ICT and integrate these technologies into the production process. It also suggests a potential explanation for the apparent paradox of diverging productivity trends across countries in conjunction with a degree of regulatory convergence. If restrictive product market regulation reduces incentives to innovate and increase efficiency it may increase barriers to implementing new technologies and slow down the associated productivity enhancements. Therefore, cross-country differences in regulation may have a stronger influence on productivity patterns in times of rapid technological innovation. The emergence of ICT in the second half of the 1990s may have amplified the effect of remaining cross-country differences in anti-competitive regulation, which were still significant. Indeed, at first glance, countries with a relatively liberal approach to competition have tended to experience a greater acceleration in productivity growth after 1995 (Figure 4).

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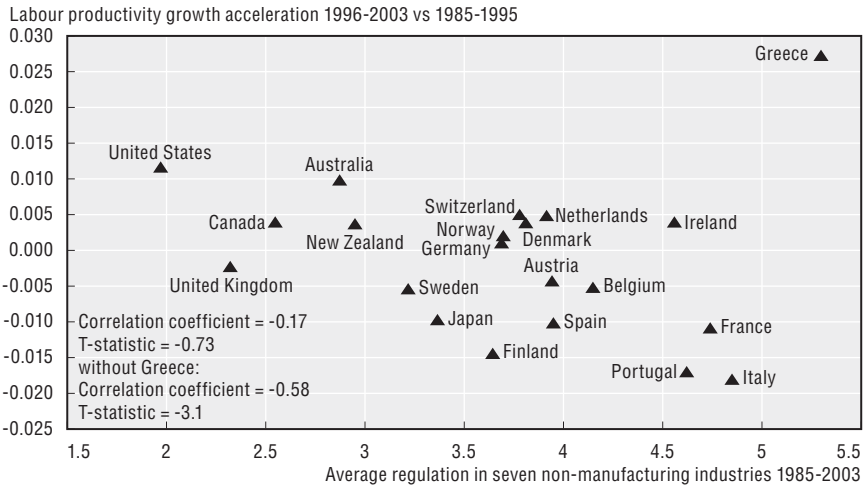
Figure 3. **Contributions to aggregate labour productivity growth**[1]



1. Annual average contributions to the growth of total value-added per person employed, in percentage points. The residual reflects adding up differences in aggregating from sectoral to the aggregate economy level. Countries are ordered according to labour productivity growth in the most recent period.

Source: Pilat, Lee and van Ark (2002) (updated).

Figure 4. **Product market regulation and labour productivity acceleration**



Source: OECD Productivity Database and OECD International regulation database.

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DOES REGULATION AFFECT PRODUCTIVITY GROWTH?

The model

To test the effect of regulation on catch-up to best practice, a model of labour productivity based on the work of Aghion and Howitt (2005) is estimated at both the aggregate business sector and sectoral levels. In this model, labour productivity growth in a given country or sector depends on its ability to keep pace with growth in the country with the highest level of labour productivity (the productivity leader) by either innovating or taking advantage of technology transfers. In turn, this possibility is affected by the policy environment in follower countries or sectors. In particular, Aghion and Griffith (2005) stress the role played by institutions that promote (or hinder) firm rivalry and/or entry of new firms in raising (or curbing) incentives to enhance productivity. In the model presented here these institutions are proxied by the OECD indicators of anti-competitive regulations described earlier. The estimated equation is:[8]

$$\Delta \ln LP_{ijt} = \delta(\Delta \ln LP_{ijt}^{leader}) + \sigma(\text{prodgap}_{ijt}) + \gamma PMR_{ijt} + \alpha(PMR_{ijt} * \text{prodgap}_{\text{ijt}}) + \\ + X'_{ijt}\beta + \text{country/industry/time dummies} + \varepsilon_{ijt}$$

with $\varepsilon \sim N(0, \Sigma)$

In this equation, the indices *i*, *j* and *t* denote countries, industries and years, respectively; LP denotes labour productivity; *prodgap* is the "productivity gap" – which is measured as the (log) ratio of the level of productivity in each country or sector relative to that of the productivity leader – and PMR is the appropriate indicator of anticompetitive product market regulation. The matrix X contains various control variables. Country, industry and country-industry fixed effects are included as appropriate so as to account for unobserved time-invariant factors affecting productivity growth in a particular sector or country (*e.g.* natural endowments or location). Time dummies are also included to control for global productivity shocks in any given year.

In this model, labour productivity shocks in the leader country or sector can have a direct effect on labour productivity growth in follower countries, the strength of which is measured by the coefficient δ. In addition, this equation also allows for the possibility that the difference in productivity levels between each country or sector and the productivity leader influences labour productivity growth. If the coefficient σ is negative and significant then the further a given country or sector is from the technological frontier the greater the scope for productivity improvements arising from technological catch up. Clearly, the higher is σ (in absolute value) the faster the catch up process.

Product market regulation can influence labour productivity growth directly – the strength of which is measured by the coefficient γ – and indirectly by affecting

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the speed with which countries catch up to the productivity leader. This indirect channel is included in the model by allowing regulation to interact with the technology gap term. This allows for the possibility that by creating barriers to entry or hindering competition amongst incumbents, anti-competitive regulation may reduce incentives to invest and adopt leading production techniques, thereby lowering the speed with which countries/sectors catch up to the productivity leader. A positive and significant value of the coefficient on this term, α, implies that more restrictive product market regulation hinders the diffusion of productivity shocks from the productivity leader.

Reflecting data availability, the aggregate business sector model is estimated over the period 1978 to 2003 for the subset of 21 OECD countries for which the aggregate indicator of regulation in seven network sectors exists. The sectoral version of the model is estimated for 20 sectors over the period 1981 to 2003 for the same countries except Ireland, given the lack of sectoral productivity data for this country. It is useful to recall at this stage that regulation in the sectoral model is proxied by the regulation impact indicators described above, which cover both manufacturing and non-manufacturing industries over the sample period.

R*esults*

The results of estimating the business sector and sectoral versions of the labour productivity model are given in Table 1 (Panels A and B). In principle, the influence of capital deepening and factors related to the quality of human and physical capital used in production should already be reflected in the productivity catch up term. However, these factors could also have a direct effect on the ability of an economy (or sector) to respond to shifts in the global productivity frontier. This would be the case, for instance, if a more educated labour force, a higher capital intensity and/or a deeper familiarity with ICT technologies were to facilitate the transfer of technology from the leader to follower countries. To account for this possibility, we include as control variables proxies for aggregate or sectoral human capital, change in the capital stock per employee, and the share of ICT in total investment. Moreover, we also include the output gap in the aggregate model to account for purely cyclical changes in productivity.

In terms of these control variables, the output gap, human capital (measured as the average years of education in the population) and, to a lesser extent, the share of ICT investment in total investment are found to significantly influence productivity growth in the business sector version of the model. Growth in the productivity leader becomes insignificant when the ICT-share in included in this regression suggesting that the latter captures the effects of shifts in the productivity frontier.[9] At the sectoral level, the change in the capital stock per employee has a positive and significant effect on labour productivity growth. The proxy for

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Table 1. **Results of productivity growth regressions**[1]

Panel A. Aggregate business sector		
Dependent variable: Growth in labour productivity per employee		
Constant	–0.191***	–0.326***
	(0.058)	(0.087)
Change in productivity in the technology leader	0.249***	–0.126
	(0.075)	(0.418)
Gap in productivity levels (lagged one year)[2]	–0.295***	–0.399***
	(0.052)	(0.077)
Product market regulation[3]	0.002	0.005
	(0.004)	(0.004)
Effect of regulation on catch up (interaction of regulation and productivity gap) (lagged one year)	0.017**	0.026**
	(0.009)	(0.011)
Output gap[3]	0.092**	0.097*
	(0.036)	(0.051)
Human capital[4]	0.012**	0.023***
	(0.005)	(0.009)
ICT investment (as a share of total non-residential investment)[4]		0.131*
		(0.069)
Country fixed effects (jointly significant: F)	Yes	Yes
Country time trends (jointly significant: F)	Yes	Yes
Time dummies (jointly significant: F)	Yes	Yes
Observations	518	288
R-squared	0.27	0.429

Notes: Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.
1. The aggregate business sector model is estimated for 21 OECD countries over the period 1978 to 2003.
2. Measured as the difference in the (log) level of productivity in each country relative to the productivity leader. The productivity leader is allowed to change over time.
3. Regulation is measured as the average of the indicators of regulation in seven non-manufacturing industries.
4. Data definitions are given in the Annex.

human capital, however, is insignificant and data for ICT shares by sector is too sparse to be used as a control in these regressions.

In both versions of the model, labour productivity growth in the productivity leader is typically found to have a positive and highly significant influence on productivity growth in less productive countries and sectors. In addition, the coefficient on the "productivity gap" is always negative and highly significant. Thus, the importance of international diffusion of best practice production techniques as a source of productivity growth increases the further a country is from the world technological frontier. These results highlight the important role of catch-up as a driver of productivity growth, reflecting a high degree of economic integration in the OECD area and the fact that technological innovation usually occurs in a given region or country.[10]

In both versions of the model, no overall direct effect of anti-competitive regulation on productivity growth is found in the base regressions. However, when the coefficient on the direct effect of regulation is estimated separately for

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Table 1. **Results of productivity growth regressions**[1] (*cont.*)

Panel B. Sectoral				
Dependent variable: Growth in labour productivity per employee				
Constant	–0.035**	–0.066	–0.405***	–0.019
	(0.016)	(0.046)	(0.110)	(0.025)
Change in productivity in the technology leader	0.091***	0.104***	0.109***	0.106***
	(0.012)	(0.014)	(0.017)	(0.015)
Gap in productivity levels (lagged one year)[2]	–0.097***	–0.126***	–0.096***	–0.093***
	(0.007)	(0.011)	(0.010)	(0.008)
Product market regulation[3]	0.014	–0.016	0.012	
	(0.020)	(0.028)	(0.026)	
Product market regulation ICT-intensive sectors[3]				–0.076**
				(0.038)
Product market regulation non-ICT-intensive sectors[3]				0.004
				(0.031)
Effect of regulation on catch up (interaction of regulation and productivity gap) (lagged one year)	0.061***	0.097***	0.052**	0.049**
	(0.017)	(0.030)	(0.024)	(0.022)
Human capital[4]		0.034		
		(0.034)		
Change in capital per worker[4]			0.029***	
			(0.008)	
Country-industry fixed effects (jointly significant: F)	Yes	Yes	Yes	Yes
Industry time trends (jointly significant: F)	Yes	Yes	Yes	Yes
Time dummies (jointly significant: F)	Yes	Yes	Yes	Yes
Observations	6 404	3 742	4 525	6 439
R-squared	0.301	0.395	0.208	0.187

N*otes*: Robust standard errors in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

1. The sectoral model is estimated for 20 OECD countries over the period 1981 to 2003. It is estimated for 21 ISIC rev. 3 sectors.
2. Measured as the difference in the (log) level of productivity in each country/sector relative to the productivity leader. The productivity leader is allowed to change over time and across sectors.
3. Regulation is measured using the regulation impact indicators described in Conway and Nicoletti (2006).
4. Data definitions are given in the Annex.

ICT-intensive (ICT-using and ICT-producing sectors) and non-ICT intensive sectors, there is evidence of a direct negative effect in the former that is significant at the 5% level. This implies that weak competition is particularly harmful for technology-driven productivity improvements in ICT-intensive sectors.[11]

The regulatory environment is also found to exert an important indirect influence on productivity growth by slowing the speed with which countries or sectors catch-up to the productivity leader. The coefficient on the interaction between regulation and the productivity gap is always positive and significant at the 1% level. These results indicate that well-functioning product markets are an important condition for rapid productivity catch-up, perhaps because they increase the incentive for incorporating new technologies into the production process and

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lower the cost of making other necessary changes, such as to the way work is organised, to fully exploit new technology. Product market regulation may also affect firms' ability to engage in co-invention or innovation in other areas, which often occur as part of the process of technological diffusion (Bresnahan and Greenstein, 1996). These results are broadly consistent with the predictions of neo-Schumpeterian growth theories (Aghion and Howitt, 2005) and the empirical results of Nicoletti and Scarpetta (2003) who use a similar approach to study the effect of regulation on multi-factor productivity (MFP).[12]

Simulation results

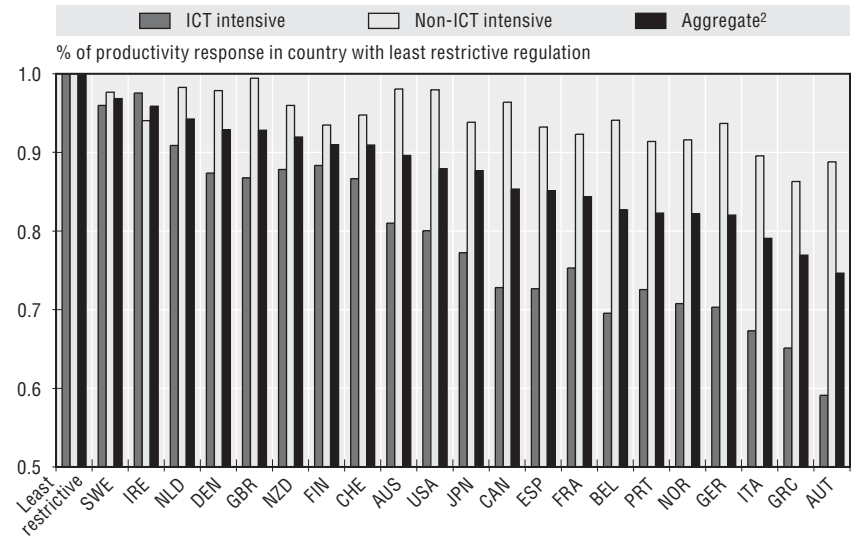
The economic significance of the estimation results reported above can be assessed by simulating the simplest version of the sectoral labour productivity growth model (Table 1B, column 1). These policy simulations are only indicative because they assume that policy changes do not change the estimated average relationships (the Lucas critique) and that these are representative of the relationships in each country (with a possible heterogeneity bias). These simulations may also under-estimate the effect of policies on aggregate productivity to the extent that reform also results in resources moving from relatively unproductive to relatively productive sectors, a possibility that is not accounted for in the sectoral model.[13] However, the simulation results provide an idea of the order of magnitude of the estimated effects of product market policies on productivity catch up.

As a starting point it is useful to use the model to illustrate the effect of current anti-competitive regulations on the diffusion of a global positive productivity shock across OECD countries. To this end, Figure 5 graphs the increase in productivity that would occur in each country five years after a one-off outward shift in the world productivity frontier of an equal magnitude in all sectors. To isolate the effect of product market regulation, this simulation is conducted from a steady-state in which the level of productivity in each sector is assumed to be initially equal across all countries. Thus, the initial shock results in the same sectoral productivity gap in all countries, which then close at different speeds depending on the relative stringency of anti-competitive regulations. The increase in productivity that would arise in response to the shock is expressed as a proportion of the increase that would occur in a country in which product market regulation in non-manufacturing sectors is the least restrictive of competition among OECD countries.

In a few countries – Sweden, Ireland, the Netherlands, Denmark, the United Kingdom and New Zealand – the influence of anti-competitive regulation on the diffusion of the productivity shock is relatively minor with aggregate productivity increasing by around 95% of the response in a country with the least restrictive product market regulation. In some of the other countries – notably Austria, Greece and Italy – anti-competitive regulation implies a greater lack of adaptability

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Figure 5. **The effect of regulation on the diffusion of a positive supply shock**[1]



1. The increase in the level of aggregate and sectoral productivity five years after a positive supply shock to the world technological frontier of an equal magnitude in each sector. The data are expressed as a percentage of the response that would occur in a country with regulation that is least restrictive of competition.
2. Productivity is derived as the average of industry-level productivities weighted with value-added weights.

in the wake of a positive global supply shock with aggregate productivity increasing by around 75% of the response in a country where product market regulation is least restrictive of competition. As a result of differences in product market regulation, the dispersion of productivity levels across countries increases over time following the positive supply shock.

In all countries, the detrimental effect of anti-competitive regulation is larger in ICT-intensive sectors (ICT-using and ICT-producing sectors) given that, as discussed in the previous section, the regulatory barriers to diffusion are estimated to be higher in these sectors in comparison to non-ICT intensive sectors. The estimated gap in productivity catch-up in ICT-intensive sectors is particularly sizeable in Austria, Greece, Italy, Germany, Norway and Belgium, all of which remain 30% to 40% below potential five years after the initial shock. In addition, reflecting larger cross-country heterogeneity in the regulation of ICT-intensive sectors, the dispersion of productivity levels across countries is also larger in these sectors following an improvement in the productivity frontier of an equal magnitude in all sectors.

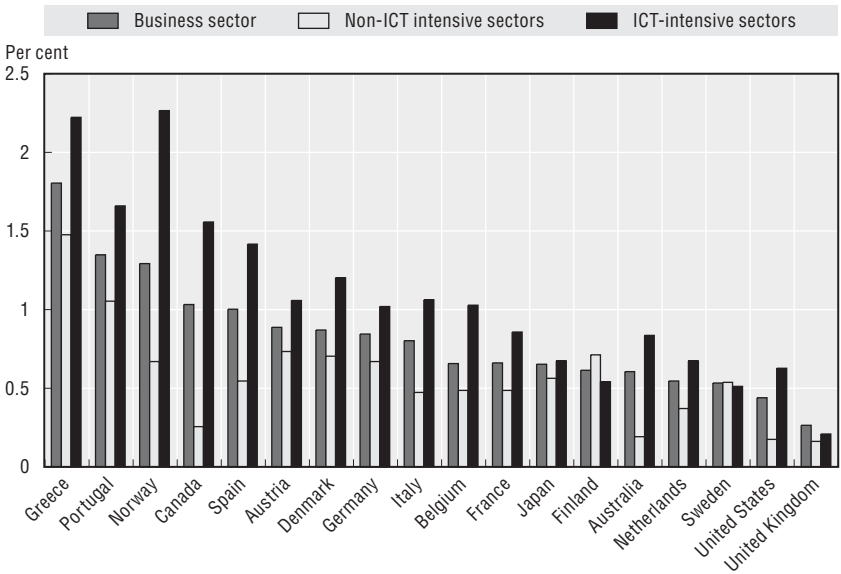
To assess the productivity dividend from faster convergence to the world productivity leader given further reform of product market regulation the steady state assumption is dropped and the model is simulated within sample from 1995 to

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2003 on the basis of the cross-country productivity gaps that prevailed over this period. The benchmark for regulatory reform used in these simulations is the implementation of the regulatory settings of the country with the lowest level of anti-competitive regulation in each of the non-manufacturing sectors that are used in calculating the regulation impact indicators. This, of course, lowers the regulation impact indicators in other sectors, as well, to an extent that depends on the initial level of regulation and the composition of intermediate inputs in each country. For some OECD countries this reform package would be considered ambitious as it would involve an easing of domestic product market regulation to levels that are less restrictive than present policy settings in any OECD member country. However, in the context of recent substantial improvements in product market regulation, this reform package would constitute a continuation of the trend to liberalise product markets, as opposed to a radical shift in policy stance.

In this scenario the productivity dividend from product market reform in each year in a given country depends on both the distance from the productivity leader in each sector and the extent of anti-competitive regulation relative to the least

Figure 6. **Increase in average annual productivity growth over the period 1995 to 2003 given a move to sectoral regulations that are least restrictive of competition in 1995**[1]



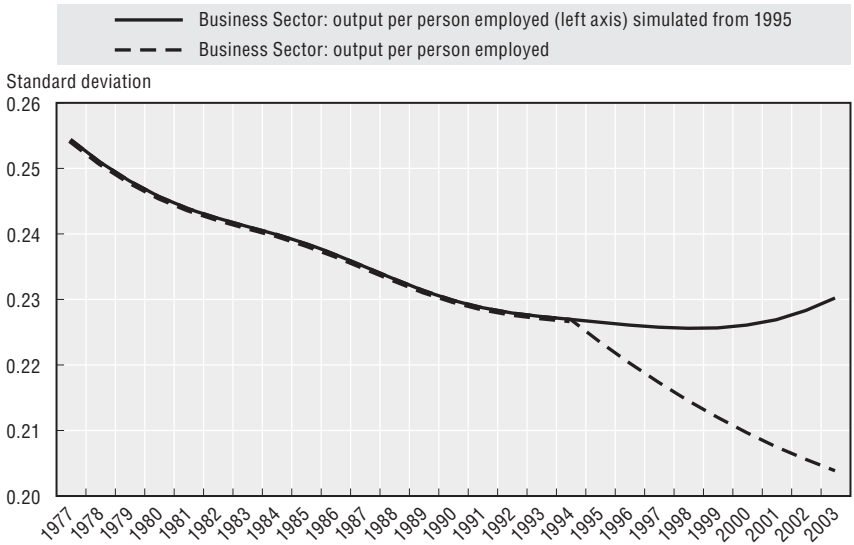
1. Data are the average increase in annual productivity over the period 1995 to 2003 following an easing in regulation to the least restrictive of competition in non-manufacturing sectors in OECD countries in 1995. The results are calculated as weighted averages of the sectoral productivity increases using value-added weights.

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restrictive country. The average increase in annual productivity growth over the period 1995 to 2003 given regulatory reform ranges from 0.2 percentage points for the United Kingdom to 1.8 percentage points for Greece (Figure 6). In some of the other continental EU countries – Portugal, Spain, Germany, Italy, Austria and France – and Norway and Canada, the increase in annual productivity growth is more than 0.75 percentage points. In all countries except Finland and Sweden the gains from product market liberalisation are greatest in ICT-intensive sectors, once again reflecting the greater exposure to anti-competitive regulation in these sectors (Figure 6).

In countries behind the technological frontier the increases in productivity growth from product market reform are relatively large and persistent, implying large total benefits from reform. Because the productivity dividend is higher in these countries, the simulations suggest that convergence in productivity levels would have continued after 1995 if countries had aligned regulation in non-manufacturing sectors on that of the least restrictive OECD country (Figure 7).

Figure 7. **The standard deviation of labour productivity across countries: Actual and in a reform scenario**[1]



1. Calculated using cyclically-adjusted series of output and employment in business sector industries for 21 OECD countries (Hodrick-Prescott filter, lambda = 100, data extended to 2006 using OECD medium-term projections to mitigate the end-point problem inherent with this filter). The simulated results are derived on the basis of countries adopting the regulatory framework of the least restrictive OECD country in non-manufacturing sectors in 1995.

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POTENTIAL TRANSMISSION CHANNELS

The results of the previous section indicate that anti-competitive product market regulation has a statistically and economically significant negative effect on the speed with which countries operating behind the world productivity frontier catch up to best practice. This section investigates this link further by assessing the impact of product market regulation on two potential transmission channels that have been shown in previous work to influence the adoption of best practice production techniques. Specifically, regression analysis is used to test the effect of product market regulation on investment in ICT and the location decisions of multinational enterprises.

These two channels are most probably interrelated. For example, ICT-producing industries tend to include a disproportionate share of multinational enterprises. However, data constraints preclude estimating a generalised model that accounts for both channels simultaneously and the impact of regulation on each is analysed separately. In both cases the same panel data regression framework is used. Specifically, the following regression is estimated separately for each potential transmission channel.

$$Y_{ijt} = R_{ijt}\,\alpha + X_{ijt}\,\beta + \gamma_i + \tau_t + \delta_j + \varepsilon_{ijt} \text{ with } \varepsilon \sim N(0,\Sigma)$$

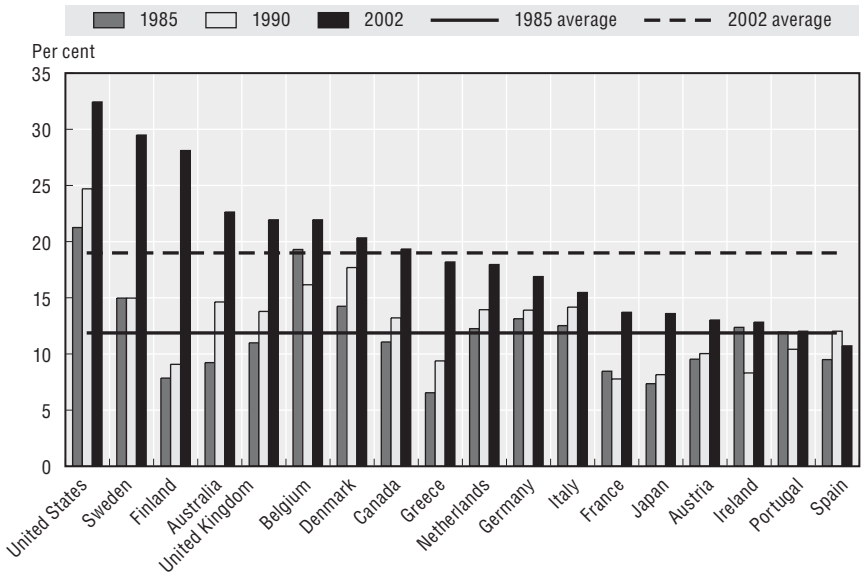
The variable Y represents one of the variables of interest – the ICT investment share or the employment share of foreign affiliates – at time *t* in sector *j* of country *i*. R is a matrix of the appropriate regulatory indicators, X is a matrix of controls that vary across each of the two regressions, and γ, τ and δ are country, time and sector-specific fixed effects, which control for unobserved individual heterogeneity. The results for each of the two regressions are discussed in turn.

The effect of product market regulation on ICT *investment*

Given its potential for enhancing productivity and rapid price declines over recent years – especially when adjusted for quality – ICT has spread rapidly throughout the OECD. On average across countries for which data exist, the share of ICT investment in total non-residential investment (measured at current prices) has increased from just over 10% in 1985 to just under 20% in 2002 (Figure 8).[14] However, rates of ICT adoption have varied considerably across countries. In 2002, the share of ICT investment was particularly high in the United States, Sweden, Finland, Australia and the United Kingdom. In contrast, ICT investment in some continental European countries and Japan was substantially lower. Several reasons can be envisaged for these differences, ranging from industry specialisation and first-mover advantage to gaps in workers' skills. However, given the wide availability of ICT and the relative homogeneity of industry features in the OECD area, cross-country differences in ICT uptake provide a useful "natural experiment"

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Figure 8. **The diffusion of information communication technology**[1]
Share of ICT investment in total non-residential fixed capital formation



1. Countries ordered according to ICT share in the most recent period.
Source: OECD, Database on capital services.

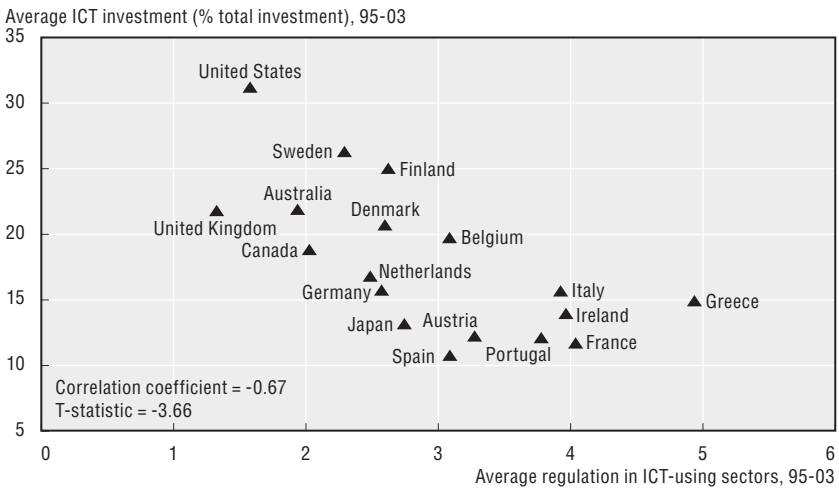
with which to test the effect of product market regulation on the adoption of new technology.

At first glance, there does appear to be a link between the diffusion of ICT and the restrictiveness of product market regulation (Figure 9). There are a number of potential reasons why this might be the case. In a competitive environment with low barriers to entry the incentive to invest in ICT so as to increase productivity and retain market share may be stronger than in a more restrictive regulatory environment where incumbents are sheltered from competitive processes. Investment in ICT may help firms increase productivity by, for example, allowing them to expand their product range, customise their services, and respond better to client demands. ICT may also help reduce inefficiencies in the production process by, for example, reducing inventories. In addition, the costs of adjusting the capital stock and firm structure and reorganising the production process, all of which are necessary if new technology is to be successfully integrated, will tend to be lower in a competitive environment. Finally, as pointed out by Alesina *et al.* (2005) in the context of general-purpose fixed investment, a competitive environment puts downward pressure on the cost of ICT, thereby promoting its diffusion.

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Figure 9. **Product market regulation and the diffusion of information communication technology**[1]

The scale of the indicators is 0-6 from least to most restrictive



1. The indicator of regulation in ICT-using sectors is the simple average of the regulation impact indicators for the individual industries included in these sectors.

The regression model outlined above is used to test the impact of anti-competitive product market regulation on the share of ICT investment in total private investment.[15] Reflecting data limitations, regressions are performed at the level of the aggregate business sector for 18 countries over the period 1985-2003 and at the sectoral level over the period 1980-2001 for five countries for which data on industry-specific ICT investment exist.[16] As in the productivity regressions, the summary time-series indicator of anti-competitive regulation in seven non-manufacturing sectors is used as a proxy for economy-wide regulation in the aggregate model whereas the regulation impact indicators are used in the sectoral model.

The aggregate and sectoral regression results are given in Tables 2 and 3 respectively. A measure of human capital is included as a control variable in the aggregate model given that countries with a more educated workforce are better placed to benefit from ICT. This variable is marginally significant when country time trends and fixed effects are included in the aggregate regression. Given that a number of ICT-using sectors are services, the share of service sectors in business sector value-added is also included in the aggregate model to control for any effect of economic structure. This variable is found to be highly significant.[17]

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Table 2. **Share of investment in information and communication technology and regulation**

Aggregate regressions: 18 countries, 1985-2003

Dependent variable: ICT share in total investment	OLS	Fixed effects	Random effects	Fixed effects	Fixed effects
Constant	–0.072	0.08	0.076	–0.168	–0.13
	(0.045)	(0.068)	(0.062)	(0.119)	(0.119)
Human capital	0.000	–0.001	0.001	0.021**	0.018*
	(0.001)	(0.005)	(0.004)	(0.01)	(0.010)
Business services share	0.602***	0.384***	0.357***	0.45***	0.439***
	(0.076)	(0.11)	(0.097)	(0.104)	(0.102)
Regulation[1]	–0.012***	–0.021***	–0.021***	–0.021***	
	(0.003)	(0.003)	(0.003)	(0.003)	
Regulation net of public ownership[1]					–0.015***
					(0.003)
Public ownership[1]					–0.006
					(0.004)
Country fixed effects (jointly significant: F)	No	Yes	No	Yes	Yes
Country time trends (jointly significant: F)	Yes	No	No	Yes	Yes
Test Ho: Homoskedasticity (chi2)	1.97				
Prob > chi2	0.160				
Breusch Pagan LM (chi2)		1 001.49			
Prob > chi2		0.000			
Hausman Test Fixed vs. Random Effects (chi2)		0.40			
Prob > chi2		0.940			
Observations	289	289	289	289	289
R-squared	87%	56% (within)	56% (within)	84% (within)	85% (within)

Notes: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

1. Summary time-series indicator of anticompetitive regulation in 7 non-manufacturing sectors including or isolating the public ownership component.

In both versions of the model, the coefficients of the indicators of product market regulation are negatively signed and significant at the 1% level, implying that restrictions to competition have a strong negative effect on ICT investment. It would seem that firms operating in a relatively liberal regulatory environment are more inclined to incorporate ICT into the production process than firms operating in an environment in which product market regulation is more restrictive. The sectoral results presented in Table 3 Panel B suggest that the negative effect of domestic regulation on ICT investment is concentrated in non-ICT producing sectors. This may reflect the fact that some ICT-producing industries are strongly exposed to foreign competition. Also, the development of ICT-producing industries often reflects factors that are unrelated to regulation, such as first-mover advantage or specialisation due to country-specific comparative advantages and/or agglomeration economies.

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Table 3. **Share of investment in information and communication technology and regulation: Sectoral regressions**[1]

Panel A. Baseline sectoral regressions

Dependent variable: Share of ICT in total investment	OLS	Robust	Random effects	Fixed effects	Fixed effects	Robust fixed effects	Robust fixed effects	Robust fixed effects
Constant	0.16***	0.16***	0.183***	0.15***	0.115***	0.084***	0.079	0.073***
	(0.008)	(0.007)	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)***	(0.007)
Regulation impact[2]	–0.141***	–0.141***	–0.182***	–0.122***	–0.059***	–0.068***	–0.059***	
	(0.011)	(0.010)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)	
Regulation impact net of public ownership[2]								–0.124***
								(0.011)
Public ownership[2]								0.1***
								(0.014)
Industry trends (jointly significant: F)	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Industry dummies (jointly significant: F)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies (jointly significant: F)	No	No	No	Yes	Yes	Yes	Yes	Yes
Country trends (jointly significant: F)	No	No	No	No	No	No	Yes	No
Ho: Homoskedasticity (Chi2)	385.62				233.17			
(Prob > Chi2)	0.000				(0.000)			
Breusch Pagan LM (Chi2)				7 197.48				
(Prob > Chi2)				(0.000)				
Hausman (Chi2)			286.91					
(Prob > Chi2)			(0.000)					
Observations	1 954	1 954	1 954	1 954	1 954	1 954	1 954	1 954
R-squared	73%	73%	68% (within)	68% (within)	77% (within)	75%	79%	79%

Notes: Human capital was omitted to avoid loss of degrees of freedom and due to insignificance.
Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

1. Countries: France, Germany, the Netherlands, the United Kingdom and the United States. Period: 1980-2001. 19 manufacturing and service sectors, see Annex for details.
2. See Conway and Nicoletti (2006) for a description of regulation impact indicators.

To assess the effect of product market regulation on ICT investment in more detail, a range of indicators that measure specific aspects of regulation or regulation in specific sectors are included in the aggregate and sectoral regressions. When the public ownership component of the regulation impact indicators is stripped out and included separately its coefficient is negative but insignificant in the aggregate regression and significantly positive in the sectoral regression, implying that public ownership *per se* need not inhibit the ICT adoption (Table 3 Panel A, last column). In fact, especially in network industries, publicly-controlled firms have in some cases been found to over-invest in new technologies. For example, private telecommunications companies have sometimes abandoned costly plans to expand digital or cable networks in the wake of privatisation. This may explain the positive coefficient on public ownership in the sectoral regression

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Table 3. **Share of investment in information and communication technology and regulation: Sectoral regressions** (*cont.*)

Panel B. Impact of regulation in particular sectors[1]

Dependent Variable: Share of ICT in total investment	Robust fixed effects	Random effects
Constant	0.122***	0.17***
	(0.009)	(0.010)
Regulation impact ICT-using	–0.07***	
	(0.012)	
Regulation impact ICT-producing	–0.121	
	(0.082)	
Regulation impact non- ICT	–0.097***	
	(0.013)	
Regulation impact net of regulation in retail distribution		–0.064***
		(0.012)
Regulation in retail distribution (1998)[2]		–0.017***
		(0.001)
Industry trends (jointly significant: F)	Yes	Yes
Industry dummies (jointly significant: F)	Yes	Yes
Country dummies (jointly significant: F)	Yes	No
Test Ho: Regulation impact differs: ICT using vs. producing vs. non-ICT (F)	2.30	
(Prob > F)	0.100	
Hausman (Chi2)		28.64
(Prob > Chi2)		(0.8036)
Observations	1 954	1 570
R-squared	78% (within)	76% (within)

N*otes*: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

1. Countries: France, Germany, the Netherlands, the United Kingdom and the United States. Period: 1980-2001. 19 manufacturing and service sectors, see Annex for details.
2. See Boylaud and Nicoletti (2001).

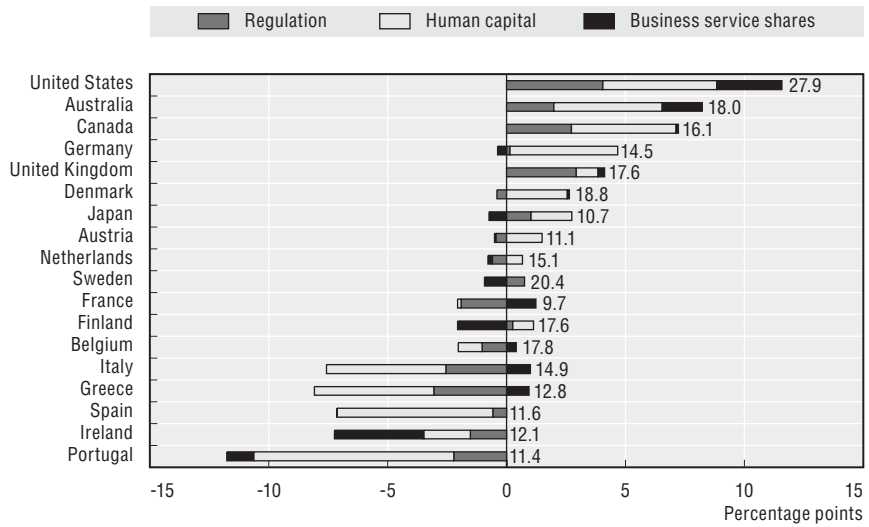
where network industries have a larger impact on average estimates (because regressions are unweighted).

