

OECD Journal

Economic Studies

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Volume 2015

OECD Journal

Economic Studies

Volume 2015

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OECD Journal: Economic Studies, volume 2015
ISSN 1995-2848 (print)
ISSN 1995-2856 (online)
http://dx.doi.org/10.1787/eco_studies-v2015-1-en

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Foreword

OECD Journal: Economic Studies, *an official publication of the Organisation for Economic Cooperation and Development (OECD) opened to external submissions. It is addressed to a broad audience of policy-makers, academics and interested readers in the wider public. It publishes papers in different areas of economic policy analysis, generally based on empirical work with a cross-country dimension, with the intention to contribute to renewing the approach to an economic issue or participating in important debates among economists or practitioners.*

This volume addresses a rich set of topical issues through new analytical work, often triggered by a need for reassessing some economic relationships in the light of the recent crisis and its aftermath, such as the link between trade and growth, between inflation and unemployment, or between the cycle and social spending. Another group of articles tries to look beyond the crisis and to address longer-term issues, by sketching a picture of how the global economy, international trade and migration flows may look like in a few decades if current trends are prolonged, and how these trends can be changed by policy decisions. Finally, reflecting on growing concerns as well as growing data availability for outcomes at the individual level, several papers examine how policies can shape the distribution of income and risk across households.

All submitted papers are reviewed by the Board of editors and, if deemed eligible, by two referees, one internal to the OECD and the other external. This guarantees that the papers that are eventually accepted are consistent with both the standards that the OECD applies to its own work for the member-countries and the requirements of academic excellence. Of course, the views expressed in the papers published remain the responsibility of the sole authors and should not be attributed to the OECD.

Articles are published online as they become available and assembled in an annual volume released at the end of each year.

Once again, but this time for the last time, OECD Journal: Economic Studies *is greatly indebted to the hard work and dedication of Lyn Urmston, who has been assisting the editors of the journal since its creation in 1983. All members the* Economic Studies *family wish Lyn a happy and well-deserved retirement.*

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Acknowlegement

The Editorial Board would like to thank the following referees who kindly reviewed articles during the preparation of this volume.

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OECD Journal: Economic Studies
Volume 2015
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Policy challenges for the next 50 years

by
Henrik Braconier, Giuseppe Nicoletti *and* Ben Westmore*

This paper identifies and analyses some key challenges that OECD and partner economies may face over the coming 50 years if underlying global trends relating to growth, trade, inequality and environmental pressures prevail. It highlights the growing need for international policy coordination and cooperation in a number of areas. For example, global growth is likely to slow and become increasingly dependent on the diffusion of knowledge and technology, while the economic costs of environmental damages will mount. The rising economic importance of knowledge will tend to raise returns to skills, likely leading to further increases in earning inequalities within countries. While increases in pre-tax earnings do not automatically transform into rising income inequality, the ability of governments to cushion this impact may be limited, as rising trade integration and consequent rising mobility of tax bases combined with substantial fiscal pressures may hamper such efforts. The paper discusses to what extent national structural policies and heightened international cooperation can address these and other interlinked challenges over the coming 50 years.

JEL classification: F, H, I2, I3, J1, O3, O4, Q5

Keywords: Global economy, growth, technological change, inequality, income distribution, immigration, environmental damages, climate change, tertiary education, fiscal consolidation, structural reforms, interdependence, co-ordination, projections

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This paper presents scenarios for global economic outcomes to 2060 and the associated challenges for public policy, stressing the scope for both domestic structural measures and international policy co-ordination.

Key messages

- **More than seven years after the onset of the financial and economic crisis the world economy is still weak,** with growth in most key regions remaining below pre-crisis levels. Unemployment rates in the OECD remain high and productive capacity in the region has deteriorated. To support the recovery and minimise risks of a relapse into stagnation, monetary policy needs to remain very accommodative for some time, while fiscal consolidation needs to proceed in line with plans. Furthermore, growth-promoting structural reforms are needed, in both OECD countries and many emerging economies, while stability in the financial sector needs to be enhanced. In combination, such policies could foster a stronger recovery, ensuring that potential growth does not remain permanently affected by the crisis, and gradually remove slack in economies.
- **As the effects of the crisis eventually subsides, the coming 50 years will likely see a major shift of economic balance towards emerging economies,** particularly those in Asia, with the share in world GDP of non-OECD countries rising well beyond that of the current OECD area by 2060. Economic growth will continue to lift masses of people out of poverty, integrating them in the world economy.
- **In the period to 2060, global growth prospects seem mediocre compared with the past,** with GDP in the OECD and the emerging G20-countries likely to grow by 2.7% in 2010-60, compared with 3.4% in 1996-2010. Global GDP is expected to grow by 3.0% per annum in 2010-60, leading to an increase in global GDP of 350%. While growth will be more sustained in emerging economies than in the OECD, it will still slow due to a gradual exhaustion of the catch up process and less favourable demographics in almost all countries. Population ageing will result in a decline in the potential labour force which can only partially be offset through increases in labour force participation and employment rates. Against this backdrop, future gains in GDP per capita will become more dependent on accumulation of skills and, especially, gains in multifactor productivity driven by innovation and knowledge based capital.
- **Especially in Africa and Asia, growth could be curbed further by the rising economic damages from environmental degradation** due *inter alia* to climate change, which are likely to affect these countries earlier than expected. By 2060, environmental damage in Sub-Saharan Africa and South and South-East Asia may lower GDP by more than 4 % compared with the central scenario.
- **Global integration is likely to continue, but at a slower pace.** Still, increases in trade intensity will be significant, and by 2060 euro area exports to Asia and emerging economies may be equivalent to 15% of GDP and similar in size to trade within the euro zone. Increased cross-country interdependence will help share the burdens of shocks

globally, but will also make the global economy more vulnerable to imbalances and a number of domestic policy instruments less potent. As the skill composition, capital intensity and consumption patterns of emerging economies gradually converge towards those of the OECD, production structures in these economies will increasingly resemble those in OECD countries.

- **Addressing the trends behind the faltering growth performance will require policy changes.** Countries can improve growth prospects by implementing policies that focus on four key areas: accelerating global integration (including encouraging migration flows), making institutions more resilient to shocks (e.g. demographic ones), curbing emissions to mitigate climate change and, especially, making the most of the knowledge economy, which will be the main driver of global growth in the future. The following broad policy areas (for which more detailed recommendations are discussed in the paper) would need to be addressed:
  - **Implement further multilateral trade and investment agreements and pursue migration policies** aimed at filling gaps in skills and labour participation, which will have to be supported by policies that favour entrepreneurial activity and worker mobility (e.g. pension portability).
  - **Enact social insurance reforms** to maintain labour supply in the face of rising longevity and an ageing workforce, while making retirement systems more resilient to productivity and demographic shocks.
  - **Ensure that strong demand for education and skills**, stimulated by rising skill premiums and prolonged working lives, can be translated into work-related skills that match the demand for jobs.
  - **Ensure that product and labour market settings make it possible for young and high-productive firms to expand fast** and encourage firms to innovate, without unduly favouring incumbents (e.g. in the area of R&D subsidies and IPR).
  - **Prevent environmental damages from slowing down growth** by taking early action to avoid locking in emission-intensive infrastructure and promote a shift toward a cleaner development path. This can be achieved through a policy mix of appropriate pricing of carbon and reform of fossil-fuel subsidies, complemented by more targeted measures.
- **In some cases, pro-growth policies may entail trade-offs relative to other policy objectives.** For example, if increased investment in tertiary education were to be solely financed with public funds, public spending in OECD countries could increase by on average 1% of GDP by 2060. Given already large fiscal challenges stemming from the crisis, rising fiscal pressures from ageing and high cross-country mobility of the high-skilled, reforms to ensure that the beneficiaries of higher education carry a larger share of the funding burden should be pursued.
- **In other cases, trade-offs may be more deep seated.** With growth increasingly driven by knowledge, skills and rising trade integration, growth in itself could keep generating rising tensions and inequalities. On current trends, earning inequality in the average OECD country may have risen by more than 30% in 2060 and would then face almost the same level of inequality as is seen in the United States today. Moreover, structural adjustment will continue, especially across firms within sectors (e.g. from low to high productivity and from polluting to less polluting firms) and in emerging economies, and the consequences for workers' wellbeing will have to be managed. If left unaddressed,

such increases in inequality and costs of adjustment could eventually backlash on stability and growth.

- However, **the scope for domestic public policy to address these tensions and inequalities will sometimes be limited.** In some regions constraints will arise from the very need to redress existing imbalances and address future pressures, especially in the fiscal domain. In some areas, traditional redistributive tools and flanking policies may become more costly and difficult to implement due to increasing cross-country mobility of tax bases in the context of rising trade and investment integration.
- One way to face this conundrum is to **use a wide range of policy tools to address inequality concerns and adjustment costs, such as:**
  - **Increase equality of opportunities in education**, with a special focus of public resources on early years and, possibly, life-long learning initiatives. As mentioned, **funding reforms** to ensure sufficient growth in tertiary education are also needed.
  - **Adjust tax and welfare systems to increasing mobility of capital and labour**, e.g. by shifting taxation towards immovable factors (e.g. property and extraction of natural resources) and reform employment regulations, benefit systems and activation policies to support workers' mobility and ensure better matching of skills to jobs. Such policies can **raise employment and thus lower income inequality, even though they may not help to lower earning inequality.**
  - **Broaden welfare systems** that provide important insurance against individual shocks and macroeconomic risks, accompanying them with conditionality to ensure their sustainability.
- In this context, **an emerging policy dilemma is that increased reliance on tax revenues from immovable factors will be made more difficult by their shrinking role in a knowledge economy driven by intangibles**, which are by nature more mobile across borders.
- **Global co-ordination and co-operation will become increasingly necessary** in areas where unfettered cross-country rivalry and coordination failures could harm global wellbeing. It is, for example, obvious that climate change mitigation has to be pursued on a global level, as domestic benefits of unilateral action are small. However, rising global integration and rising reliance on knowledge-based assets will also increase the need for international coordination in the following areas:
  - Pursuing further **trade and investment liberalisation** in a multilateral fashion produces larger benefits than regional trade agreements.
  - Lack of co-operation in **areas where tax bases are mobile** can generate negative externalities, for example in terms of high emissions (when their implicit or explicit price differs across countries), loss of fiscal revenues and rising inequalities (when corporate taxes are eluded). Further global integration (and build-up of environmental risks) will broaden these externalities and increase potential benefits from international co-ordination.
  - The growing importance of **knowledge based capital** for growth – combined with the increased internationalisation of such capital – raises several issues. Incentives for individual countries to support basic research may fall. At the same time, more international co-operation on intellectual property rights and competition law enforcement may be needed as knowledge-intensive multinational firms will likely play a bigger role in the global economy.

- Increasing trade integration will make business cycles more synchronised across countries, lowering the efficacy of domestic stabilisation and widening the scope for, and benefits from, international co-ordination. Nevertheless, policy makers will have to deal with the fact that the world economy is becoming increasingly multipolar with emerging economies constituting a larger share. This may make co-ordination more complex as the number of key stakeholders – often with different perspectives and policy priorities – increases.

1. Introduction

More than seven years after the onset of the financial and economic crisis the world economy is still weak. Unemployment in the OECD area remains above its pre-crisis level and productivity growth is sluggish. Many of the emerging economies that provided support for the global economy in the immediate aftermath of the crisis have decelerated. The road to recovery is ridden with constraints that are partly conjunctural and partly dependent on longer-term challenges that were made more acute by the crisis.

The reasons for the depth and length of the crisis are several,[1] but many of the tensions and imbalances that fed the crisis resulted from deep-seated trends that are unlikely to reverse in the coming decades, at least without major changes in policies. Examples of such trends are unprecedented demographic change as longevity increases and fertility remains low; build-up of current account imbalances; and rising polarisation of incomes as continued technological progress disproportionately benefits high skilled individuals. Similarly, the rising importance of non-OECD economies and globalisation are likely to continue, with expanding global supply chains and growing interlinkages among trade and investment partners. While the latter has helped sustain growth during global expansions it also contributed to spread the crisis and share its burdens. Unrelated to the crisis, but fundamental for future growth and welfare, is how to address environmental degradation especially at the global level. Assessing how these trends may evolve and interact can help understand future challenges, risks and opportunities for the global economy.

National, regional and global policies to deal with these challenges over the coming 50 years lie at the heart of this paper. Using a combination of modelling tools recently developed within the OECD, the paper analyses some key challenges facing OECD and non-member countries (covering on the whole 147 economies) over the long term, based on scenario analysis. The analysis revolves around a central scenario based on the *OECD Economic Outlook* long-term projections (for OECD and non-OECD G20 economies) supplemented with projections for the other 105 economies. Ancillary projections – based on regression analysis and CGE simulations – explore additional dimensions not covered in the *Economic Outlook* projections, such as technology, inequality, skill formation, migration and the environment. The narrative revolves around a central scenario that policy-makers may have to face if past trends (e.g. in ageing, migration, skill-bias in technical progress, globalisation and CO_2 emissions) were to persist in the future. Given the many uncertainties, this scenario should not be seen as a forecast but rather as a device for thinking about future challenges in a systematic way and encouraging foresighted policy action in a number of interconnected areas where tensions might arise. In this context, numerical estimates are provided only to give a sense of the possible challenges.[2]

The paper aims at providing a multidimensional framework for thinking about the future in a structured way, focusing on how international and national policy settings would need to be re-examined and adjusted to make the most out of aforementioned trends and put the global economy on a sustained growth path. The framework is also used to lay bare tensions hidden in the central scenario and to explore how policies can affect outcomes in multiple dimensions, including growth, equity, and fiscal and environmental sustainability and stability. Finally, in some areas open issues are also flagged where no firm policy recommendations are given.

In short, the ultimate purpose of the analysis is to provide policy guidance, considering likely long-term changes in underlying economic structures and in the context of multidimensional policy objectives. The focus will be on how the insights from the analysis in this paper lead to new or revised recommendations in the structural policy domain. Hence, policy recommendations specific to smoothing out cyclical developments or that are deemed to be unaffected by insights from this paper are not necessarily highlighted (Box 1). Furthermore, issues relating to the evolution of the financial sector are not addressed as they constitute the focus of a companion paper.[3]

Box 1. **Issues not dealt with in this paper**

Despite (and because of) the broad approach of this paper, a number of demarcations apply. Specifically, this paper does **not**:

- Focus on cyclical developments, such as policies to support the recovery in the short-term.
- Deal with how the regulatory system for the financial sector will evolve as a consequence of the lessons learnt from the recent crisis. Thus, the structure of the financial sector and the global interlinkages it will provide will not be analysed. The main reason for this exclusion is the lack of modelling tools connecting the financial sector to other parts of the economy.
- Focus on the risks of emerging economies facing markedly weaker growth as a consequence of insufficiently strong institutions (the so-called "middle-income trap").
- Analyse policy settings and the specific challenges that non-OECD non-G20 countries face. In particular, developing economies are largely outside the scope of this paper, in spite of their potential for strong growth and the significant policy challenges they face.
- Deal with detailed aspects of subject areas and country experiences. The focus is on broad global or regional trends and drivers, as well as the main connections across policy areas and countries.
- Produce a set of fully consistent scenarios leading to radically alternative pathways based on different assumptions about exogenous factors. Rather it uses different tools to identify tensions in the baseline scenario and to analyse how specific policies may contribute to relieve them.
- Focus on policy recommendations that – while being relevant for OECD countries – are not deemed to be altered by what is known about long-term trends in the global economy. Rather, the focus will be on how insights from this analysis may lead to new or revised policy recommendations.

The conditions for national policy making will likely change substantially over coming decades. Economic growth will slow and become increasingly dependent on innovation and knowledge-based assets, where economic dividends tend to be unevenly distributed across

both income groups and countries. This sharpening growth-equity trade-off may become even more acute as further global integration and international competition for knowledge-based activities makes traditional redistributive tools (based on taxes and transfers) more difficult to use within countries. Pursuing policies that promote equity in opportunity, e.g. in terms of education and training, could mitigate the trade-off but would have to be pursued in an environment with mounting fiscal spending pressures and risks of eroding tax bases. As economic integration proceeds, interdependence across borders will increase. This will have several implications. First, the effects of economic shocks will in many cases be shared with trading partners to a larger extent, reducing volatility and risks for individual countries. In the same vein, international spillover effects from policies are likely to increase too, in some cases pointing to benefits from further international policy co-ordination.

In addition environmental pressures from climate change will rise, becoming an increasing drag on economic growth. Given the global nature of greenhouse gas emissions, effective mitigation will require co-ordinated global action.

While demand for international policy co-ordination therefore will increase, policy makers will have to deal with the fact that the world economy is becoming increasingly multipolar as emerging economies will form a growing share of the world economy. This may make co-ordination more complex and difficult as the number of key stakeholders – often with different perspectives and policy priorities – will rise.[4] Moreover, in the shorter run, the legacy of the crisis also tends to make co-ordination both urgent and harder to achieve. Overcoming these tensions is crucial for successfully managing phenomena with large global spillovers like current account imbalances, migration flows, emissions of greenhouse gases and management of intellectual property rights.

The remainder of this paper is organised as follows. Section 2 describes the central scenario, and identifies a number of tensions in and related to it. The following sections deal with five key policy challenges that policy makers are likely to face over coming decades: slowing growth, rising inequality in market incomes, growing economic drag from changes in climate, increasing fiscal pressures, and challenges to economic stability. Section 3 deals primarily with policies to pursue growth, and the potential side-effects and spillovers such policies can generate. Section 4 analyses policies to address rising earning inequalities and how these policies may spill over onto growth and employment. In Section 5, policies to mitigate the economic impact of environmental damages are analysed. Section 6 focuses on fiscal challenges, while Section 7 deals with macroeconomic stability and policies. Section 8 concludes by summarising the main areas in which new policy thinking is needed.

The paper draws on a number of alternative scenarios (outlined in Box 4) but also on other relevant OECD studies that have recently been undertaken.

2. Key developments in a central scenario: 2010-60

Box 2. **Main trends**

- The balance of the world economy will continue to shift towards emerging economies and, especially, Asia. By 2060, the share of global GDP accounted for by non-OECD economies will be significantly larger than the share of the current OECD area. Global GDP growth is projected to slow from an annual average rate of 3.6% between 2014-30 to 2.7% from 2030-60, owing to decreasing potential for catching-up, slower increases in

Box 2. **Main trends** *(cont.)*

human capital stocks, and shrinking labour forces. Uncertainty about productivity growth, future improvements in educational attainment and slowing immigration into the OECD are main risks.

- Global trade integration will continue to grow in the central scenario, but at a slightly slower rate than seen during recent decades. The shift in trade patterns will reflect shifting economic balances, with exports from non-OECD countries rising from 35% of world exports in 2012 to 56% in 2060. Specialisation patterns will continue to evolve, partly reflecting more rapid upskilling in emerging economies. For example, China and other Asian countries will continue to specialise in electronics and increasingly in services, while the manufacturing sector will continue to shrink in the OECD. Global value added chains may develop further.
- Emissions of greenhouse gases are expected to double between 2010 and 2060 in the central scenario. Such a development would affect economic output, possibly lowering global GDP by between 1 and 3.3% in 2060 compared with the central scenario. Impacts will likely be heterogeneous amounting to more than 4% of GDP loss in the worst hit regions (Sub-Saharan Africa, South and South-East Asia) while in other regions GDP damages will be more limited.
- Earning inequalities may rise by more than 30% in the OECD area and by roughly 20% in other G20 economies until 2060, which would mean that the average OECD country could face by then the same level of inequality as currently experienced by the United States.
- Fiscal requirements to stabilise debt ratios at 60% levels (corresponding to the national public debt criteria of the Maastricht Treaty) in the context of rising pension, health and education spending pressures are estimated to be over 7% of GDP for the average OECD country by 2060. Additional fiscal risks for OECD countries entail weakening revenues due to less migration and more mobile tax bases.
- Global current account imbalances may rise in the medium term unless bold fiscal and structural reforms are pursued.

The central scenario described here has been developed using a set of models describing macroeconomic developments (Johansson et al., 2013), trade developments (Johansson et al., 2014), greenhouse gas emissions (Chateau et al., 2014, and OECD, 2015) and income inequalities (Braconier et al., 2014). The models used for producing the central scenario are described in Box 3.

Box 3. **The central scenario and its modelling base**

Forward-looking scenarios are constructed using a set of models, each describing one or several key variables (See figure, where each model is illustrated as a circle with reference to relevant descriptions). Models are connected through a set of linkages whereby endogenous outputs from one model form exogenous inputs to other models, giving a recursive structure. All models are also dependent on exogenous inputs (e.g. policies).