According to these results, product market regulation is a statistically significant determinant of investment in ICT. But to what extent does it explain observed differences in ICT investment across countries? To answer this question Figure 10 graphs the contribution of each of the explanatory variables in the aggregate regression to deviations of ICT investment from the OECD average over the full sample period. Overall, product market regulation is estimated to explain 12% of the cross-country differences in ICT investment. In the United States, the share of ICT investment in total investment is found to be more than four percentage points higher than the OECD average of 15% as a result of relatively pro-competitive regulations. In the United Kingdom, Canada and Australia, the estimated contribution of product market policies to investment in ICT relative to the OECD average also appears to have been significant (between 2.5 and 3.5 percentage points). Conversely, in Greece, Italy, Portugal and France relatively restrictive

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Figure 10. **Contributions to the deviation of the share of ICT in total investment from the OECD average, 1985-2003**[1]

Deviation from OECD average over the full sample period OECD average share = 15.5%



1. These contributions have been calculated using the results of the aggregate ICT regression reported in column 4 of Table 2. Numbers above the bars report actual shares once the contribution of other factors (including country fixed effects) has been accounted for. Countries are ordered according to the sum of the different contributions.

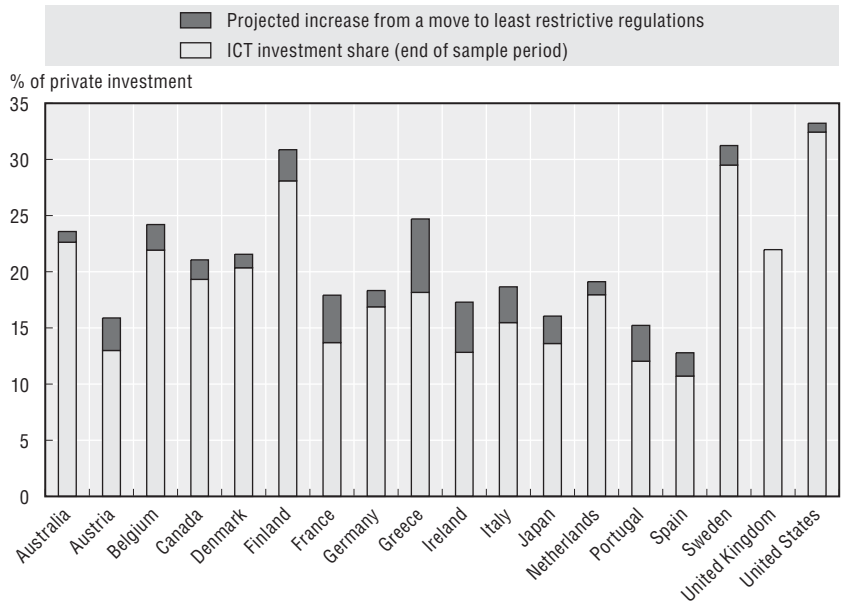
regulations are estimated to have significantly dragged down ICT investment relative to other OECD countries (by 2.5 to 3.5 percentage points).

Repeating the same exercise for 2003 suggests that the cross-country differences in ICT investment attributable to product market regulation are slightly smaller than over the full sample period, given a degree of regulatory convergence. However, both the overall picture and the country-specific results remain broadly unchanged. The contribution of policy is still noteworthy for some countries, implying that differences in the regulatory environment continue to explain a reasonable proportion of cross-country differences in ICT investment. Similar results are obtained using the sectoral version of the model, where the indicators of product market explain 20% of the variance in ICT investment across countries.[18]

Finally, the results of model simulations suggest that substantial increases in ICT investment would occur in a number of countries if they were to reform product market regulation to that of the least restrictive OECD country in each sector (Figure 11).

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Figure 11. **Increase in ICT investment share following a move to economy-wide product market regulation that is least restrictive of competition**[1]



1. These results have been calculated using the aggregate ICT regression reported in column 4 of Table 2. The United Kingdom is estimated to have the lowest overall level of anti-competitive regulation in 2003 according to the aggregate indicators of regulation in seven non-manufacturing industries used in this simulation.

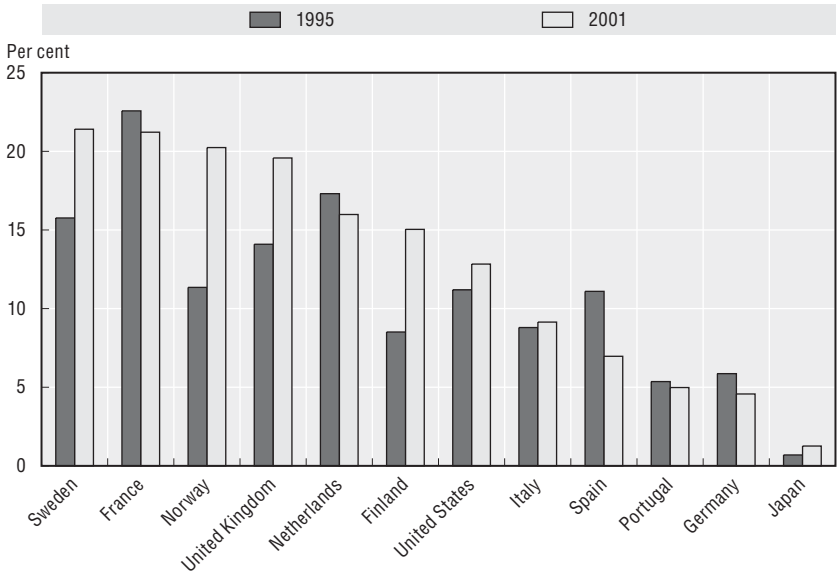
The effect of product market regulation on the location decisions of foreign affiliates

The establishment of foreign affiliates in a host country is generally considered to be beneficial for domestic productivity growth. Previous empirical work has typically shown that foreign affiliates tend to be more capital and skill intensive and invest more in research and development than domestic firms in the same industry (Keller, 2004; Keller and Yeaple, 2003). As a result, foreign affiliates tend to grow more quickly and make a larger direct contribution to productivity growth in comparison to domestic firms (Criscuolo, 2005). Foreign affiliates may also contribute indirectly to domestic productivity growth by generating positive productivity spillovers for local firms. For example, foreign affiliates may speed the diffusion of new technology and management practices across borders or train labour that is subsequently employed by local firms. Across the countries for which data are available, there is substantial variation in the share of foreign affiliates in total employment (Figure 12).[19]

As shown in Nicoletti *et al.* (2003), regulatory policies that restrict market access or reduce the potential returns to foreign investment negatively influence

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Figure 12. **Employment share of foreign affiliates in manufacturing sectors**[1]



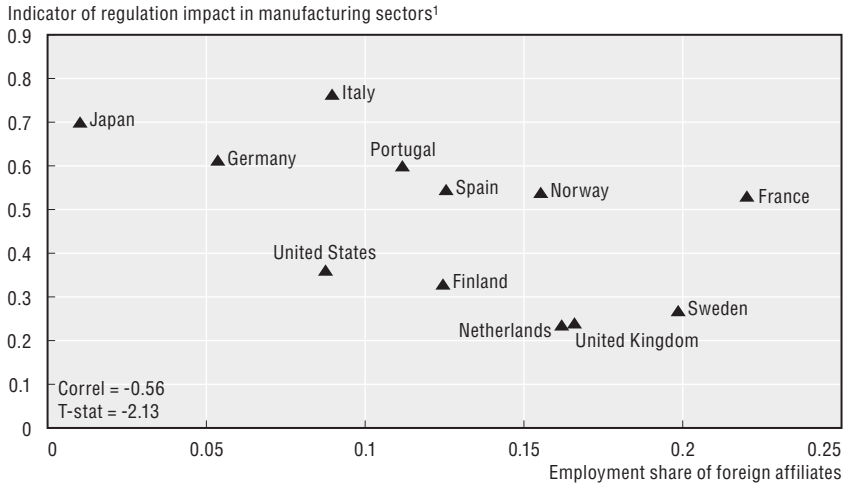
1. Weighted average of manufacturing industries based on the employment shares in the OECD STAN sectoral database. Due to missing data at the sectoral level, cross-country comparisons should be interpreted with caution. See the Annex and Criscuolo (2005) for a description of these data.

the share of foreign direct investment in OECD countries. At first glance, the employment share of foreign affiliates in the manufacturing sector indeed tends to be higher in countries with relatively liberal product market environments (Figure 13).

As with the share of ICT investment, the same regression framework is used to test the effect of product market regulation on the location decisions of foreign affiliates. The share of employment by foreign affiliates in total employment at the sectoral level is regressed on the regulation impact indicators and a number of control variables. Specifically, the OECD indicators of FDI restrictions (Golub, 2003), sectoral tariff rates, measures of domestic absorption, human capital, growth in sectoral value-added and R&D intensity are also included in the regression. Tariff rates are included in the model given that the establishment of foreign affiliates may be a way to overcome trade barriers (so-called "tariff jumping"). Domestic absorption accounts for the size of the market accessed by foreign affiliates and growth in sectoral value-added reflects the market potential in each sector.[20] R&D intensity captures the degree of innovation intrinsic in each industry. The indicator of regulation impact used in the regression is net of public ownership

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Figure 13. **Product market regulation and the employment share of foreign affiliates in manufacturing, 1995-2003**



1. Simple average of the regulation impact indicators for manufacturing industries.

given that public ownership is included as part of the indicators of FDI restrictions. The model also includes industry-country fixed effects to account for other unobservable characteristics that might influence foreign affiliate employment. A dummy variable for membership in the European Union was also included in the model to reflect the effect of the larger market accessible to foreign affiliates in EU countries. Regressions were performed for 11 manufacturing and 7 service sectors in 14 countries from the early 1990s to 2002.

Regression results are presented in Table 4. Neither domestic absorption nor the proxy for market potential turn out to be significant, but membership in the European Union has a significant and positive effect on the share of employment in foreign affiliates, suggesting that the absence of border barriers and access to a continental market are factors that influence the location decisions of multinationals. Among the other controls, R&D intensity is found to have a positive and significant effect, indicating that foreign affiliates tend to be attracted to relatively innovative sectors. This may reflect the fact that these sectors are often characterised by high sunk costs, which can lead to high concentration and a large presence of multinationals. Somewhat surprisingly, human capital has a significant negative influence on the establishment of foreign affiliates perhaps reflecting the effect of wage costs, which tend to increase with human capital. However, including various proxies for labour costs in the regression yields insignificant coefficients, while leaving the size and significance of the human capital variable unchanged.

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Table 4. **Regulation and the share of employment in foreign affiliates**[1]

Dependent variable: Share of employment of foreign affiliates in total sectoral employment	Fixed effects	Robust Fixed Effects				
Constant	0.192	0.192	0.587***	0.444***	0.299***	0.103***
	(0.153)	(0.153)	(0.046)	(0.041)	(0.043)	(0.018)
EU15 dummy	0.068***	0.068***	0.083***	0.071***	0.062***	0.043***
	(0.005)	(0.005)	(0.001)	(0.006)	(0.015)	(0.009)
Domestic absorption			0.000		0.000	
(C+I+G) at PPP			(0.000)		(0.000)	
Sectoral human capital			–0.322***		–0.489***	
			(0.039)		(0.055)	
Sectoral VA growth					–0.024	
					(0.061)	
Sectoral R&D intensity: share of R&D in sectoral VA					0.787***	
					(0.250)	
Regulation impact net of public ownership	–0.118***	–0.118***	–0.385***	–0.373***	–0.281***	–0.390***
	(0.034)	(0.034)	(0.069)	(0.060)	(0.103)	(0.085)
Sectoral FDI restrictions[2]	–0.223***	–0.223***	–0.270***	–0.268***	–0.575***	–0.510***
	(0.032)	(0.039)	(0.050)	(0.047)	(0.075)	(0.074)
Sectoral tariff barriers[2]			0.024		0.078**	
			(0.023)		(0.032)	
Industry dummies (jointly significant: F)	Yes	Yes	Yes	Yes	Yes	Yes
Industry specific trends (jointly significant: F)	Yes	Yes	Yes	Yes	Yes	Yes
Ho: Homoskedasticity (Chi2)	321.32					
(Prob > Chi2)	0.000					
Observations	1 331	1 331	838	838	396	396
R-squared (within)	51.3%	51.3%	63.1%	60.4%	72.4%	64.5%

Notes: Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

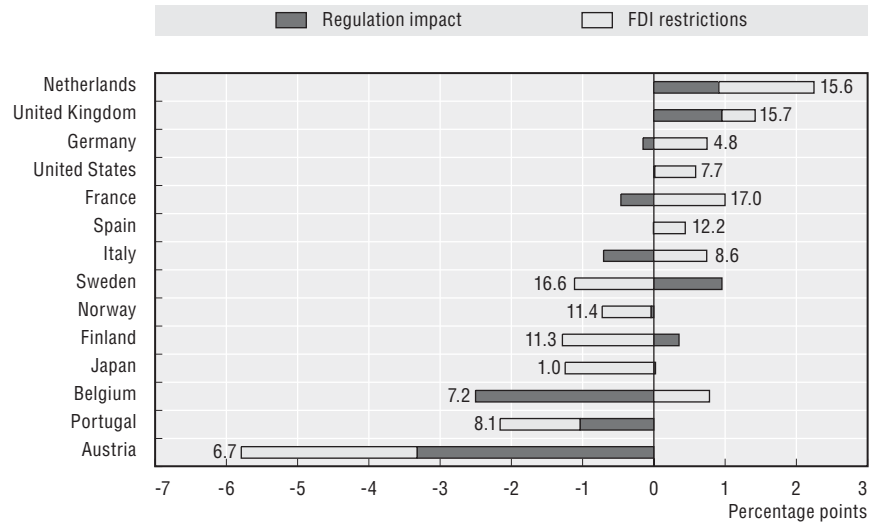
1. Countries: Austria, Belgium, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States. Period: 1997-2002. 11 manufacturing and seven service sectors. See Annex for details on data.
2. See Annex for a description of the regulation impact indicators.
3. Golub (2003). See Annex for details.

Turning to policies, sectoral tariff barriers are estimated to have a positive effect on the employment share of foreign affiliates, suggesting some kind of "tariff-jumping" motive on behalf of multinational enterprises. More importantly, regulatory restrictions to domestic competition and FDI are both found to have a significant negative effect on the employment share of foreign affiliates across model specifications. These results support the conjecture that, by raising barriers to entry, anti-competitive product market regulation discourages the establishment of foreign affiliates.[21] Regression estimates imply that product market regulation explains around 10% of the cross-country variation in the data (Figure 14). Direct restrictions on FDI account for a further 13%. Thus, altogether, regulatory settings

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Figure 14. **Contributions to the deviation of the employment share of foreign affiliates from the OECD average, 1995-2003**[1]

Deviation from OECD average over the full sample period OECD average share = 9.9%



1. These contributions have been calculated using the results of the foreign affiliate regression reported in column 5 of Table 4. Numbers in parenthesis report actual shares once the contribution of other factors (including country fixed effects) has been accounted for. Countries are ordered according to the sum of the different contributions.

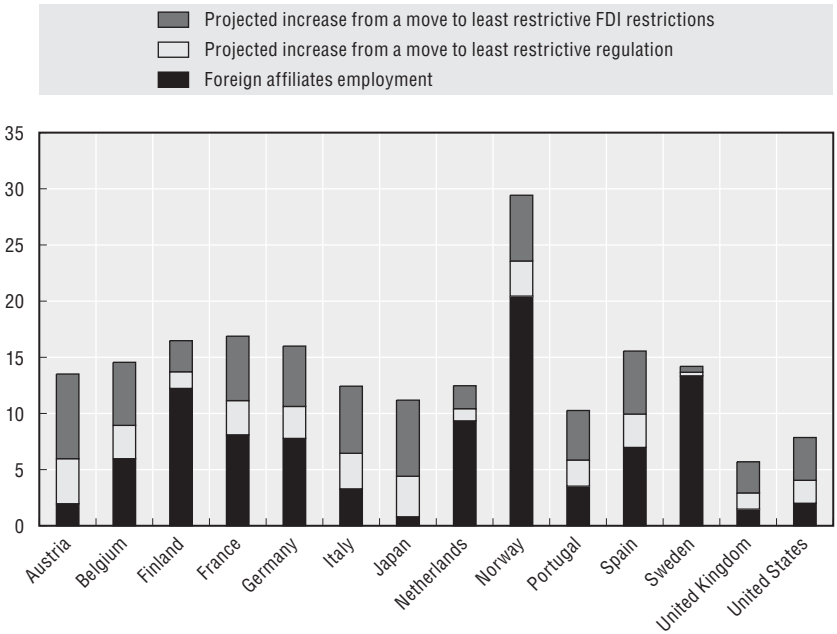
have a relatively large impact on the cross-country variability of foreign affiliates' employment shares, especially in countries that combine relatively anticompetitive non-manufacturing regulations with several FDI restrictions (*e.g.* Austria and Portugal). In this context, aligning sectoral product market policies and FDI restrictions on those of the least restrictive OECD country is estimated to substantially increase investment by multinationals in a number of countries (Figure 15). For instance, according to these estimates, such a move would roughly double the foreign affiliates' employment share in France, Germany, Belgium, Spain and Portugal, and would more than triple it in Austria, Japan, Italy and the United States.

DIRECTIONS FOR FUTURE RESEARCH

This paper has explored the effects of anticompetitive product market regulations on productivity growth and two of its determinants – investment in ICT and spillovers from affiliates of foreign multinationals. The empirical results suggest that these effects can be substantial and could help explain the twin developments of slow convergence in product market policies and divergence in productivity

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Figure 15. **Increase in the employment share of foreign affiliates following a move to sectoral regulations and FDI restrictions that are least restrictive of competition**[1]



1. Derived using the regression results reported in column 5 of Table 4, the figure shows the effect of a loosening in regulation and FDI restrictions to the level of the least restrictive country in all sectors. The numbers in this graph are the weighted averages of the sectoral increases in the employment share of foreign affiliates over the sectors for which data exist in each country. Because of limitations in the coverage of the underlying data these results should be treated as indicative.

in the face of a positive supply shock, as observed over the past two decades in the OECD area.

There are several ways in which these results could be refined, extended and made more robust. First, the insights of recent developments in endogenous growth theory could be exploited more fully. For instance, so-called neo-Schumpeterian theories of growth suggest that the effects of competition policies could depend on several factors, including their precise nature (*e.g.* ease of access for new firms *versus* incentives for rivalry among incumbent firms) and the distance of countries or sectors from the technological frontier. This would suggest further investigation of the effects of various kinds of policies for which time-series indicators are available, as well as further disaggregation that distinguishes different sectors and countries depending on their technological characteristics and level of development. Second, by looking at productivity and ICT separately, the analysis provides an incomplete account of the indirect effects that regulations may have

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on productivity through lower investment in ICT. The effects of regulation would presumably be better identified in a framework where the productivity and ICT models were estimated jointly. This, however, would require the specification of a model of how ICT affects productivity. Third, product market regulations are just one set of institutions that may affect productivity developments. Future research could look at a wider set, including labour and financial market arrangements as well as education policies.

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Notes

1. This section provides only a very brief summary of trends in product market regulation and productivity in OECD countries. For more on the construction of the indicators used to measure anti-competitive regulation and patterns of regulatory reform in OECD countries see Conway and Nicoletti (2006). All of the indicators used in this paper are available on the OECD's Product Market Regulation Homepage at *www.oecd.org/eco/pmr*. Trends in productivity in OECD countries are discussed in detail in a number of sources including OECD (2003a).
2. The economy-wide indicators of product market regulation in OECD countries are described in Conway *et al.* (2005) and Nicoletti *et al.* (1999).
3. These countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.
4. As well as intermediate inputs, the "knock-on effects" of regulation in non-manufacturing sectors will also propagate through the economy via a number of other channels such as the effect on the price of investment goods and "Baumol disease" effects that act through wages. In this context, focusing on the role of non-manufacturing sectors as suppliers of intermediate inputs provides only a lower bound to these propagation effects. It does, however, facilitate their empirical measurement, which is important in the context of the analysis that follows.
5. Cross-country differences in labour productivity reflect differences in technology in its broadest possible sense including differences in capital intensity, capital quality, human capital, economies of scale and intangibles such as management techniques. Estimates of multi-factor productivity (MFP) account for some of these additional factors by relating a measure of output to a bundle of productive inputs, making it a more precise estimate of productive efficiency. However, given difficulties inherent in measuring the capital stock and other productive inputs, estimates of MFP tend to be less robust than those of labour productivity, particularly at the industry level. Labour productivity should ideally be calculated using data on hours worked. However, comprehensive cross-country data on hours worked is only available at the level of the aggregate economy and estimates of labour productivity at lower levels of aggregation must be computed using total employment.
6. This implies the assumption of identical comparative price levels across industries. However, van Biesebroeck (2005) finds that, overall, aggregate PPPs perform as well as sectoral PPPs, where performance is measured as the correlation with sectoral deflation rates. For some service sectors aggregate PPPs are found to perform better than sectoral PPPs, while for some manufacturing sectors sectoral PPPs perform marginally better. All of the productivity data used is derived from the OECD Productivity and STAN databases. Full details on data sources are provided in the Annex.

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7. The role of ICT production and use is discussed in detail in Pilat and Wölfl (2004). Differences in the contribution of ICT-using sectors to productivity growth have also been found to be important sources of productivity divergence between the United States and Europe. See, for example, van Ark *et al.* (2002).

8. This model is a variant of the model developed by Griffith *et al.* (2004) to test the effect of R&D expenditure on productivity growth. It has also been used by Nicoletti and Scarpetta (2003) to investigate the effect of product market regulation on multi-factor productivity growth.

9. Note, however, that including the share of ICT investment in total investment in the model reduces the number of available observations substantially, impairing the comparability of the two aggregate business sector regressions.

10. Keller (2004) notes that "only a handful of rich countries account for most of the world's creation of new technology" and that in most countries "foreign sources of technology account for 90% or more of domestic productivity growth". Guellec and van Pottelsberghe de la Potterie (2001) make a similar point.

11. Conway *et al.* (2007) explore this issue further and provide a deeper evaluation of the direct effects of anti-competitive regulation on productivity growth by accounting more systematically for sectoral differences, the distance of countries and sectors from the technological frontier and the effects of different kinds of regulations (*e.g.* border and non-border barriers to competition).

12. These authors find that restrictive industry-specific product market regulation in manufacturing tends to reduces MFP growth mainly via the process of technological catch-up. They also find evidence of a direct link between a proxy for economy-wide product market regulation and sectoral MFP growth.

13. In OECD countries, productivity growth within industries has been found to make a relatively large contribution to overall productivity growth in comparison to shifts of employment across industries (OECD, 2003a). Given that the reallocation of resources across industries has played a relatively minor role in explaining cross-country differences in aggregate productivity growth, the results that emerge from the sectoral-level model may be generalized to explain aggregate patterns.

14. The share of ICT investment in total investment is typically used as a key indicator of ICT diffusion. There are, however, many other indicators that measure the pervasiveness (or otherwise) of ICT technology across countries (see, for example, OECD, 2002a). Most of these different indicators are closely correlated and tend to indicate a similar pattern of ICT diffusion.

15. The specification of this model is similar to that used in the work of Gust and Marquèz (2004).

16. The countries covered in the aggregate-level regression are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Japan, the Netherlands, Portugal, Spain, Sweden, the United Kingdom and the United States. At the sectoral level, only France, Germany, the Netherlands, the United Kingdom and the United States are included in the regression.

17. The services share is in some sense endogenous to ICT investment. However, regression results for the effect of product market regulation on ICT investment are robust to the exclusion of this variable.

18. These additional results are available from the authors upon request.

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19. The data on foreign affiliates are from Criscuolo (2005). The share of foreign affiliate employment in total employment is the preferred measure of the presence of foreign affiliates given a lack of cross-country comparability and gaps in the data for other measures. However, in services sectors these data are typically only available for more recent years and are more sparse than data for manufacturing. Accordingly, the sample is somewhat biased towards the manufacturing sector. Given data limitations, cross-country comparisons should be interpreted with caution.
20. The role of market potential, first introduced by Harris (1954), has recently been stressed in the context of FDI by Head and Mayer (2004).
21. The separate effect of product market regulation on the share of foreign affiliate employment in ICT intensive and non-ICT intensive sectors was also checked suggesting that the negative effect of anti-competitive regulation is larger and more significant in non-ICT intensive sectors. However, given the sparseness of data coverage, especially in services, this result needs to be interpreted with caution and is not reported here.

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Annex
Data Description

Labour Productivity Data

The aggregate data on business sector labour productivity are derived from national accounts and are calculated as the ratio of GDP to total employment in the business sector. GDP in the business sector in calculated by subtracting the value-added of the government sector from total GDP, while employment in the business sector is the difference between total employment and employment in the government sector. GDP figures are made comparable across countries and over time by converting nominal values to 2000 purchasing power parities. OECD labour productivity data is available at *http://oecd.org/statistics/productivity*.

Sectoral labour productivity measures are derived from the data contained in the OECD STAN database for industrial analysis (see *http://oecd.org/sti/stan*). Labour productivity is calculated as the ratio of sectoral value-added to sectoral employment. As discussed in the text, aggregate purchasing power parities were used to make the sectoral productivity data comparable across sectors, countries and time. As for the aggregate measures, the base year chosen for the conversion of value-added is 2000.

ICT Data

The aggregate ICT dataset used in this analysis consists of OECD data on gross fixed capital formation for eighteen countries over 1985-2001, with data for some countries through to 2003. The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, and United States. The variable used in regressions, ICT share of total investment, is calculated as investment in hardware, software, and computer equipment divided by total investment.

The sectoral ICT data are obtained from the University of Groningen and are described in detail in Inklaar, O'Mahoney, and Timmer (2003). These data cover five countries France, Germany, Netherlands, United Kingdom, and United States, over 1980-2001, and are disaggregated to the two digit ISIC Rev. 3 level. ICT data is available at *http://oecd.org/statistics/productivity*.

Foreign Affiliates Data

The data used for the construction of variables concerning the activity of foreign affiliates are derived from three OECD databases: the STAN productivity database; the AFA database, which contains information on activity of foreign affiliates in the manufacturing sector; and the FATS database, which contains information on activity of foreign affiliates in the service sector. Both the Activity of Foreign Affiliates (AFA) and the Foreign Affiliates in Trade and Ser-

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vices (FATS) are survey based data collected by the OECD Directorate for Science, Technology and Industry. Survey questions include employment, output, input and importing/exporting activity of foreign affiliates at the sectoral level. The countries covered in the analysis are Austria, Belgium, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States, over the period 1977-2002, although coverage is most extensive in the 1990s.

Some issues arise with foreign affiliates' data. Firstly, STAN, which is used for the construction of sector totals, is based on national accounts, and therefore on several sources, establishment data being the most important. Reported information on the activity of foreign affiliates in AFA and FATS, on the other hand, is at the enterprise rather than the establishment level. This implies that the statistics concerning foreign affiliates might incorporate secondary activity and may not, therefore, be fully comparable with the sectoral totals derived from STAN. Secondly, the definition of foreign direct investment in both databases on the activity of foreign affiliates is based on the concept of controlling interest, which differs across countries. Thirdly, the definition of foreign owned firms within countries might have changed over time. Finally, statistics on foreign presence in some sectors are only provided for recent years.

Three possible measures of the presence of foreign affiliates are available: the share of turnover, the share of value-added and the share of employment. The latter is the preferred measure of the presence of foreign affiliates given lack of cross-country comparability and gaps in the data for other measures.

Data for other control variables

The **output gap** is calculated as the difference between actual and potential output, based on national accounts and on the OECD Economic Outlook database. Aggregate **human capital** is calculated as the average years of education. As in Scarpetta and Tressel (2002), sectoral human capital is based on skill and wage data. It is calculated as the log of the wage ratios of high-skill to low-skill blue-collar and white-collar workers, weighted by the proportion of skilled workers in total employment. A measure of sectoral **border barriers** was calculated as a simple average of sectoral tariff and non-tariff barriers (from the UNCTAD/WB TRAINS database) and FDI restrictions (Golub, 2003). Data on **R&D expenditures** are derived from the OECD ANBERD database.

The classification of ICT-producing, ICT-using and non-ICT intensive sectors

Empirical measures of ICT use by sector are available for several countries, based on capital flow matrices and capital stock estimates. Work using data for the United States implies that investment in ICT equipment is concentrated in service sectors. For example, according to some estimates 78% of total business investment in ICT in the United States is undertaken in the wholesale and retail trade, finance, insurance, and real estate sectors. Manufacturing, on the other hand is found to be responsible for only 17% of ICT investment. The classification of ISIC rev.3 sectors into ICT-producing (P), ICT-using (U) and non-ICT intensive (N) sectors used in this paper follows Inklaar *et al.*, (2003) and is as follows:

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ISIC code	Industry	ICT classification
15-16	Food Products, beverages and tobacco	N
17-19	Textiles, textiles products, leather and footwear	N
20	Wood except furniture	N
21-22	Pulp, Paper, paper products, printing and publishing	U
23-25	Chemical, rubber, plastics and fuel products	N
26	Other non-metallic mineral products	N
27-28	Basic metals and fabricated metal products	N
29	Machinery and equipment, n.e.c.	U
30-33	Electrical and optical equipment	P
34-35	Transport equipment	N
36-37	Furniture; recycling	U
40-41	Electricity, gas and water supply	N
45	Construction	N
50-52	Wholesale and retail trade; repairs	U
55	Hotels and restaurants	N
60-63	Transport and storage	N
64	Post and telecommunications	P
65-67	Financial intermediation	U
70	Real estate	N
71-74	Renting of M&EQ and other business activities	U

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REGULATION OF FINANCIAL SYSTEMS AND ECONOMIC GROWTH IN OECD COUNTRIES: AN EMPIRICAL ANALYSIS

Alain de Serres, Shuji Kobayakawa, Torsten Sløk and Laura Vartia

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INTRODUCTION

The operation of the financial system can have a key impact on economic growth and the stability of the economy. It affects long-term economic growth through its effect on the efficiency of intermediation between the savers and final borrowers of funds; through the extent to which it allows for monitoring of the users of external funds, affecting thereby the productivity of capital employed; and through its implications for the volume of saving, which influences the future income-generating capacity of the economy. It affects the stability of the economy because of the high degree of leverage of its activities and its pivotal role in the settlement of all transactions in the economy, so that any failure in one segment risks undermining the stability of the whole system.

The impact of financial systems on growth has been well established empirically. Given the difficulties in directly measuring efficiency in the financial sector, a large number of empirical studies have relied on measures of size or structure to provide evidence of a link between financial system development and economic growth (Levine, 2005).[1] Indeed, nearly all studies based on macro- or sector-level data find that financial development, measured as the size of financial intermediation or of external finance relative to GDP, has a significant positive impact on growth, either directly via productivity, or indirectly via its effect on the build-up of physical and knowledge capital (Pelgrin *et al.*, 2002). And the finding is generally quite robust to variations in the sample. For instance, even though the majority of these studies cover a broad range of developed and developing countries, the results of financial development affecting growth have been found to hold also when the sample is limited to OECD countries (Leahy *et al.*, 2001).

Taken at face value, these results would suggest that in order to achieve faster growth, individual countries should vigorously pursue the development of domestic financial markets and institutions regardless of the size of their domestic economy. However, to the extent that markets for banking services and securities exchange are characterised by increasing returns to scale or network externalities, cross-border integration of financial markets may well be one of the major sources of efficiency gains. If all countries might benefit from reduction in costs arising from international market integration, only those with a comparative advantage in the provision of financial services would be expected to see an increase in the depth of their domestic financial sector. In this regard, beyond a certain threshold most likely to be reached in most developed countries, the size of a domestic

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financial system as conventionally measured may not be an adequate indicator of efficiency in terms of accessibility to credit and financial services, intermediation costs, or productivity of capital employed (Guiso *et al.*, 2004).

Another limitation of empirical studies linking growth to measures of financial sector size is the difficulty of identifying unambiguously the direction of causality. In order to address this issue, several studies have focused more directly on the determinants of financial development and/or on the mechanisms through which the latter affect growth. For instance, Rajan and Zingales (1998) exploit industry-level data across a set of countries to test the theoretical argument that financial development reduces the cost of raising funds from external sources by contributing to overcome problems of moral hazard and adverse selection. They do so by examining whether industries that are typically more reliant on external financing grow faster in countries with better-developed financial systems. More recently, Barth, Caprio and Levine (2004) use a database they have assembled on the regulation and supervision of banks around the world to examine the relationship between banking regulation and the development of the banking sector.

This paper combines the two approaches and uses industry-level data from over 20 countries to examine whether industries that rely more heavily on external sources of funds grow more rapidly in countries where regulation allows for stronger competition in markets for banking services and financial instruments.[2] The construction of regulatory indicators relies essentially on surveys conducted by the World Bank on regulations in banking and securities markets for its member countries.[3] Individual elements from these surveys are aggregated into broader indices directly used in the regression analysis.

In the case of banking regulation, the areas covered are separated according to whether they constitute unwarranted barriers to competition or whether they achieve stability objectives, such as market integrity and stability, with more limited adverse effect on competitive pressures. Regulatory impediments to competition include barriers to entry (both foreign and domestic) and lines-of-business restrictions. The extent of government ownership is also treated as a barrier to competition, reflecting the potential impact of state control on the level playing field. As for markets for debt and equity instruments, the regulatory indicators cover the following four areas: Contract enforcement, access to credit, investor protection and bankruptcy procedures.

Using panel regression techniques, the paper examines whether regulation that facilitates competition in banking and that is more conducive to securities market development and efficiency has a significant positive impact on sectoral output growth, productivity growth and firms' entry rates. The reason for looking at firm's entry rates is two-fold. First, according to the Shumpeterian approach to growth, the possibility for new, more innovative and efficient firms to compete

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with – and eventually to drive out – older less efficient firms is a key factor linking innovation to productivity gains. Second, using firm entry data is one way – albeit an indirect one – to examine the impact that financial system regulation may have on small firms, the ones most likely to face limited options in terms of access to external funding.

The output and productivity regressions are performed on a sample of around 25 countries and industries. The entry regression includes fewer countries (16) but a similar number of industries and also has a time-series dimension. Overall, the results indicate that financial system regulation has a statistically significant influence on output and productivity growth, in particular via the impact on industrial sectors relying more heavily on external sources of funding. The economic impact is also found to be non-negligible. The analysis suggests that reforms that would align regulations in banking in countries with the most restrictive stance to the OECD average could be associated with an increase in annual GDP growth by ¼ to ½ of a percentage point for a significant period of time. The impact from strengthening investor protection would be somewhat weaker.

The rest of the paper is organised as follows: The next section provides a discussion of barriers to competition in financial systems and introduces the regulatory indicators used in the empirical analysis. Empirical methodology and results are then presented and compared with findings from earlier studies. This is followed by concluding remarks.

BARRIERS TO COMPETITION IN FINANCIAL MARKETS: THE ROLE OF REGULATION AND OTHER POLICIES

This section discusses regulatory impediments to competition (both from domestic and foreign sources) in various segments of banking activities, as well as of the regulatory underpinnings of securities markets. Using essentially information from comprehensive regulatory databases compiled by the World Bank, the stance of regulation in banking and some aspects of securities markets is presented in the form of quantitative indicators. It is important to stress that the indicators presented in this section reflect for the most part the stance of domestic regulation in specific areas of banking and securities market. Financial sector development and efficiency can also be hampered by a number of less formal policy barriers to cross-border competition in securities and banking services. Such barriers, which include differences in national corporate tax systems as well as in legal, technical or accounting standards, are discussed in Box 1.

B*anking regulation*

Banking regulation has often been put in place with several – and sometimes conflicting – objectives in mind, such as promoting strong national financial

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Box 1. **Less formal and/or non-legal barriers to competition**

Apart from the formal barriers discussed above, a number of less formal or non-legal obstacles contribute to maintaining inefficiencies in financial markets. While some of these obstacles may be "natural" such as language, culture or preferences, others may result from policy settings, including unfinished agendas for facilitating international trade and market integration. Some of the most significant policy areas can be regrouped according to the type of market instrument they are most directly related to:

- In the case of *retail banking services*, including bank loans to individuals and small- and medium-sized enterprises, barriers to trade include the lack of harmonisation in consumer protection rules as well as in procedures for solving cross-border or cross-region disputes (Walkner and Raes, 2005). In addition, banks wishing to expand into neighbouring countries via foreign subsidiaries are generally subject to host country supervision rules, implying multiple reporting. Even within countries, banks operating nationwide must in some member countries deal with multiple layers of supervisory authorities, often with different reporting requirements (Dermine, 2006).
- In the case of *equity markets*, a number of factors contribute to limiting the consolidation of stock exchanges as well as to raising the cost of cross-border securities transactions. These include differences in national corporate tax systems as well as in reporting and accounting standards, and, in some cases, the vertical ownership structure of stock exchanges.* In some member states, investors/traders wishing to transact in several regions or provinces face higher costs owing to the presence of different securities exchange commissions.
- The development of the *private equity or venture capital market* is hampered in several countries by legal restrictions on holding of high-risk instruments by pension and/or mutual funds (Thompson and Choi, 2002). In addition, high capital gains taxes have been found to adversely affect venture capital development (Gompers and Lerner, 2004). Barriers to consolidation of secondary stock markets may also play a role, given the importance of exit prospects in attracting venture capital investment (OECD, 2003a).
- In the case of the *bond market*, a number of barriers have slowed the development of asset-backed securities including, in several cases, provisions from bankruptcy legislation requiring borrowers to be individually notified that the loan they contracted via a financial intermediary is being securitised, which raises the cost of such operation. More generally, the development of an integrated asset-backed securities market is hampered by cross-country differences concerning reporting regulations, rules on withholding taxes, income tax treatment of issuing vehicles and treatment of capital gains.

* This issue has been particularly well documented in the context of the European Union, with reports published by the Giovannini group (2003) as well as by the CEPS (2003).

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institutions, offering consumer protection, assisting industrial and/or regional development and preserving financial stability, in particular the safeguarding of the payment and settlement system. This has led in the past to tight and widespread regulation, ranging from interest rate ceilings and branching restrictions to capital requirements and deposit insurance. While some of the most stringent rules such as interest rate controls and branching restrictions have by now been largely eliminated in OECD countries, the sector remains nevertheless one of the most intensely regulated across countries. Furthermore, the main objectives of regulation have generally become more narrowly focused, with the main emphasis put on market integrity (conduct rules) consumer/investor protection (disclosure rules) and crisis prevention, in particular on limiting systemic risks should one or more institutions get into trouble (prudential regulation). In parallel, in an effort to level the playing field internationally, efforts have been made to harmonise prudential regulation across countries via the Basel I and II processes.

Against this background, the policy challenge is to strike the right balance between preserving the overall soundness of the banking system and fostering its efficiency. To a certain extent, rules aimed at consumer protection may contribute to re-enforce competition, for instance by helping consumers to make better informed choices, raising thereby their willingness to switch between institutions. Also, a minimum level of regulation is needed to ensure that financial institutions behave prudently, and this can raise efficiency even if it increases the cost of entry. In many cases, however, regulation aimed at stability or consumer protection is implemented at the expense of competition with the balance being unnecessarily tilted against efficient outcomes. Indeed, as long as measures such as capital requirements, disclosure rules and risk-based deposit insurance are in place to ensure banks' prudent behaviour, further reductions in direct barriers to competition need not weaken the key regulatory objectives.[4]

Construction of regulatory indicators

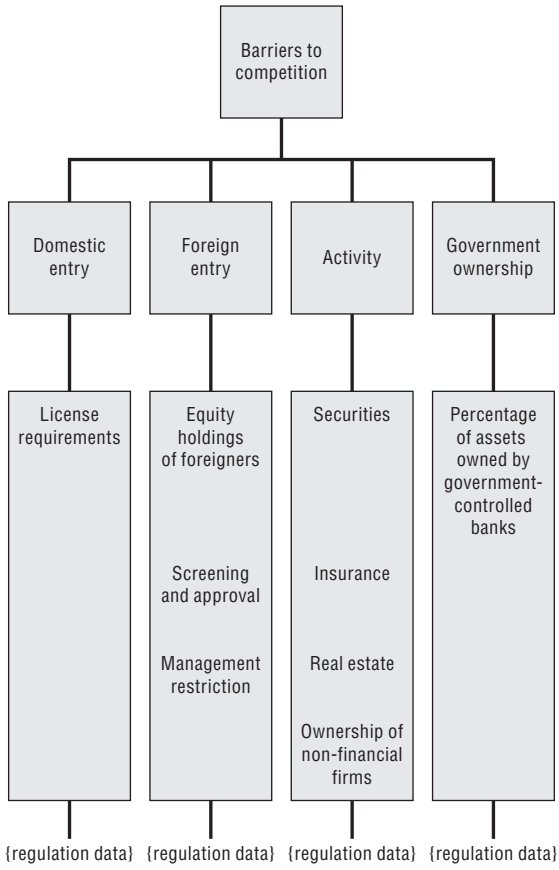
In order to compare the stance of banking regulations across countries, the analysis relies essentially on the World Bank's B*ank, R*e*gulation and S*u*pervision* D*atabase*. It compiles the results from a detailed survey of banking regulation conducted in 2000 and again in 2002-03 in a large number of countries (see de Serres *et al.*, 2006 for details regarding the questionnaire and the construction of quantitative indices). As such, it provides a measure of the stance of banking regulation in the countries covered, with some indications of the enforcement powers by supervisors. The survey consists of approximately 250 questions which, for the purpose of this exercise, have been categorised under two broad headings: Stability and barriers to competition (Figure 1).

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Each category is in turn divided in sub-groups according to the specific aspects of regulation covered. The sub-groups for the competition-barriers category include regulatory barriers on domestic and foreign entry, restrictions on banking activities and the extent of government ownership. The sub-groups for stability category consist of ten diverse regulatory areas. Even though the B*ank, Regulation and Supervision Database* contains some information about foreign entry and government ownership, the indicators used in the empirical work are based on alternative sources which were viewed as more comprehensive. More specifically, the index of restrictions on foreign entry in banking is based on earlier OECD

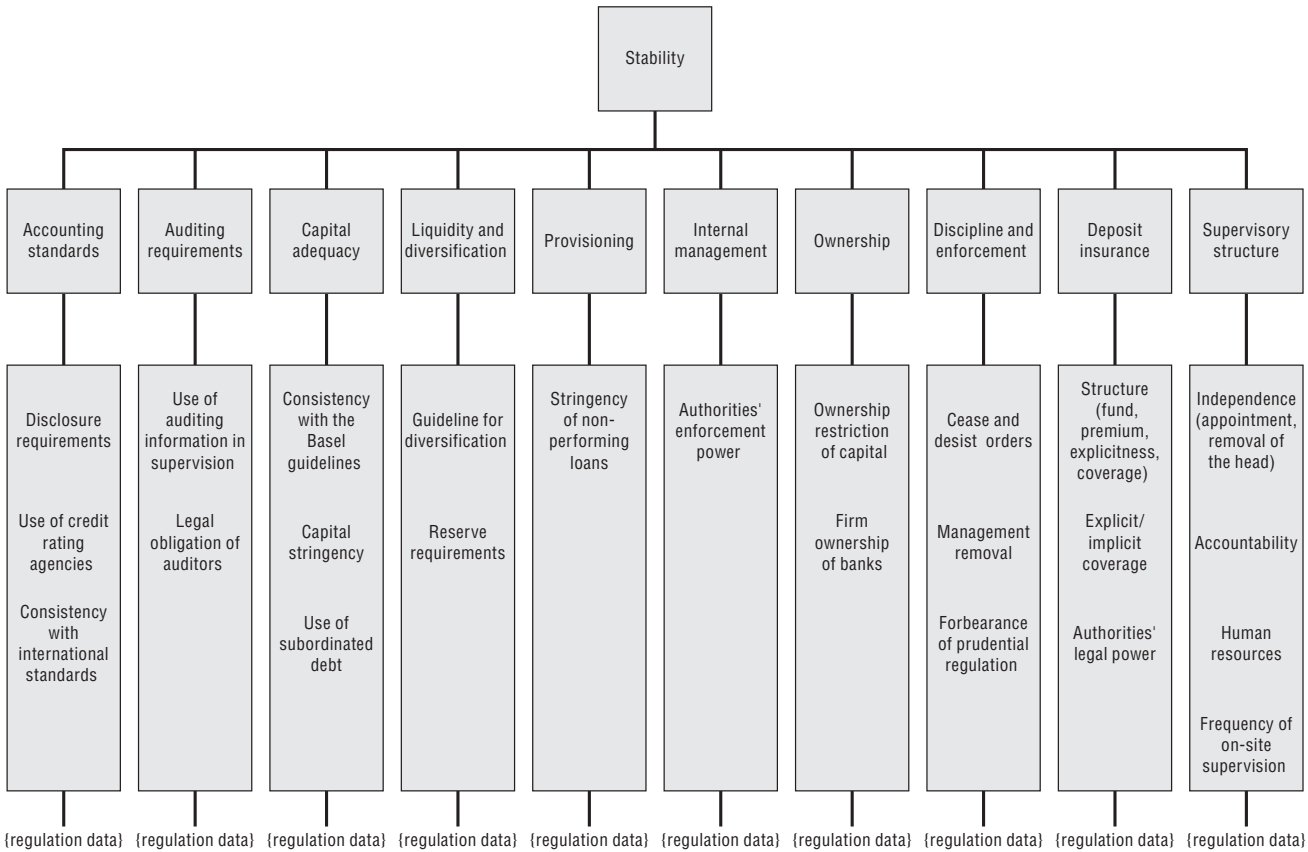
Figure 1. **The system of regulatory indicators for the banking system**

Panel A. Regulatory barriers to competition



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Figure 1. **The system of regulatory indicators for the banking system** *(cont.)*
Panel B. Regulations aimed at stability



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work on FDI restrictions (Golub, 2003). As for the measure of government ownership of banks, it is taken from La Porta *et al.* (2002).[5]

As is common practice with regulatory indicators, qualitative answers (mostly in the form of "yes" or "no") to a questionnaire have been converted into quantitative indices by attributing a score that increases according to the restrictiveness of regulation. The scores attributed to individual questions (on a scale going from 0 to 1) have first been aggregated into sub-indices, corresponding to the groupings shown in Figure 1, and then into the two broad categories, barriers to competition and stability. Converting qualitative information into quantitative indicators is not, however, without problems. A key issue is to what extent the same weight should be given to all indicators or if some indicators should have a bigger weight, which obviously is crucial to the value of the indicator. One way to address this is to assign random weights to individual or groupings of questions and provide a range of possible values for the index as a function of changing weights, as has been done in the following.[6]

Results

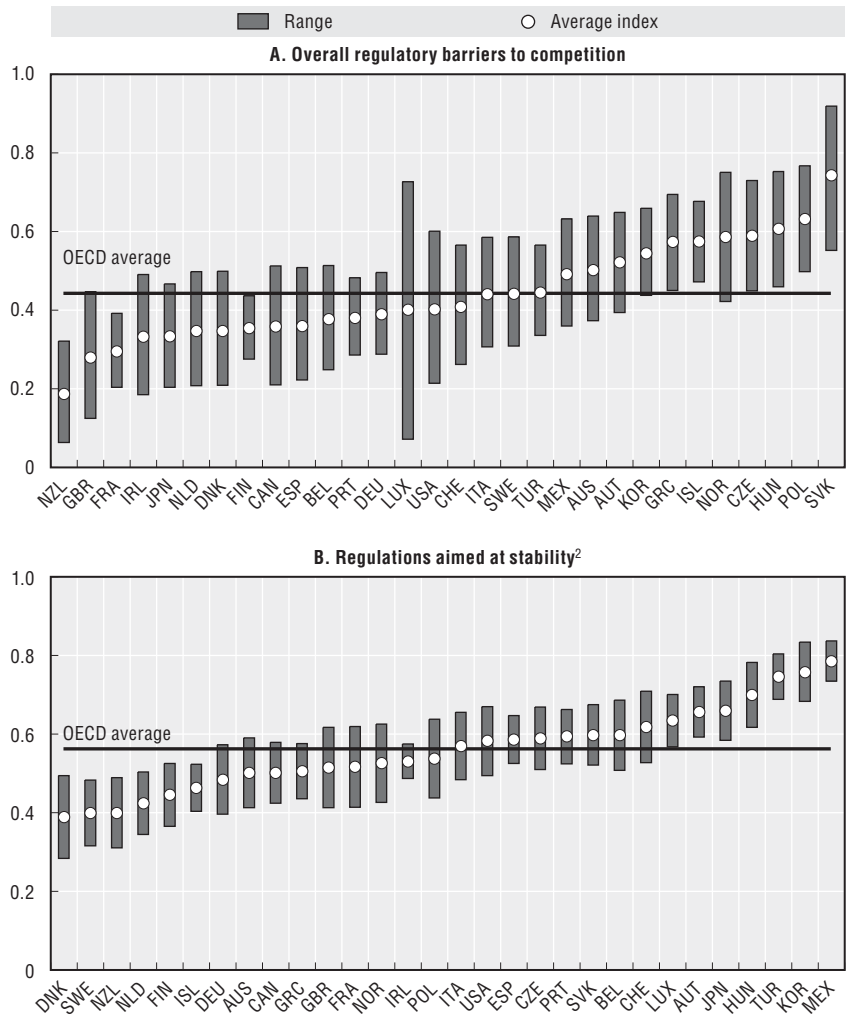
Figure 2 shows the constructed regulatory indicators for the broad competition and stability categories. The mid-point (*i.e.* the white circle) shows the average index and the ranges shown in shaded areas are calculated using the random weights technique (using 90% confidence intervals). On the basis of this technique, less than ten OECD countries differed at the time from the OECD average with respect to regulatory barriers to competition. Looking at regulations aimed at stability suggests narrower confidence intervals and hence greater dispersion with a number of countries being clearly below or clearly above the OECD average.

At the time the survey was conducted (2002-03), the indicator for regulations affecting competition shows that Korea and central and eastern European countries tended to have generally stricter regulation. By contrast, regulations in this area were particularly permissive in New Zealand. Most other countries were found to lie within a fairly narrow range around an intermediate position with respect to competition-restraining regulations in banking.

The overall indicator of barriers to competition can be further decomposed into its main sub-indices (Figure 3). Most OECD countries tend to have relatively stringent requirements to set up banking institutions and regulations tend to be comparatively homogenous across countries. Thus, basically all countries require extensive information about financial projections for new banks and their business plan, the sources of equity and the financial status of the main potential shareholders, the planned organisation of the bank and the background of future directors and managers.

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Figure 2. **Banking regulation indices, 2003**[1]



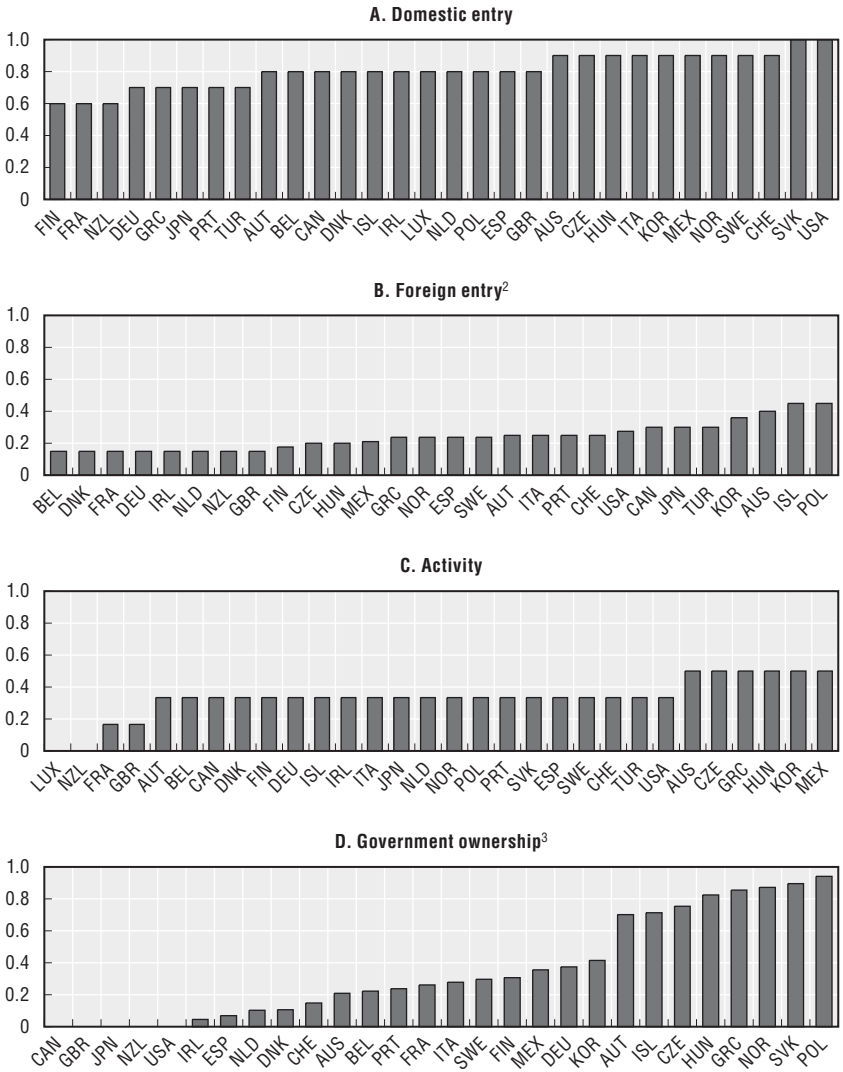
1. The scale of the indicator is 0-1 from least to most restrictive. A higher value indicates more competition-restraining regulation.
2. Covers different measures related to prudential regulation of the banking sector.

Source: OECD; World Bank, Bank Regulation and Supervision Database.

Somewhat more variations are observed with respect to activity control and restrictions to foreign entry into banking (at least as they were prevailing in the late 1990s). Controls on the types of activity that bank can engage into are particularly

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Figure 3. **Barriers to competition in banking**[1]



1. The scale of the indicator is 0-1 from least to most restrictive. A higher value indicates more competition-restraining regulation.
2. Restrictions to foreign entry are taken from Golub, S. (2003). This index reflects the stance of regulation prevailing in the period 1998-2000.
3. Measures the amount of assets held by banks (among the 10 largest) where government ownership is at least 20 per cent as a ratio of total assets (of the 10 largest banks). The measure is taken form La Porta *et. al* (2002) and applies to 1995.

Source: OECD; World Bank, Bank Regulation and Supervision Database and La Porta *et al.* (2002).

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low in many European countries. Government ownership of banks was most extensive in Korea and European member countries in the mid-1990s, while the banking system was fully in private hands in many countries, including the United States, Canada, Japan, New Zealand and the United Kingdom at that time. Overall, there is little correlation between the four sub-components, which reflect a fair degree of heterogeneity in the regulatory stance within countries across the different areas explains the relatively large confidence band (top Panel of Figure 2).

Regulations related to prudential conduct in the banking sector are comparatively strict in a few low-income member countries and relatively light in some Nordic countries, New Zealand and the Netherlands. As reflected in the comparatively narrow confidence intervals for the stability-oriented regulation index depicted in Figure 2 (lower Panel), policies tend to be applied more consistently in the ten different areas making up the index. For example, countries with tight accounting standards and auditing requirements also tend to give regulators relatively strong powers to intervene in the internal management of banks.

Correlations of banking regulations and financial development

Simple correlation analysis shows that across countries the variables measuring aspects of regulation in the banking industry appear to be related to financial development and with an effect that is in conformity with priors (Table 1). More specifically, stricter anti-competitive regulation is associated with lower bank assets relative to GDP though not with private credit by banks relative to GDP. At a lower level, these indicators of banking sector development are negatively (albeit, weakly) associated with regulations on foreign entry and activities. To some extent, these results corroborate those found in an earlier study based on the same regulatory data set (albeit from an earlier vintage, see Barth, Caprio and Levine, 2001).[7] With respect to stability-oriented regulations, the correlations reported in Table 1 suggest that they tend to be negatively associated with financial development, though the correlation is not statistically significant for most of the more specific regulatory areas.

Securities market regulation

In contrast to banking regulation, tensions between different regulatory objectives have been less of an issue in the case of securities markets. This owes much to the fact that a core objective of market regulation – investor protection defined in a broad sense – is also viewed as contributing positively to financial system efficiency. Even so, striking the right balance between protecting the rights of various stakeholders (shareholders, creditors, entrepreneurs/managers and employees) on the one hand, while allowing firms and markets to function efficiently on the other, does involve complex policy trade-offs, cutting through a wide range of regulatory areas

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Table 1. **Correlation between banking regulations and financial development**

Structural indicator	Bank assets as a share of GDP					Private credit by banks as a share of GDP				
	I	II	III	IV	V	VI	VII	VIII	IX	X
Barriers to competition	–2.15** (0.04)					–1.69 (0.16)				
Domestic entry		–0.91 (0.19)					–0.03 (0.97)			
Foreign entry			–1.90* (0.05)					–1.10 (0.31)		
Activity				–1.10* (0.06)					–1.16* (0.08)	
Government Ownership					–0.11 (0.86)					–0.32 (0.65)
Number of observations	29	29	27	29	27	30	30	28	30	28
R^2	0.15	0.06	0.14	0.12	0.00	0.07	0.00	0.04	0.11	0.01

Structural indicator	Bank assets as a share of GDP									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Stability in banking regulation	–1.43** (0.04)									
Accounting standards		–0.06 (0.92)								
Auditing requirements			–0.03 (0.96)							
Capital adequacy				–0.13 (0.79)						
Liquidity and diversification					–0.32 (0.31)					
Provisioning						–0.68*** (0.00)				
Internal management							0.08 (0.65)			
Ownership								–0.85** (0.03)		
Discipline and enforcement									–0.76* (0.07)	
Deposit insurance										–0.51 (0.22)
Supervisory structure										–0.11 (0.85)
Number of observations	29	29	29	29	29	29	29	29	29	29
R^2	0.15	0.00	0.00	0.00	0.04	0.34	0.01	0.16	0.12	0.06	0.00

1. Each column in barriers to competition and stability in banking regulation is a separate regression. Dependent variables for barriers to competition are bank assets as a share of GDP and private credit by banks as a share of GDP (average between 2000 and 2003). Dependent variable for stability is bank assets as a share of GDP. P-values are reported under the estimated coefficients. *, **, *** indicate significance at the 10, 5 and 1% level respectively.

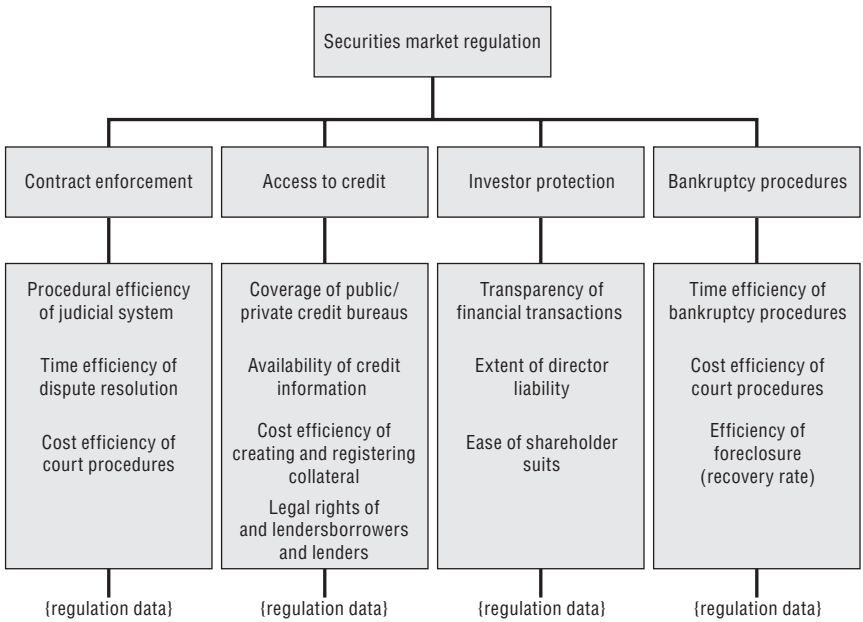
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such as securities exchange rules, company law and bankruptcy law. Accordingly, providing a comprehensive quantification of the stance of regulation in these areas with a view to identifying best practice remains a challenge.

Construction of indicators

To assess the stance of securities market regulation in member countries, quantitative indicators have been derived using the *Doing Business Database* (2005) of the World Bank.[8] Four broad indices of securities market regulation have been used:[9] Contract enforcement, access to credit, investor protection and bankruptcy procedures. Each category is constructed from sub-indices which essentially reflect aspects of transparency (information disclosure) and efficiency of legal procedures (Figure 4).[10] For instance, the access to credit index combines information about the coverage of public registries and private bureaus with estimates of cost to create collateral and with information on the legal rights of lenders and borrowers. As was the case with banking regulation, all individual items have been converted into a quantitative index ranging from 0 to 1. In contrast to banking regulation, however, and given the emphasis put on investor/creditor protection and information standards, the indices have been constructed in such a way that a higher value is interpreted as being good for financial development and overall economic performance.

Figure 4. **The system of regulatory indicators for securities markets**



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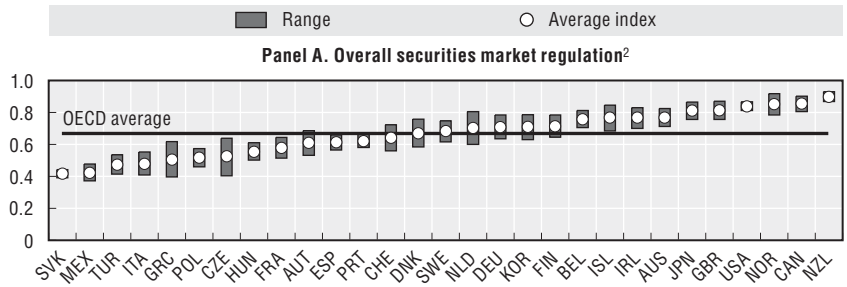
Results

The value of the overall index of securities market regulation is shown in Figure 5, Panel A. As is the case in banking regulation, the mid-point (*i.e.* the white circle) shows the average index and the ranges shown in the shaded areas are calculated using the random weights technique. Compared with the results obtained in banking regulations, a larger set of countries (English-speaking countries as well as Norway, Japan, Iceland, Belgium and Finland) have significantly more demanding regulations (*i.e.* favourable to the development of securities markets) than the OECD average. By contrast, the indicator shows that central and eastern European countries, and other countries with relatively low values, had, in around 2005, a regulatory stance less conducive to the development of securities markets.

The overall indicator of securities market regulation can be further decomposed into four broad sub-indices:

- *Contract enforcement*. Captures essentially the efficiency of commercial contract enforcement based on the number of procedures, the number of calendar days for dispute resolution and the official cost of court procedures.
- *Access to credit*. Captures two broad elements in assessing the ease of access to credit: The amount of credit information available through public registries or private bureaus; the strength of legal underpinnings in arranging collateral in protecting secured lenders.
- *Investor protection*. Captures the strength of minority shareholder protection against directors' misuse of corporate asset for personal gain from three perspectives: transparency of transactions, liability for self-dealing and shareholders' ability to sue directors for misconduct.

Figure 5. **Securities markets regulation indices**[1]

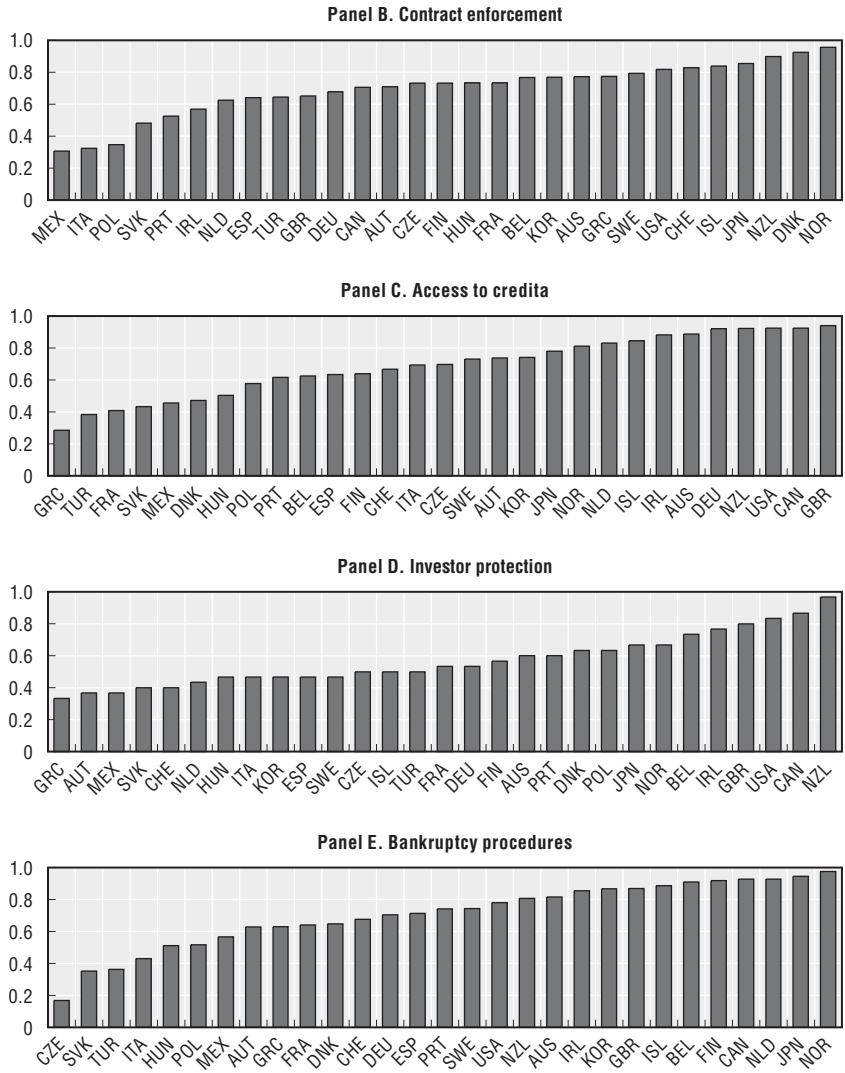


1. The scale of the indicator is 0-1 from least to most restrictive. A higher value indicates more competition-restraining regulation.
2. Covers contract enforcement, access to credit, investor protection and bankruptcy procedures.

Source: OECD; World Bank, Bank Regulation and Supervision Database.

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Figure 5. **Securities markets regulation indices**[1] *(cont.)*



1. The scale of the indicator is 0-1 from least to most restrictive. A higher value indicates more competition-restraining regulation.
2. Covers contract enforcement, access to credit, investor protection and bankruptcy procedures.

Source: OECD; World Bank, Bank Regulation and Supervision Database.

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- B*ankruptcy procedures*. Captures the efficiency of bankruptcy laws and its proceedings with respect to the time required to go through the bankruptcy procedure, the overall cost of procedures and the recovery rate.

Overall, the stance of securities market regulations in different areas tends to be correlated in each country. Some G7 countries (*e.g.* Canada, the United States and the United Kingdom) are relatively demanding in all areas, whereas central and eastern European countries tend to be fairly unrestrictive across the board (Figure 5, Panels B-E).

Correlations of securities market regulations and financial developments

Correlation analysis underlines that across OECD countries the indicators of securities market regulation appear to be related to financial development (Table 2). To be more specific, stricter regulation is associated with higher stock market and private bond market capitalisation relative to GDP. At a lower level, significant influences of contract enforcement and bankruptcy procedures are found.

Table 2. **Correlation between securities market regulations and financial development**

Structural Indicator	Stock market and private bond market capitalisation as a share of GDP				
	I	II	III	IV	V
Securities market regulation	2.41***				
	(0.01)				
Contract enforcement		1.69**			
		(0.03)			
Access to credit			1.33*		
			(0.06)		
Investor protection				0.66	
				(0.43)	
Bankruptcy procedures					1.71***
					(0.01)
Number of observations	29	29	29	29	29
R^2	0.22	0.16	0.13	0.02	0.24

Note: Each column is a separate regression. Dependent variable is the sum of stock market and private bond market capitalisation as a share of GDP (average between 2000 and 2003). P-values are reported under the estimated coefficients. *, **, *** indicate significance at the 10, 5 and 1% level, respectively.

THE IMPACT OF FINANCIAL SYSTEMS' DEVELOPMENT AND POLICIES ON ECONOMIC PERFORMANCE: EMPIRICAL EVIDENCE AT THE INDUSTRY LEVEL

This section reports on the results from panel regression analysis linking a number of indicators of regulatory policy in the areas of banking competition and securities markets reviewed in the previous section, as well as measures of financial development and costs to broad measures of economic performance. As men-

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tioned earlier, a large number of empirical studies have shown the importance of financial systems' development for growth at the aggregate level, but fewer have gone beyond standard measures of financial development and examined directly the impact of policy variables on performance at the sectoral level. The approach taken follows Rajan and Zingales (1998) and the basic argument is that insofar as financial markets and institutions do reduce the cost of raising external funds, industries that depend more heavily on external sources should benefit disproportionately from a regulatory environment that is more conducive to financial systems' development and efficiency.

To the extent that important differences prevail across industries with respect to the use of external finance, using disaggregated data also allows cross-section regression analysis to be performed over a larger and richer dataset.[11] Accordingly, the empirical investigation presented in this section is conducted on the basis of industry-level data, which are used to examine the effect of various policy indicators and measures of financial development on real value-added growth and labour productivity growth. In addition, given the importance of experimentation in the development of new products and services, and the role that financial systems can play in this process, the impact of financial development and policy on industry entry rates is also examined.[12]

Methodology and specification

The approach used to test whether regulations and the development of financial systems have a significant influence on economic growth is based on the idea that firms' dependence on external sources of finance varies across industries according to differences in technology and characteristics such as the degree of capital intensity. For example, highly capital- and R&D-intensive industries may be more dependent on external funding due to large investment costs and longer periods before the profits can be harvested. Insofar as these differences across industries in the desired degree of external dependence are broadly similar across countries, this opens the possibility to test whether industries that depend more heavily on external funds grow faster in countries that have better-developed financial systems.

Concretely, this is done by interacting an industry-specific measure of external financial dependence with a country-specific indicator of financial development or regulatory policy such as those discussed in the previous section.[13] However, the *desired* amount of external financing in each industry is not observed and can only be inferred from the *actual* amount of funds raised externally. The latter is likely to be a good proxy for the former only where financial markets are sufficiently developed to provide firms with a largely unconstrained access to external financing. Again, following Rajan and Zingales (1998), the assumption

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made is that US financial markets come closest to provide such access and accordingly, data on US listed firms are used to identify industries' need of external finance. More specifically, a firm's dependence on external finance is defined as its capital expenditure minus internal funds (cash flow from operations) divided by capital expenditure (see Annex for more details).[14]

Each interaction term is then introduced as a potential determinant in separate regressions. In principle, it would have been desirable to include all the regulatory variables in a single regression allowing for statistical discrimination, but this was not feasible due to strong multicollinearity induced by the interaction with the measure of external financial dependence.[15]

This methodology is applied to examine the impact of financial systems' regulation and development on valued-added growth, labour productivity growth and firms' entry rates. In the first two cases, the analysis is conducted on a panel dataset with country and industry dimensions, using average growth rates over the 1994 to 2003 period. A time-series dimension is included in addition in the case of firm entry rates. The latter are defined as the number of entering firms divided by the total number of firms in a specific industry and are calculated on an annual basis over the period 1990-2001. The empirical analysis is based on the estimation of the following respective equations:

a) Industry growth:

$$GROWTH_{c,i} = \alpha + \beta_1 INITSH_{c,i} + \beta_2(X_c * EXDEP_i) + \sum_c \gamma_{1c} Dcountry_c + \sum_i \gamma_{2i} Dindustry_i + \varepsilon_{c,i} \quad [1]$$

b) Industry entry dynamics:

$$ENTRY_{c,i,t} = \alpha + \beta_1 GAP_{c,t} + \beta_2(X_c * EXDEP_i) + \sum_c \gamma_{1c} Dcountry_c + \sum_i \gamma_{2i} Dindustry_i + \sum_t \gamma_{3t} Dyear_t + \varepsilon_{c,i,t} \quad [2]$$

where $GROWTH_{c,i}$ and $ENTRY_{c,i,t}$ are the dependent variables and refer to growth of value added or labour productivity and entry rates in industry *i* and country *c*, respectively. X_c stands for indicators of financial development and regulatory stances and the variable $EXDEP_i$ captures the measure of industries' dependence on external finance.[16] The model for firm entry includes also the time dimension with sub-index *t*. Dummy variables for each country, industry and year are introduced to correct for country, industry and time specific effects. An industry's initial share of the total value added, $INITSH_{c,i}$, is used to control for potential convergence effects.[17] Finally, a measure of the output gap, $GAP_{c,t}$, is used to control for business fluctuations affecting firm entry.