Long term growth projections

First, a long-term growth scenario is generated for OECD and non-OECD G20 economies: this includes the supply side of the economy as well as national savings, investment and

Box 3. **The central scenario and its modelling base** *(cont.)*

current account balances (Johansson et al., 2013). The central scenario used in this paper is identical to the one used in the *OECD Economic Outlook* No. 95 (OECD, 2014), and is based on a set of assumed future policy changes, including (See OECD, 2014a for further details):

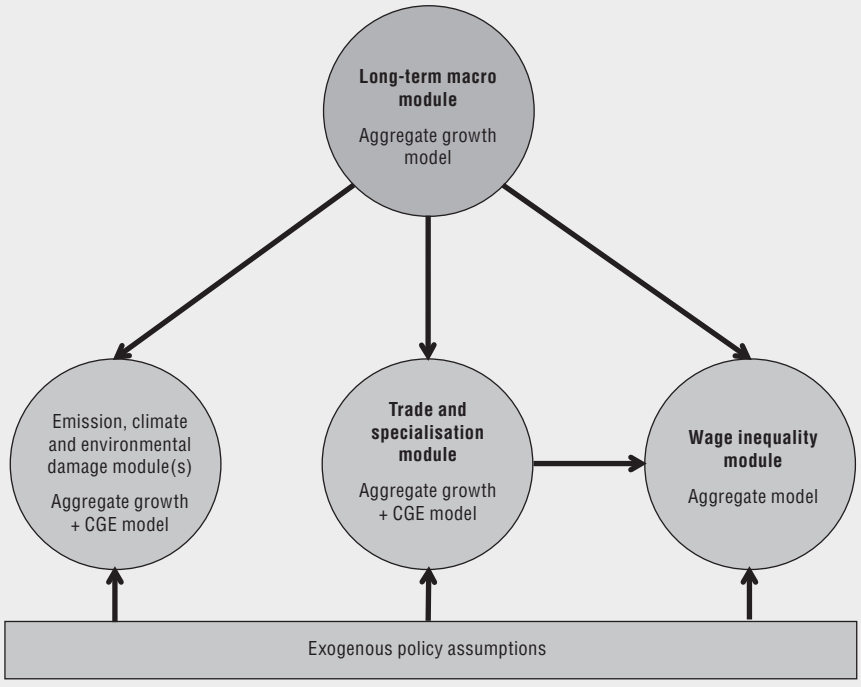
- For labour force participation up until 2030, recently legislated pension reforms are assumed to be implemented and participation rates of older workers are adjusted accordingly. After 2030, the share of active life in life expectancy is assumed to remain constant, implicitly assuming that the retirement age is indexed to longevity.
- For countries with gross general debt levels in excess of 60% of GDP, fiscal policy is assumed to adjust such that debt converges to this level. For countries with gross debt levels at or below this threshold, fiscal policy is assumed to stabilise debt as a share of GDP. Potential effects on public budgets from population ageing, pressures on health spending, and rising demand for tertiary education are not explicitly embedded in the model (though their implications for the model-based fiscal gaps are discussed).
- Product market and trade regulations are assumed to gradually converge towards the average regulatory stance observed in OECD countries in 2011 for countries where regulations are currently more restrictive, but remain constant for other countries.
- For non-OECD G20 economies, a gradual increase in public spending on social protection is assumed until it reaches a level that is equivalent to the average OECD country. This increase amounts to an average of 4 percentage points of GDP.
- Educational attainment continues to rise and converge across countries, with mean years of schooling approaching 18 years in the very long run (beyond 2100).
- Credit availability is assumed to improve with financial market deepening. The pace of expansion of credit availability is assumed to be fastest in emerging economies that start from relatively low levels of financial market development.

The outputs from the long-term growth projections feed into a number of different modules describing other dimensions of the central scenario (illustrated with non-dashed arrows):

- The trade and specialisation model described in (Johansson and Olaberría 2014) is used to generate bilateral trade patterns consistent with the *Economic Outlook* long-term growth scenario. This model contains two parts: a macroeconomic growth model (MAGE) covering 147 countries/regions, which is calibrated to mirror the OECD long-term scenarios for the OECD and G20 countries (42 countries), and complement it with MAGE scenarios for the other 105 countries and regions. These long-term scenarios are then imposed into a detailed multi-sector computable general-equilibrium (CGE) model (MIRAGE-e) that simulates production, specialisation, trade, prices and wages across countries and industries. Policy assumptions include that already agreed trade agreements will be implemented.
- The ENV-Growth and ENV-Linkages models, described in Dellink et al. (2015) and Chateau et al. (2014), are used to generate predictions on emissions of greenhouse gases, consistent with the long-term growth and trade scenarios. The models have a similar setup as the MAGE and MIRAGE models (with a macro part and a CGE part), but with a stronger focus on sectors with large environmental impacts, and on emissions of greenhouse gases. Calibration is made in the same way as for MAGE/MIRAGE-e.
- An earning inequality equation, described in Braconier and Ruiz Valenzuela, 2014, is used to generate scenarios for gross earning differentials, conditioned on inputs from the OECD long-term scenarios.

Box 3. **The central scenario and its modelling base** *(cont.)*

Generating the central scenario



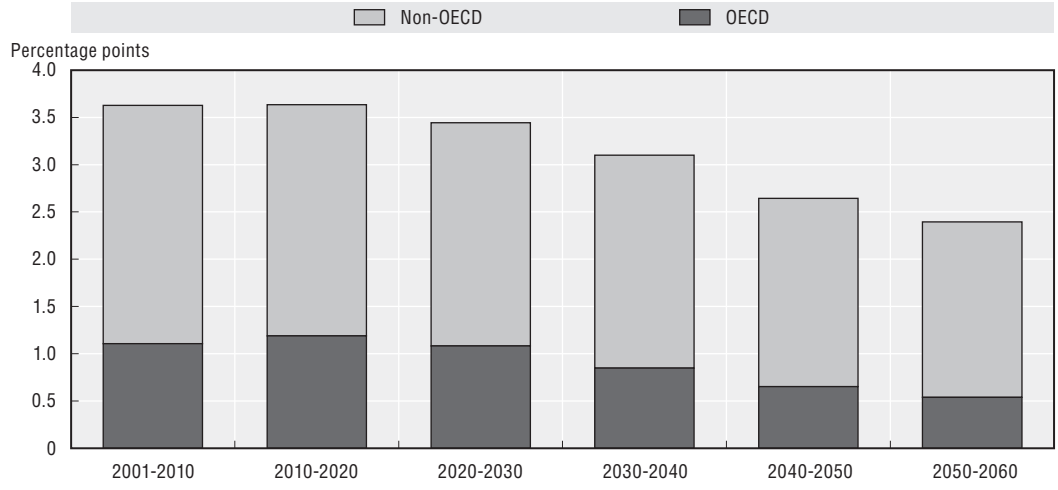
2.1. Global growth is set to slow over the coming 50 years

As discussed in detail in OECD (2014), the recovery from the global financial and economic crisis remains weak and tentative. Several trends that fed the boom and the subsequent bust remain – including overstretched households and governments and excessive reliance on financial services – and continue to weigh on the recovery. At the same time, the crisis inflicted some long-term damages to economies, through low investment, high unemployment and weak public finances that may weaken future prospects. In order to support the recovery and minimise risks of a protracted stagnation, monetary policy needs to remain very accommodative for some time, while fiscal consolidation needs to proceed in line with plans. Furthermore, growth-promoting structural reforms are needed, especially in Japan, the euro area and in many emerging economies. Phasing in higher capital requirements for banks and lower leverage in the private sector could support financial stability, and would also likely improve long-term growth prospects, at least in OECD countries. In combination, such policies could foster a stronger recovery, ensuring that potential growth does not remain permanently affected by the crisis, and gradually remove slack in economies.

In a longer perspective, potential growth in OECD and non-OECD economies is set to slow over the period to 2060, even though a rising share of fast growing non-OECD economies in global output should dampen the slowdown at the global level (Figure 1; Johansson et al., 2013). Global GDP may rise by around 350% between 2010 and 2060 and, with growth driven by emerging economies, the economic centre of gravity will shift

Figure 1. **Global GDP growth is set to slow down over the next 50 years, 2010-60**

Contribution of OECD and non-OECD to global GDP growth (annual average, constant 2005 PPP)

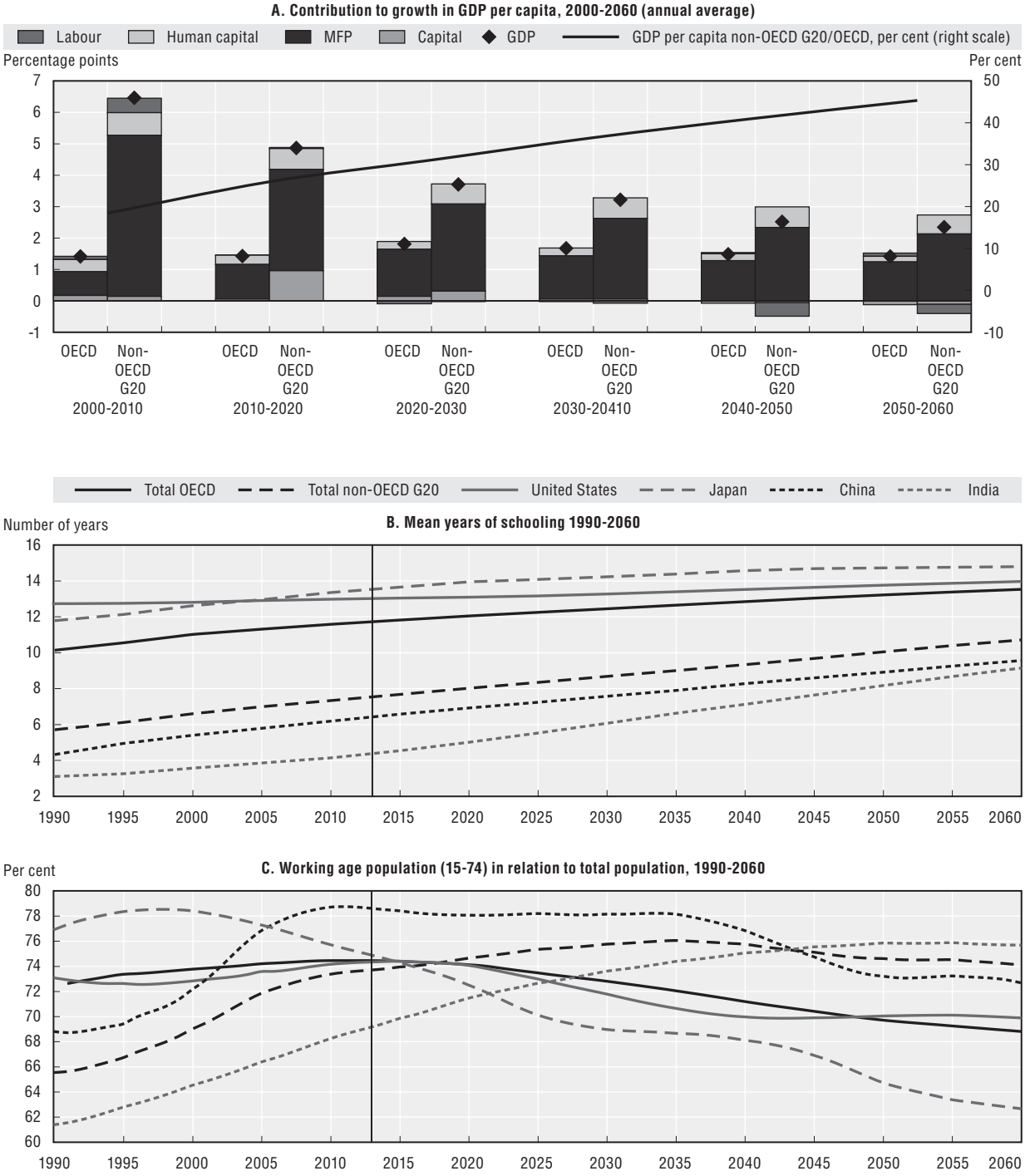


Note: The charts combine the long-term projections for 42 countries published in the *OECD Economic Outlook* 95 and, for all other countries, projections from the ENV-growth model of the OECD Environmental Directorate.
Source: OECD Economic Outlook 95 long-term database, OECD computations.

further towards Asia. By 2060, the share of non-OECD countries in world GDP will be significantly larger than that of the current OECD countries. In general, the moderation in growth among OECD and G20-countries owes to three main factors:

- Multifactor productivity (MFP) growth in most economies is expected to slow, consistent with some weakening in the growth of R&D intensity (Fernald and Jones, 2014). In the OECD, average annual MFP growth is anticipated to fall from 1.1% in the decade to 2030 to 1.0% to 2040 and 0.9% to 2050.[5] MFP growth in some non-OECD countries that have grown rapidly in recent years through catching-up is likely to slow more sharply as GDP per capita in these countries converges closer to OECD levels (Figure 2, Panel A).
- While average levels of educational attainment will continue to rise, the pace is set to slow in the central scenario (Figure 2, Panel B). This expected slowdown in the growth of human capital is consistent with roughly constant returns to investment in education (Johansson et al., 2013).
- The demographic dividend of rising participation rates, fewer dependent children and low shares of elderly citizens is bound to gradually disappear (Figure 2, Panel C). The share of population that is of working age started to fall in Japan in the late 1990s, is close to its peak in the OECD, has stopped increasing in China, while it should continue to rise until 2050 in India (OECD, 2013a). Between 2010 and 2060, the OECD's population is expected to increase by 17%, but the working age population (age 15-74 years) may fall by 7%. The central scenario assumes that further retirement and labour market reforms will be implemented to prolong working lives in line with rising longevity. Even though these assumed reforms may increase labour force participation rates in the OECD by on average 2.4 percentage points, labour's contribution to growth in GDP per capita is likely to be close to nil throughout the period in the average OECD country and will eventually turn negative in the average non-OECD G20 country (Figure 2, Panel A).

Figure 2. **Developments in OECD and non-OECD G20-countries, 1990-2060**



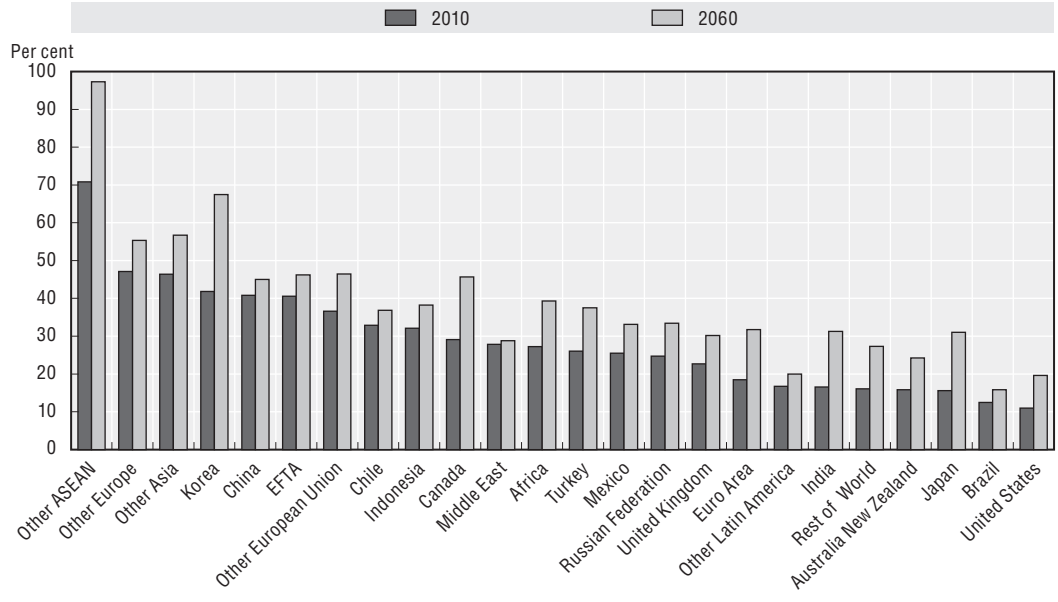
Note: The non-OECD G20 countries are Argentina, Brazil, China, India, Indonesia, Russian Federation, Saudi Arabia and South Africa.
Source: OECD Economic Outlook 95 long-term database, OECD computations.

2.2. Trade integration is set to grow, implying changes in specialisation even in the absence of further major trade deals

Global trade integration will likely deepen over the coming 50 years, as transport costs continue to fall and trade barriers are lowered in line with already agreed trade agreements

(Johansson et al., 2014). The pace of integration is likely to slow however, unless further agreements to lower trade barriers, transaction costs and regulatory obstacles are reached. The evolution of trade will also depend on the way firms define their strategies and their boundaries in global value chains, with counteracting forces coming from further reductions in trade and transaction costs, and new technologies (such as 3D printing) that may shorten physical value chains (De Backer and Miroudot, 2013). While world exports in relation to GDP tripled between 1950 and 1998 (Ventura, 2005), the increase between 2010 and 2060 could be around 60%, although regional variations are large (Figure 3). As economic gravity shifts towards Asia, trade will follow the same path. OECD countries' share of world trade is estimated to fall from 50% in 2012 to 25% in 2060 (Johansson et al., 2014).

Figure 3. **Exports as a share of GDP will increase in all regions**



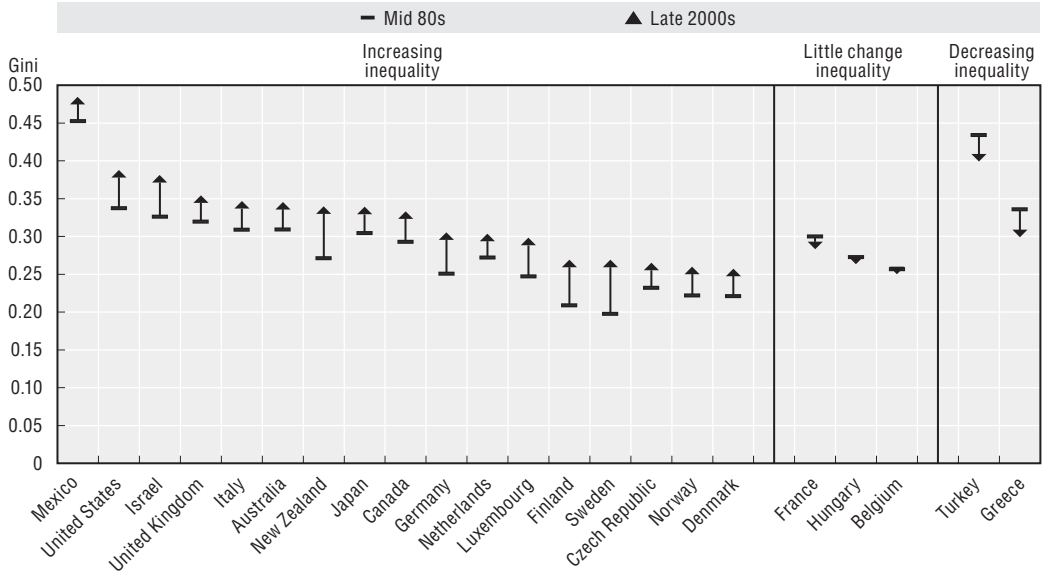
Source: Johansson and Olaberría (2014).

Rising trade integration should have a sizeable impact on global patterns of production and specialisation. As emerging economies catch-up in terms of GDP per capita, their production structure should increasingly resemble the structure in OECD countries. China and other Asian countries may however continue to specialise in electronics and increasingly in services, while manufacturing may continue to shrink in the OECD. With or without further trade agreements, services will be more traded and trade policies will have to adjust to changes in the organisation of global value chains (Miroudot et al., 2013).