The financial development and performance variables include an overall measure of size (sum of private credit and securities market capitalisation), venture capital and overhead costs in the banking sector. As for policy indicators, they cover the two broad indices of securities market regulation and barriers to competition in

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banking, as well as some of their main sub-indices as defined in the previous section. While stability-oriented regulations have been excluded from the analysis reported, preliminary results indicated no robust evidence of a significant impact of such regulation on long-term performance. All the details concerning data sources, variable definitions and country and industry coverage are exposed in the annex.

Results

Base case results

Overall, the results for value-added growth and labour productivity growth provide further support to the view that financial systems matter for economic performance (Tables 3 and 4). Both the broad measures of financial depth, venture capital and overhead costs have a significant influence on the two growth measures, with the impact going in the expected direction. As for policy indicators, both the overall indices of barriers to banking competition and securities market regulation are found to impact significantly on valued-added and productivity growth. Taken at face value, this would suggest that policies improving contract enforcement, access to credit, the efficiency of bankruptcy procedures, or reducing barriers to entry and government control in the banking sector will foster labour productivity and value-added growth, in sectors most dependent on external finance.

Turning to the impact on firms' entry rates, the results are broadly in line with those for value-added and labour productivity growth, although the degree of significance is generally somewhat weaker (Table 5). One difference is that venture capital is no longer significant. Another difference is that the impact of barriers to banking competition relative to that of securities market appears to be larger than in the case of productivity and value-added growth. This finding is consistent with the view that new and small firms tend to rely more heavily on bank financing and thus regulation on this sector may have a stronger effect on such firms. Perhaps more importantly, the negative impact of barriers to competition in banking on firm entry contradicts the view according to which greater market power in banking may facilitate entry by providing easier access to credit for young and unknown firms (Peterson and Rajan, 1995).

Even if the statistical analysis supports the importance of the financial development and regulatory variables, they explain only a small fraction of the variance in sectoral value-added and productivity growth, as well as of entry rates. Indeed, these variables account for one to two per cent of the total variance, the country, industry and (in the case of entry rates) time fixed effects accounting for almost all of the multiple correlation coefficients (R^2) of the regressions. Nonetheless, since the variation is quite large, the financial development and regulatory indicators are of significant quantitative importance. For instance, based on the empirical estimates reported above, a one standard-deviation increase in financial development would lead on average to an increase in the growth rate of value-added or

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Table 3. **Value-added growth, financial development and regulations: Empirical analysis**

Panel regressions with country and industry dimensions: average over 1994-2003

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Initial share	–0.19**	–0.20**	–0.18**	–0.21***	–0.20***	–0.18**	–0.19**	–0.20***	–0.22***	–0.20***	–0.21***
	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.08)	(0.08)	(0.07)
Financial development *EXDEP	0.38***										
	(0.13)										
Venture capital *EXDEP		1.63***									
		(0.58)									
Overhead costs in banking *EXDEP			–21.99**								
			(9.75)								
Securities market regulation *EXDEP				2.20***							
				(0.65)							
Contract enforcement *EXDEP					1.52***						
					(0.55)						
Access to credit *EXDEP						0.99**					
						(0.49)					
Investor protection *EXDEP							0.99**				
							(0.49)				
Bankruptcy procedures *EXDEP								1.33**			
								(0.54)			
Barriers to banking competition *EXDEP									–3.03***		
									(0.86)		
Regulation on entry and activity *EXDEP										–3.10**	
										(1.30)	
Government ownership *EXDEP											–1.08***
											(0.33)
Number of observations	435	444	466	466	466	466	466	466	466	466	466
R^2	0.45	0.41	0.42	0.43	0.42	0.42	0.42	0.43	0.43	0.42	0.43

N*ote*: EXDEP variable in the interaction terms refers to industries' dependence on external finance. Financial development is measured as the sum of private credit, stock market and private (0.33) bond market capitalisation to GDP. All regressions include country and industry dummies. Robust standard errors are reported in parentheses; *, **, and *** indicate significance at the 10, 5 and 1% level, respectively.

Table 4. **Productivity growth, financial development and regulations: Empirical analysis**

Panel regressions with country and industry dimensions: Average over 1994-2003

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Initial share	–0.15	–0.15*	–0.14*	–0.17**	–0.16**	–0.15*	–0.16*	–0.16**	–0.19**	–0.17**	–0.18**
	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Financial development *EXDEP	0.36***										
	(0.10)										
Venture capital *EXDEP		0.93**									
		(0.47)									
Overhead costs in banking *EXDEP			–20.50**								
			(9.82)								
Securities market regulation *EXDEP				1.96***							
				(0.56)							
Contract enforcement *EXDEP					1.32***						
					(0.50)						
Access to credit *EXDEP						0.81**					
						(0.41)					
Investor protection *EXDEP							1.16***				
							(0.43)				
Bankruptcy procedures *EXDEP								1.13***			
								(0.36)			
Barriers to banking competition *EXDEP									–2.90***		
									(0.58)		
Regulation on entry and activity *EXDEP										–3.43***	
										(1.15)	
Government ownership *EXDEP											–0.96***
											(0.22)
Number of observations	394	423	423	423	423	423	423	423	423	423	423
R^2	0.45	0.42	0.42	0.43	0.42	0.42	0.42	0.42	0.43	0.43	0.43

Notes: EXDEP variable in the interaction terms refers to industries' dependence on external finance. Financial development is measured as the sum of private credit, stock market and private bond market capitalisation to GDP. All regressions include average country and industry dummies. Robust standard errors are reported in parentheses; *, **, and *** indicate significance at the 10, 5 and 1% level, respectively.

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Table 5. **Entry rates, financial development and regulations: Empirical analysis**

Panel regressions with country, industry and time (1990-2001) dimensions

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Financial development *EXDEP	0.58*** (0.21)										
Venture capital *EXDEP		–0.28 (0.81)									
Overhead costs in banking *EXDEP			–33.21** (13.73)								
Securities market regulation *EXDEP				2.15* (1.22)							
Contract enforcement *EXDEP					1.55* (0.91)						
Access to credit *EXDEP						1.24 (0.80)					
Investor protection *EXDEP							0.73 (0.83)				
Bankruptcy procedures *EXDEP								1.73** (0.87)			
Barriers to banking competition									–3.39*** (1.22)		
Regulation on entry and activity *EXDEP										–4.73*** (1.77)	
Government ownership *EXDEP											–0.91** (0.41)
Number of observations	1 995	1 950	2 170	2 170	2 170	2 170	2 170	2 170	2 170	2 170	2 170
R^2	0.63	0.65	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63

Notes: EXDEP variable in the interaction terms refers to industries' dependence on external finance. Financial development is measured as the sum of private credit, stock market and private bond market capitalisation to GDP. All regressions include country, industry, and year dummies and output gap to control for business cycles in each country. Cluster corrected standard errors are reported in parentheses; *, **, and *** indicate significance at the 10, 5 and 1% level, respectively.

productivity in the business sector of a magnitude varying roughly from 0.2 to 0.5 percentage points (depending on the averaging method), while the impact on entry rates would range between 0.4 and 0.7 percentage points (Table 6). Improvements in the stance of banking regulations equivalent to one standard deviation would be associated with increases in growth and entry rates of similar magnitudes, whereas the impact of securities market regulation is somewhat lower.

The findings reported in this section are broadly in line with the few empirical papers looking at the growth and finance nexus from a sector-level perspective. For instance, the results on industry growth confirm the findings of Rajan and Zingales (1998) and the more recent study by Guiso *et al.* (2004) that analyses growth in the EU countries.[18] The research at the industry level has mostly focused on value-added growth and the finding that productivity growth is also positively affected by financial development provides further evidence on the relationship between finance and growth. A couple of studies examine the effects of financial development on firm entry

Table 6. **Effect of a one standard-deviation change in the indicators of financial development and regulation**

	Simple average effect	Weighted average effect
Panel A. Value-added growth		
Financial development	0.27	0.48
Venture capital	0.18	0.31
Overhead costs in banking (decrease)	0.20	0.34
Securities market regulation	0.24	0.42
Barriers to banking competition (decrease)	0.29	0.52
Panel B. Labour productivity growth		
	Simple average effect	Weighted average effect
Financial development	0.25	0.45
Venture capital	0.10	0.18
Overhead costs in banking (decrease)	0.18	0.32
Securities market regulation	0.21	0.37
Barriers to banking competition (decrease)	0.28	0.49
Panel C. Firm entry		
	Simple average effect	Weighted average effect
Financial development	0.41	0.66
Overhead costs in banking (decrease)	0.30	0.48
Securities market regulation	0.24	0.38
Barriers to banking competition (decrease)	0.34	0.53

1. Calculated as a simple average of the effect on each industry.
2. Calculated as a weighted average of the estimated effect on each industry, with the weights being based on the average share across countries of respective industries in total business sector value-added.

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(Klapper, Laeven and Rajan, 2004; Vartia, 2006) and their results are consistent with those reported in this study. Beck, Demirguc-Kunt, Laeven and Levine (2004) also find that small firms are particularly affected by financial development, in line with the above results on entry since entering firms generally tend to be small.

Robustness tests

In order to test the robustness of the findings on value-added and productivity growth and firm entry reported above, a number of sensitivity tests were carried out. In particular, the sensitivity to important omitted variables from the baseline regressions is tested. In the analysis of industry growth three additional variables are introduced to the baseline regressions (Tables 3 and 4 specifications IV and IX). These are: *i*) the rate of change of the industry-specific regulation-impact indicator;[19] *ii*) industry investment growth, and *iii*) industry R&D intensity.

The results on the effects of financial regulation seem to be relatively robust to the inclusion of these variables (see Table 7). The estimated coefficients of investment growth, R&D intensity and change in the regulation impact indicator have the expected signs. However, only the regulation indicator and investment growth have statistically significant effects on value-added and productivity growth. Including the measure of regulation impact also reduces to some extent the statistical significance of the effect of banking competition regulation on labour productivity growth.

In the case of firm entry the robustness analysis was carried out using industry value-added growth and R&D intensity as control variables (not shown in the Table). Of these, only R&D intensity was statistically significant and in neither case were the basic results affected. On the other hand, the significance of the basic results turned out to be sensitive to the inclusion of the industry-specific regulation impact indicator, but in this case the sensitivity of results was due to the exclusion of Hungary and Mexico for which no data on the regulation impact were available. One reason for this sensitivity is that firm entry regressions are performed over a smaller set of countries than value-added and productivity growth regressions. In such a case, the exclusion of Hungary and Mexico reduces considerably the cross-country variations in the banking and securities market regulation indicators. In contrast, the results from value-added and productivity growth regressions are not sensitive to the exclusion of these countries.

Given the important role played by the ratio of external dependence in the analysis, the sensitivity of the results to this variable was also examined. In particular, a potential concern is that the results presented above could be essentially driven by the extreme values for the degree of external dependence observed in two industries, namely real estate and business activities and chemicals and chemical products, where the ratios are 3.3 and 6.2, respectively (see Table A.3 in

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Table 7. **Effects of financial regulation on growth: Sensitivity to the inclusion of additional variables**

	Panel A. Effects of securities market regulation					
	Value-added growth			Labour productivity growth		
	I	II	III	IV	V	VI
Initial share	–0.03	–0.19**	–0.20***	–0.07	–0.18**	–0.16**
	(0.05)	(0.09)	(0.08)	(0.07)	(0.08)	(0.08)
Securities market regulation*EXDEP	1.23**	1.88**	1.98***	1.32**	1.85***	1.64***
	(0.58)	(0.76)	(0.69)	(0.54)	(0.56)	(0.55)
Relative change in industry regulation (1994-2003)	–15.48*			–29.49***		
	(9.33)			(11.43)		
Investment growth		4.09***			1.74	
		(1.28)			(1.44)	
R&D intensity			1.82			6.15
			(5.23)			(4.20)
Number of observations	369	382	437	357	372	398
R^2	0.56	0.44	0.42	0.50	0.48	0.42
	Panel B. Effects of banking competition regulation					
	Value-added growth			Labour productivity growth		
	I	II	III	IV	V	VI
Initial share	–0.03	–0.20**	–0.22***	–0.07	–0.19**	–0.18**
	(0.06)	(0.09)	(0.08)	(0.07)	(0.08)	(0.08)
Barriers to baking competition*EXDEP	–1.74**	–2.02**	–2.95***	–1.56*	–2.27***	–2.50***
	(0.77)	(0.91)	(0.90)	(0.85)	(0.64)	(0.62)
Relative change in industry regulation (1994-2003)	–14.63			–28.42**		
	(9.32)			(11.43)		
Investment growth		4.10***			1.70	
		(1.28)			(1.45)	
R&D intensity			1.38			5.70
			(5.08)			(4.14)
Number of observations	369	382	437	357	372	398
R^2	0.56	0.44	0.43	0.50	0.48	0.42

Notes: EXDEP variable in the interaction terms refers to industries' dependence on external finance. All regressions include country and industry dummies. Robust standard errors are reported in parentheses; *, **, and *** indicate significance at 10, 5 and 1% level, respectively.
Source: Authors' calculations.

the Annex). One factor potentially explaining the high degree of dependence on external funding in these industries is that they account for a large share of total business R&D spending, which in the national account convention, is treated as an operating expense than capital formation.

To examine this issue, the equations were re-estimated with ratio of external dependence for these two industries calculated on the basis of the whole sample of firms as opposed to a sample that excludes large firms (over a thousand employees).

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Including large firms reduces the ratios for these industries to 1.8 (from 3.3) and 1.4 (from 6.2), respectively, which leaves these industries at the upper end of the range of dependence ratios, but with values that are more in line with those found for other industries. The impact of this change on the estimated coefficients of the main variables of interest is shown in Table 8. For reasons of parsimony, Table 8 reports only the estimated coefficient on the main variable of interest in each regression, *i.e.* the interaction term between external dependence and the proxies for financial development and regulation. As in the base case, each measure of financial development and regulation are entered individually in separate regressions, along with the same additional control variables as reported in Tables 3 to 5.

Perhaps not surprisingly, the reduced variance in external dependence across industries resulting from using significantly lower values for two sectors with extremely high values is compensated for by substantially higher parameter estimates. In the value-added and productivity growth specifications, the results are largely robust to the change in external dependence, the exception being venture capital in the case of

Table 8. **Sensitivity of results to lower values of external dependence for two industries**

	Value added growth		Productivity growth		Firm entry	
	Base case	Lower ratio	Base case	Lower ratio	Base case	Lower ratio
Financial development*EXDEP	0.38*** (0.13)	0 .83*** (0.26)	0.36*** (0.10)	0.93*** (0.31)	0.58*** (0.21)	1.21** (0.52)
Venture capital*EXDEP	1.63*** (0.58)	3.05** (1.34)	0.93** (0.47)	0.99 (1.53)	–0.28 (0.81)	–2.16 (2.13)
Overhead costs in banking*EXDEP	–21.99** (9.75)	–45.67** (18.43)	–20.50** (9.82)	–56.73** (27.06)	–33.21** (13.73)	–84.95** (36.93)
Market regulation*EXDEP	2.20*** (0.65)	4.24*** (1.48)	1.96*** (0.56)	4.41*** (1.67)	2.15* (1.22)	4.19 (3.19)
Contract enforcement*EXDEP	1.52*** (0.55)	2.65** (1.04)	1.32*** (0.50)	3.21** (1.37)	1.55* (0.91)	2.86 (2.53)
Access to credit*EXDEP	0.99** (0.49)	1.93** (0.97)	0.81** (0.41)	1.93* (1.03)	1.24 (0.80)	2.62 (1.99)
Investor protection*EXDEP	0.99** (0.49)	1.97* (1.09)	1.16*** (0.43)	2.31* (1.28)	0.73 (0.83)	1.63 (2.01)
Bankruptcy procedures*EXDEP	1.33** (0.54)	2.95** (1.31)	1.13*** (0.36)	2.77** (1.12)	1.73** (0.87)	3.04 (2.13)
Barriers to banking competition *EXDEP	–3.03*** (0.86)	–5.90*** (2.02)	–2.90*** (0.58)	–6.55*** (2.01)	–3.39*** (1.22)	–7.27** (2.92)
Regulation on entry and activity*EXDEP	–3.10** (1.30)	–6.16** (2.61)	–3.43*** (1.15)	–7.61** (3.10)	–4.73*** (1.77)	–10.01** (4.30)
Government ownership*EXDEP	–1.08*** (0.33)	–2.01*** (0.73)	–0.96*** (0.22)	–2.02*** (0.68)	–0.91** (0.41)	–2.09** (0.97)

Note: In the analysis of value added and labour productivity growth, the new value for external dependence in *Chemicals and chemical products* (ISCI 24) and *Real estate renting and business activities including computer and* R&D *services* (ISIC 70-74) are 1.55 and 1.95, respectively. In the analysis of entry rates, the new value for external dependence in *Chemicals and chemical products* (ISCI 24) is 1.43 and in *Real estate renting and business activities including computer and* R&D *services* (ISIC 70-74) it is 1.82.

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productivity growth. The results are somewhat less robust in the case of firm entry. This concerns in particular the two indicators of market regulation (contract enforcement and bankruptcy procedures) which are no longer significant.

CONCLUSIONS

This paper has used industry-level data from over 20 OECD countries to examine whether industries that rely more heavily on external sources of funds grow more rapidly in countries where regulation allows for stronger competition in markets for banking services and financial instruments. In the case of banking, regulatory impediments to competition focus essentially on barriers to entry (both foreign and domestic), on lines-of-business restrictions and on the scope of government ownership. As for markets for debt and equity instruments, the regulatory indicators cover the following four areas: contract enforcement, access to credit, investor protection and bankruptcy procedures.

Using panel regression techniques, the results indicate that financial system regulation has a statistically significant influence on output and productivity growth as well as on firm entry, via the impact on industrial sectors relying more heavily on external sources of funding. The economic impact is also found to be substantial enough to matter, yet sufficiently small to remain credible.

Regulatory indicators show that member countries have at least in the past adopted different approaches to regulate banking and securities, with less significant differences found in the former case, where most countries were found to lie within a fairly narrow range around an intermediate position with respect to competition-restraining regulations. As regards the market for debt and equity, more variations was observed in the extent to which regulation is either more friendly to investors/lenders or significantly less so, as compared with the OECD average.

Despite moves to liberalise financial markets in the past, there is some indication that the degree of competition in banking has been kept weak in several member countries. The OECD countries that are characterised by strong competition in banking activities have not been subject to instability in recent decades. Weak competition in other countries cannot therefore be justified on the basis that this has fostered greater stability. One reason why stronger competition may not risk greater instability is that the authorities have developed tools to foster prudent behaviour without adverse impact on competition.

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Notes

1. For an on-going effort in assessing the performance of financial systems using a broad range of indicators, see Hartmann *et al.* (2006).
2. One motivation for combining the two approaches is that the issue of causality may still prevail even when using policy indicators given that policies are often adjusted interaction to performance.
3. The two World Bank data sources exploited in this study are the B*ank* R*egulation and* S*upervision* D*atabase* (*www.worldbank.org/research/projects/bank_regulation.htm*) and the D*oing* B*usiness* D*atabase* (*www.doingbusiness.org*).
4. Such a view is supported by recent empirical evidence suggesting that restrictions on bank competition has in the past brought significant real economic costs that are not offset by the alleged benefits such as wider access to credit by small and risky firms or lower frequency of bad loans (see Guiso, Sapienza and Zingales, 2003 in the case of Italy). Using data on the US banking markets, Cetorelli and Strahan (2006) find that stronger bank competition in local markets (lower state-level restrictions on bank entry) is generally associated with a higher share of smaller establishments as well as with a rise in the number of establishments, while larger firms which benefit from easier access to securities markets are less affected.
5. Compared with the B*ank* R*egulation and* S*upervision* D*atabase*, these two indicators are based on information that is much earlier, *i.e.* 1998-2000 in the case of restrictions on foreign entry and 1995 in the case of government ownership. As such, they are obviously not necessarily a good indication of current policies, but they are still relevant for empirical analysis over a sample period that covers most of the 1990s.
6. In this application, the random-weights selection has been applied at the first sub-level of indicators, *i.e.* at the level of the four sub-component in the case of barriers to competition and ten sub-components in the case of stability. See Freudenberg (2003) for a discussion of the application of the random weights technique to the construction of indicators.
7. Based on the 1999 Survey of banking regulation, the authors also looked at the impact of various regulatory variables on a measure of bank development in a set of OECD and non-OECD countries. Even though their regulatory indicators were defined and constructed somewhat differently, they also found restrictions on bank activities and foreign entry as well as government ownership to have a significant negative impact on the amount of bank credit to the private sector as a share of GDP, while restrictions on domestic entry did not.
8. Some of the indicators used from this publication are not strictly exogenous policy indicators but rather reflect the stance of policy to an important extent.
9. For more details see the working paper version of this article (de Serres *et al.*, 2006).

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10. All the sub-indices are based on the version of *Doing Business* published in 2005 except the cost to create collateral which is based on the 2004 publication. Although these indicators are associated with securities markets they cover aspects of regulation for debt instruments in general, including bank loans.
11. It also allows controlling for the possibility that important sectoral shifts in the industrial structure may bias the results from macro data analysis.
12. See OECD (2003b). Even though studies have shown that existing firms contribute more importantly to productivity gains than new firms, high entry rates may contribute indirectly via competitive pressures on incumbent firms.
13. From an econometric perspective, the interaction allows for testing the influence of determinants – regulation or financial development – that only have a country dimension on a dependent variable that has both the country and sectoral dimensions.
14. The computed ratios differ from those used by Rajan and Zingales (1998) in three important ways: *i*) They are derived from Worldscope instead of Compustat; *ii*) the industry classification is different and covers several service industries; and *iii*) they are calculated over a more recent period (1994-2003). Given that this period corresponded to a significant rise in (non-financial) corporate savings, the ratios for the majority industries turned out negative (*i.e.* on firms have been hoarding enough cash on average over the period to cover more than capital expenditures). To avoid this problem, the ratios have been re-calculated after excluding large firms (over a thousand employees).
15. One way to partly circumvent this limitation would be to construct broad regulatory indicators using principal component analysis.
16. In a standard difference-in-differences specification, the interaction term is included in addition to the two components separately. In this specification the separate components have been excluded as they are already captured by country and industry fixed-effects.
17. Even though there is little reason *a priori* to expect a convergence phenomenon in industrial structure, relatively high growth rates may be observed more frequently in the case of smaller industries. To the extent that this is the case, such effect needs to be controlled for.
18. These studies focus on manufacturing whereas the current study includes also services sectors. In addition, this study uses the indicator of industries' dependence of external finance that is computed using data from 1990-2003 whereas the previous studies have used the data from the 1980s.
19. See Conway *et al.* (2006). This variable is calculated using indicators of regulatory conditions in major network industries and estimates of the importance of these industries as intermediate inputs in the production process. Note also that the external dependence measure used in the firm entry and growth regressions have been calculated over a somewhat different period (1990-2001 for entry and 1994-2003 for growth).

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Annex

Data Coverage, Sources and Definitions

This Annex describes the different datasets and definitions used in the econometric analysis. (See Box 2 for data description.) In addition, it provides descriptive statistics on the main variables used in the analysis and on the measure of industries' dependence on external finance.

The empirical analysis examines the effects of financial systems' development and regulation on economic growth and firm demographics at the industry level. The endogenous variables at the industry level are the growth rates of real value-added and labour productivity, defined as real value-added divided by the number of employees in a given industry, as well as firm entry and turnover. Table A.1 reports the summary statistics of these variables.

Table A.1. **Summary statistics of the dependent variables**

	Number of observations	Mean	Median	Standard deviation	Minimum	Maximum
Real value-added growth	466	2.65	2.46	3.35	–13.83	13.35
Labour productivity growth	423	2.37	2.12	3.25	–15.80	13.51
Entry rate	2 170	12.75	11.20	8.09	0.00	60.16
Turnover rate[1]	2 011	23.43	21.55	12.29	0.00	106.16

1. The turnover rate may be larger than 100 if there are several firms that both enter and exit in the same year relative to the total number of firms in a certain industry.

The country coverage of the analysis varies depending on the availability of data (Table A.2). Industries are identified using International Standard of Industrial Classification (ISIC Rev. 3) at the two-digit level. The industries covered in the analysis of value-added and productivity growth rates are reported in Table A.3.[1]

The data on firm entry and turnover are obtained from two main data sources: *i*) The OECD firm-level database;[2] and *ii*) Eurostat Structural Business Statistics database.[3] In addition, data provided by the World Bank and Statistics New Zealand are used. The data from these different sources are merged to obtain a dataset with comparable data on firm entry and turnover for as many OECD countries as possible. The different data sources on firm dynamics include information on the total number of entering and exiting firms. In addition, for most countries data are also available according to the size of firms. The size classification differs in the OECD and Eurostat databases. In order to have a consistent size classification

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Box 2. **Data source and construction: Summary**

1) Value-added and labour productivity growth: Industry level

Period of analysis: 1994-2003.
Dimensions:
- 26 countries (value-added growth) and 24 countries (labour productivity growth);
- 22 industries.

***Endogenous variables*:** Average real value-added and labour productivity growth rates.
Construction method: Industry growth rates are computed as geometric averages over the period.
Source: OECD STAN database.

Measure of dependence on external finance
Construction method: A firm's dependence on external finance is defined as its capital expenditure minus internal funds (cash flow from operations) divided by capital expenditure. To obtain the industry-wide measure, the firm-level ratios of external dependence are averaged first over time and then aggregated across firms in each industry.
Source: Thomson Financial Worldscope database.

***Control variables (industry level)*:** Initial share (year 1994) of each industry in business sector value added, average rate of change in the indicator of regulation impact, investment growth and R&D intensity.
Construction method: Control variables are computed as simple annual averages over the period.
Source: OECD STAN database and Conway *et al.*, 2006.

2) Firm demographics: Industry level

Period of analysis: 1990-2001.
Dimensions:
- 16 countries;
- 25 industries;
- varying time spans within the 1990-2001 sample depending on each country.

***Endogenous variables*:** Firm entry and turnover rates.
Source: OECD firm-level database, Eurostat Structural Business Statistics database, World Bank and Statistics New Zealand.
Construction method: Entry rate is defined as the number of entering firms as a percentage of the total number of firms and firm turnover rate is defined as the sum of entering and exiting firms as a percentage of the total number of firms.

***Control variables*:** Output gap, indicator of regulation impact, industry R&D intensity and value-added growth.
Source: OECD Analytical database, OECD STAN database, OECD ANBERD database and Conway *et al.*, 2006.

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Table A.2. **Country coverage**

Variable	Value-added growth	Productivity growth	Firm demographics
Country:			
Australia	X	x	
Austria	X	x	
Belgium	X	x	x
Canada	X	x	
Czech Republic	X	x	
Denmark	X	x	x
Finland	X	x	x
France	X	x	x
Germany	X	x	x
Greece	X	x	
Hungary	X	x	x
Italy	X	x	x
Japan	X	x	
Korea	X	x	
Mexico	X		x
Netherlands	X	x	x
New Zealand	X	x	x
Norway	X	x	x
Poland	X	x	
Portugal	X	x	x
Slovak Republic	X	x	
Spain	X	x	x
Sweden	X	x	x
Switzerland	X		
UK	X	x	x
USA	X	x	x

in the merged dataset, firms are classified into two size groups that exist in all data sources: *i*) Firms with less than 20 employees; and *ii*) firms with 20 or more employees. The focus of the analysis is on small firms, *i.e.* on the former group, since the entrants in this size group are likely to represent the "true entrants" and not the outcome of mergers and acquisitions or some other organisational arrangements of firms.[4]

The OECD and Eurostat databases differ in the way they define entry and exit. The OECD database defines entry as those firms in year t that did not exist in the database in year t–1 but exist in year t+1. Similarly, exit in year t is defined as those firms that existed in the database in t-1 but disappeared in year t+1. This enables identification of firms that appear in the database for only one year. In the Eurostat database, "one year" firms are not identified separately. To be consistent, these firms are included in both datasets.

The variable measuring industries' dependence on external finance is computed from the firm-level information contained in the Thomson Financial Worldscope database. As in Rajan and Zingales (1998), the dependence of a given industry is computed using data on US listed firms. A firm's dependence on external finance is defined as its capital expenditure minus internal funds (cash flow from operations) divided by capital expenditure. Given that large firms tend to have more internal funds available to finance investment, external dependence was calculated excluding such firms (> 1 000 employees) so as to have more industries with positive dependence ratios. However, the relative ranking of industries according to

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Table A.3. **Industries' dependence on external finance**

Industry	Dependence on external finance
Wood and products of wood and cork (ISIC 20)	–0.45
Fabricated metal products except machinery and equipment (ISIC 28)	–0.25
Construction (ISIC 45)	–0.19
Other non-metallic mineral products (ISIC 26)	0.00
Pulp paper, paper products, printing and publishing (ISIC 21-22)	0.09
Electricity gas and water supply (ISIC 40-41)	0.12
Manufacturing n.e.c.; recycling (ISIC 36-37)	0.17
Machinery and equipment n.e.c. (ISIC 29)	0.19
Textiles, textile products, leather and footwear (ISIC 17-19)	0.19
Other transport equipment (ISIC 35)	0.19
Motor vehicles, trailers and semi-trailers (ISIC 34)	0.20
Transport and storage (ISIC 60-63)	0.43
Basic metals (ISIC 27)	0.44
Food products, beverages and tobacco (ISIC 15-16)	0.53
Rubber and plastics products (ISCI 25)	0.56
Hotels and restaurants (ISIC 55)	0.64
Wholesale and retail trade; repairs (ISIC 50-52)	0.75
Coke refined petroleum products and nuclear fuel (ISIC 23)	0.78
Electrical and optical equipment (ISIC 30-33)	1.62
Post and telecommunications (ISIC 64)	1.67
Real estate renting and business activities including computer and R&D services (ISIC 70-74)	3.35
Chemicals and chemical products (ISCI 24)	6.20

Source: Authors' calculations based on Thomson Financial Worldscope database.

their dependence on external finance only changes marginally and the overall empirical results are robust to the use of the whole sample of US listed firms.

In order to obtain the industry-level measure of dependence on external finance, the external dependence of firms is averaged first over time and then aggregated across firms in each industry. Following Rajan and Zingales (1998), the time-averaging is done by summing individual firm's external finance (difference between its capital expenditure and cash flow) over the period of interest and then by dividing the result by the sum of each firm's capital expenditure over the same period. The industry-level measure of external dependence is then defined as the median of this ratio across firms in each industry. Table A.3 displays the external dependence by industry, and shows that industries related to ICT services and manufacturing as well pharmaceuticals are most heavily dependent on external finance.

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Notes

1. The industry coverage differs slightly in the analysis of firm demographics where the industry E*lectrical and optical equipment* (ISIC 30-33) is analysed at a more disaggregated level. Given the focus on financial development as on of the key determinants, the F*inancial intermediation* sector (ISIC 65-67) has been left out form the analysis.
2. Details on the OECD firm-level database are available on line at *www.oecd.org/document/4/0,2340,en_2649_37451_1962948_1_1_1_37451,00.html*. See Scarpetta *et al.* (2002) and Bartelsman, Scarpetta and Schivardi (2003) for a detailed description and discussion of the database.
3. See Brandt (2004) for discussion on the Eurostat data and comparison between OECD and Eurostat databases.
4. Firms with zero employees are excluded since the OECD database does not include information on these firms for all countries.

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THE DRIVERS OF PUBLIC EXPENDITURE ON HEALTH AND LONG-TERM CARE: AN INTEGRATED APPROACH

Joaquim Oliveira Martins and Christine de la Maisonneuve

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INTRODUCTION

Public expenditures on health and long-term care (hereafter, LTC) are a matter of concern for governments in most OECD countries. These expenditures have recently accelerated and are putting pressure on public budgets, adding to that arising from insufficiently reformed retirement schemes and other forms of social spending. The growth of public spending on health and long-term care in OECD countries has been limited for some time via the implementation of cost-containment policies. These policies acted essentially through wage moderation, price controls and postponement of investment in the case of health care. A large share of long-term care has been informally provided by families. However, the scope for containing health and LTC expenditures along these lines is narrowing.

In trying to foresee how much health care spending could increase in the future and what policy can do about it, the different drivers of expenditure can be broadly classified into demographic and non-demographic factors. D*emographic factors* will put upward pressure on health and long-term care costs since they tend to rise with age. Accordingly, previous projections of future health expenditures were mainly based on a given relation between health care spending and age (see Dang *et al.* 2001; EC-EPC, 2001; Health Canada, 2001). But this approach was essentially static, as it did not take into consideration a dynamic and positive link between health status and longevity gains, reflecting a "healthy ageing" process. This will lower the average cost per individual in older age groups, all the more so as major health costs tend to come at the end of life. Healthy ageing should also reduce the share of dependents per older age group, thereby mitigating future pressures on long-term care costs. On balance, however, ageing is expected to push health spending up.

N*on-demographic factors* will also push spending up. Empirical evidence on health care income elasticities is still inconclusive, though recent analysis (*e.g.* Dreger and Reimers, 2005) suggests that unit income elasticity for health care could be a reasonable approximation. Against this background, health care costs can grow faster than income for two main reasons. First, technological progress increases the variety and quality of products and treatments. Second, even when technological progress is cost-saving and reduces the relative price of health products and services, overall expenditures may still rise because of the high price elasticity of demand for health care. Because of lack of data, evidence concerning long-term care income elasticities is just not available, though these could

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be low. Still, long-term care expenditures as a share of GDP are likely to increase, due to a "cost disease". Limited scope for productivity gains, wage equalisation throughout the economy and low price elasticity could drive LTC expenditures up in line with relative price increases.

Along these lines, this paper explores two alternative scenarios for future public spending. In a "cost-pressure" scenario, non-demographic pressures on expenditures are assumed to remain fully operative, resulting in spending trends that correspond to observed trends over the recent past. In a "cost-containment" scenario, policy action is assumed to curb non-demographic drivers of expenditures. The paper begins with a short overview of spending trends over the past decades. Then it turns to the projection method of health care expenditure, decomposing demographic and non-demographic drivers and discussing the main mechanisms at work in each case. Alternative projection scenarios are presented, followed by a discussion of the sensitivity of the results to key assumptions. The same sequence of analysis applies to long-term care expenditures. The paper concludes with a summary of the results and some policy conclusions.

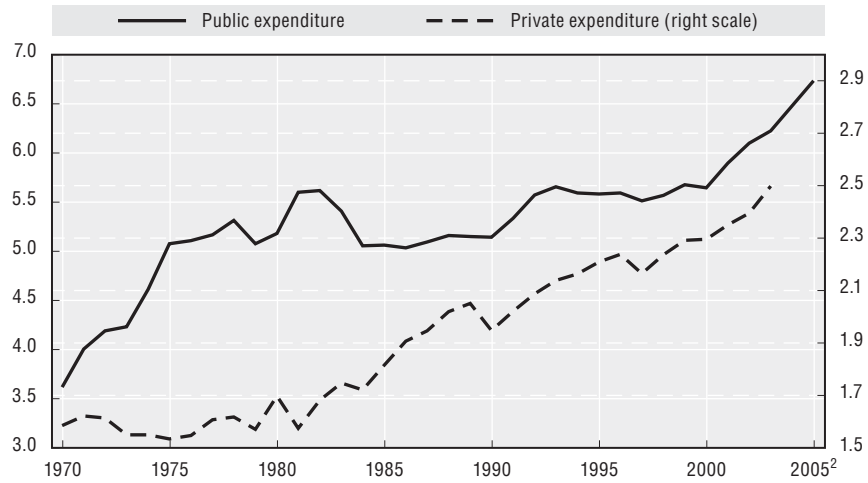
EXPENDITURE TRENDS OVER THE PERIOD 1970-2005

As a share of GDP, public spending of health and long-term care grew by some 50% between 1970 and the early 1980s (Figure 1). Governments started to react to these trends in the course of the 1980s by putting in place a number of cost-containment policies (see Docteur and Oxley, 2003). These policies acted mainly through macroeconomic mechanisms, such as wage moderation, price controls and postponement of investments. As a result, from mid-1980s to late 1990s, OECD public expenditure of health and long-term care remained roughly stable in per cent of GDP. Concomitantly, private health spending started to accelerate in the early 1980s.

Public cost-containment policies could not be sustained forever. It is difficult to contain wages and, at the same time, attract young and skilled workers in the health care sector. The replacement of retiring staff in public sectors, such as health care, will create strong demand pressures in the context of diminishing cohorts of younger workers entering the labour markets (see Høj and Toly, 2005). Controlling prices is not easy when technical progress is permanently creating new products and treatments. Equipments also need to be renovated, especially in presence of rapid technical progress. Thus, after a long period of cost contention, since 2000, the share of public health and long-term care expenditures to GDP is increasing at a rate of over 3% per year for the OECD. In this context, an important question is which factors will drive future expenditures, notably in relation to projected demographic trends.

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Figure 1. **Evolution of public and private OECD total health spending**[1]
As a % of GDP



1. Unweighted average of available OECD countries.
2. OECD estimates.
Source: OECD Health Database (2005).

HEALTH CARE

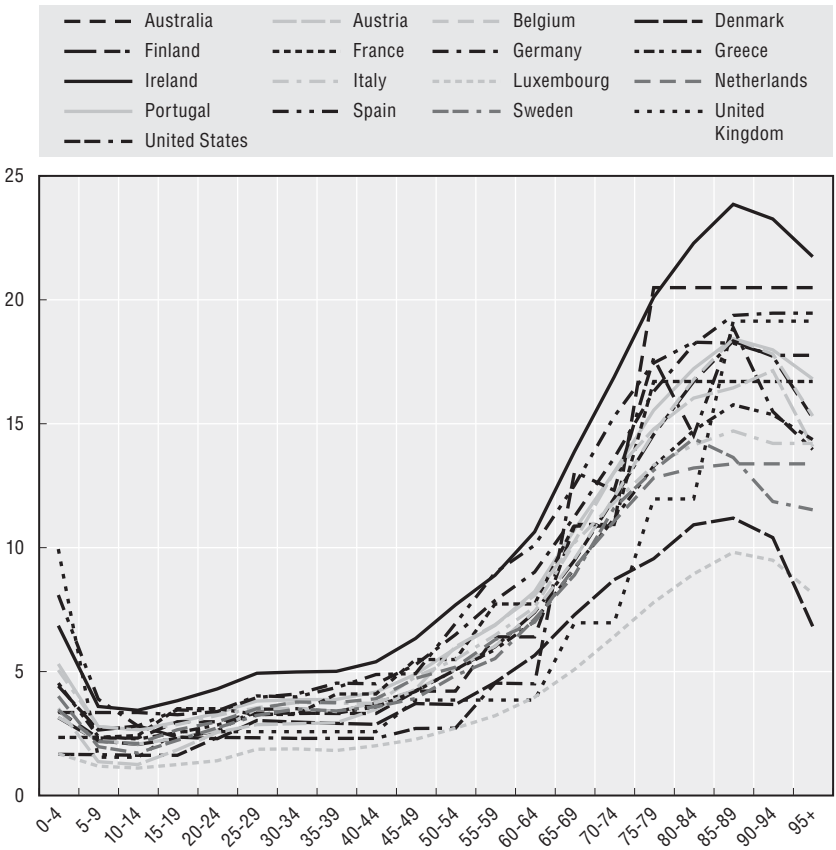
Demographic drivers of expenditure

While the effect of ageing on public health expenditures per capita has been weak in the past,[1] it is commonly expected that it will increase in the future. This assessment is based on the combined effect of the projected increase in the share of older people and the tendency for health expenditures per capita to increase with age.[2] The average expenditure profiles by age available for the year 1999 (Figure 2) are relatively high for young children, decrease and remain stable for most of the prime-age period and then start to increase rapidly at older ages.[3] On the basis of these expenditure profiles and population estimates, older people (age 65+) accounted for a significant share (around 35%) of public health care expenditures by 2005.

Major health expenditures occur in the proximity to death.[4] The shape of the average expenditure curves reflects the interaction between these "death-related costs" and mortality rates. While mortality rates increase with age, the costs of health care near death tend to be higher at young and prime age than for elderly people (April, 2004). This explains why expenditures first increase with age, then peak and after decline at very old ages. The little spike in health expenditures at

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Figure 2. **Public health care expenditure by age groups**[1]
% of GDP per capita



1. Expenditure per capita in each age group for the year 1999 divided by GDP per capita.
Source: ENPRI-AGRI, national authorities and authors' calculations.

the beginning of the curve is just related to early infant mortality being higher than young and prime-age mortality.

For the purpose of projecting health expenditures it seems then convenient to disentangle the expenditures for survivors and non-survivors. The expenditures for the *non-survivors* can be estimated by multiplying the health costs near to death by the number of deaths per age group. Here, the proxy for the 'death-related costs' is the health expenditure per capita for the group 95+ years old (assuming that after 95 years, health expenditures are only related to death). This amount was then multiplied by a factor, equal to 4 for an individual from 0 to 59 years old[5]

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and declining linearly to 1 afterwards, to reflect the decline of the death-related costs with age. The *survivors*' cost curve can be derived from the difference between the total cost curve and the non-survivor curve (see Annex).

To be coherent, if health costs are mostly death-related, the projected increase in life expectancy must be accompanied by an equivalent gain in the numbers of years spent in good health. Otherwise, an increasing share of the population living in bad health would emerge and health care expenditures would then cease to be mainly driven by the death-related costs, as initially assumed (*q.e.d.*).

In such a scenario, the expenditure curve for *survivors* is allowed to shift rightwards in line with longevity gains, progressively postponing the age-related increases in expenditure.[6] This development tends to reduce costs compared with a situation in which life expectancy would not increase. The baseline projections presented in this paper follow this "healthy ageing" scenario, but the sensitivity of the results to alternative assumptions (Box 1) is also tested below.

Box 1. **Longevity and health status scenarios**

Different scenarios have been envisaged in the literature on the link between longevity and health expectancy. In an "expansion of morbidity" scenario (Grunenberg, 1977), the share of life spent in bad health would increase as life expectancy increases, while a "compression of morbidity" scenario (Fries, 1980) would mean the opposite. Manton (1982) put forward a "dynamic equilibrium" hypothesis where longevity gains are translated one-to-one into years in good health (or "healthy ageing"). Under this scenario, health care expenditures would be postponed over time in line with the increase in life expectancy. Michel and Robine (2004) proposed a general approach to explain why countries may shift from an expansion to a contraction of morbidity regime, or achieve a balanced equilibrium between longevity gains and the reduction of morbidity. They identified several factors at work: *i*) An increase in the survival rates of sick persons which would explain the expansion in morbidity; *ii*) a control of the progression of chronic diseases which would explain a subtle equilibrium between the fall in mortality and the increase in disability; *iii*) an improvement in the health status and health behaviour of the new cohorts of old people which would explain the compression of morbidity, and eventually; *iv*) the emergence of very old and frail populations which would explain a new expansion in morbidity. Depending on the relative size of each of these factors, countries could evolve from one morbidity regime to another.

As regards *non-survivors*, two different effects are at play. On the one hand, the number of deaths is set to rise due to the *transitory* effect of the post-war babyboom.

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On the other hand, if mortality falls over time, due to a *permanent* increase in longevity, fewer will be at the very end of life in each given year, mitigating health care costs.[7] The total effect on public health care expenditures will depend on the relative size of these effects.

Non-demographic drivers of expenditure

Income growth is certainly the main non-demographic driver of expenditures. However, the vast literature on this topic is still somewhat inconclusive on the precise value for the income elasticity. First, income elasticity tends to increase with the level of aggregation, implying that health care could be both "an individual necessity and a national luxury" (Getzen, 2000). Second, the high income elasticities (above unity) often found in macro studies may result from the failure to control for true price effects (Dreger and Reimers, 2005). In this context, a reasonable approach seems to assume unitary income elasticity and, subsequently, to test the sensitivity of the projections to this assumption.[8]

After controlling for demographic effects and conditional to the income elasticity, a residual expenditure growth can be derived. Between 1981 and 2002 (Table 1), public health spending grew on average by 3.6% per year for OECD countries,[9] of which 0.3 percentage point was accounted by pure demographic effects[10] and 2.3 percentage points by income effects (with unitary income elasticity). Thus, the average residual growth can be estimated at around 1% per year.

The central expenditure projections assume this OECD average residual growth. There are at least two reasons for not using a country-specific residual in the context of long-run projections. First, in countries where cost-containment policies have resulted in a low or negative residual (*e.g.* Austria, Denmark, Ireland, Italy, Sweden) there could be a trend reversal, *e.g.* because new personnel has to be attracted or run-down facilities renewed. Second, in countries where the residual growth was very high (*e.g.* Portugal, Turkey, the United States) it may seem likely that cost-containment policies will be implemented in the future. These effects would lead to a certain cross-country convergence of the expenditure residual over time.

What are the factors underlying the residual expenditure growth? The main culprits are technology and relative prices.[11] Indeed, the gains in health status discussed above do not only arise from improvements in lifestyle (Sheehan, 2002; Cutler, 2001), but also from advances in medical treatment/technology. The latter do not come free of economic cost. Technical progress can be cost-saving and reduce the relative price of health products and services, but its impact on expenditure will depend on the price elasticity of the demand for health care. If it is high, a fall in prices will induce a more than proportionate rise in demand, increasing expenditures.[12] Even if prices do not fall, new technologies may increase

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Table 1. **Decomposing growth in public health spending,[1] 1981-2002[2]**
Average annual per cent change

	Health spending	Age effect	Income effect[3]	Residual
Australia (1981-2001)	3.6	0.4	1.8	1.4
Austria	2.2	0.1	2.1	0.0
Belgium (1995-2002)	2.9	0.4	1.7	0.6
Canada	2.6	0.4	1.7	0.6
Czech Republic (1993-2002)	2.7	0.4	2.8	–0.4
Denmark	1.3	0.1	1.7	–0.5
Finland	2.6	0.3	2.1	0.2
France	2.8	0.2	1.6	1.0
Germany	2.2	0.2	1.2	1.0
Greece (1987-2002)	3.4	0.4	1.3	0.8
Hungary (1991-2002)	1.5	0.3	2.8	–1.5
Iceland	3.5	0.1	1.5	1.9
Ireland	3.9	0.1	4.9	–1.0
Italy (1988-2002)	2.1	0.7	1.7	–0.1
Japan (1981-2001)	3.8	0.4	2.2	1.1
Korea (1982-2002)	10.1	1.4	6.1	2.4
Luxembourg	3.8	0.0	3.9	–0.1
Mexico (1990-2002)	4.5	0.7	0.5	2.4
Netherlands	2.6	0.3	1.9	0.3
New Zealand	2.7	0.2	1.5	1.0
Norway	4.0	0.1	2.5	1.5
Poland (1990-2002)	3.1	0.5	3.2	–0.6
Portugal	5.9	0.4	2.6	2.8
Slovak Republic (1997-2002)	2.1	0.5	4.2	–1.5
Spain	3.4	0.3	2.3	0.8
Sweden	1.5	0.1	1.7	–0.4
Switzerland (1985-2002)	3.8	0.2	0.8	2.9
Turkey (1984-2002)	11.0	0.3	2.3	8.3
United Kingdom	3.4	0.2	2.3	1.0
United States	4.7	0.1	2.0	2.6
Average	3.6	0.3	2.3	1.0

1. Total public health spending per capita.
2. Or the longest overlapping period available.
3. Assuming an income elasticity of health expenditure equal to 1.
Source: OECD Health Database (2004), ENPRI-AGIR and authors' calculations.

demand by increasing the variety and quality of products,[13, 14] thus decreasing the "true" relative prices of health care products and services.[15] Finally, the particular incentives prevailing in health care, *i.e.* an insurance system on the basis of retrospective costs, tend to boost R&D, innovation and relative prices (Weisbrod, 1991).

Projection model for health care

Defining HE, Y and N as real health care expenditures, real income and population, respectively; and, ε the income elasticity of health expenditures and ONDF

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the other non-demographic factors, the growth of health expenditures can be decomposed as follows:

$$\Delta \log\left(\frac{HE}{N}\right) = \Delta \log(Adjusted\ age\ factor) + \varepsilon \cdot \Delta \log\left(\frac{Y}{N}\right) + \Delta \log(ONDF) \qquad [1]$$

or expressed in share of expenditure to GDP:

$$\Delta \log\left(\frac{HE}{Y}\right) = \Delta \log(Adjusted\ age\ factor) + (\varepsilon - 1) \cdot \Delta \log\left(\frac{Y}{N}\right) + \Delta \log(ONDF) \qquad [2]$$

Intuitively, the mechanical effect of population ageing on expenditures can be seen as moving up along the expenditure curve, assuming that the age profile of expenditures remains constant over time. This demographic effect is adjusted for the "healthy ageing" by shifting the expenditure curve rightwards, implying that older people still cost more than the young, but at progressively older ages. Finally, the cost curve shifts upwards due to non-demographic drivers (income and other non-demographic effects).

In order to make the projections less sensitive to the starting year and allow for some convergence of expenditures to GDP across countries,[16] the total logarithmic growth rates derived from equation [2] for each country are applied to the OECD average expenditure share to GDP in 2005 (a sort of "representative" OECD country). The changes in expenditure shares calculated from this common base are then added to the country-specific shares in 2005 to obtain the projected ratios of expenditure to GDP (see Annex).

Additional exogenous assumptions underlying the projections for both health and long term care are listed in Box 2 (more details are also provided in the Annex).

Alternative scenarios for OECD *countries*

The framework described above was used to project expenditures over the period 2005-50. In the main scenarios, the income elasticity is set to one, thus income effects are not creating additional pressures in terms of expenditure shares to GDP.

Demographic effects

As shown in Panel A of Figure 3, demographic effects can be decomposed into the health care spending for survivors, the adjustment for "healthy ageing" and the death-related costs. Pure ageing effects can be quite large for some countries, but they tend to be compensated by a better health status, as longevity increases. The death-related costs account only for a small fraction of the increase in expenditures as a share of GDP (to around 7% of total health care spending by 2050). The

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Box 2. **Exogenous variables and assumptions underlying the projections**

The projections require a set of exogenous data, as follows:

1) Population projections (N). The population projections were gathered by the OECD Directorate on Employment, Labour and Social Affairs, directly from national sources. Given that the underlying assumptions on fertility and life expectancy are not necessarily uniform across countries (see Oliveira Martins *et al.*, 2005 for a discussion), this paper also uses a population maquette (Gonand, 2005) to test the sensitivity of the results to uniform longevity assumptions for a selected group of countries.

2) Labour force participation projections (L/N) rely on previous OECD work (Burniaux *et al.*, 2003). These projections are constructed on the basis of a, so-called, cohort approach. They correspond to a baseline scenario, *i.e.* the impact of current policies is assumed to influence labour participation over the next decades, but no additional assumptions are made concerning future policy changes.

3) Labour productivity (Y/L) growth is assumed to converge linearly from the initial rate (1995-2003) to 1.75% per year by 2030 in all countries, except former transition countries and Mexico where it converges only by 2050.

Summary statistics on the exogenous assumptions are provided in OECD (2006). The projected GDP per capita is directly derived from the above exogenous variables (Y/N = Y/L × L/N). This simple framework is not supposed to capture in the best way productivity differentials across countries, but to isolate, as far as possible, the effect of ageing and other demographic factors on the projections.

net effect of demographics on health care expenditures ranges from virtually zero in Sweden to 1.6 percentage points of GDP for Korea. This can be mapped to differences in evolving old-age dependency ratios (Panel B of Figure 3).

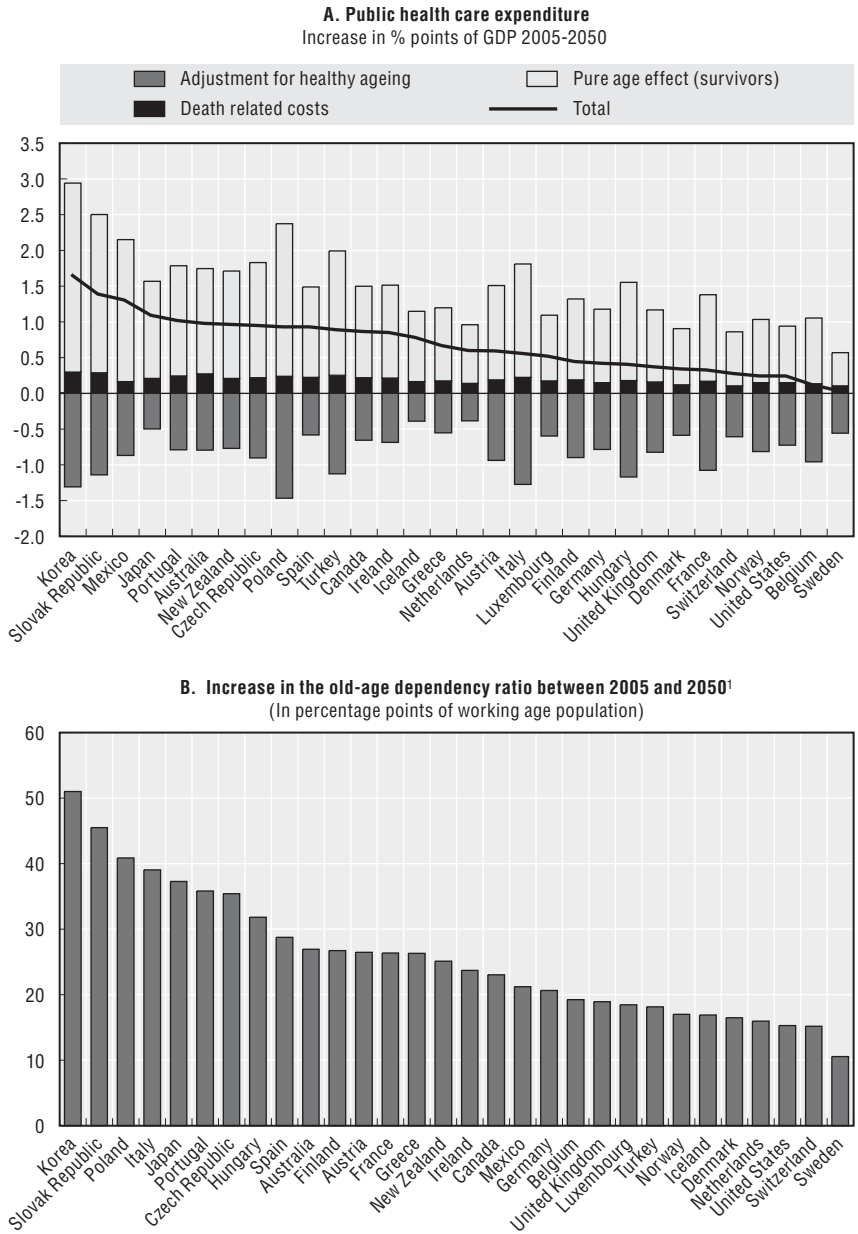
On average, demographic effects account for a small increase in expenditure, from 5.7% in 2005 to 6.3% by 2050, or 0.6 percentage points of GDP (Table 2). Admittedly, the "healthy ageing" assumption can be viewed as relatively optimistic, albeit in line with observed patterns of morbidity regimes in many OECD countries. The sensitivity of the results to this assumption was tested (see below.)

A *cost pressure scenario*

In this scenario it is assumed that, on top of the demographic effects and unitary income effects, the expenditure residual continues to grow at 1% per year over the projection period. This induces a substantial increase in the health expenditures, averaging nearly 4 percentage points of GDP from 2005 to 2050. In

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Figure 3. **Demographic effects on health care expenditure**



1. Ratio of population aged 65 and over to population aged 15-64.
Source: Authors' calculations.

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Table 2. **Projection scenarios for public health care expenditure, 2005-2050**[1]

In % of GDP

	2005[2]	Demographic effect	Cost-pressure	Cost-containment	Sensitivity analysis					
					Country-specific residuals	Income elasticity = 0.8	Income elasticity = 1.2	Residuals at 1.5%	Compression of morbidity	Expansion of morbidity
		2050								
Australia	5.6	6.5	9.7	7.9	8.5	7.1	8.9	8.7	7.1	8.7
Austria	3.8	4.4	7.6	5.7	4.4	5.0	6.6	6.6	5.0	6.7
Belgium	5.7	5.8	9.0	7.2	6.7	6.4	8.1	8.0	6.4	8.2
Canada	6.2	7.0	10.2	8.4	7.8	7.6	9.3	9.2	7.9	9.1
Czech Republic	7.0	8.0	11.2	9.4	7.5	8.9	9.9	10.2	8.5	10.3
Denmark	5.3	5.6	8.8	7.0	5.1	6.2	7.9	7.8	6.4	7.6
Finland	3.4	3.8	7.0	5.2	4.1	4.3	6.3	6.0	4.4	6.1
France	7.0	7.3	10.6	8.7	8.7	8.1	9.5	9.6	7.8	9.8
Germany	7.8	8.2	11.4	9.6	9.6	8.9	10.3	10.4	9.0	10.4
Greece	4.9	5.5	8.7	6.9	6.6	6.1	7.9	7.7	6.4	7.5
Hungary	6.7	7.1	10.3	8.5	5.4	7.5	9.6	9.3	7.6	9.6
Iceland	6.8	7.5	10.7	8.9	10.5	7.9	10.1	9.7	8.5	9.3
Ireland	5.9	6.8	10.0	8.2	5.6	6.9	9.8	9.0	7.7	8.8
Italy	6.0	6.5	9.7	7.9	6.4	7.3	8.6	8.7	6.8	9.2
Japan	6.0	7.1	10.3	8.5	8.7	7.9	9.1	9.3	7.9	9.0
Korea	3.0	4.6	7.8	6.0	8.6	5.3	6.9	6.8	4.8	7.3
Luxembourg	6.1	6.6	9.9	8.0	6.6	6.9	9.4	8.9	7.5	8.6
Mexico	3.0	4.3	7.5	5.7	8.3	4.4	7.3	6.5	4.9	6.5
Netherlands	5.1	5.7	8.9	7.0	6.1	6.3	8.0	7.9	6.8	7.4
New Zealand	6.0	6.9	10.1	8.3	8.4	7.6	9.1	9.1	7.7	9.1
Norway	7.3	7.5	10.7	8.9	9.6	8.1	9.8	9.7	8.1	9.7
Poland	4.4	5.3	8.5	6.7	4.6	5.5	8.2	7.5	5.5	8.2
Portugal	6.7	7.7	10.9	9.1	12.6	8.3	10.1	9.9	8.4	9.9
Slovak Republic	5.1	6.5	9.7	7.9	4.9	7.2	8.6	8.7	6.8	9.0
Spain	5.5	6.4	9.6	7.8	7.5	7.1	8.5	8.6	7.2	8.3

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Table 2. **Projection scenarios for public health care expenditure, 2005-2050**[1] (*cont.*)

In % of GDP

	2005[2]	Demographic effect	Cost-pressure	Cost-containment	Sensitivity analysis					
					Country-specific residuals	Income elasticity = 0.8	Income elasticity = 1.2	Residuals at 1.5%	Compression of morbidity	Expansion of morbidity
		2050								
Sweden	5.3	5.3	8.5	6.7	4.9	5.9	7.7	7.5	6.3	7.3
Switzerland	6.2	6.4	9.6	7.8	11.4	7.1	8.6	8.6	7.4	8.4
Turkey	5.9	6.7	9.9	8.1	n.a	7.3	9.1	8.9	7.3	9.2
United Kingdom	6.1	6.5	9.7	7.9	7.9	7.1	8.8	8.7	7.1	8.7
United States	6.3	6.5	9.7	7.9	10.8	7.1	8.9	8.7	7.3	8.6
Average	**5.7**	**6.3**	**9.6**	**7.7**	**7.5**	**6.9**	**8.7**	**8.5**	**7.0**	**8.5**

1. For the definition of the different scenarios see Table A1.
2. Estimates, taking into account the observed expenditure growth between 2000 and 2003 (or 2002 if not available).

Source: Authors' calculations.

most countries, health care expenditures would then approach or exceed 10% of GDP by the end of the projection period. While these figures are a useful benchmark, it is unlikely that public health care expenditures to GDP could continue to grow at such constant rate, without limit.

A *cost-containment scenario*

In a voluntarily optimistic "cost-containment" scenario, the residual expenditure growth is assumed to converge to zero by 2050,[17] implicitly meaning that some policies in place are effective in controlling expenditure growth driven by some of the non-demographic factors. These policies could progressively rein in the expenditure residual, for example by ensuring that future technology improvements are mainly used in a cost-saving way. In the absence of additional ageing effects, this would imply that public health care expenditure and income would evolve in parallel over the very long-run.[18] It should be stressed, nevertheless, that a continuous cost-containment over such a long period would be rather challenging.

Under this scenario, public health care expenditures in the OECD area would still increase on average by two percentage points between 2005 and 2050, from 5.7% to 7.7% of GDP (*cf.* Table 2). Moreover, large increases (above 2.5 percentage points of GDP) by 2050 are found (in descending order) in Korea, the Slovak Republic, Mexico and Japan, which are experiencing a rapid demographic change.

Sensitivity analysis

To assess the robustness of the results, a number of parameters were changed compared with the "cost-containment scenario". These include the income elasticity, the magnitude of the residual, health status scenarios and demographic projections. Overall, these sensitivity tests do not change dramatically the overall picture, although country by country large differences may emerge. Moreover, combinations of a change in assumptions that influence the results in the same direction could alter significantly the results.

Residuals, income elasticity and different health status

Applying country-specific expenditure residuals[19] significantly change the spending projections for individual OECD countries (*cf.* right columns Table 2). Korea, Mexico, Portugal, Switzerland and the United States record increases above 2 percentage points of GDP compared with the "cost-containment" scenario.[20] If anything, this illustrates how unsustainable are current health expenditure trends in some OECD countries. Conversely, in countries where cost-containment policies were successful, the projected expenditure shares would tend to be more moderate than in the cost-containment scenario (*e.g.* Denmark, Sweden). Other

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countries would display large decreases in expenditures because the effect of past residual growth resulting from idiosyncratic conditions, such as the scaling back of former welfare systems during economic transition (the Czech Republic, Hungary, Poland and the Slovak Republic), would be prolonged in the future.

Concerning income elasticities, projections were run with values below and above unity (0.8 and 1.2, respectively), while keeping the residual as in the cost-containment scenario.[21] Under these alternative scenarios, average OECD public health care expenditure shares would range from around 7% to 8.7% of GDP. The countries with the largest projected GDP per capita growth (*e.g.* Ireland, Mexico, Poland) are obviously the most affected by changes in income elasticity.

As discussed above, the residual was derived from trends observed over the two past decades, a period characterised by efforts to contain costs. Assuming a residual at 1.5% growth per year, in line with 1970-2002 average (but still declining to zero over the projection period) would induce an average increase of less than 1 percentage point of GDP compared with the cost-containment scenario.

Sensitivity to alternative health status was also explored. In a "compression of morbidity" scenario the shift in the cost curves is twice the adjustment applied in the "healthy ageing" regime. Alternatively, a regime of "expansion of morbidity" corresponds to a scenario where longevity gains are not translated into "healthy ageing". Under these scenarios, average health expenditures by 2050 range from 7 to 8.5% of GDP. This shows that alternative morbidity regimes matter for projecting future expenditure trends, but their impact appear to be smaller than non-demographic effects.

Alternative population projections

As noted in Box 2, national population projections are not based on harmonised assumptions across countries. In particular, projected longevity gains can differ widely and, on average, are also lower than observed in the past decades.

To test the effect of alternative demographic assumptions, longevity was assumed to increase in line with past trends (two years per decade).[22] The simulations were carried out for five large OECD countries (France, Germany, Italy, Japan and the United States). As it could be expected in a world of "healthy ageing", the implied deviations are small (taking the cost-containment scenario as a benchmark, see Table 3). But without this assumption, the results would be more sensitive to idiosyncrasies in national population projections. If an "expansion of morbidity" assumption is combined with higher longevity gains, the two effects reinforce each other and generate an increase in expenditures (around 1 percentage point, compared with the cost-containment scenario). This highlights the importance of the interaction effects.

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Table 3. **Sensitivity analysis of health care expenditure to population projections**
Assuming longevity gains of 2 years per decade (In % of GDP)

		Healthy ageing	Expansion of morbidity	*Memo item*: Cost-containment scenario
	2005[1]	2050		
France	7.0	8.8	9.8	*8.7*
Germany	7.8	9.6	10.7	*9.6*
Italy	6.0	8.1	9.2	*7.9*
Japan	6.0	8.4	9.5	*8.5*
United States	6.3	7.7	8.6	*7.9*
Average	**6.6**	**8.5**	**9.6**	***8.5***

1. Estimates, taking into account the observed expenditure growth between 2000 and 2003 (or 2002 if not available).
Source: Authors' calculations.

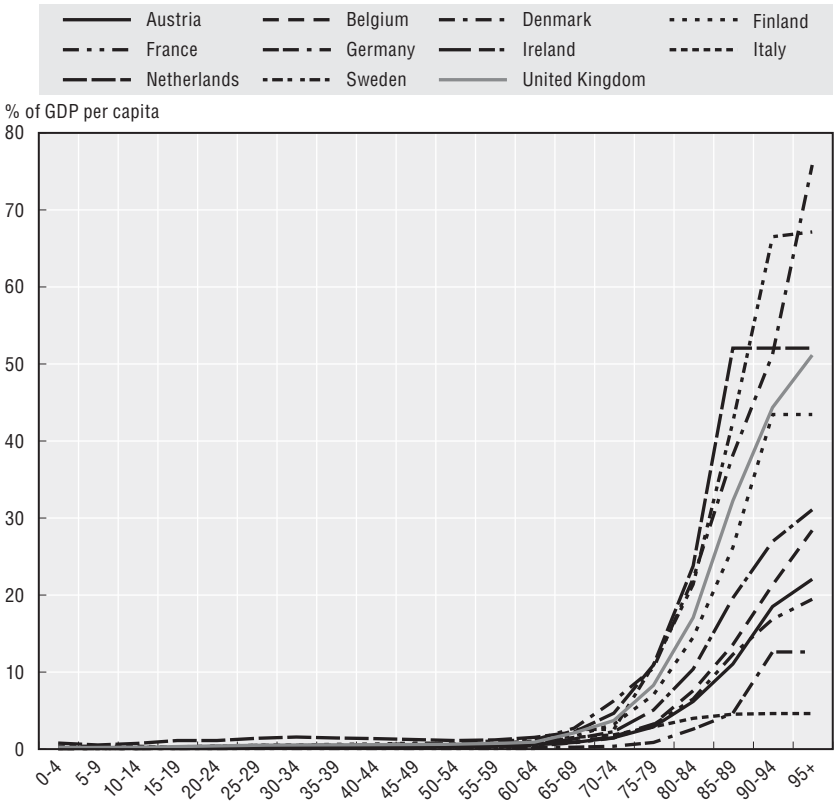
LONG-TERM CARE

After analysing health care expenditures, a parallel projection method is used for long-term care (LTC). While health care services aim at changing a health condition (from unwell to well), long-term care merely aims at making the current condition (unwell) more bearable. Individuals may become dependent and need LTC due to disability, chronic condition, trauma, or illness, which limit their ability to carry out basic self care or personal tasks that must be performed every day. Such activities are defined as activities of daily living, ADLs (eating, dressing, bathing, getting in and out of bed, and incontinence) or instrumental activities of daily living, IADLs (preparing own meals, cleaning, laundry, taking medication, getting to places beyond walking distance, shopping, managing money affairs and using the telephone/Internet).

Compared with health care, the importance of current public LTC spending is still limited (only 1-2% of GDP). However, as LTC is heavily concentrated among the elderly (Wittenberg *et al.*, 2002), given projected demographic changes, its share in the economy is set to increase. LTC expenditure profiles by age groups are the foundation of the projection framework. In contrast with health care, these expenditure curves are basically close to zero up to age 60-65, and then increase sharply and monotonically, with different slopes across countries (Figure 4). These characteristics stem from different features, such as the mix between (expensive) formal and (inexpensive) informal care and the current prevalence of dependency (disability status).[22] On the basis of the LTC expenditure profiles and population estimates, older people (aged 65+) accounted for 82% of public LTC expenditures by 2005.

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Figure 4. **Public long-term care expenditure by age group**[1]



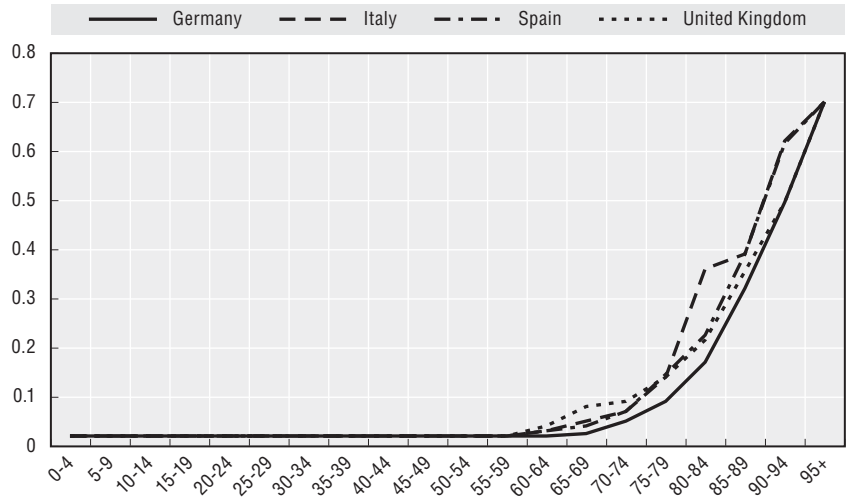
1. Expenditure per capita in each age group divided by GDP per capita, 1999.
Source: ENPRI-AGIR and authors' calculations.

Demographic drivers of expenditure

Whereas health care projections distinguished between survivors and non-survivors, the LTC projections split each age group into *dependants* and *non-dependants*.[24] Deriving the cost of LTC *per dependant* requires an estimate of the prevalence of dependency by age group. One of the most comprehensive studies in this area by Comas-Herrera *et al.* (2003) provides dependency figures only for Germany, Italy, Spain and the United Kingdom (Figure 5). As an approximation, it was assumed here that dependency ratios are uniform across countries and are equal to average of the four countries above (this has the advantage of making the projections less sensitive to initial conditions). By dividing the original expenditure profile by the average cross-country dependency ratio, the LTC expenditures per dependant person can be derived.

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Figure 5. **Prevalence of dependency by age group**[1]



1. Dependency is defined as the inability to accomplish one or several Activities of Daily Living (see text).
Source: Comas-Herrera *et al.* (2003) and authors' calculations.

Box 3. **Has disability fallen over time?**

Consistent cross-country data on disability rates do not exist. Disability is usually measured through the inability of performing one or more Activities of Daily Living (ADL). Evidence for some OECD countries suggests that the share of the severely disabled has fallen over time, while no conclusion could be reached concerning the evolution of moderate disability. Studies on the United States, for which more data are available, show that disability rates may have declined somewhat among the oldest but have increased among younger age groups, a phenomenon that is often linked to obesity trends (*cf.* Rand Research Bulletin, 2004).

Nonetheless, downward trends in disability may not be accompanied by a lower pressure on expenditures. On the contrary, increased spending on health care is rather the precondition for lower disability (Lichtenberg and Virabhak, 2002; Lichtenberg, 2003; Jacobzone, 2003) and helping a chronically-ill person to be autonomous may require access to the high-cost bio-technologies and drugs.

Concerning disability regimes, there is a great deal of uncertainty (see Box 3). Internationally comparable data in this area are rather scarce (Lagergren and Batljan, 2000; Jacobzone *et al.* 2000; Wittenberg *et al.* 2001). Moreover, disability is not necessarily translated into dependency, as technical progress can help a disabled

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person to work and take part in everyday life. Given the lack of hard evidence on these phenomena, this paper adopts a conservative view by assuming that only *half* of the longevity gains are translated into a reduction in dependency. This limited "healthy ageing" scenario for LTC could be justified on the grounds that for the oldest old, where dependency is most prevalent, the potential for experiencing complete healthy longevity gains is decreasing.

Non-demographic drivers of expenditure

LTC expenditures are closely related to the shares of *formal* and *informal*[25] care and how they will evolve over time.[26] Currently, the bulk of LTC is provided informally (at explicit no-cost) throughout the OECD, and it is especially dominant in southern European countries. As labour force participation is projected to increase in the future, it is likely that less resources for informal care will be available and will have to be replaced by expensive formal care (OECD, 2005b; Comas-Herrera *et al.* 2005).[27]

Another major driver is labour costs of staff providing LTC. Data for the United Kingdom show that staff costs in public sector homes accounted for 85% of total unit costs (Netten *et al.*, 1998). Reinhold (2001) also found that staff costs accounted for 70% to 90% of total unit costs of nursing homes in Germany.

While LTC is highly labour-intensive, room for productivity gains is probably limited. This makes the ingredients for a potential "cost disease" (Baumol, 1967, 1993). Reflecting a negative productivity differential and equalisation of wages across sectors, it implies that relative prices of LTC *vis-à-vis* other goods and services in the economy will tend to rise. With a low price-elasticity of demand, the share of LTC expenditure in GDP will also increase over time. To capture this Baumol effect it is assumed here that unit costs rise in line with aggregate labour productivity, a proxy for wage growth of care staff (see Comas-Herrera *et al.*, 2003).