2.3. Earning inequalities are likely to continue to rise, reflecting skill-biased technological change and a slower growth in educational attainment

In parallel, inequality in household disposable incomes has increased in most OECD countries in recent decades (Figure 4). Rising capital incomes (which tend to be highly concentrated), less redistributive tax and benefit systems and changing household formation patterns, have all contributed to this outcome (OECD, 2011b; Hoeller et al., 2012), but the main driver of increasing income dispersion has been the widening gap in earnings. Top gross earnings (wages) in OECD countries – measured as the upper bound of the 9th decile

Figure 4. **Income inequality has increased in most, but not all OECD countries**



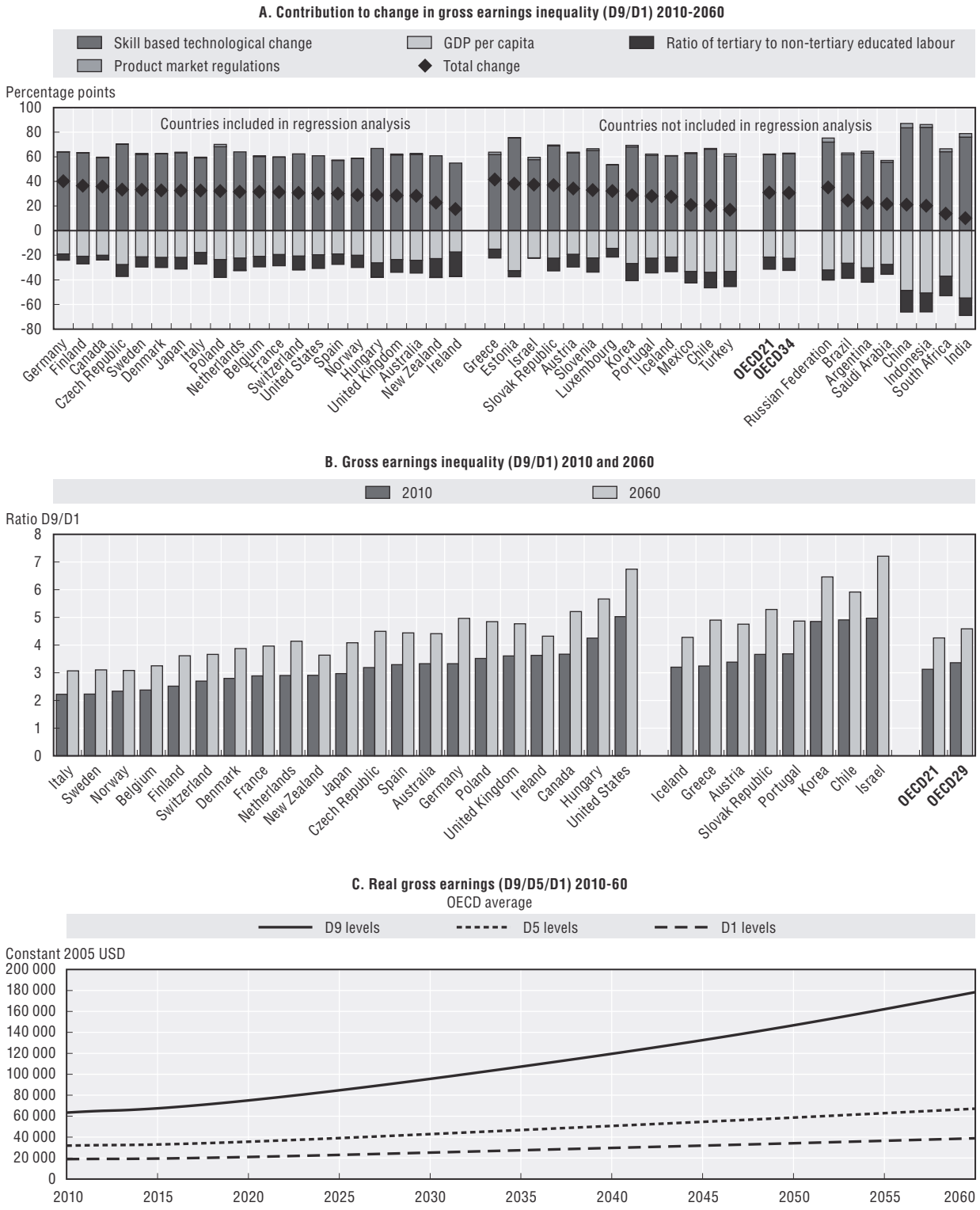
Source: OECD Database on Household Income Distribution and Poverty.

of the earnings distribution for full-time employed– have risen 0.6% faster per annum than those at the bottom (upper bound of the 1st decile) over the two decades up to the crisis (Braconier et al., 2014). This increase largely reflects that skill-biased technological change (SBTC) has more than compensated the effects of rising levels of educational attainment and per capita income growth, which both have tended to lower earnings dispersion.[6] The pace of SBTC over the coming 50 years cannot be predicted with certainty, but a likely scenario is that past trends will continue, given that the direction of technological change has persistently been skill-biased over the post-war period.[7] The potential for a falling labour share in GDP could add to these distributional pressures (Piketty, 2014), though no consensus on the likely future path of the labour share has been reached.

Assuming that historical trends and relationships prevail – while GDP and educational attainment grow in line with the long-term growth projections – the widening of earnings dispersion would accelerate slightly to 0.6% in the central scenario over the coming 50 years, as the moderating effects of improvements in educational attainment on inequality will further diminish due to progressively slower human capital accumulation.[8] As a consequence, earning inequality could grow between 17% and 40% within the OECD (Figure 5, Panel A). Earning inequalities in low inequality countries – like Italy, Sweden and Norway – might by 2060 be similar to those seen in the average OECD country today, whereas the OECD average in 2060 might be close to US levels today (Figure 5, Panel B). Virtually all increases in earnings dispersion would take place between high- and medium-income earners, in line with recent evidence suggesting that technology increasingly replaces medium-skilled jobs, leading to earnings polarisation (Braconier et al., 2014; Goos et al., 2010; Causa et al., 2014).

Rising gross earning inequalities may not fully translate into increases in inequality in household disposable incomes. First, earning inequalities only relate to full-time employees, disregarding distributional effects from part-time work and employment. Second, they do not consider the mitigating impact of taxes and benefit systems (Joumard et al., 2012).

Figure 5. **Earnings inequality and earnings**



Note: Ratio of gross earnings (before tax and transfers) of the 9th and the 1st decile of the earnings distribution. Skill-biased technological change is measured as the combined effect of the global trend and multifactor productivity (See Braconier et al., 2014). Product market regulation measures how deregulation of markets will increase inequality.
Source: OECD calculations based on the *OECD Economic Outlook* 95 long-term database.

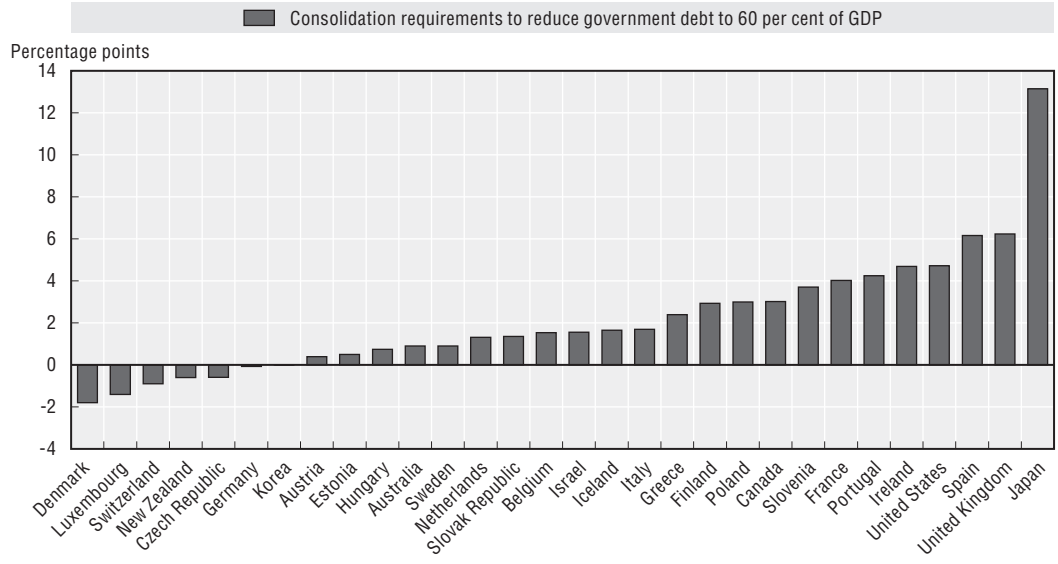
However, the potential for rising earning inequality highlighted in the central scenario points to the size of the challenge that would have to be faced by redistributive policies. Consequences for policy making will be discussed in Section 4.

2.4. Fiscal consolidation will require major efforts in several countries

Fiscal pressures will build up in several areas over the coming decades unless extensive fiscal reforms are pursued. The legacy of the crisis – with often large increases in public debt – unfavourable demographics, and rising spending pressures in areas like health and education all contribute to substantial fiscal pressures (Fall et al., 2014). In the central scenario, these fiscal pressures are assumed to be resolved through a combination of fiscal and structural reforms (Box 3): with medium term (2030) fiscal consolidation, being achieved through both higher revenues and lower spending. Beyond 2030, retirement reforms are assumed to keep pension spending in relation to GDP constant while other spending are also assumed to stay constant in relation to GDP.

Despite these relatively benign assumptions, the additional budgetary effort required in several OECD countries is significant though smaller than the effort already achieved by some European crisis countries (OECD, 2014). Figure 6 shows an estimate of the fiscal consolidation needed to reach the 60% public debt threshold by 2060, based on initial fiscal gaps and the assumed constant spending ratios. These gaps are estimated to be more than 5% of GDP in the UK and Spain and more than 13% in Japan. The effort required of most countries would be much stronger, however, if projected increases in pension, health and education spending ratios were taken into account (see Section 2.6.4).

Figure 6. **Fiscal gaps in the central scenario**



Note: The long-term consolidation needs ("fiscal gap") measures the difference between the underlying primary balance as a per cent of GDP that keeps gross general government debt stable at 60% of GDP in 2060 and a baseline projection. Only OECD countries are covered by the analysis.
Source: OECD Economic Outlook 95 long-term database; OECD calculations.

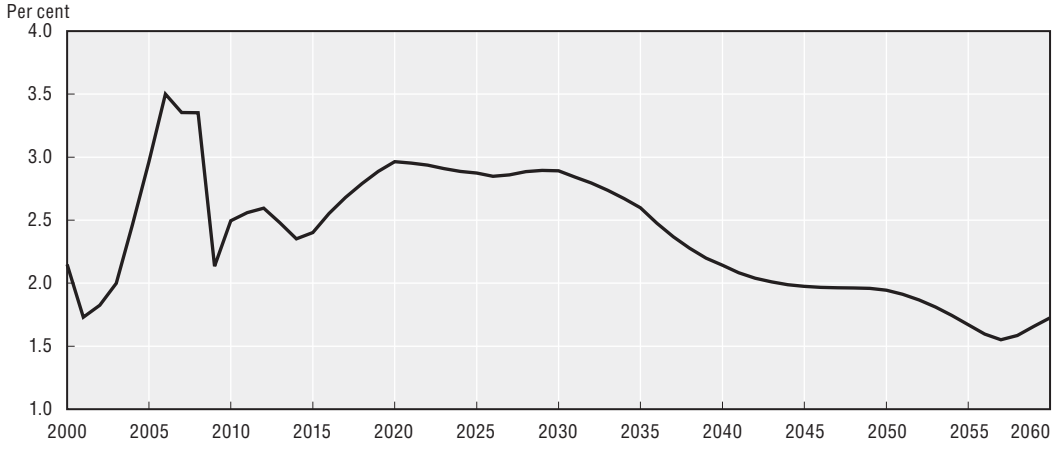
In highly indebted countries, such fiscal pressures could be worsened by adverse movements in real interest rates. As discussed in OECD, 2014, shrinking savings due to demographic developments may push up real interest rates by as much as three-quarters

of a point between 2015 and 2060. Such increases would impact public finances via higher debt service, especially where public debt levels are high. Rising needs to replace ageing infrastructure and investment in the transition to a greener economy or to mitigate effects of climate change could also add to these pressures.

2.5. Fiscal consolidation and structural reforms are needed to rein in global imbalances in the medium term

Global current account imbalances narrowed during the crisis though they remain high relative to the pre-2000 period (Figure 7). Long-term demographic trends with more rapid ageing – and consequently faster falling savings – in surplus countries may push towards lower imbalances.[9] Moreover, rising interest rates in net debtor countries with persistent current account deficits may push down investment, also dampening imbalances. However, this may not be sufficient to counteract rising imbalances in the medium term without further policy action (Ollivaud and Schwellnus, 2013). Ambitious fiscal consolidation in the United States, euro area deficit countries and Japan could stabilise imbalances. If fiscal consolidation is accompanied by structural reforms, imbalances could start to decrease (see Section 7.2).[10]

Figure 7. **Global current account imbalances will increase**



Note: In projecting imbalances, private and public saving are distinguished for OECD countries, whereas for non-OECD countries only total national saving is projected given the absence of detailed fiscal accounts. For further details, see Johansson et al. (2013).
Source: OECD Economic Outlook 95 long-term database.

Continued increases in inequality may have repercussions for savings and investment patterns, affecting global imbalances. The potentially widespread and large increases in inequality highlighted in the central scenario could lead to increased savings, as saving rates tend to be higher for high-income households than for low-income ones (Dynan et al., 2004). To the extent that capital is fully mobile across borders, countries with fast-rising inequality would tend to experience improvements in current accounts. There are some indications that OECD countries that experienced large increases in earning inequality also tended to improve their current account positions. But continued increases in income inequality could contribute to building up new financial imbalances. It has been argued that rising inequality could thus be one factor behind falling real interest rates in

many countries over the last decades, reflecting rising *ex ante* excess saving relative to investment demand (Rajan, 2010). To allocate rising savings towards borrowers, credit growth and financial intermediation grew, which together with high leverage and lax lending standards may have contributed to the recent financial crisis (Kumhof and Rancière, 2010). These effects would have to be weighed against factors pointing in the opposite direction, like decreasing global savings due to ageing and lower precautionary saving in large emerging markets as social expenditures in these countries rise.

2.6. Tensions and risks for the global outlook until 2060

2.6.1. Prospects for future growth in multifactor productivity are uncertain

Under the central scenario, multifactor productivity growth is expected to contribute, on average, 75% of the growth in GDP per capita in OECD and major non-member economies in the period to 2060 (Figure 2, Panel A). While the pace of MFP growth may moderate over the forecast horizon, the trend growth rate in most countries is expected to be high compared with recent history. Relatively strong MFP growth reflects strong investment in knowledge-based capital (KBC), such as R&D, organisational know-how, databases, design, brands and various forms of intellectual property, as well as pro-competition reforms in countries where regulations are relatively restrictive (Box 3) and the continued dissemination of new discoveries made at the technological frontier. Nevertheless, the pace of future MFP growth is highly uncertain, in large part due to uncertainty in the future growth rate of the stock of frontier ideas (Fernald and Jones, 2014). Indeed, there are strongly contrasting views on the most likely pace of future frontier growth, with much of the discussion revolving around the potential of ICT in transforming economies:

- An optimistic view, positing that once organisational systems and processes are redesigned to exploit the full potential of ICT there will be cascading growth in complementary innovations. This would drive the technological frontier forward at a fast pace relative to history (e.g. Brynjolfson and McAfee, 2011).[11] As support for this theory, advocates point to the significant lag between the discovery of other general purpose technologies in history (e.g. electricity) and the burst of innovation that their discovery facilitated (e.g. the light bulb or the telephone).
- A pessimistic view, that argues that the main impact of the ICT revolution has withered and future inventions that derive from ICT are unlikely to fundamentally change trend productivity (e.g. Gordon, 2012). Such a view is consistent with the recent slowdown in productivity in many OECD countries, though it is difficult to differentiate between the cyclical impact of the financial crisis and changes in the pace of discovery at the technological frontier.

Irrespective of which scenario unfolds, countries that have a high stock of knowledge-based assets are likely to be better able to adapt to changes in the pace of frontier growth. As argued in the next section, the accumulation of such assets can be encouraged by appropriate government policies.

Rising trade integration will likely also increase the pace of international technology diffusion, thus raising multifactor productivity growth. These dynamic effects are likely to be particularly important for countries that are far from the technology frontier. As these effects are not factored into the baseline, they thus pose an upside risk to growth.

2.6.2. Rising demand for highly-educated workers will constitute a challenge for tertiary education systems, with consequences for growth and equity

While average levels of educational attainment will continue to rise, increases are set to slow in the central scenario.[12] This expected slowdown in the growth of human capital is consistent with roughly constant returns to investment in education (Johansson et al., 2013). As discussed in Section 2.3, earning inequalities may rise in the future mainly due to the increased knowledge orientation of the global economy, raising incentives to invest in education. This suggests that demand for education could grow faster than in the central scenario.

OECD analysis based on an estimated demand and supply model for tertiary education (see Braconier, 2014 for details) suggest that if demand for tertiary education reacts to earning differentials and incomes in the same way as during the last two decades, it may indeed grow faster than in the central scenario in most OECD countries (Figure 8). The question then is whether and under which policy conditions supply of tertiary education can expand to meet this higher demand. If it does, skill upgrading and growth could be boosted and increases in inequality mitigated compared with the central scenario.[13] If it does not, then growth will be lower and inequalities higher.

Box 4. **Using models to identify risks, tensions and consequences of alternative scenarios**

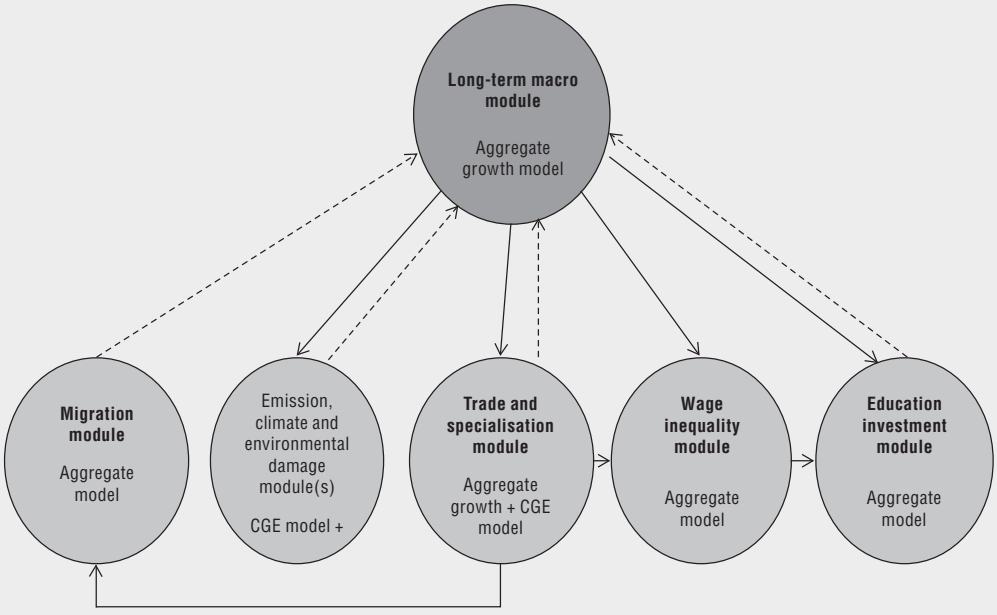
Identifying risks and tensions

Outputs from models are also used to question exogenous assumptions and illustrate potential feedback mechanisms (dashed arrows in the figure) in order to question exogenous assumptions in the central scenario, so as to highlight risks and tensions:

- The rising trade intensities that MIRAGE-e predicts could spur faster productivity growth than in the baseline, due to the role of trade intensity as a driver of technological progress in the long term growth model. Growth could also be higher due to a long ICT wave while, in contrast, a slowdown in frontier productivity growth would have significant negative consequences for global growth.
- Demographic projections embodied in the central scenario may turn out to be too optimistic once endogenous factors driving economic migration are properly accounted for. A model predicting international stocks of migrants (described in Westmore, 2014) suggests that due to the income convergence between traditional host and home countries taking place in the central scenario, migration flows into the OECD may dry up or even reverse.
- Projected emissions of greenhouse gases, and subsequent increases in temperatures, could feed back to economic activity (GDP) and specialisation patterns, indicating that GDP could be lower than in the central scenario in the long run. Extensions of the ENV-growth and ENV-linkages models to incorporate this mechanism in a model (described in Dellink et al., 2015, and OECD, 2015) translates temperature changes into weather consequences and weather changes into economic damages (e.g. in tourism and agriculture).
- Demand and supply for tertiary education may behave differently than in the central scenario, due to developments in returns to education. A model for tertiary education – described in Braconier, 2014 – indicates that demand for tertiary graduations may rise faster than in the central scenario due to increasing GDP per capita and relative earning differentials. This suggests that higher growth and lower earning inequality than in the central scenario could be achieved if supply (funding) can be provided.

Box 4. **Using models to identify risks, tensions and consequences of alternative scenarios** *(cont.)*

The full analytical framework



Alternative scenarios

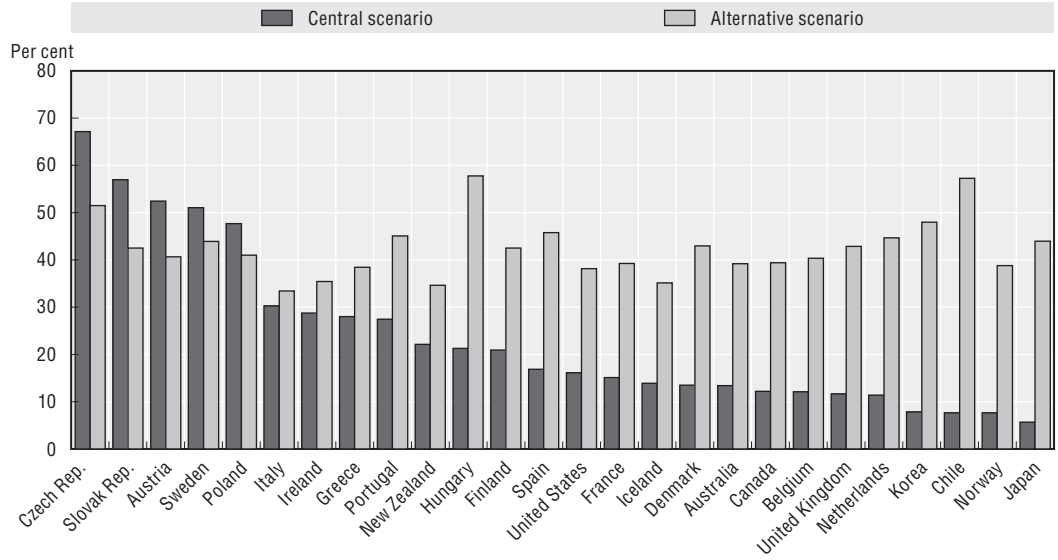
The full analytical framework for this study is used to analyse different alternative scenarios, often related to exogenous changes in policies. The modelling approaches are different for each alternative scenario, allowing for different degrees of feedback between various elements. For example, alternative scenarios relating to the effects of lower tariffs on trade specialisation and the impacts of climate change on GDP are modelled using a combination of CGE models and the aggregate growth model, allowing a relatively high degree of endogeneity. However, the four other alternative scenarios consider only partial effects. The alternative scenarios considered in this paper are designed to respond to the following questions:

- How can enabling factors – such as managerial capabilities and R&D spending – increase productivity growth?
- What would be the effects on specialisation and growth of lower tariffs and trade costs?