Turning to income effects, empirical evidence on the income elasticity of LTC expenditure is just not available. But, considering that LTC can be characterised as a necessity, the income elasticity is probably close to zero. This is another crude assumption because the future development of long-term care services could induce more demand for higher quality services; therefore, an alternative value for the income elasticity will be tested below.

To assess the impact of these drivers on observed differences of LTC expenditures per dependant across countries, the following simple econometric model was specified:[28]

$$Log\left(\frac{LTC}{ND}\right) = \alpha + \beta_1 \cdot Age + \beta_2 \cdot Z + \beta_3 \cdot W + u \qquad [3]$$

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where LTC is total long-term care expenditure, ND, the number of dependants, A*ge* is the central point in each age bracket (2, 7, 12,…, 97), Z a proxy capturing the provision of informal care and W a proxy for the other effects (relative prices and/or income). This equation was estimated in a panel of eleven EU countries by twenty age groups (Table 4). Following alternative specification tests (not reported here), the availability of informal care appeared to be best captured by the participation ratio of the population aged 50-64. The level of GDP per capita was included but it did not appear significant, suggesting that the income elasticity could indeed be small. Given the reduced size of the sample and co-linearity problems, it was not possible to test for relative price (or wage inflation) effects. The estimates of the age and old-age participation coefficients are robust across different specifications and display the expected sign.

Table 4. **Econometric estimates of long-term care costs per dependant**

Log of long-term care cost per dependant	Fixed effects	Robust OLS with age-invariant explanatory variables	
Age	0.0335***	0.0348***	0.0345***
	(0.0014)	(0.0025)	(0.0023)
Participation ratio of people		0.0394***	0.0378***
aged 50-64		(0.0054)	(0.0066)
GDP per capita			0.0748
			(0.0509)
Constant	6.433***	4.217***	2.356*
	(0.079)	(0.380)	(1.317)
Number of countries	11	11	11
Number of age groups	20	20	20
Number of observations	185	185	185
R-squared	0.77 (within)	0.62	0.62

N*otes*: *** significant at 1% and * significant at 10%. Standard errors in parentheses.
S*ource*: Authors' estimates.

P*rojection model for long-term care*

Combining the different drivers, the logarithmic growth of long-term care expenditures to GDP can be decomposed as follows:

$$\Delta\log\left(\frac{LTC}{Y}\right) = \Delta\log(Adjusted\ age\ factor) + (\varphi - 1)\cdot\Delta\log\left(\frac{Y}{N}\right) + \gamma\cdot\Delta\log(Baumol\ effect) + \omega\cdot\Delta\log(Share\ of\ informal\ care) \quad [4]$$

where Y and N are income and population, as defined previously; φ is the income elasticity of LTC expenditures and γ the elasticity characterising the "Baumol

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effect", *i.e.* the extent to which an increase of average labour productivity in the economy (a proxy for wage growth) is translated into an increase of LTC costs per dependant.

Using this framework, the drivers are allowed to operate in several ways (see Annex for further details). The demographic effect is adjusted in such a way that *half* of the projected longevity gains are translated into years with lower dependency, shifting dependency curve rightwards.[29]

On non-demographic factors, the expenditure curve per dependant shifts upwards due to the "cost-disease" effect. In most scenarios, the "Baumol elasticity" (γ) was assumed to be 0.5, probably a mild view on the extent to which the productivity of LTC services could under-perform relatively to the rest of the economy. The income elasticity was assumed in general to be zero, implying that income growth tends to drive down LTC expenditures as a share of GDP.

The second non-demographic effect aims at capturing the effect of a decreasing share of informal care in the total supply of LTC through the labour market participation rate of people aged 50-64. Using estimated equation [3], increasing labour market participation induces an upward shift in the LTC cost curve. The baseline projections on participation rates are derived from Burniaux *et al.* (2003). The latter rely on a cohort approach, but the last cohort used to project participation is the one entering the labour market in year 2000. The behaviour of subsequent cohorts remains unchanged thereafter. This simplification could lead to a downward bias in the projections, especially in countries where participation rates were well below the OECD average in 2000. Therefore, sensitivity analysis below will test for a more sanguine scenario on participation rates.

Alternative scenarios for OECD *countries*

Similar to the approach followed for the health care projections, LTC expenditures were projected under a range of scenarios over the period 2005-50.

D*emographic effects*

Because the prevalence of dependency increases sharply with age, demographic effects contribute to a relatively much larger increase in LTC expenditures than the one observed for health care. On average, LTC expenditures would reach 2.3% of GDP by 2050 or an increase of 1.2 percentage points of GDP compared with 2005 (Table 5). Very large increases (from around 2 to close to 4 percentage points of GDP) are found in fast-ageing countries, such as Korea, the Slovak Republic, Poland and Mexico.

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Table 5. **Projection scenarios for public long-term care expenditure, 2005-2050**[1]

In % of GDP

	2005[2]	Demographic effect	Cost-pressure	Cost-containment	Sensitivity analysis				
					Unitary income elasticity	Compression of disability	Expansion of disability	Increase in dependency	Increased participation
		2050							
Australia	0.9	2.2	2.9	2.0	2.6	1.5	2.4	3.1	3.2
Austria	1.3	2.5	3.3	2.5	3.0	2.0	2.9	3.6	5.4
Belgium	1.5	2.4	3.4	2.6	3.2	2.2	3.1	3.7	5.9
Canada	1.2	2.3	3.2	2.4	3.0	1.9	2.9	3.6	2.9
Czech Republic	0.4	2.0	2.0	1.3	1.7	0.9	1.8	2.4	3.2
Denmark	2.6	3.3	4.1	3.3	3.9	2.9	3.7	4.2	3.5
Finland	2.9	4.3	5.2	4.2	4.8	3.7	4.6	5.4	4.9
France	1.1	2.3	2.8	2.0	2.5	1.6	2.4	3.0	3.7
Germany	1.0	1.9	2.9	2.2	2.7	1.7	2.7	3.4	3.2
Greece	0.2	1.0	2.8	2.0	2.6	1.4	2.6	3.5	3.0
Hungary	0.3	1.5	2.4	1.0	1.6	0.6	1.3	1.8	5.4
Iceland	2.9	3.5	4.4	3.4	4.1	3.1	3.8	4.3	3.5
Ireland	0.7	1.7	4.6	3.2	3.9	2.5	3.9	4.9	3.7
Italy	0.6	2.0	3.5	2.8	3.3	2.2	3.5	4.5	6.3
Japan	0.9	2.3	3.1	2.4	2.8	1.9	2.9	3.7	2.3
Korea	0.3	4.1	4.1	3.1	3.7	2.3	3.9	5.1	5.1
Luxembourg	0.7	1.6	3.8	2.6	3.3	2.0	3.1	4.0	4.9
Mexico	0.1	2.0	4.2	3.0	3.8	2.2	3.9	5.1	3.7
Netherlands	1.7	2.4	3.7	2.9	3.5	2.4	3.4	4.1	3.9
New Zealand	0.5	2.0	2.4	1.7	2.2	1.2	2.1	2.8	2.1
Norway	2.6	3.3	4.3	3.5	4.1	3.1	3.9	4.5	3.6
Poland	0.5	2.6	3.7	1.8	2.5	1.3	2.2	2.8	6.2
Portugal	0.2	1.3	2.2	1.3	1.9	0.8	1.8	2.4	2.1
Slovak Republic	0.3	2.6	2.6	1.5	2.0	1.1	2.0	2.6	6.6
Spain	0.2	1.0	2.6	1.9	2.3	1.3	2.4	3.3	3.0

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Table 5. **Projection scenarios for public long-term care expenditure, 2005-2050**[1] (*cont.*)

In % of GDP

	2005[2]	Demographic effect	Cost-pressure	Cost-containment	Sensitivity analysis				
					Unitary income elasticity	Compression of disability	Expansion of disability	Increase in dependency	Increased participation
		2050							
Sweden	3.3	3.6	4.3	3.4	4.0	3.2	3.6	4.0	3.6
Switzerland	1.2	1.7	2.6	1.9	2.4	1.5	2.3	2.8	1.9
Turkey	0.1	1.8	1.8	0.8	1.4	0.5	1.2	1.7	6.8
United Kingdom	1.1	2.1	3.0	2.1	2.7	1.7	2.6	3.2	2.6
United States	0.9	1.8	2.7	1.8	2.4	1.4	2.2	2.8	1.9
Average	**1.1**	**2.3**	**3.3**	**2.4**	**2.9**	**1.9**	**2.8**	**3.5**	**3.9**

1. For the definition of the different scenarios see Table A2.

2. Estimates, taking into account the observed expenditure growth between 2000 and 2003 (or 2002 if not available).

Source: Authors' calculations

A *cost-pressure scenario*

With a "full Baumol" effect, LTC costs per dependant increase in line with average labour productivity in the economy. This induces a steady increase in relative prices, pushing LTC expenditures to 3.3% of GDP by 2050, or an increase of 2.2 percentage points of GDP compared with 2005.

A *cost-containment scenario*

Policies could "contain" the cost pressures associated with the Baumol effect, although it is difficult to give a clear content for such policy lever. In practical terms it would mean that governments deploy a continuous effort to generate productivity gains and/or contain upward pressures on wages of staff providing long-term care. In the scenario simulated here, the supply of informal care remains relatively abundant because mild baseline increases in the participation ratios are combined with an increase of the population in the group of 50-64 years old due to the ageing trends. Even under these optimistic assumptions, the average LTC expenditures more than double from the current base to reach 2.4% of GDP by 2050. The larger effects are found in countries where the 50-64 participation ratios are projected to increase significantly and demographic pressures are strong (Greece, Italy, Ireland and Spain).

Sensitivity analysis

Given the many uncertainties, sensitivity analysis is particularly important to test the robustness of LTC projections. A first simulation captures the possibility of stronger income effects. With unit income elasticity, LTC expenditure to GDP by 2050 would increase by around ½ percentage point compared with the cost-containment scenario.

A scenario of "compression of disability" was tested, where the dependency curve is shifted to the right twice as fast as in the cost-containment scenario. This reduces LTC expenditures by around ½ percentage point of GDP for the OECD group compared with "cost-containment" scenario. In an "expansion of disability" scenario, the dependency rates remain constant as life expectancy increases and the effect would be symmetrically opposite.

Another alternative scenario captures a possible estimate of the impact of the worrying obesity trends on dependency.[30] Indeed, between 1986 and 2000, the proportion of moderately obese individuals (those with a Body mass index of 30-35) merely doubled in the United States. In contrast, the proportion of individuals with a BMI of 40 or greater quadrupled. Sturm and Lakdawalla (2004) argue that if current trends in obesity continue, disability rates will increase by 1% a year more in the 50-59 age group than if there were no further weight gains. This effect was

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captured here by an autonomous increase in the dependency rate by 0.5% per year. On average LTC expenditures would reach 3.5% of GDP by 2050, a significant shift of above 1 percentage point of GDP compared with the cost-containment case.

In an "increased participation" scenario, the availability of informal care is dramatically reduced by assuming that all countries converge towards an old-age participation ratio of at least 70% by 2050 (countries having already a participation ratio above that level were supposed to follow their country-specific pattern). This is well above the baseline labour participation projections and would lead to average LTC costs roughly at 4% of GDP by 2050, or an additional expenditure of 1.5 percentage points of GDP compared with the cost-containment scenario. The most significant increases would occur in countries where old-age participation ratios are currently particularly low (*e.g.* Austria, France, Italy, Turkey and former transition countries).

The comparison between this scenario and the cost-containment one gives a sense of the trade-offs involved with policies aiming at increasing participation rates, on the one hand, and the objective of containing future LTC expenditures, on the other hand. In this context, competing demands on the age group 50-64 could be particularly strong.

The sensitivity to alternative population projections was also tested for five OECD countries (France, Germany, Italy, Japan and the United States). Under the "healthy ageing" assumption (*i.e.* the dependency curves are shifted by half of the increase in life expectancy), higher longevity gains (two years per decade) *per se* do not have a strong impact on expenditures (see Table 6). By contrast, a scenario where higher longevity gains are coupled with an 'expansion of disability' would push average LTC expenditures to above 4% of GDP by 2050.

Table 6. **Sensitivity analysis of long-term care expenditure to population projections**
Assuming longevity gains of 2 years per decade (In % of GDP)

		Healthy ageing	Expansion of disability	*Memo item*: Cost-containment scenario
	2005[1]	2050		
France	1.1	2.2	3.1	*2.0*
Germany	1.0	3.0	4.4	*2.2*
Italy	0.6	3.5	5.3	*2.8*
Japan	0.9	3.6	5.2	*2.4*
United States	0.9	1.7	2.6	*1.8*
Average	**0.9**	**2.8**	**4.1**	***2.3***

1. Estimates, taking into account the observed expenditure growth between 2000 and 2003 (or 2002 if not available).
Source: Authors' calculations.

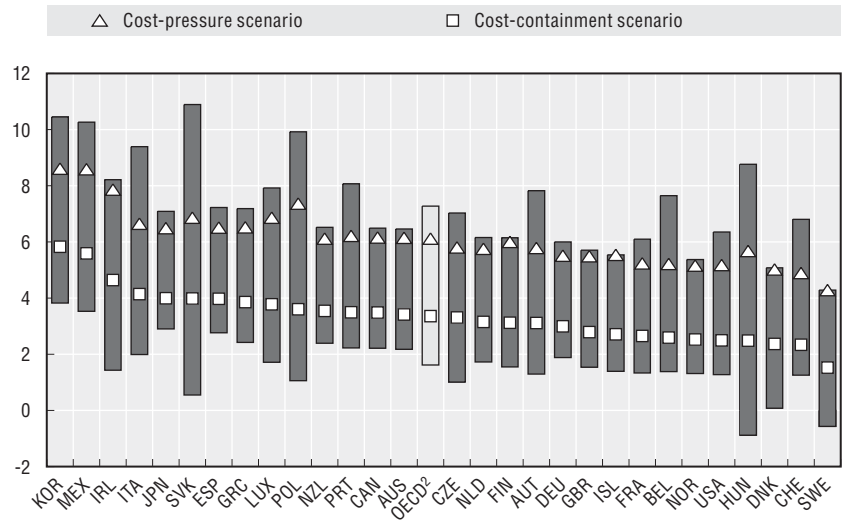
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To sum-up, the sensitivity analysis showed that the long-term care projections presented here seem relatively robust to alternative specifications of the income elasticity, health status and longevity assumptions. In contrast, increased dependency associated with obesity trends or lower provision of informal care could have a much stronger impact on expenditures. A combination of these negative factors would obviously generate a rather gloomy perspective for public budgets.

AN OVERVIEW OF CROSS-COUNTRY RESULTS

Combining health and long-term care projections, together with sensitivity analysis generates striking differences across countries (Figure 6). A group of countries stands out with increases of total spending at or above four percentage points of GDP over the period 2005-50, even in the optimistic 'cost-containment' scenario. It includes rapidly ageing countries (Italy, Japan and Spain), countries that will experience a dramatic change in their population structure (Korea, Mexico and the Slovak Republic), and countries where labour participation is currently low and may face a substantial increase in the demand for *formal* long-term care (Ireland, Italy and Spain). In contrast, Sweden is in the lowest range with an increase below two

Figure 6. **Total increase in health and long-term care spending by country, 2005-2050**[1]
In percentage points of GDP



1. The vertical bars correspond to the range of the alternative scenarios, including sensitivity analysis. Countries are ranked by the increase of expenditures between 2005 and 2050 in the cost-containment scenario. Turkey was not included because data limitations made it impossible to calculate one of the scenarios.
2. OECD average excluding Turkey.

Source: Authors' calculations.

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percentage points of GDP. This country is in a mature phase of its ageing process and already spends a relatively high share of GDP on health and long-term care.

CONCLUSIONS

This paper has shown that spending on health and long-term care is a first-order policy issue. Between now and 2050, public spending on health and long-term care could almost double as a share of GDP in the average OECD country in the absence of policy action to break with past trends in this area. And that estimate takes into account that as people live longer, they also remain in good health for longer. Even with containment measures, public spending on health and long-term care could rise from the current average level of 6-7% of GDP to around 10% by 2050. In some countries, the increase could be dramatic.

Yet, these projections may be on the low side. For example, an expansion of morbidity – *i.e.* a scenario in which increases in longevity would translate into a higher share of life in bad health, together with higher longevity gains, would produce a more pessimistic outlook. Likewise, technology could exert greater pressures on health care demand than assumed in the projections, while dependency rates could increase more than expected, reflecting *inter alia* a continuation of recent obesity trends and lower provision of informal care.

These heavy pressures on public finances call for policy action, which would involve curbing the impact of technology and prices on health care spending and mitigating the cost-disease effect in long-term care provision *via* productivity gains. These are not easy tasks. To improve cost-efficiency at the microeconomic level, reforms will have to be deeper and more sophisticated than those implemented so far. And in any event, policy makers will face difficult trade-offs. In particular, reining in the impact of technological progress on health care demand without foregoing the benefits it provides to patients will be challenging. Likewise, new ways will have to be found to minimise the pressures on long-term care expenditures that may arise from an increased participation of women and older workers in the labour force, which yet is much needed for the sustainability of old-age social spending.

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Notes

1. See Culyer (1990), Gerdtham *et al.* 1992), Hitiris and Posnett (1992), Zewifel *et al.* (1999), Richardson and Roberston (1999), Moise and Jacobzone (2003), and Jönsson and Eckerlund (2003).

2. Across all health expenditure types, expenditures per capita of those aged over 65 are around four times higher than those under 65. The ratio rises to between six to nine times higher for the older groups (Productivity Commission, 2005; OECD Health Database, 2005a).

3. The data is based on the EU-AGIR Project; see Westerhout and Pellikaan (2005). The complete expenditure profiles were only available for a subset of OECD countries. A number of different adjustments and estimations were made in order to derive these curves for other OECD countries. Moreover, for some countries only total costs were available and thus health care had to be separated from long-term care. For 12 countries, the data were simply not available. In this case, the expenditure curves were estimated by adjusting expenditures as a spline function of age, based on available data and were calibrated on the basis of total health expenditures derived from OECD (2005a). These estimation procedures are described in detail in the Annex.

4. For a discussion and evidence on the "death-related costs", see Seshamani and Gray (2004), Batljan and Lagergren (2004).

5. This proportion is based on April (2006) and some evidence gathered by the EC-Ageing Working group (EC-EPC, 2005). The results are not very sensitive to the alternative assumptions, because mortality rates are rather low for young and prime-age people.

6. By contrast, in "pure demographic" projections, the expenditure curves would not shift rightwards with ageing, reflecting the implicit assumption of unchanged health status at any given age. When the cost curves stay put in presence of longevity gains, the share of life lived in "bad health" increases when life expectancy increases.

7. See for example Fuchs (1984), Zwiefel *et al.* (1999), Jacobzone (2003) and Gray (2004).

8. See OECD (2006) for a discussion of the empirical literature and econometric estimates of the income elasticity under alternative specifications for a panel of 30 OECD countries for the period 1970-2002.

9. This estimate was carried out for total health spending given that the split between health care and long-term care expenditures is not available in time series for historical data. Given the low share of public long-term care expenditure to GDP in 2000 (typically below 1% of GDP; OECD, 2005b), this approximation of the residual growth seems reasonable.

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10. To simplify calculations, the effect of past ageing does not incorporate "healthy longevity" and "death-related costs" as is done in the projections. In any event, the ageing effect was small and would have been even smaller if a more sophisticated method had been applied. If anything, *ceteris paribus*, ignoring these past factors is likely to have lead to a downward bias in the estimated residual.

11. See Fuchs (1972), and Mushkin and Landefeld (1979). More recently, there has been a renewal of interest in this technology residual approach, see Newhouse (1992), KPMG Consulting (2001), Wanless (2001) and Productivity Commission (2005a-b).

12. For example, Dormont, Grignon and Huber (2006) found that in France the unit price of certain surgical treatments, such as cataract, decreased whereas the frequency of the treatments increased significantly. Such effects can explain much of the recent upward shift in the health care cost curves in France.

13. Some governments are attempting to introduce such quality adjustments in the measure of output (and hence prices) of public services. See Grice (2005) for a discussion on this point based on the Atkinson Review, prepared for the UK Office for National Statistics.

14. For a comprehensive overview of key studies that explicitly estimate price elasticity for health services, see Ringel *et al.* (2002).

15. This is equivalent to say that the "true" relative price of health care *vis-à-vis* all other goods in the economy decreases. Consider for example the case of a demand for variety model with a CES utility function: $U = \sum x_i^{(\sigma-1)/\sigma}$, where $\sigma > 1$ is the elasticity of substitution among products. To simplify, let us assume price symmetry ($p_i = p$, $\forall i$). The true composite price index is then equal to $P^* = n^{(1-\sigma)} \cdot p$. With two types of composite goods, say health (H) and all other goods (O), the true relative price would be: $P_H^* / P_O^* = (n_H / n_O)^{(1-\sigma)} \cdot (p_H / p_O)$. Thus, even if the usual price ratio (p_H / p_O) remains constant, the "true" relative price P_H^* / P_O^* would decrease when the pace of product creation in the health sector is much faster than in the rest of the economy.

16. Without this specification, spending patterns of countries with equivalent expenditure drivers would diverge in terms of share of expenditure to GDP merely due to different initial expenditure to GDP ratios. Such a divergent scenario is not very appealing in the context of long-term projections.

17. This is roughly equivalent to assuming that the residual grows at a constant rate of ½ per cent per year.

18. This convergence assumption (or transversality condition) may appear controversial in view of past experience. The assumption is justified by the fact that the expenditure growth has to be financed by the public purse. Under perfect health market conditions, a continuing increase in the share of income going to health care spending could reflect individual preferences. But the health care market is not perfect and governments are footing most of the bill. Thus, rapid growth of the share of health care spending in income would have to be compensated by reductions in other public spending items, which may be difficult to achieve and/or increased health care charges for individuals. Such cost sharing has already been introduced in most countries. Similar transversality conditions have also been imposed in other projection exercises. For example, Englert (2004) assumes that income elasticity ultimately converges to one. For symmetry, negative residuals are assumed to increase towards zero over the projection period, in the scenario with country-specific residuals.

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19. Note that the technology residual is still assumed to converge towards zero over the projection period.

20. Given the very high historical growth rate of the residual for Turkey, this country was excluded from this simulation as it produced rather implausible shares of health care expenditures to GDP by 2050.

21. Note that when the chosen income elasticity is assumed to be changed both in the past and in the future, applying sub-unity elasticity would increase the residual when explaining past data. This means, when projecting, that the drag on expenditure growth from lower income elasticity would be offset by a higher residual, and *vice versa*. By construction, such scenarios would not produce very different results.

22. These alternative population projections were derived from a stylised demographic model, which mimics national projections (see Gonand, 2005).

23. For comprehensive discussions of long-term care, see for example OECD (2005b), Lundsgaard (2005), Karlsson *et al.* (2004), Comas-Herrera *et al.* (2003), Norton (2000) and Wittenberg *et al.* (1998). Interesting UK case studies are Davies *et al.* (1990) and Evandrou *et al.* (1998). As an indication of the potential spending pressures, the average cost per year of institutional long-term care for old persons in France is currently at EUR 35 000 per dependant, and in the range of $40 000-75 000 per dependant for the United States (Taleyson, 2003).

24. Indeed, even if the unit costs of long-term care per dependant are equal in, say, countries A and B, the expenditure curves by age group would still differ if the share of dependants in each age group is different in each country.

25. Most informal care is provided by partners or children. To be considered informal, the provision of care cannot be paid for as if purchasing a service. However, an informal care giver may receive income transfers conditioned on his/her provision of informal care and possibly, in practice, some informal payment from the person receiving care. On the other hand, formal care is provided by care assistants who are paid for providing care under some form of employment contract. It includes care provided in institutions as well as care provided at home. The difference between formal and informal care is first of all not about the type of care, but who provides it (Lundsgaard, 2005).

26. Due to lack of sufficiently comparable information across countries, this paper does not incorporate another important distinction, which is the subdivision of formal care into institutional care and care delivered to the patient's home. There are indeed fundamental differences between countries in the way they organise their formal LTC. Institutional LTC is particularly widespread in the Nordic countries. Norway and Sweden stand out with substantially higher LTC spending than any other country due to generous services (single rooms and well-equipped housing infrastructure) provided for residents in nursing homes (OECD, 2005b). Whether this organisation is adopted by other countries or a (cheaper) ambulatory help-at-home strategy is pursued could have important consequences for public expenditures.

27. There are indications that the proportion of older people living alone increased up to the early 1990s, although trends appear to have changed since (Tomassini *et al.*, 2004 and Borsch-Suppan, 2005).

28. Given that the shape of the expenditure curves by age is close to an exponential function, a log-level specification was used.

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29. Note that this method differs somewhat from what was presented earlier for health care expenditures, where the cost profile for survivors was shifted directly in line with projected longevity gains. Here the cost profile is shifted indirectly through the shift in dependency rates.

30. See also Olshansky *et al.* (2005) for a discussion on the effect of obesity trends on life expectancy.

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Annex

Data Sources and Methods

Estimating death-related costs

The primary data for 18 OECD countries are drawn from the AGIR data set (Westerhout and Pellikaan, 2005, based on EC-EPC, 2001) for EU15 countries and from national sources for Australia, Canada and the United States.

The cost of death for the oldest group (95+) is assumed to be the lowest and was proxied by their observed health expenditure per person when available. For France, Germany, Italy, the United Kingdom, Spain, the Netherlands and Australia for which the expenditure for the oldest group were not available, the cost of people aged 75-79 was taken as a proxy. In fact, when available, expenditure at age 95+ is roughly equal to the level of expenditure at age 75-79. For the countries where no cost expenditures were available, the cost of death for the oldest group was estimated by taking three times the average health expenditure per capita.

The costs of death for other age groups are then derived by multiplying this estimate by an adjustment factor equal to four between ages 0-4 to 55-59, gradually decreasing to 1 afterwards. Multiplying these costs of death by the estimated number of deaths by age group (using mortality data) gives the death-related cost (DRC) curve.

Estimating the survivors' expenditure curves

The cost curve for *survivors* can be simply derived by subtracting the death-related costs just described from the total expenditure curves, when available (18 OECD countries). Given the uncertainties surrounding these data, it seemed preferable to estimate an average expenditure curve for survivors and then calibrate this curve for each country (see below). In this way, the projections are less sensitive to initial conditions and to country-specific data idiosyncrasies.

This average expenditure curve for *survivors* was estimated econometrically in a panel of 18 countries by 20 age groups, using a spline function, as follows:

$$\left.\frac{\text{Health Exp.}}{\text{Population}}\right|_{age\ group} = -137.8 \cdot age + 9.94 \cdot age^2 - 0.29 \cdot age^3 + 0.004 \cdot age^4 - 0.00002 \cdot age^5 + 1222.6$$

where *age* is the central point in each age bracket (*e.g.* 2, 7, 12,…, 97). All the estimated coefficients are significant.

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Calibration of the expenditure curves on the OECD health database

The cost curves derived for the year 2000 were first calibrated in order to fit with levels of 2005, the starting point of the projections. The total health and long-term care expenditures for 2005 being not yet available in the OECD Health Data (2005a), an estimate was made by applying the observed growth rate in expenditures 2000-03 (or 2002, depending on the countries) for the whole period 2000-05. A second step was to split the total spending into health and long-term care. The details of this split are provided below and involved an estimate of the shares of long-term care expenditures using OECD (2005b).

The costs of death by age group for 2005 were derived by applying the same growth rate as the total health expenditures between 2000 and 2005. The total death-related costs in 2005 were computed as the product of the cost of death by the projected number of deaths by age group in that year. The total survivor expenditures were then derived by subtracting the total death-related costs from the total health spending. Using this information, the survivor cost curve was calibrated proportionally for each age group.

Projecting the demographic effects under a "healthy ageing" scenario

Shifting the survivor cost curve according to longevity gains involves two steps:

- The survivor expenditure curve by five-year age groups is interpolated in order to derive a profile by individual age. In this way, the cost curve can be shifted smoothly over time in line with life expectancy gains.
- An "effective age" is calculated by subtracting the increase in life expectancy at birth according to national projections from current age. For example, a 70-year old person in Germany is projected to have an effective age of 67 by 2025 and 64 by 2050.

The death-related cost curve remains constant over time (to isolate the demographic effect) and the total costs of death are projected according to the number of deaths.

Deriving expenditure curves for long-term care (LTC)

Expenditure curves for 11 EU-countries were obtained from the AGIR data set (Westerhout and Pellikaan, 2005, based on EC-EPC, 2001). An average dependency ratio (prevalence of dependency by age group) was derived from Comas-Herrera (2003) study for four countries (the United Kingdom, Spain, Italy and Germany). As the Comas-Herrera study only provides dependency ratios for old ages, this ratio was assumed to start at 2% for younger ages.

More precisely, the LTC expenditures per dependant were derived as follows:

$$\left.\frac{LTC}{dependant}\right|_{age\ group} = \left.\frac{LTC}{population}\right|_{age\ group} \times \left.\frac{1}{dependency\ ratio}\right|_{age\ group}$$

where $\left. dependency\ ratio = \frac{number\ of\ dependants}{total\ population}\right|_{age\ group}$

An average LTC expenditure curve per dependant and age group was estimated using the following equation (see Table 4, in the main text):

$$Log\left(\frac{LTC}{dependant}\right) = 4.217 + 0.0348 \cdot age + 0.0394 \cdot (Labour\ Force\ participation\ ratio\ of\ 50–64)$$

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This equation was used to derive the shift in the LTC expenditure curve associated with changes in the participation ratios. Having the expenditure curves per dependant in each age group, the total LTC costs can be calculated as follows:

$$Total\ \ LTC = \sum_i \left[\left. \frac{LTC}{dependant} \right|_{age\ group\ i} \cdot number\ of\ \ dependants \Big|_{age\ \ group\ i} \right]$$

The total LTC expenditure in percentage of GDP in 2000 was calibrated to fit the estimates of the OECD Long-term Care study (OECD, 2005b), when available. Data for the countries not available in this study were obtained by applying the ratios of LTC to GDP observed in "similar" benchmark countries, as indicated in the table below:

Country estimated	Benchmark countries
Belgium	Netherlands
Czech Republic	*Average* (Hungary, Poland)
Slovak Republic	*Average* (Hungary, Poland)
Denmark	*Average* (Norway, Sweden)
Finland	*Average* (Norway, Sweden)
Iceland	*Average* (Norway, Sweden)
France	Germany
Greece	Spain
Italy	*Average* (Germany, Spain)
Portugal	Spain
Switzerland	Germany
Turkey	Mexico

The starting point of the projections

The projected changes in spending expressed in percentage of GDP were calculated from a common base applied to all OECD countries. This base was taken as the OECD average of expenditure in 2005. These changes were added to the initial level of expenditures in each country. This approach makes the projected changes (expressed in per cent of GDP) less dependent from the base year levels and also allows for a certain catch-up of expenditure ratios across countries. More precisely, the variation of the share of expenditure to GDP in country *j* between, say, 2005 and 2050, is calculated as:

$$\Delta\left(\left. \frac{Expenditure}{GDP} \right|_{\substack{country\ j \\ 2050-2005}} \right) = \exp\left[\Delta \log(Drivers)_{\substack{country\ j \\ 2050-2005}} + \log\left(\left. \frac{Expenditure}{GDP} \right|_{\substack{OECD\ average \\ year=2005}} \right) \right] - \left(\left. \frac{Expenditure}{GDP} \right|_{\substack{OECD\ \ average \\ year=2005}} \right)$$

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Table A1. **Assumptions underlying the alternative projection scenarios: Health care**

Scenarios	Health Status	Income elasticity	Expenditure residual
Demographic effect	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	Income elasticity is equal to 1	n.a.
Cost-pressure scenario	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	Income elasticity is equal to 1	**The expenditure residual grows at 1% per year over the projection period**
Cost-containment scenario	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	Income elasticity is equal to 1	Residual growth is equal to 1% in 2005 and converges to 0 by 2050 (transversality condition)
Country-specific residuals	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	Income elasticity is equal to 1	**Residual growth is country-specific and converges to 0 by 2050 (transversality condition)**
Income elasticity = 0.8	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	**Income elasticity is equal to 0.8**	Residual growth is equal to 1% in 2005 and converges to 0 by 2050 (transversality condition)
Income elasticity = 1.2	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	**Income elasticity is equal to 1.2**	Residual growth is equal to 1% in 2005 and converges to 0 by 2050 (transversality condition)
Residuals at 1.5%	Healthy ageing: Longevity gains are translated into equivalent additional years in good health	Income elasticity is equal to 1	**Residual growth is equal to 1.5% in 2005 and converges to 0 by 2050 (transversality condition)**
Compression of morbidity	**Longevity gains are doubled into additional years in good health**	Income elasticity is equal to 1	Residual growth is equal to 1% in 2005 and converges to 0 by 2050 (transversality condition)
Expansion of morbidity	**No healthy ageing adjustment, *i.e.* longevity gains do not translate into additional years in good health**	Income elasticity is equal to 1	Residual growth is equal to 1% in 2005 and converges to 0 by 2050 (transversality condition)

Note: The key assumption changed in each scenario is in bold.

Table A2. **Assumptions underlying the alternative projection scenarios: Long-term care**

Scenarios	Health Status	Participation rates (proxy for availability of informal care)	Income and "cost disease" effects
Demographic effect	Healthy ageing: The prevalence of dependency per age is shifted by ½ year every 10 years (approximately half of the projected longevity gains)	n.a.	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) Income elasticity equal to zero
Cost-pressure scenario	Healthy ageing: The prevalence of dependency per age is shifted by ½ year every 10 years	Participation rates of people aged 50-64 increase in line with baseline labour force projections	**Long-term care costs per dependent increase in line with average labour productivity (full Baumol effect)** Income elasticity equal to zero
Cost-containment scenario	Healthy ageing: The prevalence of dependency per age is shifted by ½ year every 10 years	Participation rates of people aged 50-64 increase in line with baseline labour force projections	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) Income elasticity equal to zero
Unitary income elasticity	Healthy ageing: The prevalence of dependency per age is shifted by ½ year every 10 years	Participation rates of people aged 50-64 increase in line with baseline labour force projections	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) **Income elasticity equal to one**
Compression of disability	**The prevalence of dependency per age is shifted by 1 year every 10 years**	Participation rates of people aged 50-64 increase in line with baseline labour force projections	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) Income elasticity equal to zero
Expansion of disability	**No healthy ageing adjustment, *i.e.* the prevalence of dependency remains constant over time**	Participation rates of people aged 50-64 increase in line with baseline labour force projections	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) Income elasticity equal to zero
Increase in dependency	Healthy ageing: The prevalence of dependency per age is shifted by ½ year every 10 years, but **dependency rates are assumed to increase by 0.5% per year**	Participation rates of people aged 50-64 increase in line with baseline labour force projections	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) Income elasticity equal to zero
Increased participation	Healthy ageing: The prevalence of dependency per age is shifted by ½ year every 10 years	**Participation rates of people aged 50-64 converge to at least 70% by 2050 in all countries**	Long-term care costs per dependent increase by *half* of average labour productivity (partial Baumol effect) Income elasticity equal to zero

N*ote*: The key assumption changed in each scenario is in bold.

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LESS THAN YOU THOUGHT: THE FISCAL AUTONOMY OF SUB-CENTRAL GOVERNMENTS

Hansjörg Blöchliger and David King

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INTRODUCTION

State and local governments in OECD countries have access to various fiscal resources. Discretion over them varies considerably, and so does sub-central governments' power to shape their budget and to determine outcomes like public sector efficiency, equity in access to public services or the long term fiscal stance. Data on the revenue structure of sub-central governments (SCG) would therefore be helpful. But indicators have long insufficiently reflected the way state and local budgets are funded. The most frequently used indicator is the ratio of SCG to total tax revenue, which is a poor measure for assessing the true autonomy SCGs enjoy. Since the power over fiscal revenue is a critical determinant for government finance, a set of more refined indicators for assessing fiscal autonomy should be established.

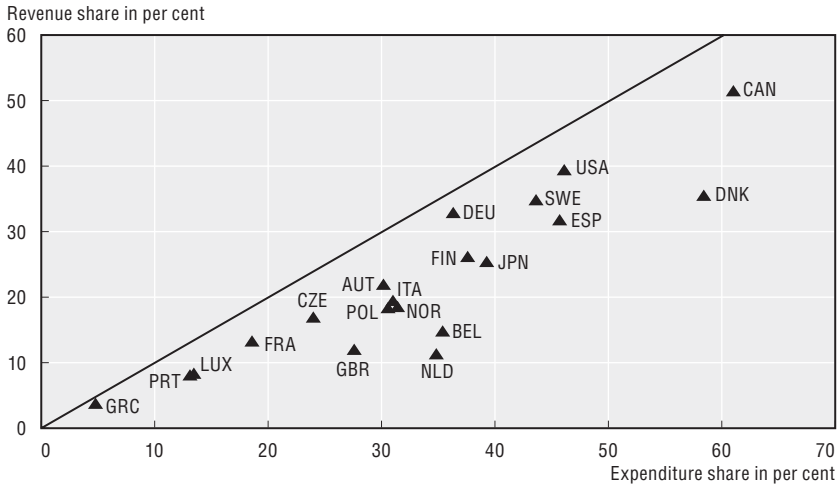
This article provides data and interpretation on the fiscal resources of sub-central governments in a majority of OECD countries. The article is organised as follows: The first section gives an overview on revenue and expenditure assignment using the "standard" decentralisation indicator. The second section describes the indicator set for sub-central tax revenue autonomy. The third section develops the indicator set for intergovernmental grants and the different conditions attached to them. The fourth section assesses overall sub-central fiscal autonomy and analyses the relationship between various autonomy indicators. The fifth and final section summarises the findings and shows how the new dataset can help assess the impact of fiscal federal design on policy outcomes.

DECENTRALISATION RATIOS

The common measure to compare and assess fiscal autonomy is the share of resources and responsibilities assigned to local and regional governments. SCG tax and expenditure indicators (or "decentralisation ratios") drawn from National Accounts can help gauge fiscal decentralisation and its evolution over time. While these indicators can hardly capture the complexity of fiscal arrangements, they can give a first impression of how much fiscal power regional and local jurisdictions enjoy. The following figures show the current state of financial decentralisation as measured by sub-central government shares of total tax revenue and expenditure in OECD countries (Figure 1) and the evolution of these indicators over the last decade (Figure 2).

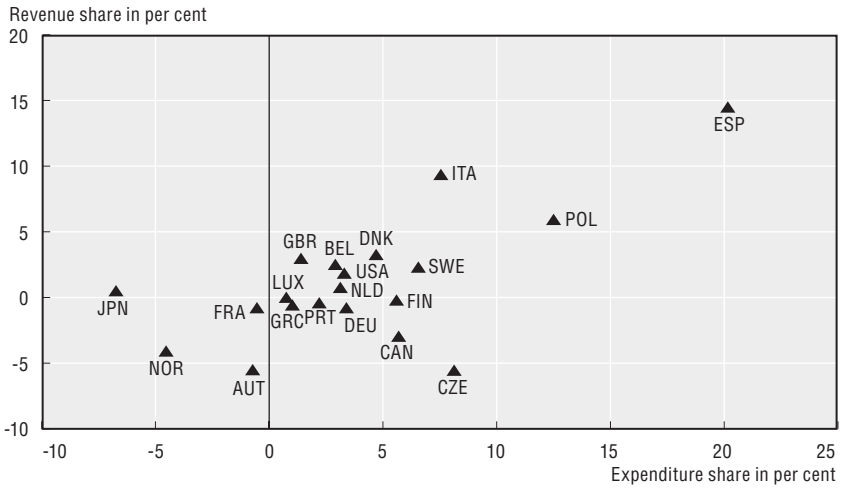
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Figure 1. **Decentralisation ratios in OECD countries**
Share in general government revenues and expenditure, 2004



Source: National Accounts of OECD Countries, 2005.

Figure 2. **Decentralisation ratios, evolution**
Changes expressed in percentage points, 1995-2004



Source: National Accounts of OECD countries, 2005.

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The stylised facts shown in these figures can be summarised as follows:

- The degree of decentralisation varies greatly across OECD countries. While the sub-central share of total government expenditures varies between less than 6% and more than 60%, the sub central tax share stretches from 3 to 50%. The constitutional background of a country – whether it is federal or unitary – says little about actual fiscal autonomy. Local governments in some unitary countries have a higher share in public spending than local and regional governments together in federal countries.
- The sub-central tax share and the sub-central expenditure share have diverged over the last ten years. While the share of sub-national expenditures generally increased, the sub-central tax share – with a few notable exceptions – remained almost stable. The rising expenditure share partly reflects new responsibilities assigned to sub-central governments such as health care and/or non-university education in Italy, Mexico and Spain, or active labour market policies in Canada. On the other hand, local taxing power was reduced in many countries, such as in France or Japan, where local taxes were replaced by intergovernmental transfers.
- In all countries, sub-central government expenditures by far exceed tax revenue and this "fiscal gap" has widened in the last decade. The difference between responsibilities and resources points to large intergovernmental transfer schemes. The fiscal gap tends to be larger in countries with high sub-central fiscal autonomy (Canada, Denmark and – not shown in Figure 1 – Switzerland); somewhat paradoxically, more decentralisation can go hand in hand with more dependency on central government resources. Size and structure of intergovernmental grants thus become a crucial policy issue for decentralizing countries.

A serious problem with these simple ratios, however, is that they only poorly measure the true discretion that SCG enjoy in practice. On the revenue side, limits to set tax bases, rates and relief reduce the extent to which sub-central governments can determine the size of their budget. On the expenditure side, local spending may be strongly influenced by upper level government regulation, thereby reducing discretion over various expenditure items. In some countries, the transfer of financial responsibility for education or health care was hardly more than a change in accounting procedures, while essential regulatory power remained with the central level. Moreover, the various conditions attached to intergovernmental transfers may further influence the spending pattern of sub-central governments. To have a more accurate picture of sub-central fiscal autonomy, a more detailed indicator set is required.

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TAXING POWER OF SUB-CENTRAL GOVERNMENTS

A taxonomy of tax autonomy

The term "tax autonomy" captures various aspects of freedom sub-central governments have over their own taxes. It encompasses features such as sub-central government's right to introduce or to abolish a tax, to set tax rates, to define the tax base, or to grant tax relief to individuals and firms. In a number of countries taxes are not assigned to one specific government level but shared between the central and sub-central governments. Such arrangements deny a single SCG any control on tax rates and bases, but collectively SCGs may have the power to negotiate the sharing formula with central government. The wealth of explicit and implicit, statutory and common, institutional arrangements has to be encompassed by a set of indicators that are simultaneously appropriate (they capture the relevant aspects of tax autonomy), accurate (they measure those aspects correctly) and reliable (the indicator set remains stable over time).

The indicator set comprises five main categories of autonomy and several sub-categories (Table 1). Categories are ranked in decreasing order from highest to lowest taxing power. Category "a" represents full power over tax rates and bases, "b" power over tax rates (essentially representing the "piggy-backing" type of tax), "c" power over the tax base, "d" tax-sharing arrangements and "e" no power on rates and bases at all. Category "f" represents non-allocable taxes. Special atten-

Table 1. **Taxonomy of taxing power**

a.1	The recipient SCG sets the tax rate and any tax relief without needing to consult a higher level government
a.2	The recipient SCG sets the rate and any relief after consulting a higher level of government
b.1	The recipient SCG sets the tax rate and a higher level government does not set upper or lower limits on the rate chosen
b.2	The recipient SCG sets the tax rate and a higher level government does set upper and/or lower limits on the rate chosen
c.1	The recipient SCG sets tax relief – but it sets tax allowances only
c.2	The recipient SCG sets tax relief – but it sets tax credits only
c.3	The recipient SCG sets tax relief – and it sets both tax allowances and tax credits
d.1	There is a tax-sharing arrangement in which the SCGs determine the revenue split
d.2	There is a tax-sharing arrangement in which the revenue split can be changed only with the consent of SCGs
d.3	There is a tax-sharing arrangement in which the revenue split is determined in legislation, and where it may be changed unilaterally by a higher level government, but less frequently than once a year
d.4	There is a tax-sharing arrangement in which the revenue split is determined annually by a higher level government
e	Other cases in which the central government sets the rate and base of the SCG tax
f	None of the above categories (a, b, c, d or e) applies

Source: OECD (1999).

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tion was paid to tax sharing arrangements, where the four "d" subcategories should capture the various rules for determining the sharing formula. Altogether 13 categories were established to encompass the various tax autonomy arrangements in OECD countries. Where applicable, countries were asked to send separate data for both the state/regional and the local level. Since category six "non allocable" was hardly used, the taxonomy seems to reflect well the taxing power universe.

Taxing power in 2002

Although there is wide variation across countries, the stylised facts on taxing power of state and local governments in 2002 can be summarised as follows (Table 2):[1]

- First, only a part of sub-central tax revenue is under effective control of sub-central governments. At the average, the tax revenue share with full or partial discretion (categories a, b and c) amounts to around 60% for state and 70% for local government. In many countries (not shown in the table), permitted maximum tax rates often double minimum rate.
- Second, state and regional governments have less discretion over their tax revenue than local governments, since tax revenue of the former is often governed by tax sharing arrangements. On the other hand, with 51% of SCG tax revenue, the state level has a higher share in high-powered autonomous taxes (category "a"), while local governments are often allowed to levy a supplement on selected regional or central taxes only (category "b" or "piggy-backing" tax).
- Third, the "c" category (representing control over the tax base but not the tax rate) plays a negligible role in OECD countries. It appears that countries are gradually banning tax relief and abatements as local and regional economic development incentives, particularly in the European Union.

In some countries, SCG have the right to vary tax rates but actually set the same rate across the country. Such "unused taxing power" invites a deeper look into fiscal institutions and the incentives they generate for tax competition.

Tax sharing agreements account for a large part of sub central tax revenue in most constitutionally federal countries (Austria, Belgium, Germany, Mexico and Italy), in constitutionally non-federal Spain, in the Czech Republic and in Poland. Tax sharing is often considered as providing a balance between granting local/regional fiscal autonomy and keeping the overall fiscal framework stable. The collective power for sub-central governments to negotiate their tax share varies considerably across countries, from arrangements where sub-central governments are in full control over their share, to arrangements where the share is unilaterally set and modified by the central government. In some countries the distribution formula is

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Table 2. **Taxing power of sub-central governments, 2002**

As share of sub-central tax revenue

	Sub-central tax revenue as % of total tax revenues	Discretion on rates and relief (a)	Discretion on rates (b)		Discretion on relief (c)	Tax sharing arrangements (d)				Rates and relief set by CG (e)	Other (f)	Total
			Full	Restricted		Revenue split set by SCG	Revenue split set with SCG consent	Revenue split set by CG, pluri-annual	Revenue split set by CG, annual			
Australia	**31.4**											
States	28.4	54.4	–	–	–	–	45.6	–	–	–	–	100.0
Local	3.0	100.0	–	–	–	–	–	–	–	–	–	100.0
Austria	**18.4**											
States	8.8	7.0	–	–	–	–	82.7	–	–	9.6	0.8	100.0
Local	9.6	2.7	–	5.4	–	–	66.5	–	–	20.0	5.5	100.0
Belgium	**27.8**											
States	22.8	63.8	–	–	–	–	36.2	–	–	–	–	100.0
Local	5.0	10.0	–	86.4	–	–	–	–	–	3.6	–	100.0
Canada	**44.1**											
Provinces	35.5	98.4	–	–	–	–	1.6	–	–	–	–	100.0
Local	8.6	1.8	95.6	–	–	–	–	–	–	2.3	0.3	100.0
Czech Republic	**12.5**											
Local	12.5	5.5	–	4.1	–	–	–	88.8	–	1.5	0.1	100.0
Denmark	**35.6**											
Local	35.6	–	86.0	4.7	–	–	–	2.9	–	6.4	–	100.0
Finland	**21.5**											
Local	21.5	–	85.3	4.6	–	–	–	–	9.9	–	0.1	100.0
France	**10.0**											
Local	10.0	72.1	–	8.5	9.1	–	–	–	–	3.6	6.6	100.0
Germany	**28.7**											
Länder	21.8	–	–	2.4	–	–	86.3	–	–	11.2	–	100.0
Local	7.0	17.6	–	33.6	–	–	47.6	–	–	1.1	0.2	100.0
Greece	**0.9**											
Local	0.9	–	–	64.6	–	35.4	–	–	–	–	–	100.0
Iceland	**25.2**											
Local	25.2	–	–	91.2	–	–	–	–	–	–	8.8	100.0
Italy	**16.4**											
Regional	11.3	–	–	58.8	–	–	23.7	17.6	–	–	–	100.0
Local	5.2	27.1	–	50.4	–	–	–	13.1	–	9.3	–	100.0
Japan	**26.0**											
Local	26.0	0.1	79.7	–	–	–	–	–	–	20.2	–	100.0
Korea	**18.9**											
Local	18.9	–	–	64.3	–	–	–	–	–	35.7	–	100.0
Mexico	**3.4**											
States	2.4	100.0	–	–	–	–	–	–	–	–	–	100.0
Local	1.0	100.0	–	–	–	–	–	–	–	–	–	100.0
Netherlands	**3.6**											
Local	3.6	–	99.2	–	–	–	–	–	–	–	0.8	100.0
Norway	**12.9**											
Local	12.9	3.3	–	96.7	–	–	–	–	–	–	–	100.0
Poland	**17.5**											
Local	17.5	–	–	23.2	–	–	–	76.4	–	0.4	–	100.0
Portugal	**6.0**											
Local	6.0	–	–	44.0	–	–	–	18.5	–	37.3	0.2	100.0
Spain	**26.6**											
Regions	18.1	58.3	–	0.1	–	–	41.6	–	–	–	0.0	100.0
Local	8.5	27.2	–	51.4	–	–	21.4	–	–	–	0.0	100.0
Sweden	**32.1**											
Local	32.1	–	100.0	–	–	–	–	–	–	–	–	100.0

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Table 2. **Taxing power of sub-central governments, 2002** (*cont.*)
As share of sub-central tax revenue

	Sub-central tax revenue as % of total tax revenues	Discretion on rates and relief (a)	Discretion on rates (b)		Discretion on relief (c)	Tax sharing arrangements (d)				Rates and relief set by CG (e)	Other (f)	Total
			Full	Restricted		Revenue split set by SCG	Revenue split set with SCG consent	Revenue split set by CG, pluri-annual	Revenue split set by CG, annual			
Switzerland	**43.1**											
States	27.0	90.4	–	–	–	–	9.6	–	–	–	–	100.0
Local	16.2	2.9	–	97.1	–	–	–	–	–	–	–	100.0
Turkey	**6.5**											
Local	6.5	–	–	–	–	–	–	–	–	–	100.0	100.0
United Kingdom	**4.5**											
Local	4.5	–	–	100.0	–	–	–	–	–	–	–	100.0
Unweighted Average												
States	19.6	52.5	–	6.8	–	–	36.4	2.0	–	2.3	0.1	100.0
Local	12.4	15.4	22.7	34.6	0.4	1.5	5.6	8.3	0.4	5.9	5.1	100.0

Source: National source and OECD Revenue Statistics 1965-2004, 2005 Edition.

enshrined in the constitution and can only be changed with the consent of all or a majority of sub-central governments. Tax sharing is discussed in the section on "tax sharing arrangements" in more detail.

Evolution of taxing power 1995-2002

Taxing power increased from 1995 to 2002, albeit unevenly across countries (Table 3). The share of taxes over which sub-central governments have full or partial control rose by 25 percentage points for states and 8 percentage points for local governments, mostly to the detriment of tax sharing arrangements. Such agreements lost significance in countries such as Austria, Belgium, Germany, Mexico or Spain. In Norway, local governments gained more autonomy over income taxes, while in Austria and Germany, they lost revenue from autonomous local business taxes. In some countries (*e.g.* France and Sweden) the central government is required to compensate the loss of sub-central tax revenue through additional transfers; this effect is not shown in Table 3.

The forces shaping the evolution of SCG tax revenue and tax autonomy are political, fiscal and economic in nature.

- First and probably most important are policy reforms such as a reassignment of taxes to another government level, a change in tax autonomy or a swap between local/regional taxes and intergovernmental grants. Constitutional and legislative amendments largely account for the rapid change in countries such as Belgium or Spain involved in a secular decentralisation process.

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Table 3. **Evolution of taxing power of sub-central governments**

Change in 1995-2002

		As a share of sub-central tax revenues								
	Sub-central tax revenues as % of total tax revenues	Discretion on rates and relief (a)	Discretion on rates (b)		Discretion on relief (c)	Tax-sharing arrangements (d)				Rates and relief set by CG (e)	Other (f)
			Full	restricted		Revenue split set by SCG	Revenue split set with SCG consent	Revenue split set by CG, pluri-annual	Revenue split set by CG, annual		
Austria	**–0.1**										
Länder	–1.2	5.0	–		–	–	–15.3	–	–	9.6	0.8
Local	1.1	–5.8	–5.9		–	–	–14.0	–	–	20.0	5.5
Belgium	**–0.2**										
States	0.3	59.8	–47.5		–	–	–12.3	–	–	–	–
Local	–0.5	–2.5	2.4		–	–	–	–2.5	–1.0	3.6	–
Czech Republic	**–0.5**										
Local	–0.5	3.5	–0.9		–3.0	–	–	–1.2	–	1.5	0.1
Denmark	**4.6**										
Local	4.6	–	–3.8		–	–	–	0.9	–	2.9	–
Finland	**–0.5**										
Local	–0.5	–	0.9		–	–	–	–11.0	9.9	–	0.1
Germany	**–0.3**										
Länder	–0.2	–	2.4		–	–	–13.7	–	–	11.2	–
Local	0.0	16.6	–18.4		–	–	0.6	–	–	1.1	0.2
Iceland	**5.2**										
Local	5.2	–8.0	–0.8		–	–	–	–	–	–	8.8
Japan	**–12.7**										
Local	–12.7	27.1	–38.1		–	–	–	13.1	–	–2.2	–
Mexico	**–16.6**										
States	–13.6	86.0	–		–	–	–86.0	–	–	–	–
Local	–3.0	100.0	–		–	–	–	–74.0	–	–26.0	–
Netherlands	**1.1**										
Local	1.1	–	–0.8		–	–	–	–	–	–	0.8
Norway	**–7.1**										
Local	–7.1	3.3	94.2		–	–	–	–0.5	–	–97.0	–
Poland	**10.5**										
Local	10.5	–	–21.8		–1.0	–	–	22.4	–	0.4	–
Portugal	**0.8**										
Local	0.8	–	0.2		–	–	–	–4.3	–	3.8	0.2
Spain	**13.3**										
Regions	13.3	44.0	–0.5		–	–	31.7	–	–	–	–75.2
Local	0.0	–1.5	–2.8		–	–	6.1	–	–	–	–1.8
Sweden	**0.1**										
Local	0.1	–2.0	2.0		–	–	–	–	–	–	–
Switzerland	**5.1**										
States	5.0	1.4	–		–	–	3.6	–5.0	–	–	–
Local	0.2	2.9	0.1		–	–	–	–3.0	–	–	–
United Kingdom	**0.5**										
Local	0.5	–	–		–	–	–	–	–	–	–
Unweighted Average											
States	0.6	32.7	–7.6		–	–	–15.3	–0.8	–	3.5	–12.4
Local	0.0	7.9	0.4		–0.2	–	–0.4	–3.5	0.5	–5.4	0.8

Source: National source and OECD, Taxing Powers of State and Local government, Tax Policy Studies No. 1 and Revenue Statistics 1965-2004, 2005 Edition.

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- Second, fiscal reasons such as a relative change in tax rates or bases can also affect the pattern of taxing power, *e.g.* if one government level changes its tax rate or base while another government level does not. In many countries rates and base of local property taxes remain unchanged over long periods of time, while the bases of central government income taxes or goods and services taxes are regularly updated.
- Third, different taxes react differently to the business cycle or to structural change and this may affect tax revenue of different government levels. A local profit tax reacts more swiftly to an economic downturn than a central government income tax, and a local sales tax on goods reacts more slowly to the rise of the service sector than a central value added tax.

Altogether, the net effect of the three forces slightly favoured sub-central governments between 1995 and 2002. Although the share of tax revenue going to the sub-central level hardly changed, the power attached to those taxes rose. For most countries no tax erosion could be detected, either in terms of the revenue share or in terms of autonomy. However, the tax share must be set against the expenditure share, which increased considerably in about the same period (Figure 2).

Tax autonomy across tax category

The data on tax autonomy by tax type defy the beliefs on optimal local taxation (Table 4). While fiscal federalism theory asserts that mobile taxes should be allocated to higher levels of government, in practice the largest single tax assigned to local and regional governments is the highly mobile income tax on individuals, with more than 36% of total SCG tax revenue. If local corporate taxes are added, the share rises to more than 41%. Taxes on goods and services account for 21% of total SCG tax revenue. Taxes on immovable property account for 19% only. Although most OECD countries apply some sub-central property taxation, its yield is often limited and supplemented or even replaced by other taxes such as a local income tax. In more decentralised countries, local income tax revenue largely exceeds local property tax revenue.

A closer look at tax autonomy may alleviate the fears of inappropriate tax assignment. Some mobile sub-central taxes go with little power only. Especially the personal income tax is often built into tax sharing arrangements that limit tax competition and potential tax erosion. Moreover, fiscal equalization – a set of fiscal transfers that aims at reducing differences in sub-central fiscal capacity – may partially offset losses in the revenue of mobile taxes.[2] Even when sub-central governments have the right to set tax rates and bases and could hence enter tax competition, they often do not make use of this right for fear of losing other revenue sources. Put together, it appears that countries succeed in containing the drawbacks of mobile sub-central taxes, but it would be useful to have a closer look into the functioning of respective arrangements.

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Table 4. **Taxing power of sub-central governments by type of tax**

As a percentage of sub-central tax revenue[1]

	Discretion on rates and relief	Discretion on rates		Discretion on relief	Tax sharing arrangements				Rates and relief set by CG	Other	Total
		Full	Restricted		Revenue split set by SCG	Revenue split set with SCG consent	Revenue split set by CG, pluri-annual	Revenue split set by CG, annual			
1000 Taxes on income, profits and capital gains	5.9	9.9	10.3	2.8	–	0.8	9.9	0.3	1.5	0.3	41.7
1100 Of individuals	5.2	9.3	8.1	2.8	–	0.8	8.2	–	1.1	–	35.5
1200 Corporate	0.7	0.6	2.2	–	–	–	1.4	0.3	0.4	0.3	5.9
1300 Unallocable between 1100 and 1200	–	–	–	–	–	–	0.3	–	–	0.0	0.3
2000 Social security contributions	0.1	–	–	–	–	–	–	–	0.0	0.1	0.3
2100 Employees	0.1	–	–	–	–	–	–	–	–	0.1	0.2
2200 Employers	–	–	–	–	–	–	–	–	–	0.0	0.0
2300 Self-employed or non-employed	–	–	–	–	–	–	–	–	–	–	
2400 Unallocable between 2100, 2200 and 2300	–	–	–	–	–	–	–	–	–	–	
3000 Taxes on payroll and workforce	2.4	–	0.2	–	–	–	–	–	0.7	–	3.3
4000 Taxes on property	11.5	5.5	9.0	0.3	0.2	–	0.2	–	0.8	–	27.3
4100 Recurrent taxes on immovable property	6.4	5.3	6.4	–	–	–	0.0	–	0.5	–	18.6
4200 Recurrent taxes on net wealth	0.4	–	1.1	–	–	–	–	–	0.0	–	1.5
4300 Estate, inheritance and gift taxes	0.3	–	0.0	–	–	–	0.0	–	0.1	–	0.4
4400 Taxes on financial and capital transactions	2.5	0.0	1.3	0.3	0.2	–	0.1	–	0.2	–	4.6
4500 Non-recurrent taxes	0.1	0.2	0.2	–	–	–	–	–	–	–	0.5
4600 Other recurrent taxes on property	–	–	–	–	–	–	–	–	–	–	
5000 Taxes on goods and services	3.4	1.5	1.3	0.0	0.9	4.2	5.2	–	4.5	0.3	21.4
5100 Taxes on production, sale, transfer, etc.	2.2	0.1	0.2	0.0	0.9	2.8	5.0	–	3.4	0.3	14.9
5200 Taxes on use of goods and perform activities	1.2	1.5	1.2	–	–	–	0.1	–	1.1	–	5.1
5300 Unallocable between 5100 and 5200	–	–	–	–	–	–	–	–	–	0.0	0.0
6000 Other taxes	2.1	0.1	1.4	–	–	–	0.4	–	1.2	0.6	5.9
6100 Paid solely by business	0.9	0.1	1.4	–	–	–	–	–	0.0	0.2	2.7
6200 Other	1.2	–	–	–	–	–	0.4	–	1.1	–	2.8
Total	25.5	17.1	22.3	3.0	1.1	5.0	15.6	0.3	8.7	1.4	100.0

1. Unweighted average. Countries included are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland and Turkey.

Source: National sources and OECD, Revenue Statistics 1965-2004, 2005 Edition.

Tax sharing arrangements

Tax sharing is an arrangement where tax revenue is divided vertically between the central and sub-central governments as well as horizontally across sub-central governments. Often tax sharing arrangements contain an element of horizontal fiscal equalization. Tax sharing has become a means to provide adequate resources to the sub-centrallevel while maintaining central control over fiscal aggregates. Tax sharing grants less autonomy to sub-central governments than autonomous taxes, and it may also change SCGs' fiscal behaviour. By turning SCG

Box 1. **Drawing a dividing line between tax sharing and intergovernmental grants**

Both tax sharing arrangements (category "d" of tax autonomy) and intergovernmental grants provide resources to sub-central governments. Drawing the dividing line between the two fiscal arrangements proves sometimes difficult. On one hand, many tax sharing formulae have become so complex that there is no link between what a SCG collects on its territory, what it sends into the common pool and what it finally gets back. On the other hand, policy reforms have made some intergovernmental grants more look like a share in the national tax yield. While the National Accounts and the Revenue Statistics provide some guidelines, in practice what counts as tax sharing in one country may count as intergovernmental grant in another; within some countries even, different central government bodies have adopted different views on how to classify fiscal resources (*e.g.* Australia or Belgium). Such lack of clarity jeopardises the coherence of SCG revenue statistics and reduces strength and utility of fiscal design analysis. In order to ensure that fiscal arrangements are recorded properly and on a comparative basis, a set of distinctive criteria is required.

For future statistical work a guideline is proposed that enables a dividing line to be drawn between the two fiscal arrangements. The guideline consists of four criteria. The criteria relate to the revenue risk that sub-central governments are exposed to, the freedom of use of the revenue obtained, the rules and formulas that define the distribution of financial revenue and the institutional decision mechanisms defining each SCG's annual share. In order to be considered a tax sharing, an arrangement must cumulatively fulfil all four criteria. A fiscal arrangement between levels of government can hence be called tax sharing if the amount going to each government level is a strict share of total tax revenue, if this share is predefined and cannot be changed in the course of the fiscal year, if the revenue for SCG is not earmarked and if the revenue allocated to a single SCG either corresponds to the revenue it has collected, or is distributed across jurisdictions according to population, employees, or inversely related to tax raising capacity. Once agreed upon, the criteria can be used for collecting National Accounts and Revenue Statistics data.

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tax revenue into a common pool resource for all government levels, tax sharing may change fiscal incentives and the resulting fiscal outcomes. For both statistical and analytical reasons, it is necessary to distinguish carefully tax sharing from intergovernmental grants (see Box 1).

Tax sharing arrangements can be analyzed on various grounds: the type of tax that is shared, the legal procedures involved in changing the formula, the frequency of an adjustment to the formula and whether the sharing formula contributes to an equalizing objective (Table 5).

Most tax sharing arrangements cover major taxes such as personal income taxes, corporate income taxes or value-added taxes. Their high yield makes them attractive for the sub-central level, and the pooling tackles potential drawbacks of purely local taxation. The procedure for changing the sharing formula is mostly laid down in laws on tax sharing, fiscal equalisation or the like. For the countries under scrutiny, decisions on the tax sharing arrangements seem to be taken at the parliamentary level; in some countries the share is defined in the constitution and adjustments require a qualified majority in parliament. Consultation of SCG is quite frequent, but their explicit consent for adjustments is needed in some federal countries only. The frequency and regularity of formula adjustment varies across countries, from irregular to never, but it appears that tax sharing arrangements are a rather stable item in national fiscal policy. Finally, some countries combine tax sharing and fiscal equalization in one single arrangement.

Table 5. **Tax sharing arrangements**

	Tax type shared	Procedure for formula changes	Frequency of formula changes	Horizontal equalisation objective
Austria	PIT, CIT, property tax, VAT	Parliament, Law on Fiscal Equalisation	Every four years	Yes
Czech Republic	PIT, CIT, VAT	Government, Law of Tax Assignment	Irregularly	Yes
Denmark	PIT, CIT	Government, Law on Tax Sharing	Very rarely	No
Finland	CIT	Government, Law on Tax Sharing		No
Germany	PIT, CIT, VAT	Both Parliaments (*Bundestag* and *Bundesrat*)	13 changes Since 1970	Yes
Greece	Transaction and specific service taxes	Central government	Rarely	No
Spain	VAT, excise duties	Parliament	Rarely	No
Switzerland	PIT	Parliament, Law on Fiscal Equalisation	Never since 1959	Yes

Note: PIT=Personal Income Tax, CIT=Corporate Income Tax, VAT=Value Added Tax.
Source: National Sources.

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INTERGOVERNMENTAL GRANTS

Intergovernmental transfers (or grants) provide sub-central governments with additional financial resources, thus filling the gap between own tax revenue and expenditure needs. The main objectives for intergovernmental grants can be roughly divided into subsidization of SCG services and the equalisation of fiscal disparities; often these reasons overlap. A flowering garden of intergovernmental grants has evolved, with grants having different purposes and different effects on sub-central governments' behaviour. Rules and conditions attached to intergovernmental grants vary widely, ranging from transfers that grant full autonomy and come close to tax sharing, to grants where central government retains tight control. The following paragraphs give an overview on grants from a donors' perspective, a classification of the various strings attached to grants, and the policy areas for which grants are used.

Donors and recipients of grants

Table 6 shows a simplified version of the National Accounts donor/recipient matrix of intergovernmental grants, with five donor levels (central, state, local, international and social security) and – depending on the country type – one or two recipient levels (local, or state and local). The category "international" displays

Table 6. **Grants by donor and recipient sub-sector, 2004**
As a percentage of total grant revenue

Country	As a percentage of total tax revenue	Central level	State level	Local level	International level	Social Security	Total
Australia[1]	**11.0**						
State	9.8	100.0	–	–	–	–	100.0
Local	1.3	61.8	38.2	–	–	–	100.0
Austria	**15.2**						
State	11.5	69.4	5.1	3.8	0.6	21.1	100.0
Local	3.8	49.2	16.1	12.7	0.3	21.7	100.0
Belgium	**11.1**						
State	3.9	81.3	13.9	3.6	1.0	0.1	100.0
Local	7.1	26.4	73.3	–	–	0.3	100.0
Canada	**17.5**						
State	9.0	99.8	–	0.2	–	–	100.0
Local	8.5	0.4	99.6	–	–	–	100.0
Czech Republic	**12.4**						
Local	12.4	99.1	–	–	0.9	–	100.0
Denmark	**13.4**						
Local	13.4	99.5	–	–	0.5	–	100.0

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Table 6. **Grants by donor and recipient sub-sector, 2004** (*cont.*)
As a percentage of total grant revenue

Country	As a percentage of total tax revenue	Central level	State level	Local level	International level	Social Security	Total
Finland	**12.1**						
Local	12.1	98.5	–	–	1.5	–	100.0
France	**8.6**						
Local	8.6	97.0	–	–	3.0	–	100.0
Germany	**12.8**						
Länder	5.9	79.0	–	14.7	6.4	–	100.0
Local	7.0	1.4	98.4	–	–	0.2	100.0
Greece[1]	**4.1**						
Local	4.1	100.0	–	–	–	–	100.0
Hungary	**16.7**						
Local	16.7	67.2	–	3.0	0.5	29.4	100.0
Iceland	**1.9**						
Local	1.9	100.0	–	–	–	–	100.0
Italy[2]	**19.1**						
Regional	12.7	94.8	–	–	5.2	–	100.0
Local	6.4	54.3	45.7	–	–	–	100.0
Korea	**34.4**						
Local	34.4	82.6	–	17.4	–	–	100.0
Mexico	**43.4**						
State[3]	43.4	100.0	–	–	–	–	100.0
Local							
Netherlands[1]	**27.8**						
Local	27.8	100.0	–	–	–	–	100.0
Norway	**11.3**						
Local	11.3	100.0	–	–	–	–	100.0
Poland[1]	**37.9**						
Local	37.9	99.6	–	0.4	–	–	100.0
Portugal	**7.8**						
Local	7.8	86.5	–	–	12.9	0.6	100.0
Spain	**19.4**						
Regional	14.0	77.7	–	16.7	–	5.6	100.0
Local	5.5	66.6	31.2	–	–	2.2	100.0
Sweden	**9.4**						
Local	9.4	100.0	–	–	–	–	100.0
Switzerland	**23.4**						
State	16.1	73.7	5.6	20.7	–	–	100.0
Local	7.2	0.2	77.6	22.3	–	–	100.0
Turkey	**15.8**						
Local	15.8	100.0	–	–	–	–	100.0
Unweighted average							
State	14.0	86.2	2.7	6.6	1.5	3.0	100.0
Local	11.8	72.3	21.8	2.5	0.9	2.5	100.0

1. 2003 figures.
2. 2002 figures.
3. Including grants to local government.

Source: National sources and OECD Revenue Statistics 1965-2004, 2005 Edition.

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funds directly allocated to SCG in some countries.[3] On the average, grants account for around a quarter of total tax revenue,[4] with Mexico having the largest grant system and Iceland the smallest in relative terms. With 72% central government provides the overwhelming part of grants to local governments in both federal and unitary countries, although in most federal countries (Belgium, Canada, Germany and Switzerland) are states the main source for local governments. Around 3% of all grants flow across states/regions and 2% across local governments. However, such horizontal arrangements not always being recorded properly may be underestimated.

In the period 2000 to 2004, the share of grants to total tax revenue remained almost stable (Table 7). However, average figures conceal that almost three quarters of countries experienced an above-average growth of transfers. In a majority of countries, transfer growth laid above total government expenditure growth (not shown in Table 8). Grants from the central government, by far the most significant donor, rose by an annual 6% for states and 8% for local governments, exceeding the growth rate of total tax revenue. The international level emerges as a source for regional government finance, reflecting development assistance from the European Union to the regions. While some transfer growth reflects institutional reforms such as responsibility reassignment or a swap between tax revenue and grants, some transfer growth could be the result of creeping demand increases from sub-central governments and hint at growing pressure on the central budget.

Taxonomy of grants

The design of grants should be captured with a taxonomy that reflects their variety (Figure 3).[5] The main dividing line separates earmarked from non-earmarked grants; a distinction crucial for assessing sub-central fiscal autonomy. Both types of grants can be divided further into mandatory and discretionary transfers, reflecting the legal background that governs their allocation. Earmarked grants may be further subdivided into matching and non-matching grants, *i.e.* whether the transfer is linked to SCG own expenditure or not. A final subdivision is between grants for capital expenditure and grants for current expenditure. On the non-earmarked side grants may be further subdivided into block and general purpose grants, where the latter provide more freedom of use; since both forms are unconditional, the distinction often collapses. The taxonomy is consistent with the one established by the Council of Europe.