  What are the fiscal implications of expanding tertiary education through providing more public funding?
- How would changes in structural policies (e.g. in terms of product market regulation) affect earning inequality and growth?
- What is the likely economic impact of climate change over the forecast horizon?
- How will international economic migration be impacted by expected future global growth patterns?

The flexible structure of the framework also means that it can be used to analyse a variety of other scenarios in the future. A further step which has not been taken in this paper would be to incorporate in the central scenario the impact of the expected evolution of economic migration and climate change on GDP.

Figure 8. **Increase in demand for tertiary graduation in the central and an alternative scenario 2009-60**



Note: Central scenario refers to the implied increase in tertiary graduations between 2009 and 2060 needed to generate the share of tertiary graduates in the labour force assumed in the central scenario (see Braconier, 2014 for details). Alternative scenario refers to scenario 1 in Braconier, 2014, where demand for graduations is derived from an estimated econometric model. Increased demand for education is mainly driven by a combination of rising D9/D5 earnings premia and rising per capita incomes. Based on an estimated supply model, the scenario assumes that real household expenditures per enrolled student are constant while public funding is assumed to adjust to ensure that supply will equal demand.
Source: OECD calculations.

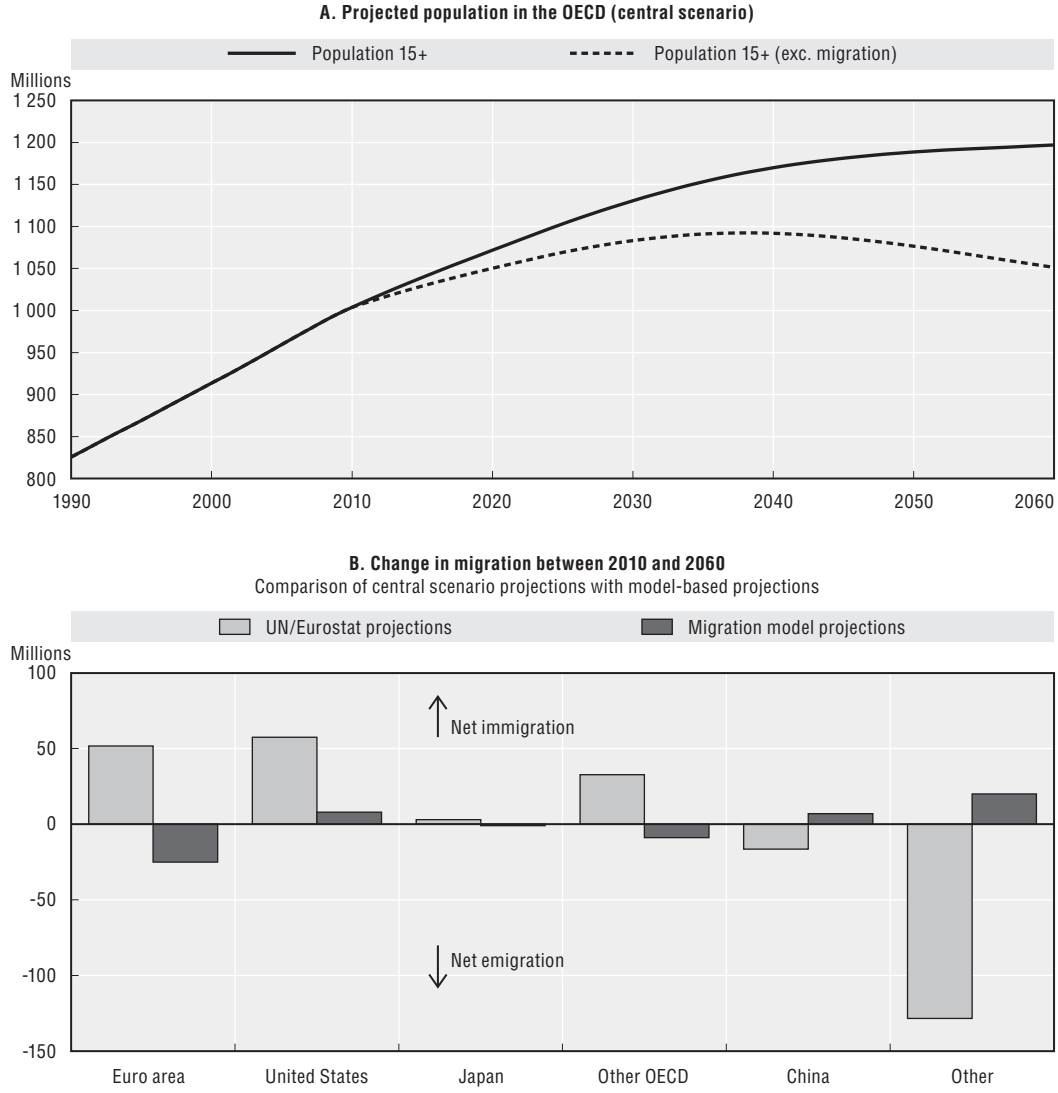
2.6.3. Income convergence between OECD countries and developing economies may dampen work-related migration flows, exacerbating labour shortages in the OECD

The UN and Eurostat population projections, which the central scenario is based on, anticipate international migration will alleviate some of the natural decline in the working age population of the OECD (Figure 9, Panel A). However, the expected (if partial) income and wage convergence between OECD countries and emerging economies will lower the economic incentives for migration over the next 50 years. As suggested by the analysis in Westmore (2014), these diminished incentives may significantly impact flows of immigration into OECD countries so that the OECD may in fact experience net emigration of economic migrants between 2010 and 2060 (Figure 9, Panel B; Westmore, 2014).

The direction and the composition of these alternative migration flows differ across regions. According to the analysis in Westmore (2014), some developed regions – such as the US – would continue to experience a net inflow of economic migrants, whereas others – such as the euro area – may experience a net outflow over the period to 2060, as wage growth in traditional "source" countries is expected to be relatively fast. Decomposing the projections by skill level, the net outflow of migrants from euro-countries is expected to be mostly low-skilled (Westmore, 2014). Rather than a sharp increase in emigration, this trend reflects a substantial decline in the flow of low skilled immigrants that have traditionally moved to the euro area. Of course, this trend in economic migration could be countervailed by people moving for other reasons, such as family reunification or conflict in their origin country.

Focusing only on economic migrants, the consequences of the potential trends presented in Figure 9B on the labour force and GDP of some OECD countries could be

Figure 9. **Population and migration, 2010-60**



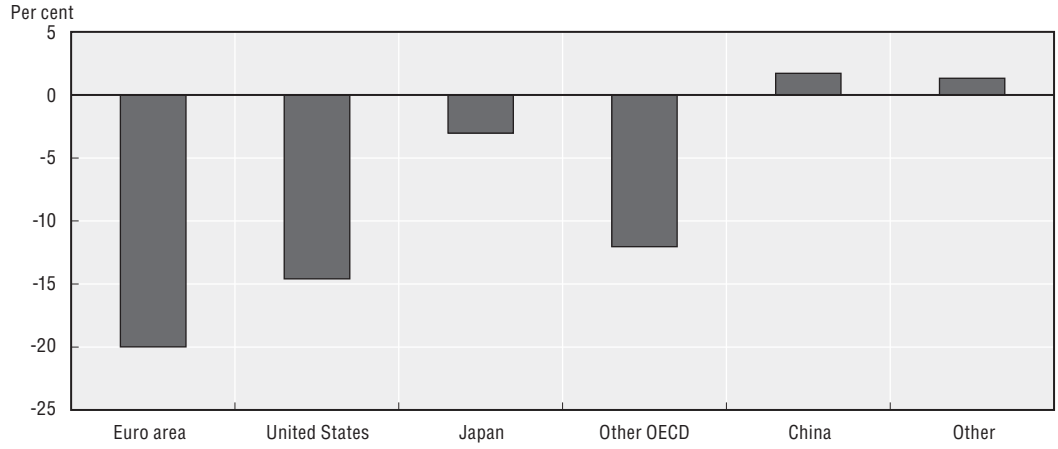
Note: The "Migration model" projections in Panel B are obtained by combining; i) the estimated sensitivity of migrant stocks to changes in relative wage differentials (i.e. destination to origin country) from the migration model, with; ii) bilateral migration stock data in 2000 for 195 country pairs and; iii) wage projections over the period to 2060 from the central scenario. From this, the estimated change in migrant stocks to 2060 due to wage movements (holding all else constant) is obtained at the country level before being aggregated into the regions presented in Panel B. See Westmore (2014) for further details.
Source: UN, Eurostat, OECD estimates.

significant. For example, estimates suggest that the modelled decline in migrants may lower the potential labour force by as much as 20% in the euro area and 15% in the United States by 2060 relative to the central scenario (Figure 10).

2.6.4. Costs related to ageing, health and education will increase fiscal pressures, and a drying up of migration could make things worse

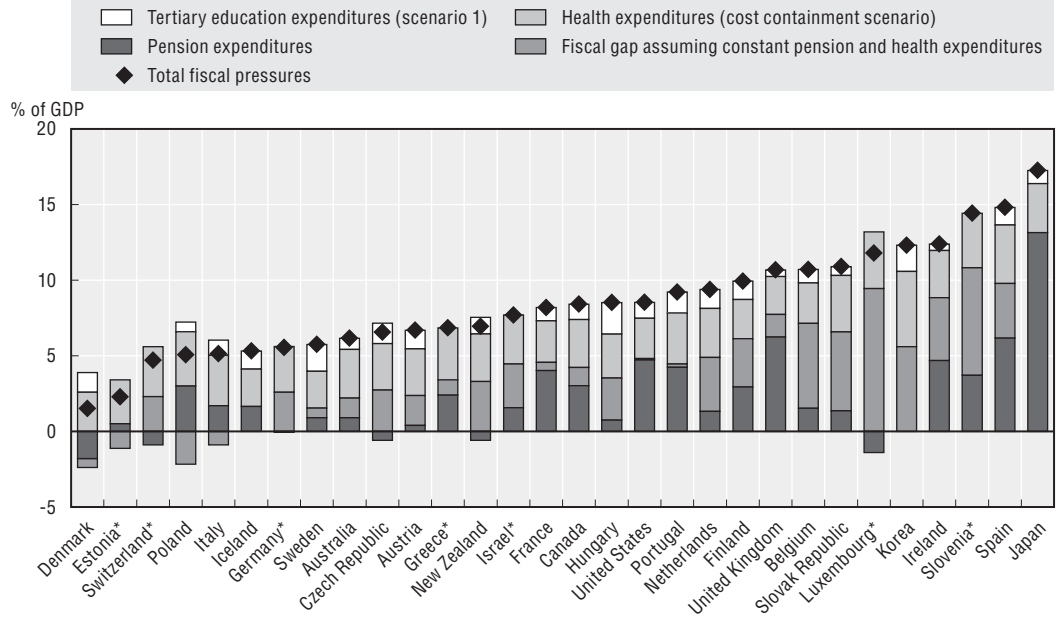
As already mentioned, the scale of the needed structural and fiscal reforms to stabilise public debt at 60% of GDP in the central scenario is substantial. To illustrate this, Figure 11 shows fiscal challenges that OECD countries may face from health, pension and education spending – on top of the fiscal adjustments that are needed to reach the 60% of GDP gross

Figure 10. **Potential labour force with modelled migration flows**



Note: The potential labour projections at 2060 are obtained by assuming the same time-varying country-specific age distribution of net migrants as the UN/Eurostat projections. Under this scenario, the potential labour stocks at 2060 are estimated by calculating the number of immigrants in each country at 2060 that are above 15 years of age and holding the labour force participation rate and the natural rate of unemployment constant at the value assumed in the central scenario. The potential labour projections are calculated for all countries included in the long-term scenarios (Johansson et al., 2013) apart from Estonia and Saudi Arabia that are excluded due to poor data quality for the migrant age profile. The country level estimates are then aggregated into the regions presented in Figure 4.
Source: OECD estimates.

Figure 11. **Fiscal pressures in the OECD area are strong**



* Tertiary education spending projections not available.
Source: OECD Economic Outlook 95 long-term database, OECD (2013i), de la Maisonneuve and Oliveira-Martins (2013), Fall et al. (2014).; OECD calculations.

debt target. Clearly, these additional fiscal pressures pose a major downside risk to the fiscal position embedded in the central scenario for OECD countries.

The fiscal challenges that emerging economies face are to a large extent similar to those in OECD countries. Demographic pressures are building up in many countries – like China and Brazil – which will add pressure to retirement funding (Fall and Bloch, 2014).

Similarly, de la Maisonneuve and Oliveira Martins (2013) estimate that even in the cost containment scenario, the BRIICS total health and long-term care expenditure will increase from 2.5% currently to above 5% of GDP in 2060. Finally, the fiscal pressures from expanding public education systems are likely to be larger in emerging economies than in the OECD, reflecting the need to build up primary and secondary education together with a rapid expansion of tertiary education.

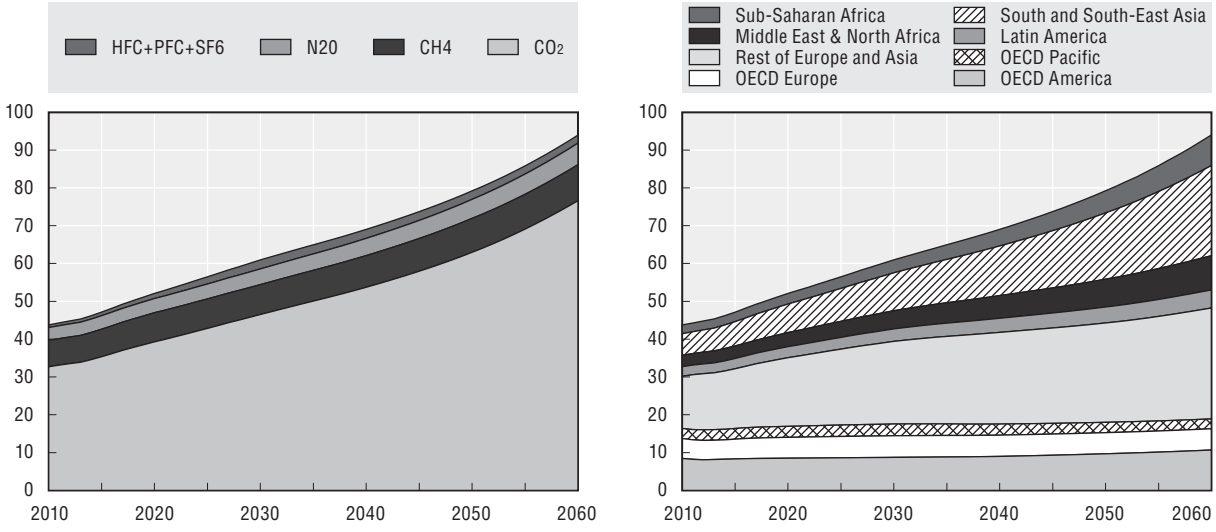
2.6.5. *Pressures from climate change will continue to build up, with substantial losses to GDP even before 2060*

Environmental pressures associated with business as usual growth are expected to continue to build (OECD, 2012b). By 2050, terrestrial biodiversity is projected to decline by a further 10%, 40% of the world's population is projected to be living in areas of high water scarcity, premature deaths linked to airborne particulate matter are projected to double, and disruptive climate change is likely to be locked in as a result of a large increase in greenhouse gas emissions.

Rising greenhouse gas concentrations pose a significant global risk to economic output. Without dramatic changes in the carbon intensity of global energy production and consumption, economic growth will lead to constantly rising greenhouse gas (GHG) emissions and increasing concentration of such gases in the atmosphere (Figure 12), consistent with IPCC scenarios. This will significantly increase the risk of costly climatic change as well as exacerbating other environmental pressures. Contributions from non-OECD countries will rise rapidly as their share of world economic output grows. While the full effects of unfettered GHG emissions are expected to produce their largest economic damages after 2060, rising global temperatures are projected to already affect GDP earlier (OECD, 2015).

Figure 12. **Evolution of greenhouse gas emissions**

Gigatons of CO_2 equivalent

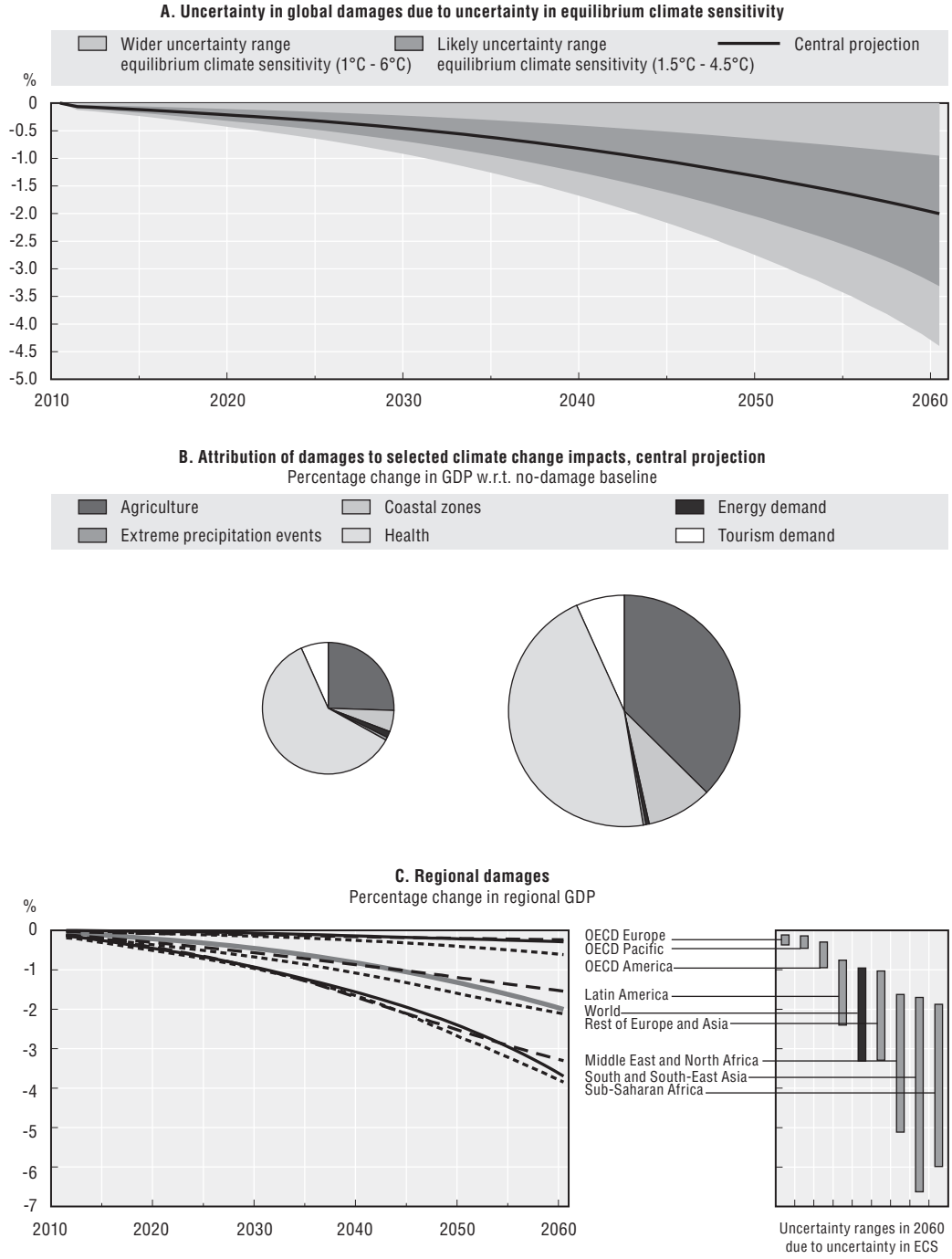


Note: OECD Pacific includes Australia, Japan, Korea and New Zealand, OECD America includes Canada, Chile, Mexico and United states. Latin America excludes Chile and Mexico.
Source: OECD calculations from the ENV-Linkages model, OECD (2015).

The central scenario does not reflect the economic damages from climate change, which will entail a significant pressure on global output and living conditions in the long

run. An alternative scenario (OECD, 2015) suggests that world GDP in 2060 may be lowered by between 1% and 3.3% due to the effects from a selected number of climate change impacts (Figure 13, Panel A). Climate change will affect economic performance through a

Figure 13. **Damages from selected climate change impacts**



Note: Agriculture refers to changes in crop yields and fisheries yields. Energy shows estimated changes in demand for cooling and heating. Health captures changes in labour productivity due to occupational heat stress (but excludes welfare losses due to premature deaths). Coastal zones denote damages related to coastal land losses and damages to capital. Extreme events cover damages from hurricanes. For details, see OECD (2015).
Source: OECD calculations from the ENV-Linkages model, OECD (2015).

number of channels. On a global level, labour productivity losses from occupational heat stress and falling agricultural productivity are likely to be among the main contributors to climate change-related impacts on GDP by 2060 (Figure 13, Panel B).