With roughly 60%, non-earmarked grants account for a larger part of total grant revenue, but the remaining 40% give the central level a strong stake in SCG budgets (Table 8). It is slightly surprising to see that earmarked grants, and hence central control, are more important for state and regional governments than for local governments. Around a third of earmarked grants is matching, *i.e.* linked to SCG own expenditure. Through lowering the price of sub-central public services matching

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Table 7. **Evolution of grants by donor and recipient sub-sector**

Annual growth rates 2000-2004

Country	Change in total tax revenue	Central level	State level	Local level	International	Social Security
Australia[1]	**–0.8**					
State	–0.7	1.2	–	–	–	–
Local	–0.1	9.3	–7.2	–	–	–
Austria	**–0.7**					
State	–0.3	3.9	–8.6	0.9	1.8	1.7
Local	–0.5	–0.2	9.8	–7.9	19.4	–0.1
Belgium	**1.4**					
State	0.8	11.1	1.9	13.6	45.0	–18.4
Local	0.6	14.9	3.0	–	–	–5.3
Canada	**1.4**					
State	0.9	5.7	–	–31.3	–	–
Local	0.5	–3.9	4.0	–	–	–
Czech Republic	**6.8**					
Local	6.8	30.8	–	–	–	–
Denmark	**2.5**					
Local	2.5	8.3	–	–	–	–
Finland	**3.9**					
Local	3.9	12.1	–	–	6.0	–
France	**1.3**					
Local	1.3	6.5	–	–	–	–
Germany	**–0.1**					
Länder	0.0	–0.2	–	0.7	0.8	–
Local	–0.1	4.5	–0.4	–	–	–2.4
Greece[1]	**0.8**					
Local	0.8	13.4	–	–	–	–
Hungary	**1.7**					
Local	1.7	13.9	–	6.5	–	12.9
Iceland	**0.4**					
Local	0.4	14.6	–	–	–	–
Korea	**1.3**					
Local	1.3	9.6	–	11.6	–	–
Mexico	**3.6**					
State[2]	3.6	11.1	–	–	–	–
Local						
Netherlands[1]	**3.6**					
Local	3.6	7.2	–	–	–	–
Norway	**–3.5**					
Local	–3.5	–2.3	–	–	–	–
Poland[1]	**2.1**					
Local	2.1	8.0	–	–12.4	–	–
Portugal	**0.7**					
Local	0.7	7.3	–	–	5.0	17.6
Spain	**–7.1**					
Regional	–6.6	9.7	–	15.3	–	–40.6
Local	–0.5	4.5	10.8	–	–	–17.0
Switzerland	**1.5**					
State	1.0	2.5	13.8	–0.4	–	–
Local	0.5	–3.1	1.9	6.4	–	–

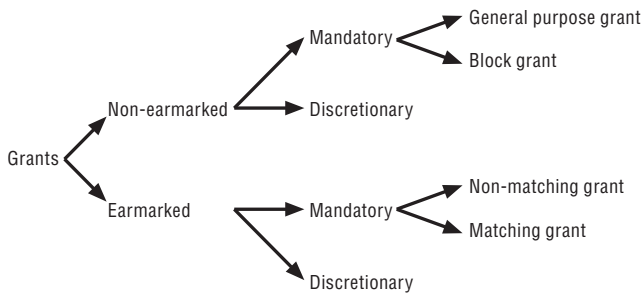
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Table 7. **Evolution of grants by donor and recipient sub-sector** (*cont.*)
Annual growth rates 2000-2004

Country	Change in total tax revenue	Central level	State level	Local level	International	Social Security
Turkey	**–19.2**					
Local	–19.2	10.6	–	–	–	–
Unweighted average						
State	–0.2	6.4	1.0	–0.3	6.7	–8.2
Local	0.2	8.3	1.1	0.2	1.5	0.3

1. 2003 figures.
2. Including grants to local government.
Source: National sources and OECD Revenue Statistics 1965-2004, 2005 Edition.

Figure 3. **A taxonomy of grants**



grants are thought to foster spending, but by doing this may put some pressure on both central and sub-central budgets. Around three-quarters of all earmarked grants are mandatory, giving SCG more revenue security but leaving less scope for central governments to adjust expenditures rapidly to overall fiscal conditions. Only one-quarter of earmarked transfers can be – at least from a legal, if not political, point of view – adjusted within short notice. Whether discretionary transfers fluctuate more than mandatory grants remain to be analyzed once data for a longer time period are available.

Grant design has little evolved between 2000 and 2004, except for the strong increase in the share of earmarked matching grants, at the expense of almost any other transfer type (Table 9). This evolution could mean that matching grants indeed exert some pressure on central – and also sub-central – budgets. The share of non earmarked grants has slightly increased, pointing at more fiscal leeway for SCG, whereby the local level has benefited more than the state and

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Table 8. **Grant revenue by type of grant, 2004**

As a percentage of total grant revenue

	Earmarked grants						Non earmarked grants			Total
	Mandatory				Discretionary		Mandatory		Discretionary	
	Matching		Non-Matching				General purpose grants	Block grants		
	Current	Capital	Current	Capital	Current	Capital				
Australia										
State	–	–	–	–	81.6	11.3	2.9	–	4.1	100.0
Local	–	–	–	–	16.7	–	83.3	–	–	100.0
Austria										
State	57.0	1.8	2.0	18.4	0.6		12.5	0.2	7.5	100.0
Local	39.3	3.5	7.4	34.8	1.2		13.7	0.1	0.0	100.0
Belgium										
State	67.2	10.9	14.7		1.0	0.1	6.0	–	–	100.0
Local	71.6		0.1		0.5	23.8	4.0	–	–	100.0
Canada										
State	–	–	18.6		–	–	81.4	–	–	100.0
Local	–	–	91.4	4.3	–	–	4.3	–	–	100.0
Czech Republic										
Local	12.4		–	–	74.1	13.6	–	–	–	100.0
Denmark										
Local	37.9		0.8		4.9	0.1	56.2	–	0.0	100.0
Finland										
Local	5.7		–	–	1.8	1.6	16.3	74.0	0.6	100.0
France										
Local	6.5		0.1		1.3	3.8	81.9	6.4	–	100.0
Greece										
Local	61.3	38.7	–	–	–	–	–	–	–	100.0
Hungary										
Local	40.1	7.4	–	–	3.8	5.6	41.9	–	1.1	100.0
Iceland										
Local	3.0		8.4		6.5	3.1	79.0	–	–	100.0
Italy[1]										
Regional		4.7		4.7	10.6	8.7	71.4	–	–	100.0
Local	–		–		39.4	36.1	24.5	–	–	100.0
Korea										
Local	6.4		–	–	11.2	10.2	69.9	–	2.4	100.0
Mexico										
State[2]	53.9		–	–	5.3		40.8	–	–	100.0
Local										
Netherlands[3]										
Local	73.6		–	–	–	–	26.4		–	100.0
Norway										
Local	12.2		9.4		19.4	3.9	–	55.1	–	100.0
Poland										
Local	24.1	5.4	–	–	–	–	70.5	–	–	100.0
Portugal										
Local	–	–	–	–	11.4		85.0	–	3.6	100.0

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Table 8. **Grant revenue by type of grant, 2004** (*cont.*)
As a percentage of total grant revenue

	Earmarked grants						Non earmarked grants			Total
	Mandatory				Discretionary		Mandatory		Discretionary	
	Matching		Non-Matching				General purpose grants	Block grants		
	Current	Capital	Current	Capital	Current	Capital				
Spain										
Regional	8.1	5.4	–	–	0.9	0.5	85.2	–	–	100.0
Local	14.3	16.4	3.1		–	–	66.2	–	–	100.0
Sweden										
Local	–	–	–	–	0.7	28.1	71.3	–	–	100.0
Switzerland										
State	64.8	12.9	–	–	–	–	22.2	–	–	100.0
Local	71.7	8.7	–	–	–	–	19.6	–	–	100.0
Turkey										
Local	–	–	–	–	77.3		–	–	22.7	100.0
Unweighted average										
State	31.4	4.5	4.4	2.9	12.5	2.6	40.3	0.0	1.5	100.0
Local	22.9	3.8	5.7	1.9	9.2	9.9	38.8	6.5	1.5	100.0

1. 2002 figures.
2. Including grants to local government.
3. 2003 figures.

Source: National sources.

regional level. Again structural change varies widely across countries, pointing at some path-dependency of the intergovernmental transfer system.

Grants by government function

Grants are used for different policy areas or government functions (Table 10). The National Accounts divide government activities into ten functions in the so-called Classification of Functions of Government (COFOG), and this division is also applied to intergovernmental grants. Data are available only for earmarked grants because unconditional grants are not tied to specific government functions. While National Accounts data are available for eight countries, the questionnaire asked all countries to provide data with the same precision as provided by the National Accounts. In the end the data of 11 countries could be used to assess and compare the functional structure of intergovernmental grants.

The category "general public services" accounts for the largest, rather unspecific share of intergovernmental transfers. Education is the second largest category, pointing at the weight of local and regional governments in providing primary and secondary education, with central government retaining considerable

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Table 9. **Evolution of grant revenue by type of grant**

Change in 2000-2004, percentage points

	Earmarked grants						Non earmarked grants		
	Mandatory				Discretionary		Mandatory		Discretionary
	Matching		Non-Matching				General purpose grants	Block grants	
	Current	Capital	Current	Capital	Current	Capital			
Australia									
State	–	–	–	–	12.0	–0.2	–13.6	–	1.8
Local	–	–	–	–	9.6	–0.5	–9.1	–	–
Austria									
State	2.3	–0.7	–0.9	–1.2	0.0		0.8	0.0	–0.2
Local	0.7	–5.5	2.5	–0.2	–0.3		2.8	0.0	0.0
Belgium									
State	–6.9	9.7	–2.1		1.0	–0.3	–1.3		–
Local	–15.5	–3.2	0.0		–2.0	23.1	–2.4		–
Canada									
State	–	–	–0.6		–	–	0.6	–	–
Local	–	–	–0.4	–0.2	–	–	0.6	–	–
Czech Republic									
Local	–16.8		–	–	33.7	–16.9	–	–	–
Denmark									
Local	–1.9		0.2		0.8	0.0	0.9	–	0.0
Finland									
Local	–4.1		–	–	0.2	–1.5	16.3	–10.1	–0.8
France									
Local	–1.2		0.0		–1.1	–1.1	6.7	–3.3	–
Greece									
Local	7.7	–7.7	–	–	–	–	–	–	–
Hungary									
Local	–0.5	–1.7	–	–	–1.3	0.6	6.0	–	–3.1
Iceland									
Local	–15.4		1.2		–11.3	0.7	24.8	–	–
Korea									
Local	–2.9		–	–	0.7	–1.3	3.2	–	0.3
Mexico									
State[2]	3.8		–	–	–0.4	–3.4	–	–	
Local									
Netherlands[1]									
Local	5.0		–	–	–	–	–5.0		–
Norway									
Local	–8.7		8.4		2.2	0.7	–	–2.6	–
Poland									
Local	–8.4	–1.0	–	–	–	–	9.4	–	–
Portugal									
Local	–	–	–	–	–5.1	1.5	–	3.6	
Spain									
Regional	–35.3	0.9	–	–	0.0	0.1	34.3	–	–
Local	–1.5	3.0	0.6		–	–	–2.1	–	–

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Table 9. **Evolution of grant revenue by type of grant** (*cont.*)
Change in 2000-2004, percentage points

	Earmarked grants						Non earmarked grants		
	Mandatory				Discretionary		Mandatory		Discretionary
	Matching		Non-Matching				General purpose grants	Block grants	
	Current	Capital	Current	Capital	Current	Capital			
Switzerland									
State	1.4	–1.9	–	–	–	–	0.5	–	–
Local	–1.9	–2.1	–	–	–	–	3.9	–	–
Turkey									
Local	–	–	–	–	12.4		–	–	–12.4
Unweighted average									
State	–5.0	1.1	–0.5	–0.2	1.8	–0.1	2.6	0.0	0.2
Local	–3.6	–1.0	0.7	0.0	1.4	0.2	3.2	–0.9	0.0

1. 2003 figures.
2. Including grants to local government.
Source: National sources.

control over funding and regulation. "Economic affairs" is the third largest category, largely reflecting the weight of shared responsibilities in local and regional development policy. Again the grant structure varies widely, reflecting the different responsibility assignments and funding arrangements in countries. In general, except for "defence" and "public order and safety", some degree of responsibility sharing and overlapping characterises most government functions. However, the low number of country responses does not yet allow for stringent conclusions.

FISCAL AUTONOMY OF SUB-CENTRAL GOVERNMENTS

Revenue structure

Sub-central governments rely on own tax revenue, shared taxes and intergovernmental grants. In Table 11 the three main categories of fiscal revenue are put together, to allow for an overall assessment and comparison across SCGs. In order to facilitate the reading of the table, a number of tax autonomy and intergovernmental grant categories are aggregated. Finally nine categories encompass the different revenue sources available to state and local governments. As for all statistics in this article, borrowing and fees are not included due to the lack of comparable data.

With an un-weighted average of roughly 60% against 40%, tax revenue accounts for a larger share of SCG revenue than intergovernmental grants (Table 11). With 38% autonomous taxes are the single largest category. Earmarked

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Table 10. **Grants by government function, 2004**

In per cent of total earmarked grants

	General public services	Defence	Public order and safety	Economic affairs	Environment protection	Housing and community amenities	Health	Recreation, culture, religion	Education	Social protection	Others	Total
	01	02	03	04	05	06	07	08	09	10		
Australia	–	–	0.2	9.0	–	4.9	39.6	0.1	37.5	8.4	0.3	100.0
Austria												
Belgium	–	–	24.3	21.4	–	–	0.1	–	25.3	28.9	–	100.0
Canada												
Czech Republic	9.3	0.0	0.5	6.0	0.3	7.5	2.2	0.7	54.3	17.7	1.4	100.0
Denmark												
Finland	5.5	–	0.6	17.2	1.8	0.4	12.0	16.9	27.0	18.7	–	100.0
France	16.9	1.7	8.0	13.0	2.3	22.4	–	30.8	5.0	–	–	100.0
Germany												
Greece	56.6	–	–	18.9	5.6	5.6	–	7.2	–	6.1	–	100.0
Hungary												
Iceland												
Italy[1]	16.9	–	–	40.6	3.8	–	31.7	–	7.0	–	–	100.0
Korea												
Mexico												
Netherlands	0.0	–	0.6	1.4	1.1	8.6	5.3	0.5	22.4	50.2	9.9	100
Norway	79.3	0.2	0.1	–	0.0	0.1	14.0	–	4.7	1.7	–	100.0
Poland	3.1	3.5	16.2	4.4	8.9	5.5	10.8	5.2	17.9	24.6	–	100.0
Portugal	3.2	26.0	–		61.3	9.5	100.0					
Spain	42.4	–	0.2	35.4	0.6	3.2	4.7	0.9	2.5	10.0	–	100.0
Sweden	3.5	1.1	0.0	6.2	3.8	–	56.3	–	29.1	–	–	100.0
Switzerland												
Turkey	43.2	–	–	14.2	19.1	22.2	–	0.9	–	0.5	–	100.0
Unweighted average	20.0	0.5	3.6	15.3	3.4	5.7	17.0	4.5	16.6	11.9	1.5	100.0

1. 2002.

Source: National sources.

Table 11. **Revenue structure of sub-central governments**

Percentages of total sub-central revenue, 2002

	Autonomous taxes			Tax sharing				Other taxes	Grants		Total
	Discretion on rates and relief	Discretion on rates	Discretion on relief	Revenue split set by SCG	Revenue split set with SCG consent	Revenue split set by CG, pluri-annual	Revenue split set by CG, annual		Earmarked	Non earmarked	
Australia											
States	41.1	–	–	–	34.4	–	–	–	21.9	2.7	100.0
Local	80.6	–	–	–	–	–	–	–	3.1	16.2	100.0
Austria											
States	3.7	–	–	–	43.5	–	–	5.5	37.4	10.0	100.0
Local	2.3	4.5	–	–	55.4	–	–	21.2	14.3	2.3	100.0
Belgium											
States	57.1	–	–	–	32.4	–	–	–	9.7	0.8	100.0
Local	7.5	65.0	–	–	–	–	–	2.7	23.8	0.9	100.0
Canada											
Provinces	76.0	–	–	–	5.5	–	–	–	3.0	15.5	100.0
Local[1]	0.9	47.7	–	–	–	–	–	1.3	48.0	2.2	100.0
Czech Republic											
Local	3.2	2.4	–	–	–	51.8	–	0.9	41.7	–	100.0
Denmark											
Local	–	67.9	–	–	–	2.2	–	4.8	12.5	12.6	100.0
Finland											
Local	–	60.4	–	–	–	–	6.7	0.1	3.4	29.4	100.0
France											
Local	39.3	4.6	5.0	–	–	–	–	5.6	5.7	39.8	100.0
Germany											
Länder	–	1.9	–	–	68.2	–	–	8.9	21.0		100.0
Local	8.7	16.7	–	–	23.7	–	–	0.6	50.3		100.0
Greece											
Local	–	11.6	–	6.3	–	–	–	–	82.1	–	100.0
Italy											
Regional	–	28.4	–	–	11.4	8.5	–	–	14.8	36.9	100.0
Local	12.1	22.6	–	–	–	5.9	–	4.2	41.7	13.5	100.0
Korea											
Local	–	24.9	–	–	–	–	–	12.8	18.0	44.3	100.0
Mexico											
States[3]	5.0	–	–	–	–	–	–	–	54.4	40.6	100.0
Local											
Netherlands											
Local	–	11.8	–	–	–	–	–	0.1	61.7	26.5	100.0
Norway											
Local	1.6	–	45.3	–	–	–	–	–	24.2	29.0	100.0
Poland											
Local	–	11.7	–	–	–	38.6	–	0.2	17.9	31.6	100.0
Portugal											
Local	–	21.2	–	–	–	8.9	–	18.1	5.7	46.0	100.0
Spain											
Regions	32.6	0.1	–	–	23.3	–	–	0.0	7.0	37.1	100
Local	16.1	30.4	–	–	12.7	–	–	0.0	13.1	27.8	100
Sweden[2]											
Local	–	74.0	–	–	–	–	–	–	7.5	18.5	100.0
Switzerland											
States	57.4	–	–	–	6.1	–	–	–	28.0	8.5	100.0
Local	2.0	66.9	–	–	–	–	–	–	25.2	5.9	100.0

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Table 11. **Revenue structure of sub-central governments** (*cont.*)
Percentages of total sub-central revenue, 2002

	Autonomous taxes			Tax sharing				Other taxes	Grants		Total
	Discretion on rates and relief	Discretion on rates	Discretion on relief	Revenue split set by SCG	Revenue split set with SCG consent	Revenue split set by CG, pluri-annual	Revenue split set by CG, annual		Earmarked	Non earmarked	
Unweighted average											
States	30.3	3.4	–	–	25.0	0.9	–	1.6	21.9	16.9	100.0
Local	9.2	28.6	2.6	0.3	4.8	5.6	0.4	3.8	26.3	18.2	100.0

1. Local figures with Quebec tax autonomy.
2. 2004.
3. Including grants to local government.

Source: National sources and OECD Revenue statistics 1965-2004, 2005 Edition.

grants follow as the second largest category with 22%, indicating that more than one-fifth of total revenue is largely outside the discretion of SCG. Non-earmarked grants account for 19%, while tax sharing arrangements – widely used in constitutionally federal countries – account for 16%. Countries with tax sharing arrangements have a smaller grant system and *vice versa*, suggesting some substitutability between the two fiscal arrangements. Again there is wide variation across countries; while for some tiers own tax revenue accounts for the overwhelming part (Canada states, Switzerland states), for others it is tax sharing (Australia states, Austria local, Germany states, Czech Republic), for others again it is either earmarked or non-earmarked grants (Greece, Mexico, Netherlands).

Fiscal autonomy indicator set

Fiscal autonomy of sub-central governments is multi-faceted and must be assessed using several indicators. Table 12 provides a summary of fiscal autonomy indicators developed in this article, including the share of tax revenue allocated to sub-central governments, the discretion over those taxes, the share of transfers allocated to sub-central governments and the percentage of earmarked transfers. Although not treated in this article, two indicators for fiscal rules are added, reflecting, respectively, the right to run deficits and the right to borrow (Box 2).

Altogether, the table comprises six indicators capturing fiscal autonomy from different angles. The seventh indicator "share of autonomous SCG tax revenue" is the product of the sub-central tax revenue share and the autonomy over those taxes; this product comes closest to what one could call a composite indicator of fiscal autonomy. Correlation between indicators is weak, and statistical concepts like factor analysis fail to produce a single "summary indicator of sub-central fiscal autonomy".[6]

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Table 12. **Summary of fiscal autonomy indicators**

In percentages

	SGG tax revenue/Total tax revenue	Discretion on rates and relief/Total SCG tax revenue	Total grants/ Total tax revenue	Non earmarked grants/Total grants	Budget and deficit autonomy	Borrowing autonomy	SCG autonomous tax revenue/ Total tax revenue
Australia	31.4	58.8	11.0	13.1			18.5
States	28.4	54.4	9.8	7.1	10.0	62.5	15.4
Local	3.0	100.0	1.3	83.3	10.0	62.5	3.0
Austria	18.4	7.6	15.2	19.0			1.4
States	8.8	7.0	11.5	20.2	40.0	100.0	0.6
Local	9.6	8.1	3.8	13.9	40.0	100.0	0.8
Belgium	27.8	69.7	11.1	5.3			19.4
States	22.8	63.8	3.9	6.0			14.6
Local	5.0	96.4	7.1	4.0			4.8
Canada	44.1	94.1	17.5	43.9			41.5
Provinces	35.5	93.3	9.0	81.4			33.1
Local	8.6	97.4	8.5	4.3			8.4
Czech Republic	12.5	9.6	12.4	0.0			1.2
Local	12.5	9.6	12.4	0.0	70.0	62.5	1.2
Denmark	35.6	90.7	13.4	56.3			32.3
Local	35.6	90.7	13.4	56.3	0.0	25.0	32.3
Finland	21.5	89.9	12.1	90.8			19.3
Local	21.5	89.9	12.1	90.8	60.0	75.0	19.3
France	10.0	89.8	8.6	88.3			8.1
Local	10.0	89.8	8.6	88.3	60.0	37.5	8.1
Germany	28.7	14.2	12.8	43.4			4.1
Länder	21.8	2.4	5.9	42.5	70.0	87.5	0.5
Local	7.0	51.1	7.0	44.4	0.0	62.5	3.6
Greece	0.9	64.6	4.1	0.0			0.6
Local	0.9	64.6	4.1	0.0			0.6
Hungary			16.7	43.1			
Local			16.7	43.1			
Iceland	25.2	91.2	1.9	79.0			23.0
Local	25.2	91.2	1.9	79.0	100.0	62.5	23.0
Italy	16.4	64.7	19.1	55.1			10.6
Regional	11.3	58.8	12.7	71.4			6.6
Local	5.2	77.6	6.4	24.5			4.0
Japan	26.0	79.8					20.8
Local	26.0	79.8			70.0	50.0	20.8
Korea	18.9	64.3	34.4	72.3			12.1
Local	18.9	64.3	34.4	72.3	60.0	12.5	12.1
Mexico	3.4	100.0	43.4	40.8			3.4
States	2.4	100.0	43.4	40.8			2.4
Local	1.0	100.0	0.0				1.0
Netherlands	3.6	99.2	27.8	26.4			3.6
Local	3.6	99.2	27.8	26.4	0.0	75.0	3.6
Norway	12.9	100.0	11.3	55.1			12.9
Local	12.9	100.0	11.3	55.1	40.0	50.0	12.9
Poland	17.5	23.2	37.9	70.5			4.1
Local	17.5	23.2	37.9	70.5	80.0	37.5	4.1

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Table 12. **Summary of fiscal autonomy indicators** (*cont.*)

In percentages

	SGG tax revenue/Total tax revenue	Discretion on rates and relief/Total SCG tax revenue	Total grants/ Total tax revenue	Non earmarked grants/Total grants	Budget and deficit autonomy	Borrowing autonomy	SCG autonomous tax revenue/ Total tax revenue
Portugal	6.0	44.0	7.9	88.6			2.6
Local	6.0	44.0	7.9	88.6	60.0	37.5	2.6
Spain	26.6	64.8	19.4	79.9			17.3
Regions	18.1	58.4	14.0	85.2	0.0	25.0	10.6
Local	8.5	78.6	5.5	66.2	0.0	37.5	6.7
Sweden	32.1	100.0	9.4				32.1
Local	32.1	100.0	9.4		40.0	100.0	32.1
Switzerland	43.1	94.0	23.4	21.4			40.6
States	27.0	90.4	16.1	22.2	70.0	75.0	24.4
Local	16.2	100.0	7.2	19.6	60.0	37.5	16.2
Turkey	6.5	0.0	15.8	22.7			0.0
Local	6.5	0.0	15.8	22.7	70.0	25.0	0.0
United Kingdom	4.5	100.0					4.5
Local	4.5	100.0					4.5
Unweighted Average							
States	19.6	58.7	14.0	41.9	38.0	70.0	12.0
Local	12.4	73.1	11.3	45.4	45.6	52.8	9.4

Source: National sources and OECD, Revenue Statistics 1965-2004, 2005 Edition.

A *few* (*non*) *correlations among fiscal autonomy indicators*

As described above, the various indicators for fiscal autonomy are not or only weakly correlated, pointing at the multidimensionality of fiscal autonomy and the great diversity of fiscal institutions in OECD countries. Some of these non-correlations are interesting from a policy perspective since they may either support or contradict a number of beliefs in the area of decentralised public finance. The following scatter diagrams show a number of simple two-dimensional relationships.

- The first scatter diagram shows the relationship between the share of sub-central tax revenue and the degree of autonomy over these taxes. The share of sub-central government's own tax revenue is hardly related to their autonomy over those taxes. While in some countries SCGs have wide discretion over a small tax base, in some other countries SCGs have very little autonomy over a large tax base, especially in tax sharing arrangements.The picture again supports the view that a simple share of tax revenue is a poor measure to assess true fiscal autonomy of sub-central governments and that for analytical purposes, *e.g.* assessing the impact of decentralisation on aggregate finance, more sophisticated indicators should be used.

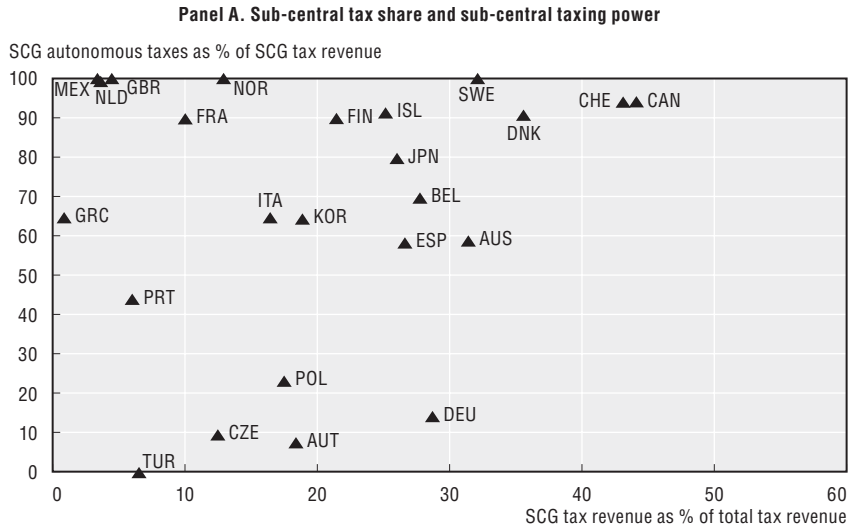
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Box 2. **Fiscal rules and their impact on sub-central government autonomy**

Rules constraining the discretionary power of sub-central budget policymakers have become quite widespread among OECD economies. While fiscal rules for sub-central governments can be a means to achieve sustainable long-term aggregate finance, they reduce the power governments have over their own budget. The same fiscal rules can therefore be viewed from both a "stringency" and an "autonomy" perspective; with a more stringent rule assumed to reduce the discretion a SCG has over its budget or selected budget items.

In order to assess the extent SCG fiscal autonomy is constrained by fiscal rules, two indicators for fiscal rules stringency were calculated based on Sutherland, Price and Joumard (2006). A simple linear transformation of these indicators yields "fiscal rule autonomy" indicators. The "fiscal rule autonomy" indicators have the same dimensions as the other fiscal autonomy indicators shown in Table 12 and the same meaning, *i.e.* the higher the value, the more lenient the respective rule and the higher sub-central budget autonomy.

Figure 4. **Relationship between fiscal autonomy indicators**

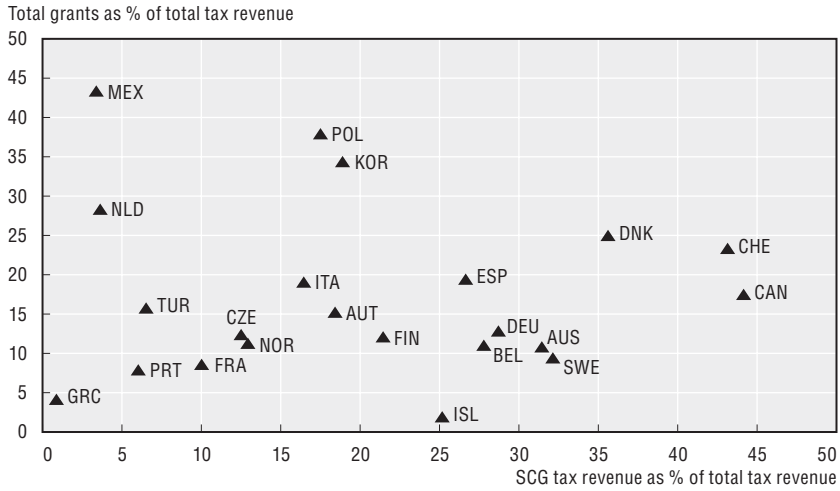


Source: National sources and OECD *Revenue Statistics 1965-2004*.

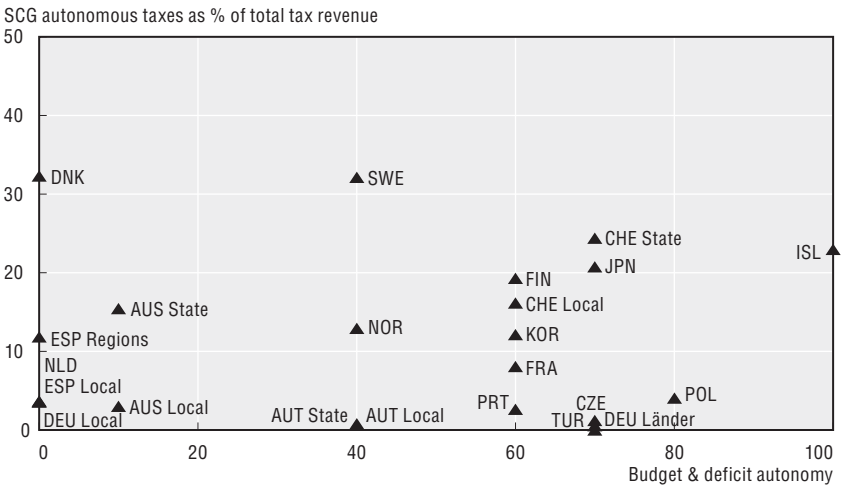
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Figure 4. **Relationship between fiscal autonomy indicators** *(cont.)*

Panel B. Sub-central tax share and size of the grant system



Panel C. Sub-central tax share and budget autonomy



Source: National sources and *OECD Revenue Statistics 1965-2004*.

- The second scatter diagram shows the relationship between the share of sub-central tax revenue and the size of the grant system. While fiscal policy could substitute own tax revenue for intergovernmental grants and *vice versa*,

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there is actually no relationship between the two fiscal arrangements. While in some countries small local tax revenue meets with a small grant system, others combine large local tax revenue with a large fiscal gap and an extended transfer system to cover it. Only unconditional grants (not shown in the figure) and own tax revenue seem to be substitutes, which points to the close relationship between tax sharing and grants arrangements. Policy makers might be interested to know whether increased sub-central tax autonomy can reduce the need for intergovernmental transfers.

- The third scatter diagram shows the relationship between the share of sub-central tax revenue and the extent to which SCG are allowed to run deficits. This figure actually assesses whether countries with high sub-central taxing power apply stricter rules on fiscal behaviour. The lack of a close relationship suggests that in practice fiscal rules are neither a substitute nor a complement for SCG autonomy. Some countries grant SCG large tax autonomy but impose strict fiscal rules, others are likely to do the reverse, while some countries restrict both forms of fiscal autonomy. Large local and regional tax autonomy is neither coupled to strict nor to lenient fiscal rules.

Any conclusion with respect to the relationship between different fiscal autonomy indicators must be taken with great care since those indicators represent only one point in time. To assess the dynamics between different autonomy indicators one needs to observe fiscal design and its outcome over several time periods. What those indicators say after all is that fiscal federal design is partially country-specific and its evolution likely to be path-dependent.

SUMMARY AND OUTLOOK FOR POLICY ANALYSIS

This article assessed the power of sub-central governments over their revenue sources. For that purpose, a detailed set of indicators was developed encompassing both tax autonomy and autonomy over revenue from intergovernmental grants. Tax revenue was divided into categories ranging from full autonomy over tax bases and rates to no autonomy at all, while revenue from intergovernmental grants was divided into earmarked and non-earmarked grants. The resulting indicators are supposed to give a more accurate picture of the true fiscal power that sub-central governments enjoy.

Results suggest that state and local discretion over fiscal resources is limited and that the simple share of sub-central to total revenue overestimates SCG fiscal power. In particular:

- T*he taxing power of sub-central governments is limited*. Sub-central governments command 60% of their own tax revenue only, while the remaining 40% are part of tax sharing arrangements or under entire control of the central government. Taxing power is lower for state than for local governments. With

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31%, the share of sub-central to total tax revenue remained stable over the period 1995-2002, but the autonomy over this share has slightly increased.

- S*ub-central taxation relies strongly on mobile taxes*. With more than 40%, the highly mobile personal and corporate income tax revenue accounts for the largest part of sub-central tax revenue. Taxes on immovable property account for 19% only. Many taxes potentially prone to spatial mobility are part of tax sharing arrangements or fiscal equalisation arrangements that limit the danger of sub-central tax erosion, though.
- A *large part of intergovernmental grants is earmarked*. With roughly 60%, non-earmarked grants account for a large part of total grant revenue, but the remaining 40% give central governments still a strong stake in SCG budgets. Earmarked grants are more important for state and regional governments than for local governments. On average, expenditures on grants have increased more than total government expenditure, pointing to a certain pressure on the central budget.
- T*axes are more important a revenue source than grants*. Tax revenue accounts for 60% of sub-central revenue, while grants account for 40%. Autonomous taxes are the single largest category with 38%, but earmarked grants follow as the second largest category with 22%. Tax sharing arrangements account for 16%. Countries with tax sharing arrangements have a smaller grant system and *vice versa*, suggesting some substitutability between the two fiscal arrangements.
- F*iscal autonomy indicators are largely uncorrelated*. There is no single pattern of sub-central fiscal design, and fiscal federal design is at least partially country specific and path-dependent. If set against each other, the various indicators used reveal that there is no relationship between the share of sub-central tax revenue and tax autonomy, nor between the amount of sub-central tax revenue and the size of the grants system, nor between the extent of fiscal autonomy and the stringency of fiscal rules.

Although a part of fiscal federal design is utterly country specific and its evolution path-dependent, some policy issues are common to all or most countries. The new database can open the way for a more focused analysis of fiscal federalism issues:

- F*iscal autonomy and fiscal stability*. A key policy issue in fiscal federalism is how sub-central autonomy affects fiscal stability. Evidence on this is scant and inconclusive. While some policy research suggests that fiscal autonomy leads to a deficit bias (*e.g.* de Mello, 2000) or has pro-cyclical effects (*e.g.* Wibbels and Rodden, 2005), others come to opposite findings (*e.g.* Neyapti, 2003 or Ebel and Yilmaz, 2002). One of the main reasons for inconclusive results is the poor data used for defining fiscal autonomy. The

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refined dataset developed in this article allows better assessing the link between fiscal federal arrangements and fiscal outcomes and may give more precise guidance on whether autonomy is compatible with stability.

- A*utonomy and efficient public service delivery*. Another policy issue is whether ceding more fiscal autonomy to the sub-central level will increase or decrease public service efficiency. Although higher autonomy is thought to be associated with higher efficiency, governments are often hesitant to increase sub-central taxing power or to substitute earmarked for general grants, fearing that without proper central regulation sub-central jurisdictions are either unable or unwilling to deliver an efficient and equitable access to public services. Linked to outcome variables the new database can help evaluate the effect of different budget rules and funding arrangements on sub-central spending efficiency.
- S*ub-central taxes versus intergovernmental grants*. Countries have adopted different approaches towards funding sub-central public services. While some give taxing power to sub-central governments, others use intergovernmental grants. The substitutability between both arrangements raises policy questions such as: Which arrangement allows for higher public service efficiency? Which arrangement leads to more equity across jurisdictions? Which arrangement puts more pressure on central and sub-central budgets, and what role can fiscal rules play? The new dataset can be used to assess the relationship between the two fiscal federal arrangements and their interaction with the various policy objectives.
- W*hich taxes at the sub central level*? Contrary to the allegations of fiscal federalism theory, highly mobile income taxation makes up for more than 40% of average sub-central tax revenue. While this arrangement functions well in a number of countries – since mobile taxes are often built into tax sharing or fiscal equalisation schemes – in some others sub-central jurisdictions appear to struggle with tax erosion. A country-wise analysis of the new database can help identify tax arrangements that help maintain fiscal autonomy of the sub-central level while containing the potential drawbacks of tax mobility.

In the coming years, the OECD Network on Fiscal Relations across Government Levels is poised to work on this policy agenda.

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Notes

1. Since for some categories no or very small numbers were reported, some sub-categories were merged and their number reduced from 13 to 10.
2. Fiscal equalisation also limits tax competition, see Blöchliger *et al.* (2007).
3. The central government figures for Greece include EU grants. In other countries, grants are directly paid to the receiving sub-central government.
4. Intergovernmental grants are an expenditure item and they should be set in relation to total expenditure. However, National Accounts data on government expenditure are lacking for a number of countries, so total tax revenue was used as a proxy, which was taken from the *Revenue Statistics*.
5. Details on how block grants are distinguished from general purpose grants can be found in Bergvall, Charbit and Kraan (2006).
6. This supports the findings of Sutherland, Price and Joumard who found very little correlation between indicators for fiscal rules (Sutherland, Price and Joumard, 2005).

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