The strength of the impact depends on geographic and climatic conditions as well as the prevailing specialisation patterns. Therefore, the extent and timing of climate change damage is likely to differ substantially across countries and regions (Figure 13, Panel C). Regions that already experience high temperature variability, have large agricultural sectors and are vulnerable to sea level rise may be worst hit, with damages in Africa and South and South-East Asia projected to amount to between 2 and 6% of GDP in 2060. In more temperate regions losses may be limited by improved terms of trade and, in some cases, reduced cold-related diseases, reduced energy expenditures and stronger net demand for tourist services.

3. Policies to face the growth challenge

Box 5. **Main policy conclusions on how to strengthen growth**

- Further agreements on trade liberalisation could boost growth, especially in some emerging economies. Global benefits are larger from multilateral than regional trade liberalisation. Effects on wage differentials would likely be small.
- Rising international connectedness in general terms and specifically the important role MNEs play in global business R&D mean that the benefits from public basic research and support to private R&D will become more global, weakening incentives for individual governments to support these activities. Global mechanisms to fund and support basic research as well as coordination in tax treatment of R&D incentives may be warranted.
- Intellectual property rights (IPRs) are crucial for investment in some types of knowledge based assets, but could also hinder innovation in some areas (such as ICT). Reviewing and co-ordinating internationally IPR approaches could support growth.
- Some enabling factors, such as private R&D and high-quality management, enhance capabilities to absorb and deploy effectively new technologies, thus supporting productivity growth.
- Fostering competition at home and in international markets, also via closer co-operation among competition authorities, complements IPR and stimulates the build-up of growth-enabling factors.
- There is little evidence that the pace of structural change will rise over the coming 50 years. However, an ageing workforce will likely be less able to adapt to structural change, risking an increase of mismatches in the labour market and slow structural change. This may require a shift in the focus of labour market policies from search activities towards work incentives and retraining.
- Longevity adjustment in retirement ages will be needed to mitigate negative labour supply and growth effects from ageing.
- Migration and labour supply can be boosted by a combination of labour and product market flexibility and labour-migration friendly policies.
- Private and social returns to education are likely to increase as earning differentials widen and working lives become longer and will lead to rising demand for tertiary education. Meeting this demand can spur growth and support equity, but tuitions should contribute a larger share of total costs of tertiary education. In this context, lending schemes to finance tuitions to address liquidity constraints and share rising idiosyncratic earning risk are desirable.

Box 5. **Main policy conclusions on how to strengthen growth** *(cont.)*

- As working lives lengthen in response to rising longevity, strategies and funding for life-long learning will have to be strengthened. Given lower cross-country mobility among older workers, the scope for public funding is wider than for younger tertiary students.
- Ambitious mitigation and adaptation policies can reduce the future costs of climate change and, perhaps more importantly, limit the downside risks to economic growth associated with high impacts and crucial tipping points.

In the central scenario outlined in Section 2 growth is set to slow in both OECD countries and non-member economies, with tensions and risks on both the up- and downside. This section deals with policies to support stronger growth, the trade-offs and spillovers these will entail, and how trade-offs and policy recommendations may evolve over the coming 50 years.

3.1. A more integrated global trading system can boost growth but would increase interdependence and pressures to adjust structural policies

3.1.1. Further trade liberalisation and improved framework policies would increase trade and promote growth

Openness to trade is associated with higher incomes and growth (see e.g. Bouis et al., 2011). These benefits are transmitted through several channels: shifting production from low to high productive locations; relocation of factors of production towards sectors and firms with high productivity; and rising incomes due to an increase in market size that supports more specialisation, faster technology diffusion and stronger incentives to invest in "non-rival" assets (Rivera-Batiz and Romer, 1991; Ventura, 2005). The former two effects include mostly static gains from international trade in goods, services and factors of production, while the latter entails dynamic growth effects. As shown in Johansson and Olaberría, 2014, significant static and dynamic efficiency gains – especially for developing countries – could be reaped through further multilateral trade liberalisation, while global welfare gains from regional agreements are much more limited due to trade diversion (Box 6).[14] While fostering multilateral trade liberalisation has proved difficult in the recent past and regional arrangements have been frequent, the former should remain priority due these larger benefits and despite the practical challenges of seeing through such reforms in a multi-polar world.

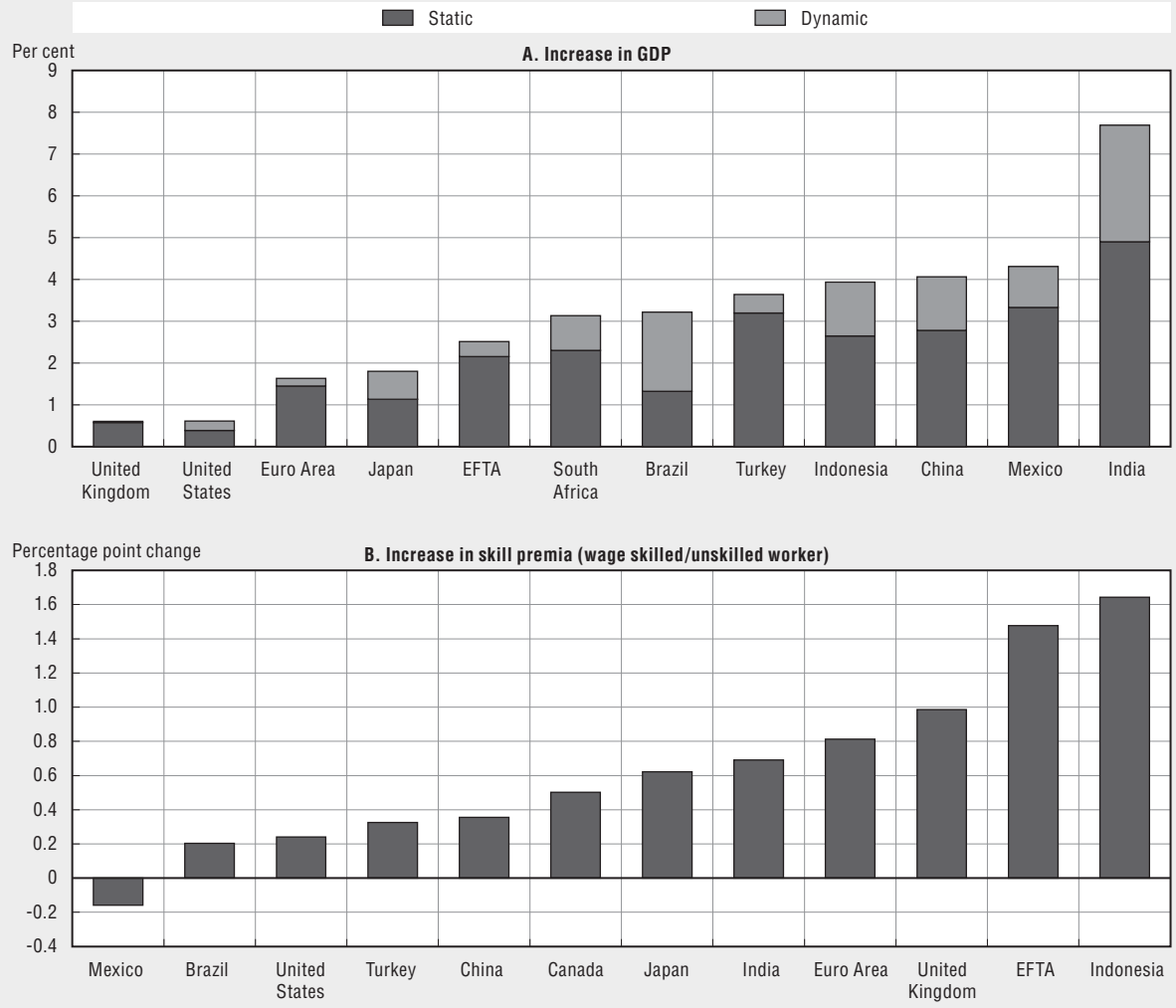
Box 6. **The economic impact of further multilateral trade liberalisation**

Recent OECD work (Johansson and Olaberría, 2014) illustrates the potential effects from further multilateral and regional trade liberalisation. The multilateral scenario assumes that tariffs on goods are reduced by 50% relative to baseline, while transaction costs are reduced by 25%. Significant reductions of regulatory barriers are implemented, while agricultural support is reduced by 50% in the European Union, the United States, Japan, Korea and in EFTA countries.

As a consequence of these liberalisation policies, world trade could increase by 15%, in 2060. Effects on specialisation patterns would include a reallocation towards more service production in emerging economies. Economic benefits from multilateral liberalisation range from 0,5% of GDP for some OECD economies to almost 8% for India (See figure). Skilled wage premia will tend to increase.

Box 6. **The economic impact of further multilateral trade liberalisation** *(cont.)*

Effects of further trade liberalisation on GDP and skill premia by 2060



Note: Based on "Multilateral" scenario in Johansson and Olaberría, 2014, relative to central scenario.
Source: OECD calculations.

Well-designed framework policies and institutions promote growth by facilitating trade. Trading internationally entails costs and additional risks for firms such as exchange rate uncertainty and increasing potential for infringement of property rights. These costs and risks tend to rise with the complexity of supply chains and with the extent to which intangible assets are part of the production process (Nunn and Trefler, 2013), while they tend to decrease with the quality of institutions of trading partners. A high overall quality of institutions promotes aggregate exports, with a stronger effect on exports in sectors with complex supply chains (Johansson and Olaberría, 2014). Moreover, the positive effects of lowering tariffs are magnified in sectors characterised by long cross-border value-added chains. As the complexity of global supply chains likely will grow, and production increasingly will rely on knowledge-based capital, the benefits of improving framework conditions and lifting trade barriers are likely to increase in the future.

3.1.2. …but could also imply negative side effects by increasing earnings inequality and the pace of restructuring

However, reforming framework policies to reap larger benefits from trade can also have negative side-effects on other public policy objectives, which need to be weighed against the benefits and may require countervailing policies:

- Trade financing and the management of exchange rate risk requires access to financial services and a larger financial sector – in terms of credit to GDP – is associated with higher exports especially in sectors with high dependence on external financing (Johansson and Olaberría, 2014). However, higher credit-to-GDP ratios may also entail larger financial risks (Sutherland and Hoeller, 2012) and hamper growth, all other things equal (Cournède and Denk, 2014).
- The figure in Box 6 suggests that trade liberalisation may tend to increase both GDP and domestic inequality, suggesting a possible trade-off. However, the role of rising international trade in explaining widening earnings and income differentials within countries remains open to dispute. Compensating mechanisms, for example in terms of efficient adjustment of the skill composition to changes in relative wages, may be at work. Indeed, most cross-country empirical analyses suggest that rising trade exposure explains little of recent increases in inequality.[15]
- While the overall impact of rising exposure to trade on aggregate wage differentials and employment may be limited, the social costs relating to the restructuring of production along new trade specialisation patterns may be much bigger. Trade reforms lead to reallocation of resources across sectors, occupations and firms as specialisation patterns respond to changes in relative prices. For instance, Levchenko and Zhang (2013) show that if factors of production are immobile across sectors, the integration of China, India and the Central and Eastern European countries into the world trade system may have increased aggregate welfare in the rest of the world by 0.4%, but factor incomes in individual sectors may fall or rise by more than 5%.

Dealing with relative wage pressures and needs for structural adjustment due to rising trade integration will thus be important. However, these challenges are not conceptually different from those emanating from changing demand structure or technological change, discussed in Section 3.3. Policies to deal with such challenges are analysed in Section 4 below.

3.2. Supporting knowledge-based growth

In the central scenario, growth becomes increasingly dependent on rising multifactor productivity (see endnote 5 for details of the calculation), with the contribution to GDP per capita rising from around 54% to 88% in OECD countries between 2010 and 2060 and from 79% to almost 91% in non-OECD G20 countries. Knowledge will thus be the main driver of growth in the future and policies geared towards enhancing KBC will be crucial. Two classes of policies are considered in this section: public policies to support knowledge creation, development and absorption of new technologies; and policies that influence the effectiveness with which new technologies are used. Accompanying labour market and distributional policies are discussed next.

3.2.1. Innovation will become even more global, calling for a review of policies and further cross-country co-ordination in some areas

Publicly funded research often plays a crucial role in the development of new general purpose technologies, such as the internet (Sheehan and Wyckoff, 2003). Ensuring sufficient

funding for public R&D will therefore be important for future growth and for the transition towards a greener economy given that this will require the development of new technologies. Growing international trade integration and improving communication technologies will spread the benefits of public R&D further, generating larger positive global spillovers. However, as international knowledge spillovers from government funded R&D increase, countries will find it more difficult to appropriate the benefits associated with such research. This may lower the willingness of governments to invest in basic R&D, pointing to potential benefits of international coordination in funding such work.

Innovation is becoming increasingly globalised with rapid growth in the scientific capability of some emerging economies and the offshoring of R&D (Andrews and de Serres, 2012). Given that knowledge based asset growth is partly reliant on the accumulation of mobile resources such as skilled labour and FDI, countries' ability to grow at the pace projected in the central scenario may depend on their ability to attract such resources. This could result in policy competition between countries, for example, through changes in the settings of personal income and corporate tax policies to attract investment and managerial ability. Such a scenario has the potential to harm growth through the emergence of fiscal pressures or excessive reallocation of factors, in which case there could be some benefit from cross-country tax policy co-ordination.

With the anticipated rise in globalisation there may be increasing instances of multinational enterprises using cross-border tax strategies to shift profits generated by KBC across countries (OECD, 2013). This may lead to unintentionally high levels of total tax support for R&D and place domestic "stand-alone" firms that perform R&D at a competitive disadvantage. Recent OECD work highlights the potential benefits of international co-operation to limit unintended tax relief for R&D stemming from cross-border tax planning (OECD, 2013k) as well as the potential growth benefits of designing R&D support schemes that do not privilege incumbents vis-à-vis young innovative firms (Andrews and Criscuolo, 2013).

As per capita income differences between the OECD and many emerging economies converge and international specialisation patterns change in line with increased global integration, the traditional distinction between innovating advanced economy firms and imitating emerging economy firms is likely to blur further. In this context, views on IPR may converge and international policy co-ordination with respect to IPR protection will grow in importance.[16] Exploiting opportunities for coordination is increasingly important since intellectual property rights (IPR) regimes will need to be frequently updated to keep pace with technological change. For instance, in some emerging KBC sectors where the innovation process is typically fragmented (e.g. software) the patent system may unduly favour incumbents at the expense of young firms, thus undermining incentives to invest in KBC and creating a policy dilemma that needs to be addressed.[17]

Besides reviewing IPR regimes, further pro-competitive reforms to domestic product market regulations may be another avenue to overcome any barriers to KBC accumulation created by existing patent systems, given that IPR regimes are most effective when they are coupled with pro-competition policies (Aghion et al., 2005; Westmore, 2013). But with further globalisation, promoting the accumulation of knowledge based assets through competition is likely to require greater cross-border co-operation between competition authorities. Both the number of cartel cases and the number of mergers involving parties from abroad have risen dramatically since 1990 (OECD, 2013h). In the face of such linkages

across jurisdictions, global co-operation between competition authorities – usually on a bilateral basis – has improved. However, existing agreements tend to be based purely on information sharing and do not formally promote co-operation with regard to enforcement. Looking forward, multilateral agreements may be pursued. In addition the development of international standards for authorities acknowledging the decisions of partner jurisdictions or co-ordinating investigations of cross-border competition cases may be needed.

3.2.2. National policies can raise pay-offs from faster technological change

Through encouraging the accumulation of KBC, more effective competition and innovation policies can also help generate additional investments, for example in skills, capital or organisational change. The ability of organisations to restructure is a key determinant of the extent to which they benefit from new technologies (Pozzi and Schivardi, 2012). For example, in order to extract the maximum benefit from ICT, firms typically need to adopt ICT as part of a "system" of mutually reinforcing organisational changes (Brynjolfsson et al., 1997). Box 6 illustrates how enabling factors – like managerial quality and private sector R&D – are important for adapting to changes in the pace of growth at the technological frontier.[18]

Box 7. **Enabling factors impact on growth**

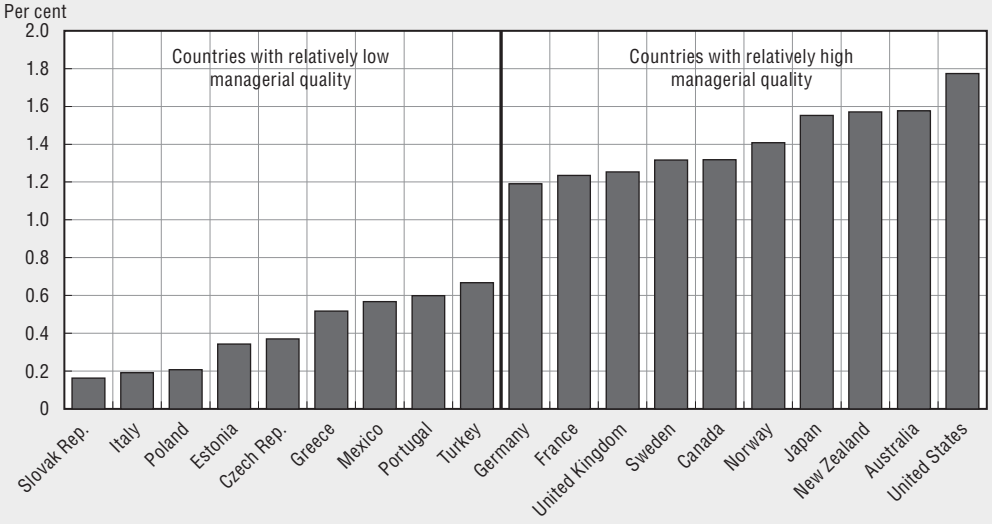
Any increase in global integration will raise the sensitivity of growth prospects to developments at the technological frontier. Irrespective of the pace of frontier growth, the presence of enabling factors – like managerial quality and private sector R&D – will be increasingly crucial in aiding countries to adjust (Andrews and Westmore, 2014). The first figure below provides an example of how a country's ability to benefit in the event of a positive shock to growth of frontier technologies (with an annual growth rate of 1.8% instead of the 1.3% assumed in the central scenario) is affected by the quality of managerial capital. Government policies that promote competition are likely to provide an incentive for firms to implement strong management practices in order to survive (Bloom and Van Reenen, 2010). Reductions in product market regulations are one such policy.

A country's ability to benefit from new discoveries is also linked to the extent of domestic R&D. For instance, Griffith et al., (2002) argue that higher R&D spending produces productivity benefits through two different channels (the so-called "two faces" of R&D). The first channel works through stimulating innovation and the second through better enabling the imitation of others' discoveries and the absorption of foreign technologies. Thus, countries with high business R&D spending (such as Japan, Switzerland and Sweden) may expect to benefit more from a positive technological shock than countries such as Hungary and the Slovak Republic (See second figure below). As already mentioned, a number of structural policies may be important in encouraging KBC investment, including business R&D. However, innovation-specific policies, such as R&D tax incentives and government direct support, are also associated with higher business R&D spending (Westmore, 2013).

Given these channels are not incorporated in the long-run growth model, a further implication of this analysis is that the central scenario may underestimate GDP per capita in countries with high absorptive capacity. For example, on average, countries with high managerial quality and high business R&D (that is, those that appear in the right hand side of the first and second figures) may experience an additional increase in GDP per capita at 2060 of 1% and 2%, respectively, when the role of these enabling factors is taken into account.

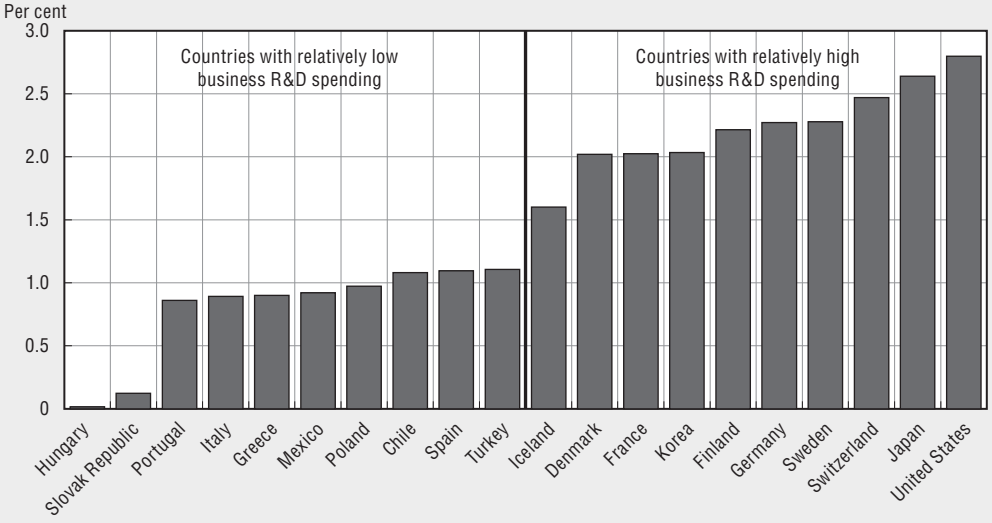
Box 7. **Enabling factors impact on growth** *(cont.)*

Additional GDP per capita gains from a positive shock to frontier growth due to managerial quality



Note: The long-run growth model is re-specified to reflect the new OECD evidence that suggests that countries will converge more rapidly to the long-run steady state MFP level when managerial quality is relatively high (see Andrews and Westmore, 2014). The above graph shows the additional effect on GDP per capita from the "high frontier growth" scenario when the re-specified model is used (relative to the results from the base specification). For example, the figure indicates that re-specifying the model to allow for managerial quality gives no boost to GDP per capita in Hungary at 2060 under the high growth scenario. In contrast, the re-specification results in 1.8% higher GDP per capita in the US at 2060 relative to the case when the high frontier growth scenario is run using the base specification of the model.
Source: OECD estimates.

Additional GDP per capita gains from a positive shock to frontier growth due to business R&D



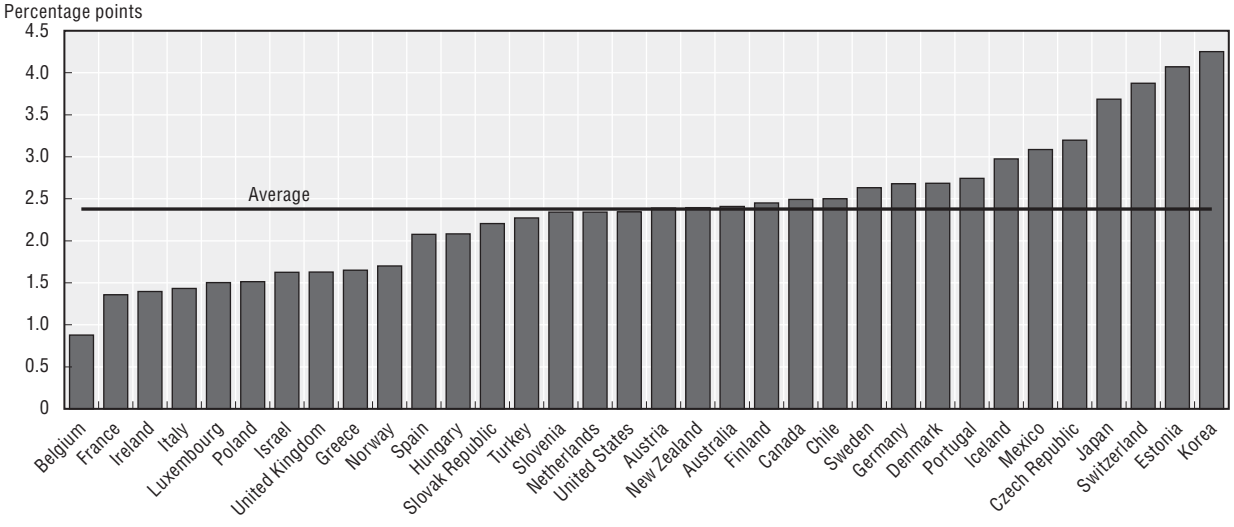
Note: Evidence suggests that countries will converge more rapidly to the long-run steady state MFP level when domestic business R&D spending is relatively high (Andrews and Westmore, 2014). The figure shows the difference in the effect of the "high frontier growth" scenario on GDP per capita at 2060 relative to the effect under the base specification of the model. For example, while the additional GDP per capita effect of using the re specified model is minimal in Slovakia, in Switzerland, the high frontier growth scenario results in GDP per capita at 2060 that is 2.5% higher using the re specified model than when the same scenario is run in the base specification.
Source: OECD estimates.

3.3. Labour and education policies have to adjust to changing demographics and rising skill requirements

3.3.1. Retirement reforms and immigration friendly policies are two ways to address ageing

Unfavourable demographics will lead to shrinking labour supply and slower growth in many countries, even if the retirement age is assumed to be adjusted for longevity in the central scenario. In this scenario, retirement reforms that raise labour force participation and employment include two phases. First, the implementation of recently legislated pension reforms will increase the average OECD retirement age from around 63 to 65 by 2030 (OECD; 2014). Secondly, rising longevity is assumed to be accompanied by further reforms to extend working lives so as to keep the share of active lives constant even as life expectancy increases. This further increases labour force participation rates in 2060 by a total average of 2.4 percentage points (Figure 14). Clearly, the gap between legislated and needed reforms is substantial and the possibility that the implementation of these further reforms may stumble on political obstacles should be pre-empted via adequate communication and sequencing.

Figure 14. **Longevity adjustment of the retirement age increases labour force participation**



Source: OECD Economic Outlook 95 long-term database, OECD calculations.

In parallel, policy makers in OECD countries cannot take for granted that large migration inflows will ameliorate an already difficult demographic situation, as wage convergence between OECD and non-OECD countries could lower incentives for work-related migration (Westmore, 2014). Hence, OECD countries may need to pursue more migration-friendly policies in order to encourage labour-related inward migration. While migration policies aiming to control population flows have often not been successful in achieving their stated objectives (Skeldon, 2008), there may be scope for well-designed government programs that seek to attract certain types of workers. For instance, Hatton and Williamson (2002) argue that changes in US immigration policy were important in influencing the volume and composition of migration flows throughout the 20th Century. There are a number of distinct types of immigration policies (e.g. skills based point systems, family reunification

programmes, refugee policy, illegal immigrant policy), which can be calibrated to target different groups of migrants. Settings in one country may also have spillover effects on other regions. For example, a change in policy to attract more low skilled workers may be more effective if it is introduced at a time when a number of other destination countries are implementing less accommodative measures for such migrants.

Benign structural policy settings can also attract inward migration and help make the most of immigration, for instance by providing migrants good access to jobs and opportunities for starting businesses. Indeed, less strict business regulations appear to be positively associated with immigration (Westmore, 2014). Well-functioning labour markets may be especially important for immigrants, as they more often tend to be formally overqualified for their jobs than the native population (OECD, 2013g).

3.3.2. A changing structure of labour demand combined with an ageing labour force will require emphasis on flexibility and matching issues

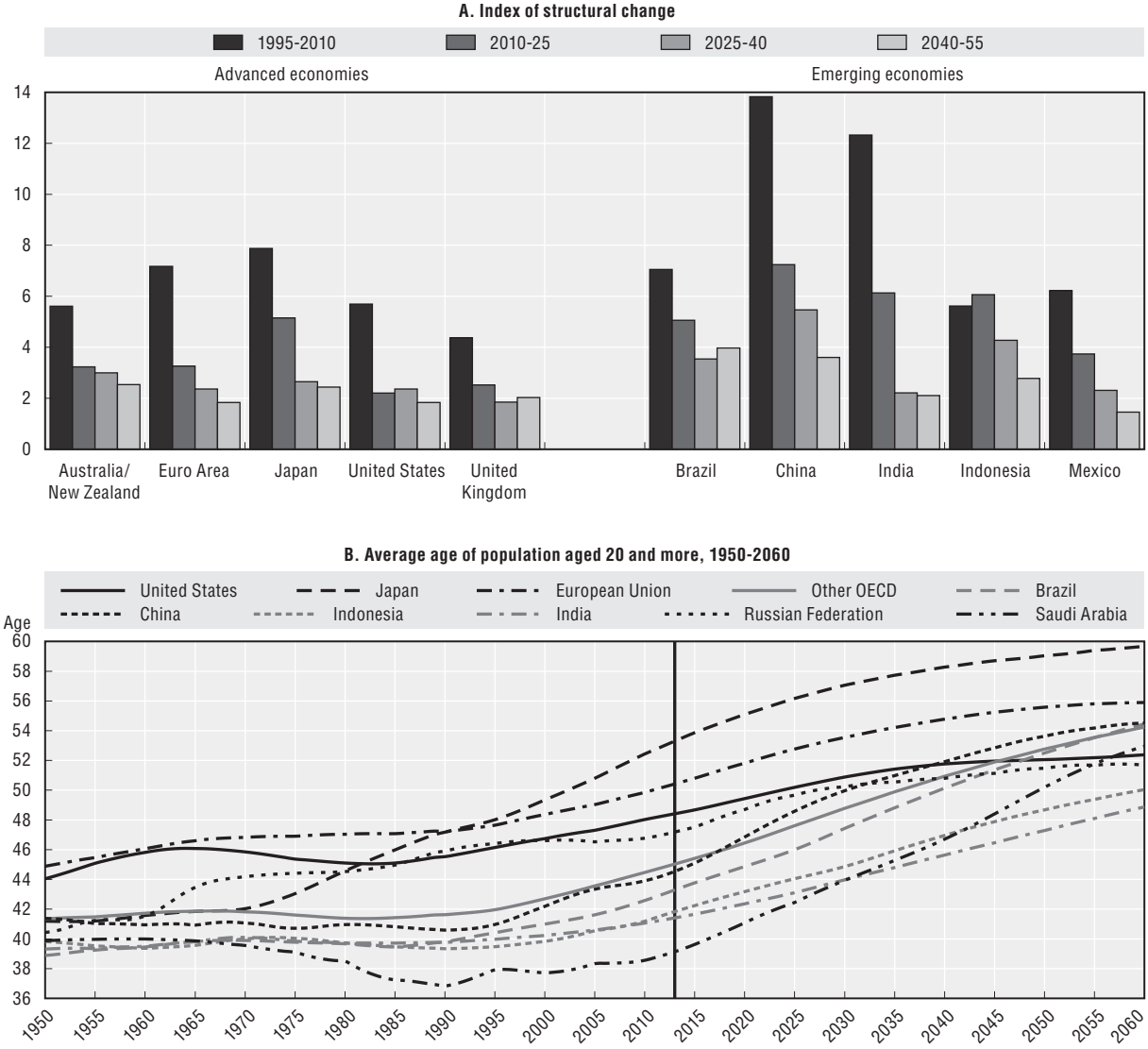
Economic growth, technological change and changing patterns of specialisation will continue to generate shifts in the structure of labour demand. It is difficult to predict whether the pace of structural change will slow or increase over the coming 50 years. Figure 15 (Panel A) suggests that the pace of structural change – measured in terms of the sectoral composition – may decline in the central scenario, especially in emerging economies that will be exhausting the shift out of primary production. These estimates only tell part of the story however, as shocks not incorporated in the central scenario will inevitably affect future developments, not least changes in demand patterns. Furthermore, within-sector structural change will continue as KBC-based growth entails substantial firm turnover. A flexible labour force and labour markets that facilitates mobility and job matching are likely to adapt more quickly to new skill requirements and changes in industrial and occupational structures.

However, over the coming 60 years labour forces will age substantially, reflecting both the composition of the population and likely increases in retirement ages (Figure 15, Panel B). As the mean age of the workforce increases, labour supply is likely to become less dynamic. This may lead to lower risk-taking, flexibility and geographic mobility with important repercussions for policy:

- A rising median age in the workforce will likely force a shift in the composition of active labour market policies. While younger workers tend to be unemployed frequently and for short spells, warranting a focus on search activities, older workers risk longer spells of unemployment and higher risks of exit out of the labour force. A shift in the pool of unemployed towards middle-aged and older individuals with lower mobility, higher wage expectations and a larger occupation-specific human capital may require a stronger focus on maintaining and updating general skills as well as lowering reservation wages.
- Longer working careers, ageing and rising skill-requirements will also increase the need for on-job training and out-of-job retraining. An ageing workforce and longer working-lives will mean a longer period where depreciation of skills and technological change risk making human capital obsolete. This effect is accentuated by the fact that key skills depreciate with age, especially when adjusting for education and demographic factors (Figure 16).

- Other measures to improve labour-market matching can complement activation policies in building and maintaining human capital. For instance, lower employment protection – at least on permanent contracts – may make employers more willing to hire workers whose skills and formal qualifications are not up to expected standards initially, in the expectation that they may develop these skills "on-the-job". This is important, because skills are also affected by labour market experience, where appropriately challenging tasks can help to maintain and develop skills, whereas underutilisation of individuals' skills may lead to faster depreciation of human capital.

Figure 15. **Structural challenges to labour markets**

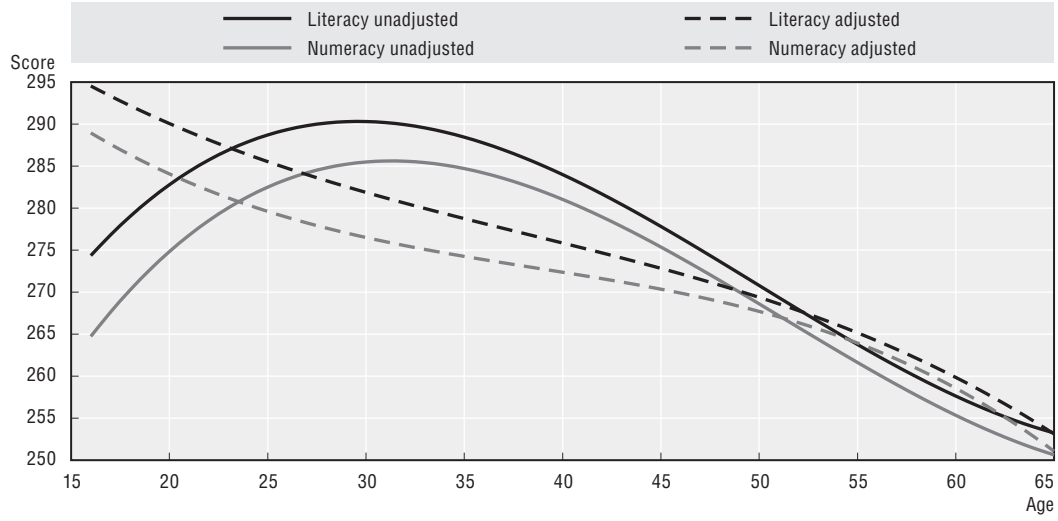


Note: The structural change index (SCI) is constructed as the annual absolute change in each industry's share of total value added, summed across industries and divided by 2 in order to produce an index bounded between 0 and 100.
Hence

$$SCI = \frac{1}{2}\sum | x_{it} - x_{it-1} |$$

Source: OECD Economic Outlook 95 long-term database.

Figure 16. **Literacy and numeracy skills and age**



Note: Adjusted values refer to scores adjusted for educational and demographic background factors.
Source: Survey of Adult Skills (PIAAC; 2013).

3.3.3. Rising demand for skills will have important repercussions for education policies

Knowledge-based growth will require an increasingly skilled labour force. Skill requirements will continue to increase and change as a consequence of skill-biased technical change, changing specialisation patterns and an evolving demand composition.[19] Educational policies will therefore be crucial in shaping growth, but achieving large increases in educational attainment and skills will entail substantial challenges:

- Social excess returns to education are high, but relate mostly to earlier stages of education and especially for disadvantaged individuals (Heckman et al., 2005). Increasing the quality of lower level schooling across broad segments of the population will thus be important both for securing improved productivity, but also for achieving rising participation in higher education.[20] High quality primary and secondary education will therefore be a prerequisite for raising skill levels and expanding tertiary education and should be prioritised in public funding.
- While longer working lives will increase incentives to invest in education, it will also raise risks that acquired education and skills become obsolete, requiring an increased emphasis on life-long learning. The case for government support for life-long learning may in fact be stronger here than for tertiary education for the young, as lower cross-country mobility among older workers means that the social benefits in terms of higher productivity and longer careers to a larger extent will benefit the domestic economy.

3.3.4. Fiscal constraints and international mobility of skilled labour will make co-payments for higher education more attractive

Private benefits of participation in higher education will likely remain high due to increasing relative demand for skilled labour. Meeting the expected rise in demand for tertiary education will entail substantial strains on public budgets if alternative funding sources are not found or new cheaper studying arrangements do not make significant inroads. As highlighted in the previous section, a government funded expansion to meet the higher demand for tertiary graduations embedded in the central scenario may raise

public spending by around 1% of GDP in the average OECD country if spending per student remains constant.[21] Funding arrangements for tertiary education vary extensively across the OECD, but pressures for larger co-payments by students may rise across the board.

A shift towards higher student co-payments can have several benefits:

- In its absence, fiscal constraints could hold back funding for tertiary education, leading to stagnant supply of graduate studies openings or falling funding per student, which could hamper growth and increase earning dispersion relative to the central scenario.
- There may also be efficiency reasons for increasing student co-payments. As shown in Braconier, 2014, the supply of graduates seems substantially more sensitive to increasing levels of co-payments than to increasing funds from government or corporate sources, without having a negative impact on demand.[22] Based on these estimates, total direct costs of tertiary education would rise by 0.2% of GDP in the average OECD country if increases in funding came from household co-payments, while the increase would amount to 1.0% of GDP if increases were covered by public funding.[23]
- Rising internationalisation of higher education – with the number of students from OECD countries enrolled abroad more than doubling between 2000 and 2011 (OECD, 2013d) – and increasing international mobility of skilled labour, further strengthens the rationale for students to cover a larger share of the costs of tertiary education.

Altogether, this suggests that funding reforms where students finance a larger share of direct costs could align incentives better and provide additional funding for an expansion of tertiary education.

At the same time, an increasing reliance on tuition funding will require further developing loan systems to ensure an equitable access to tertiary education. Designing loan systems that are fully compatible with international student and labour mobility will be a challenge, but could provide a compromise between equitable access and the necessary resilience of public finances to cross-border labour mobility. In comparison to tax financed systems such a system is less vulnerable to free riding in a world with international mobility, where income taxes are paid in the country where the graduates are working.

In this context, loan systems with repayments contingent on income can also provide some insurance against risk. Indeed, while average private returns to education remain high, within-education class and within-occupation wage dispersion has increased, suggesting that risks relating to investment in education may be increasing. For example, recent evidence shows that qualification- and job mismatches are substantial in several OECD countries (OECD, 2013g).

Funding reforms are important to improve educational attainment levels, but new methods of training and studying may change the production of higher education dramatically over the coming 50 years. Increasing spread of participation in courses via internet, such as "massive online open courses" suggests ways to increase availability and participation at a low cost. To what extent these new methods can supplant traditional education – reliant on face-to-face interaction with professors and peers – remains an open question.

3.3.5. *International spillovers from educational policies may mainly come through migration patterns*

Trade integration and cross-border labour mobility may generate spillovers of national education policies on partner countries. For instance, recent OECD work explores the

national and global effects of slower increases in human capital stocks in China, India and Indonesia, finding that real GDP by 2060 is lowered by 7% for China, 12% for India and 9% for Indonesia (Johansson and Olaberría, 2014).[24]

The slower upgrading of educational attainment in these emerging economies may spill over globally through trade and migration patterns. Trade spillovers mainly take place through changing patterns of specialisation, with less upgrading of skills pushing up relative wages of skilled labour and slowing the process of specialisation in more human capital intensive production (such as electronics and services). As a consequence, OECD economies will retain more of their comparative advantage in these areas. Nevertheless, the effects on wages in trading partners seem minor (Johansson and Olaberría, 2014).

Higher relative wages for skilled labour in China, India and Indonesia will also affect migration patterns towards the OECD. The analysis in Westmore, 2014 suggests that higher relative wages for skilled workers in emerging economies coming from less ambitious education policies will slow migration flows towards the OECD, whereas inflows of less-skilled migrants will increase. By 2060 the US stock of skilled migrants would then be lowered by around 0.4% of the labour force, while the stock of less-skilled migrants would be larger by roughly the same amount. For the Netherlands, the corresponding numbers would be 1.8% and 2.8%, respectively.

4. Policies to deal with rising inequality and pressures on social institutions

Box 8. **Main policy conclusions on dealing with inequality and pressures on social institutions**

- Further improvements in educational attainment levels can support equity and growth.
- Tighter restrictions on product and labour markets and higher tax wedges would lower gross earning inequality. However, such reforms would hurt growth substantially.
- As more stringent product market regulation and higher tax wedges tend to affect employment negatively, the net impact of such reforms on household income inequality is uncertain. Trade-offs between growth and inequality in household incomes are therefore less severe than between growth and inequality in gross earnings.
- Tax and benefit systems cushion the impact of market income inequality on household disposable income through redistribution. Further global integration will likely increase costs of redistribution, sharpening the growth-equity trade-off provided by tax and benefit systems. Globalisation may also put labour market and social institutions under pressure.

The growing importance of the knowledge-based economy will reward skills. Skill-biased technological change (SBTC) has been a key driver behind rising earning and income inequality in recent decades (Braconier and Ruiz Valenzuela, 2014), whereby technological progress has substituted for routine and medium-level tasks, thereby displacing workers, while increasing the value of other "new economy" tasks (Autor et al., 1998). In the central scenario technological progress is assumed to continue to be skill-biased, following the same trend seen in recent decades.

While skill-biased technological change has been – and is likely to continue to be – the main driver of rising earning inequality, there is little scope for stopping SBTC. As the analysis in Annex 1 shows, SBTC is highly correlated with multifactor productivity growth, meaning that trying to hinder SBTC will slow productivity growth. Furthermore, the strong

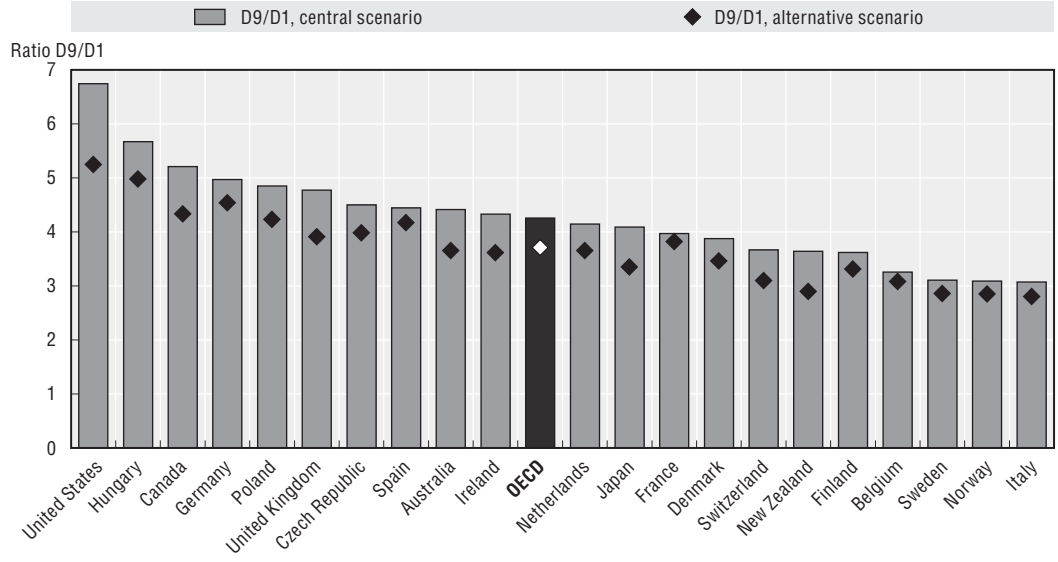
cross-country component in SBTC suggests that even if domestic productivity growth was stopped, global trends in SBTC would affect the domestic economy – through trade – in a skill-biased direction.

4.1. Policy instruments that can lower earning inequality sometimes harm growth

OECD analysis has identified complementarities and trade-offs in broad classes of policy settings vis à vis the twin objectives of enhancing growth and lowering income inequality (Fournier and Koske, 2012; OECD, 2013d; OECD, 2013f, Causa et al., 2014). In the central scenario, increasing educational attainment between 2010 and 2060 is expected to reduce earning inequality, measured as the D9/D1-ratio by roughly 10% in the average OECD country compared with what would have been the case if no increase would take place.[25] As was discussed in Section 2, further increases in educational attainment levels could help contain increases in earning inequality. In order to fully counter projected increases in earning inequality, a very ambitious scaling up of education policies would be needed however. In turn, reducing inequality by other means could have positive repercussions on educational attainment as high inequality reduces investment in education for poor households who are credit constrained.

Changes in structural policies and settings – such as regulations and structures in product and labour markets – over recent decades have contributed to rising earning inequality (OECD, 2011a; Braconier and Ruiz Valenzuela, 2014). Reversing these developments could lower earning inequality. To illustrate how earnings-equalising structural reforms may impact earnings dispersion, a scenario is constructed in which product market regulations, employment protection, union coverage and tax wedges are assumed to converge to the highest levels prevailing in the OECD area around 2010.[26] The thought experiment, based on analysis in Braconier and Ruiz Valenzuela, 2014, suggests that the

Figure 17. **Decrease in earnings inequality if employment protection, union coverage, tax wedges and product market regulation converge to the highest levels in the sample (2060)**



Note: OECD average of the 21 countries included. Highest levels are identified for the last available year in the sample. These correspond to: France (employment protection), Austria (union coverage), Belgium (tax wedges) and Poland (product market regulation).
Source: OECD estimates.

baseline increase in earning inequality up until 2060 would be reduced from 30% to 16% for the average OECD country (Figure 17). Effects would be larger for English-speaking countries, where there is more room for policy settings to adjust.

However, as indicated in Table 1, such earning-equalising reforms would – perhaps severely – harm growth, reflecting an acute trade-off.[27] This negative impact is due to two types of mechanisms. First, especially in knowledge-based economies, extensive product market regulation tends to slow structural transformation, hampering the ability of the economy to fully benefit from new technologies and organisational improvements. Second, structural settings that tend to affect wages positively in the lower part of the spectrum may also lower employment, thereby affecting GDP negatively.

4.2. Trade-offs between the distribution of household disposable income and growth are often less severe but may grow as international integration proceeds

Policies to address rising gross earning inequality are just one step to mitigate rising income inequality, however. Conceptually, the effect of any policy on after tax labour incomes in the lower part of the distribution can be decomposed into three effects: the gross wage effect, the employment effect and the net tax and benefit effect, where the D9/D1 earning-differential only incorporates the wage effect. For example, higher tax wedges seem to lower earning dispersion (Braconier and Ruiz Valenzuela, 2014), but at the same time lower employment (Arnold et al., 2011). In addition, they also affect after tax incomes, with an inconclusive net effect on the inequality of disposable income (Causa et al., 2014). The influence of policies on labour market patterns (such as participation rates and the extent of part-time work) and tax and benefit systems are therefore important drivers of the wedge between gross earnings inequality and inequality of household disposable incomes. Sometimes these wedges are large enough to lead to diverging developments of gross earnings and household disposable incomes (Table 1, columns 3 and 4).

Table 1. **Impact of structural reforms on growth, earning dispersion and equality in household incomes**

	Effect on GDP	Effect on employment	Effect on earning equality (D9/D1)	Effect on equality in disposable income
Increasing overall employment protection	0/- (Bouis et al., 2011; Causa et al., 2014)	0 (Bassanini and Duval, 2006; OECD, 2011b)	+ (OECD,2011b; Braconier and Ruiz Valenzuela, 2014)	? (Causa et al., 2014)
Higher union coverage	?	- (OECD, 2011b)	+ (OECD, 2011b; Fournier and Koske, 2012)	?
More stringent product market regulation	- (Bouis et al., 2011; Johansson and Olaberría, 2014)	-[1] (Bassanini and Duval, 2006; OECD, 2011b)	+ (OECD, 2011b, Braconier and Ruiz Valenzuela, 2014)	- (Causa et al., 2014)
Higher tax wedges	- (Arnold et al., 2011; Causa et al., 2014)	- (Bassanini and Duval, 2006; OECD, 2011b)	+ (OECD, 2011b)	0 (Causa et al., 2014)
Higher unemployment benefits	? (Causa et al., 2014)	- (Bassanini and Duval, 2006; OECD, 2011b)	- (OECD, 2011b)	0/+[2] (Causa et al., 2014)

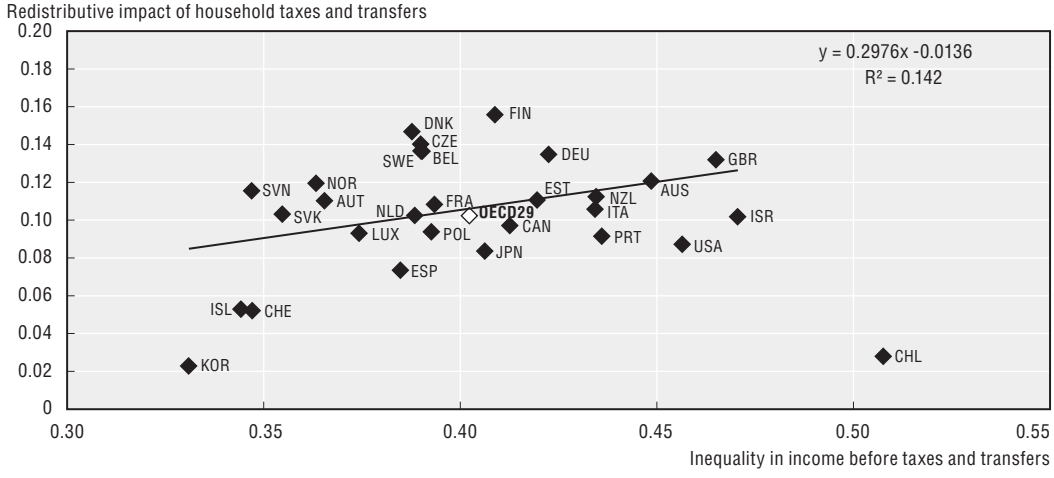
1. Bassanini and Duval (2006) find a negative and significant effect for female but not for male employment rates.
2. The positive effect relates to benefits for long-term unemployed.

Differential impacts of structural reforms on earnings inequality and employment sometimes raise difficult policy trade-offs. The severity of these trade-offs varies across

policies. For example, product market reforms tend to increase employment but also raise earning inequality (Table 1). In contrast many pro-employment policies – like lowering the gap in employment protection between those on permanent and temporary contracts – will also tend to lower inequality and thus do not exhibit such a trade-off (OECD, 2012a). The severity of trade-offs can be mitigated by combining structural reforms with conditionality. Strict conditionality may, for example, mitigate the negative employment effects of large tax wedges or high unemployment benefits.

In general, tax and transfer systems cushion the impact of changes in market earnings to household disposable income, but as transfer systems in the OECD area have become less redistributive, their mitigating impact has decreased over the past decades (OECD, 2011b; Joumard et al., 2012). While the redistributive impact tends to be larger in countries with higher pre-tax and pre–transfer income inequality, there is substantial cross-country variation in efficacy, mainly due to the redistributive effects of transfers (Figure 18). This suggests scope for better-targeted tax and benefit systems to mitigate the impact of rising market income inequality on household income dispersion in many countries. Well-designed social benefit systems also provide additional benefits through providing *ex ante* risk-insurance (and thus *ex post* equity), while lowering moral hazard and incentive problems (and thus more efficiency) through conditionality (Andersen, 2013).

Figure 18. **Taxes and transfers reduce income dispersion, and more so in "unequal" countries**



Note: Inequality in income before taxes and transfers is measured by the concentration coefficient. The redistributive impact of taxes and transfers is defined as the difference in the concentration coefficients for income before cash transfers and taxes (i.e. household market income) and after cash transfers and taxes (i.e. household disposable income). Two approaches can be used to measure the concentration of market income, i.e. by ranking households by their market income or by their disposable income. In this illustration and, throughout the paper, households have been ranked by disposable income due to data limitations (see Box 4.1 for more discussion). The trend line shown above has been calculated excluding Chile.

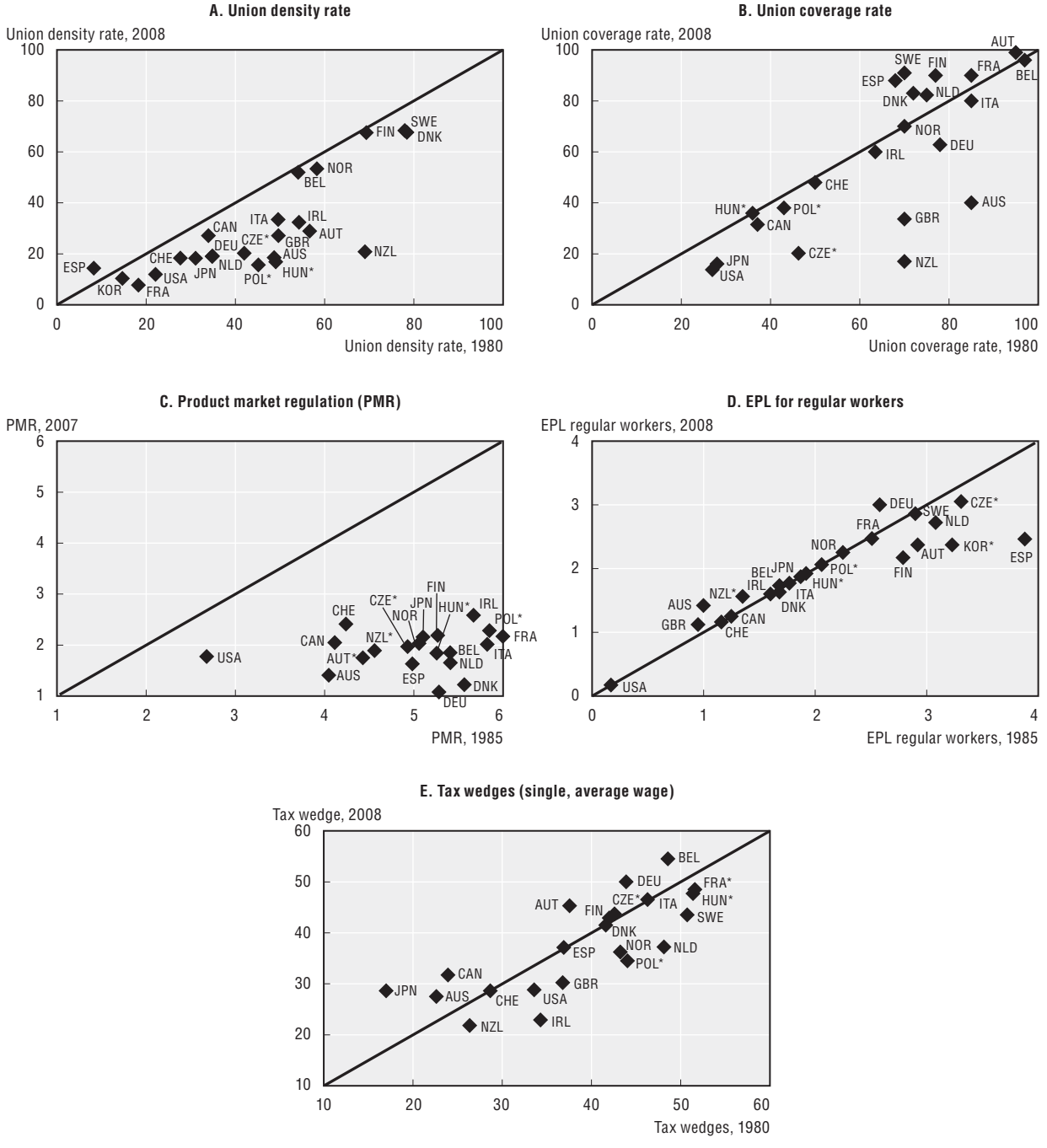
Source: OECD Household Income Distribution and Poverty Database, December 2012.

Increasing global integration and rising competition for mobile skilled workers may reduce the economic viability of some redistribution instruments, as these often impose costs on firms and taxpayers. This could lead to an institutional "race to the bottom" (Myles and Quadagno, 2002). The concomitant increases of the demand for redistribution (as earning differentials increase) and of the costs of redistribution points to a sharpening growth-equity trade-off for national policy makers. This challenge can be addressed in three ways: greater

reliance on increasing equality of opportunity, such as educational reforms already discussed; a shift of taxes from mobile to less mobile tax bases; increased international coordination of tax policies. The latter two options will be discussed in Section 6.

A "race to the bottom" is by no means a certain outcome of further global integration and SBTC. First, many labour market and social institutions provide income insurance

Figure 19. **Changes in labour market institutions and policies, 1980-2008**



* The series begin in the 1990s.

Source: Union coverage (B) and union centralisation/co-ordination (C) from Visser (2009); all others are from *OECD Employment Database*, *OECD Taxing Wages Database and OECD Benefits and Wages Database*, OECD (2011), *Divided We Stand: Why Inequality Keeps Rising*.

against productivity, unemployment and health risks (Andersen, 2008). To the extent that rising globalisation and SBTC would imply larger such risks, the demand (and willingness to pay) for insurance would likely rise as they proceed. Second, there is only patchy evidence that rising global integration so far has affected the extent of social and labour market reforms. While corporate taxes, product market regulation and union density have fallen significantly since 1980, (regular) employment protection has remained fairly stable (Figure 19). Third, the projected strong growth of emerging economies is likely to result in labour market institutions in these regions becoming more developed and social spending rising in relation to GDP.

5. Policies to address climate change

Box 9. **Addressing climate change requires a mix of policies**

- Dealing with climate change requires a balanced set of policies to i) mitigate climate change by reducing emissions that are the drivers of climate change, and ii) adapt to the remaining impacts.
- A broad policy mix is needed to mitigate climate change, with appropriate pricing of carbon complemented by more targeted measures that may include reforming fossil-fuel subsidies, standards and regulations, increased investment in R&D, regulatory reforms of energy and transport markets and information-based policies.
- A negative side-effect of rising trade integration could be that the location of emission-intensive production becomes more sensitive to energy-prices, promoting tax and subsidy competition and excessive emissions. In the absence of a binding multilateral agreement on emissions reduction, pressure for alternative mechanisms such as border carbon adjustments will increasingly be felt. The potential costs and practical difficulties of implementing such measures should provide a strong incentive to find a globally coordinated solution. In the meantime, regional co-operation such as through plurilateral linking of carbon markets can help to reduce effects of carbon emissions "leakage".
- At the same time, integrated economies may be better able to share the costs of climate damages through shifting trade patterns in response. Given that regional environmental impacts are hard to predict, international trade and investment integration provides some insurance against climate change risk, as long as impacts are not strongly positively correlated across regions.
- A switch towards more environmentally friendly sources of energy could lower climate change damages and improve global welfare, but may require some substantial initial up-front investment.

As discussed in Section 2, the full costs of climate change will be felt beyond 2060, but costs will already be significant by 2060 in the central scenario. These costs should be seen in the context of rising risks for threshold effects that would trigger a major negative event, due to the inertia built into polluting production systems (e.g. energy plants and transport systems) and atmospheric greenhouse gas concentrations. There is therefore a need for swift policy action both for mitigation and for adaptation (OECD, 2009).

A broad policy mix is needed to mitigate climate change, with appropriate pricing of carbon complemented by more targeted measures that may include reform of fossil-fuel subsidies, standards and regulations (e.g. energy efficiency standards in buildings),

increased investment in R&D, energy market regulation reforms and information-based policies (e.g. energy efficiency labels). Such policies would not only help to address environmental damages, but could also generate significant fiscal revenues. For example, recent analysis (OECD, 2013i) identifies 550 measures that support fossil-fuel production or use, amounting to USD 90 billion in 2011. Meanwhile, the IEA estimates that price-driven subsidies encouraging the consumption of fossil fuels in a selection of emerging and developing countries amounted to approximately USD 544 billion in 2012 (IEA, 2013). Estimates in OECD (2009) suggest that fiscal revenues from stabilising CO_2 concentration around 450 parts per million (ppm) could amount to 6% of GDP per year by 2050, although large uncertainties surround these estimates.[28]

Comparable cross-country data gathered by the OECD shows a significant increase in the use and stringency of environmental policy instruments (of which climate change policies are a subset) over the past two decades, helping to limit the economic risks of unabated environmental damage. In addition, increasing stringency does not seem to harm productivity, and the most technologically-advanced industries and firms have experienced higher productivity levels as a result of tightening environmental policies (Kozluk et al., 2014).

The global consequences of climate change point to the need for a co-operative policy solution. Countries are working through the UN towards a global agreement in 2015, but challenges to co-operation are substantial, reflecting the fact that costs and benefits differ widely across countries.[29] Convergence in per capita income over the coming 50 years may lower somewhat global differences in preference for emission abatement and climate change mitigation. This could facilitate coordination, but the heterogeneous economic impacts of climate change may hinder it.

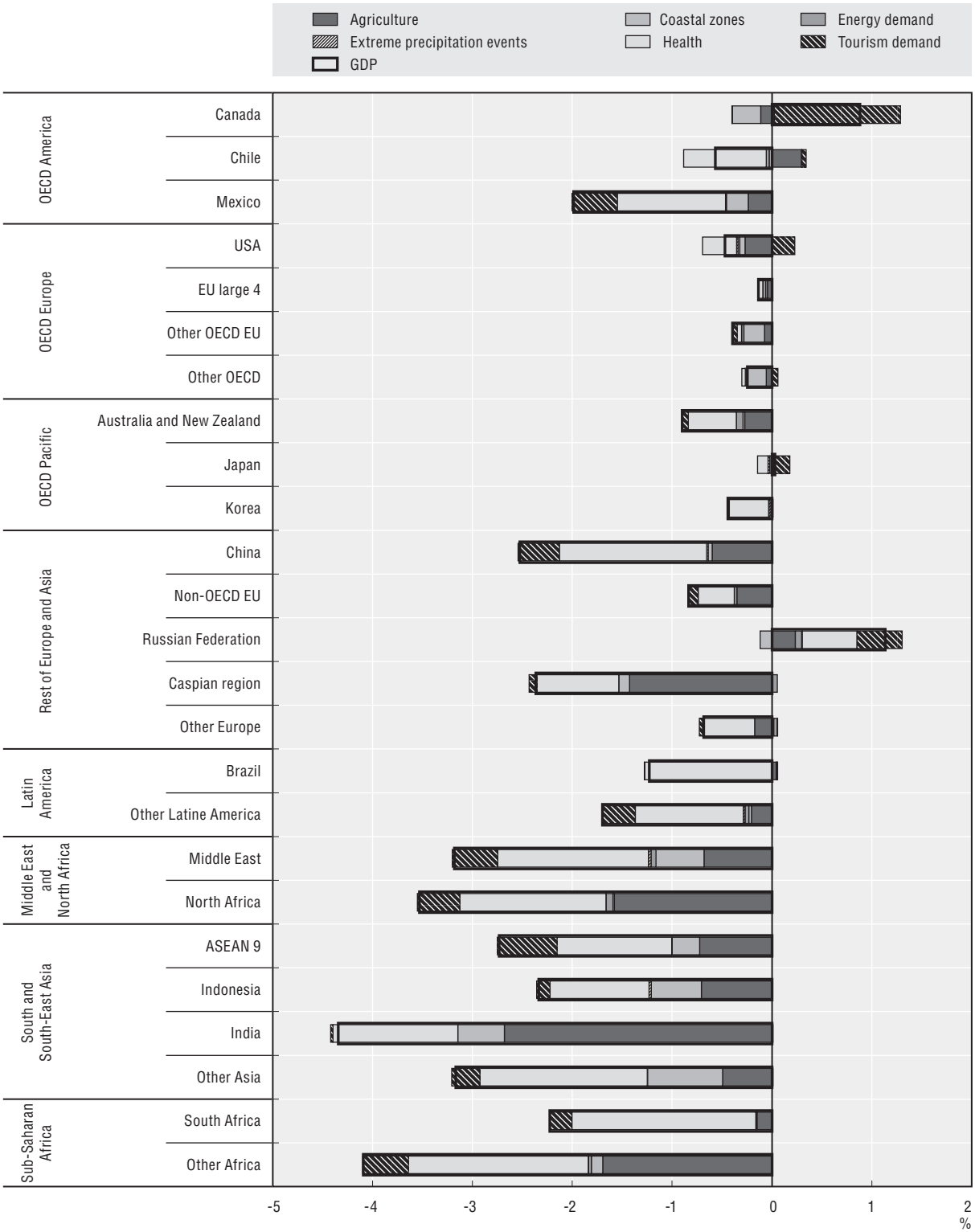
Co-ordination problems may be exacerbated by further falls in trade costs, which will make the localisation of high-emission activities more sensitive to local costs and may dissuade countries from imposing higher carbon prices for fear of the relocation of some activities to pollution havens. In the absence of enhanced international co-operation on emissions reduction agreed at the multilateral level, pressure for alternative mechanisms such as border carbon adjustments will increasingly be felt notwithstanding the practical difficulties their implementation would raise (Cosbey, 2008). The potential costs of such measures should provide a strong incentive to find a globally co-ordinated solution. In the meantime, regional co-operation such as through plurilateral linking of carbon markets can help to reduce effects of carbon emissions "leakage".

Changing climatic conditions will affect relative production costs and therefore comparative advantages of countries. For example, a climate change-induced decline in agricultural production could subtract between around 1 and 2% from GDP in some African and South-East Asian regions at 2060 (Figure 20). Further global trade integration can lower the costs of adapting to climate change by allowing specialisation patterns to shift and global adaptation to take place at a lower cost, although international trade also contributes to emissions.

While estimates of global climate change damages are surrounded by uncertainties, the distribution of regional damages is even more uncertain. In addition, risks of more dramatic regional developments even within the coming 50 years are substantial, with associated costs in terms of disrupted food supply, lost output and environmental migration pressures. Given high levels of uncertainty around regional impacts, global

Figure 20. **Contribution to GDP impact from climate change**

Damages by region and impact category in 2060



Note: The figure indicates percentage change in GDP at 2060 relative to the "no-damages" baseline.
Source: OECD (2015).

risk-sharing mechanisms could be valuable. While trade integration provides one such mechanism further financial integration, especially in terms of long-term investment, could also improve risk sharing.

Climate change mitigation will require substantial investment in developing new technologies, improving the uptake of existing technologies, and developing greener energy systems. Similarly, climate change will mean that large investments in adaptation will be required, especially as a certain amount of damages from climate change are likely to be already "locked in". Enabling pension funds to invest more freely across borders could provide additional sources for long-term investment in mitigation and adaptation, without jeopardising macroeconomic balances.

6. Policies to deal with fiscal challenges

Box 10. **Policies to deal with fiscal challenges**

- Fiscal pressures from fiscal gaps and health and pension spending are estimated to 10% of GDP in 2060 for the average OECD country, with additional fiscal risks associated with education cost and slowing migration. Dealing solely with these challenges through fiscal consolidation would substantially lower both growth and equity. Therefore, structural reforms to reduce reliance on public funding should be sought.
- In the light of large uncertainties relating to demographics and productivity, the resilience of public finances could be increased by moving to defined-contribution pension systems. This would however shift more risks towards participants.
- Further global integration will make some tax bases more mobile. Rising tax competition due to increased mobility will put pressure on environmental (production-based) taxes and corporate taxes, with negative impacts on the environment (and hence growth) and equity. One option will be to switch taxation towards less mobile tax bases including property, resource extraction and consumption based taxes.
- Stronger global tax co-ordination in areas where global negative externalities are large (e.g. carbon taxation) would be beneficial and could increase efficiency and raise revenues. These benefits will rise as global integration continues.

6.1. Fiscal challenges could force countries to consolidate through increasingly bad instruments

Section 2 described the fiscal challenges and risks that OECD countries will likely face over the coming 50 years. Recent OECD analysis has shown that many tools for fiscal consolidation imply trade-offs with growth, equity and current account imbalances, especially in the short run (Cournède et al., 2013).[30] The extent to which countries should utilise consolidation instruments with negative side-effects depends on the scale of needed consolidation, national preferences in terms of income versus equity, and the relative efficacy of instruments. Table 2 gives the ranking of consolidation instruments based on their assessed impact on long-term growth and equity, disregarding country-specific factors and preferences.[31]

This ranking provides a good starting point for strategies to address fiscal challenges, but some further issues apply when focusing on the 2060 horizon. First as shown in Section 2, long-term consolidation needs are likely larger than those identified in Cournède et al. (2013). This may force countries to increasingly rely on "bad" instruments to address unsustainable

Table 2. **Assessment of long-term growth and equity effects of fiscal consolidation instruments**

Instrument	Long-term ranking	Growth	Equity
Subsidies	1	++	+
Pensions	2	++	
Other property taxes	3-6		+
Unemployment benefits	3-6	+	
Environmental taxes	3-6	+	
Recurrent taxes on immovable property	7-9		
Sales of goods and services	7-9	+	-
Sickness and disability payments	7-9	+	-
Personal income taxes	10-12	--	+
Corporate income taxes	10-12	--	+
Consumption taxes (other than environmental)	10-12		
Public investment	13-14	--	
Health services provided in kind	13-14	-	-
Social security contributions	15-16	--	-
Family	15-16	-	--
Education	17	--	--

Note: The table shows the effect of a cut in spending or an increase in tax on GDP growth and equity in the distribution of disposable income.
Source: Cournède et al., (2013); authors' calculations.

fiscal positions – at least in the absence of structural reforms – with adverse effects on growth and equity. Second, fiscal costs of pensions (based on existing and legislated rules), expanding educational spending, and the risk of additional labour shortages from a drying up of immigration to OECD countries, adds to the estimated consolidation needs that Cournède et al. (2013) identify.

6.2. Structural reforms can mitigate fiscal pressures and help managing risks

In several cases, structural reforms can mitigate fiscal pressures without harming growth and equity, thus providing a way to avoid difficult trade-offs. As has already been discussed – and implicitly assumed in the baseline scenario – longevity adjustment of the retirement age can help resolving soaring pension deficits, while a stronger reliance on tuition fees can fund the expected growth in tertiary education. In both cases, positive side effects on growth (retirement reform) and equity (tuition reforms) could result, if policies are carefully implemented. Also in other areas, like financing of infrastructure or long-term care, a greater reliance on private funds could be considered.

Given uncertainty about future developments, structural reforms can also increase resilience of public finances to unexpected developments and exogenous shocks. State-dependent policies – including automatic longevity adjustment of retirement ages and balancing mechanisms in e.g. pension systems – can be particularly useful here, although such policies in themselves do not resolve the trade-off between sustainability, adequacy and efficiency that social protection systems face, with generous systems often providing high adequacy, but low financial sustainability and efficiency (Fall, 2014). In the case of several of the main risks discussed in Section 2, defined-contribution pension (both notional and fully-funded) systems are more resilient to such shocks than defined-benefit systems. For example, when comparing pay-as-you-go pension systems with defined benefits (DB) and defined contributions (DC), Fall (2014) shows that the effects of productivity, longevity and migration shocks will mainly affect the financial balance in the

DB system but not in the DC system. However, this resilience comes at the cost of shifting more of income risks towards participants in a DC system (Lindbeck and Persson, 2003).

Demographic shocks can also impact the capital returns of funded pension systems, as a weaker development of the labour force leads to lower returns on domestic capital. Hence, policy settings that enable investment by pension funds in foreign markets can improve allocation of capital across countries and be beneficial both through raising returns and sharing productivity and migration risks. These benefits will however have to be weighed against the costs associated with higher exchange rate risk. Policy measures that facilitate the portability of workers' pension benefits may improve the allocation of labour to regions where shortages are most chronic, while countries that provide portable and attractive (actuarially neutral) pension benefits may be able to attract foreign workers.

6.3. Rising global integration may reorder the ranking of fiscal instruments over the coming 50 years

The ranking of fiscal instruments may also change over the coming 50 years, as economic structures and policy objectives evolve and rising global integration potentially raises the efficiency losses of fiscal consolidation.

Rising global integration will further increase the cross-border mobility of capital and production, raising the deadweight costs of taxing these sources. In addition, the rising importance of knowledge-intensive (non-physical) assets and multinational enterprises in the global economy affects the ability of governments to collect taxes, as the possibilities to shift profits across borders are significant. Thus corporate income taxes, but also production-oriented environmental taxes, will likely become less efficient as fiscal instruments for the individual country.

At the same time, the risks that tax competition in these areas will drive down tax rates below optimal levels – with repercussions for income distribution and the environment, respectively – point to potential gains from international tax coordination.[32] As discussed in Section 5, the fiscal revenues from co-ordinated environmental action could be large. Such co-ordination has to be quite broadly encompassing, however, as there would be some leakages from more limited participation. Similar arguments, although to a lesser extent, could also apply to personal income taxes given the income sensitivity of migration.[33]

Changes in the ranking of instruments may also vary across countries, reflecting how each is likely to move in terms of income levels and inequality. Countries that may experience above-average increases in incomes and inequality (such as the Czech Republic) may wish to prioritise fiscal instruments with lower impact on inequality (like raising personal income taxes), especially if their current position in terms of income and equity reflects social preferences. Conversely, countries that are likely to face below-average increases in incomes and inequality (such as New Zealand) may wish to put higher priority on using growth-enhancing fiscal instruments.

7. Policies for greater macroeconomic stability over the coming 50 years

Box 11. **Improving macroeconomic resilience and stability**

- With increasing economic integration, the effects of domestic shocks will be increasingly shared with trading partners, diminishing the domestic impact and hence the need for

Box 11. **Improving macroeconomic resilience and stability** *(cont.)*

stabilisation policies. At the same time the efficacy of domestic fiscal policy for stabilisation will also diminish with increasing integration, pointing to an increasing scope for co-operative stabilisation policies, whenever possible.

- Concerted efforts in deficit and surplus countries to hinder a renewed build-up of current account imbalances is needed, including via both structural and fiscal measures.

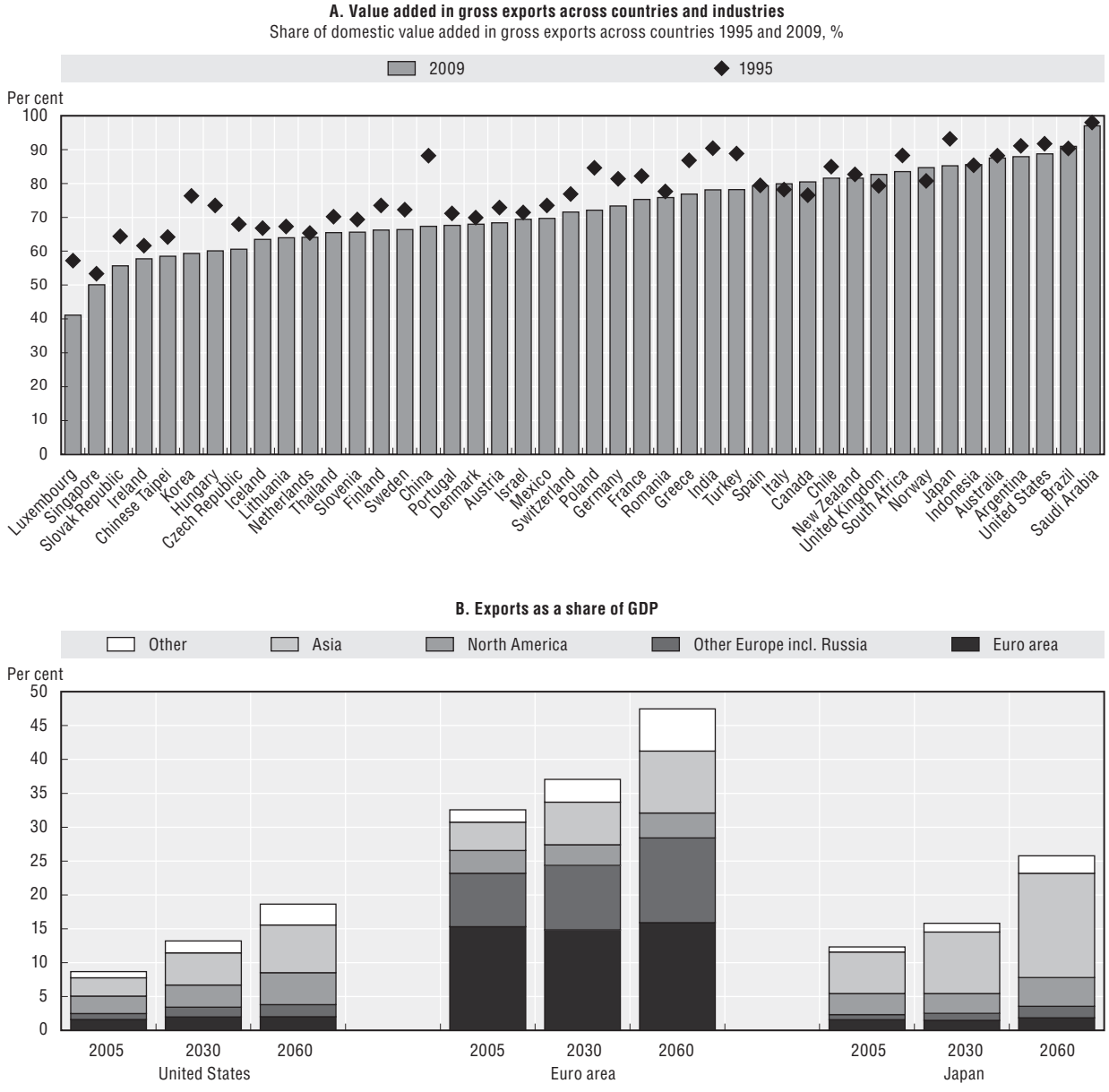
7.1. Rising trade integration will increase interdependence and could require stronger international co-ordination on fiscal and structural policies

Trade and investment integration generates not only economic but also policy interdependence among partner countries. With world trade expected to increase from 25% to almost 45% of global GDP in the central scenario, the median OECD country will be 23% more open in 2060 than in 2010. Moreover, international trade in intermediate inputs has grown even more rapidly than total trade, reflecting the increasing complexity of global supply chains, with the share of domestic value added in gross exports falling in most economies (Figure 21, Panel A). Continued decline in transport and transaction costs, improved logistics and an increasing availability of ICT tools to manage production across locations and countries will likely mean that these trends will continue, although cost convergence across countries will dampen the impact (OECD, 2013d). Long and complex supply chains propagate supply shocks across borders effectively and quickly, as illustrated by the global repercussions of the 2011 Tohoku earthquake and tsunami that hit Japan (OECD, 2011). Combined with the rise in trade openness, these trends will likely result in the international spillovers from demand and supply shocks increasing steeply.

More intertwined economies will mean increased risk-sharing, where trading partners will share the burdens of country-specific shocks and policies. This will raise the exposure of countries to ill-executed and – if economic cycles are not synchronised – ill-timed policies in trading partners, while benefitting less from well-conducted domestic policies. Further co-ordination on stabilisation and structural policies between close trade partners (like the EU) would therefore be useful (Di Giovanni and Levchenko, 2009). But, in the longer-run, it will be important for OECD countries to develop co-ordination with emerging economies. OECD countries' exposure to shocks emanating from emerging economies is already significant (OECD, 2013b). As trade integration proceeds and the importance of emerging economies in the world economy increases, the magnitude of such spillovers will rise rapidly (Figure 21, Panel B). In 2060 euro area exports to Asia, Africa and Latin America will amount to 15% of GDP and be as big as exports within the euro area.

Deeper integration should have a stabilising impact on economies in general and make business cycles more synchronised.[34] This stabilising effect may be more muted for OECD countries which will experience a rising exposure to emerging economies – where volatility tends to be higher. As cross-border trade increase, domestic fiscal multipliers are likely to diminish as leakages increase. Thus, while the impact of a given shock on the domestic economy decreases, the effectiveness of policies to address it – both in terms of automatic stabilisers and discretionary measures – will also decrease. The need for domestic stabilisation policies may therefore fall, while the costs will increase. The benefits from international co-operation in monetary and fiscal action will rise, especially as business cycles become more synchronised.

Figure 21. **OECD countries will become increasingly exposed to shocks from emerging economies**



Source: Own calculations based on Johansson and Olaberría (2014).

7.2. Polices to handle current account imbalances and mitigate their impact

A targeted use of structural policy instruments could prevent a renewed build-up of current account imbalances in the medium term (OECD, 2013a): labour market reforms in euro area deficit countries and Japan, product market reforms in euro area surplus countries, less favourable tax treatment of interest expenses in the United States, and financial liberalisation and expanding social safety nets in China could raise growth, improve efficiency and dampen global imbalances (Figure 7; Ollivaud and Schwellnus, 2013).

In the longer term, demographic factors (including migration) and fiscal policies will tend to drive current account imbalances. Apart from addressing large imbalances, policies need to

mitigate risks that global – and regional – imbalances lead to future macroeconomic crises. While the evolution of international financial linkages over the coming 50 years is very much an open question – reflecting uncertainty around the "rules of the game" that will emerge – the composition of those linkages matter to the probability that imbalances will lead to a crisis. A high reliance on short-term borrowing in foreign currency increases risks of current account and financial crises, whereas capital inflows in terms of FDI and equity seem to pose much less risks (Ahrend and Goujard, 2012). To the extent that the rising importance of knowledge-based assets in production and lower transport and trade costs continue to feed FDI, it can play an increasingly important role in mitigating current account risks. From this perspective, international policy coordination (e.g. on IPR or corporate taxation) could facilitate further FDI penetration and thus stability. For emerging countries further liberalisation of capital controls has tended to make them less prone to current account crises (Frankel and Wei, 2004), although recent developments have challenged that view (Rey, 2013).

8. Economic policies for a shifting world

Even though the world economy will change substantially over the coming 50 years, many policy issues and priorities are likely to remain valid to 2060. Material living standards and life expectancy will probably keep improving substantially – especially in emerging economies – lifting billions out of poverty. Still, resource scarcity will persist and in some areas may be more pressing, such as in terms of public funds and non-renewable resources. Policies that enhance productivity, that support equity, that ensure robust public finances, and that discourages overuse of natural resources will therefore still be important as will be the need to strengthen and enhance economic and political institutions.

A changing economic environment – and uncertainty around future developments – will, however, likely shift the way those policies should be pursued. The main conclusions from the analysis are:

8.1. Supporting growth

- Further global integration and the rising reliance on knowledge-based assets for growth will increase potential benefits from international co-ordination and co-operation on the provision of certain global public goods. Thus growth could be enhanced by international co-ordination on basic research, legislation on intellectual property rights and competition regulation and enforcement. Rising trade integration will also make international co-operation on taxation of greenhouse gas emissions and highly mobile tax bases (such as capital and intangibles) more important.
- Flexible product and labour markets will become even more important for growth, supporting a faster deployment and absorption of new technologies and methods and lowering costs of structural adjustment (and probably also contributing to reduce potential impediments to growth for currently emerging economies). In addition they may improve the incentives for work-related migration contributing to diminish the ageing shock in individual countries. Such policies will, however, have to be pursued in a way that cushions their potentially negative impact on equity.
- Private and social returns to education are likely to rise, creating potential for stronger growth and lower increases in inequality. Given tight fiscal conditions, public funds should be focused on pre-tertiary education (with high social returns) and life-long learning (where international labour mobility is low). Tertiary education should expand

through higher reliance on tuition due to fiscal constraints and efficiency considerations. A tuition-based and loan-financed system is likely to be more efficient in recovering costs than a tax based system in a world with high mobility of skilled labour.

8.2. Improving equity and the functioning of labour markets

- Even though productivity growth will tend to increase incomes for most groups, earning inequalities are likely to continue to rise as long as technological progress remains skill-biased. Structural policies that can mitigate inequality in pre-tax earnings (such as employment protection) are often very costly in growth terms, and their ability to counteract skill-biased technological change is limited. This policy dilemma may be addressed by putting more emphasis on policies that enhance equality of opportunities (e.g. in education).
- It may be the case that the pace of structural change will slow in OECD economies over the coming decades, as increases in trade intensity and the pace of productivity growth will be slower than in the past. Emerging economies will at least initially face a much higher pace of structural change, reflecting inter alia the transition from high dependence on agriculture. The flexibility of the workforce will, however, decline in both regions reflecting ageing, longer working lives and rapidly evolving skill requirements. Thus, while the overall need to support restructuring with active labour market policies may not increase (at least in the OECD), the composition of such policies should change to reflect the ageing workforce, with an added emphasis on training and lowering reservation wages.

8.3. Addressing rising climate change costs

- Economic costs of climate change are projected to already be significant by 2060. Given the lag between policy action and effects on climate, and in particular the risk of locking-in emission intensive infrastructure, action should be front-loaded. An appropriate pricing of carbon emissions is crucial to discourage emissions, but requires international co-ordinated efforts.
- Further global trade and investment integration will make production-based taxes on emission-intensive activities less efficient, especially in the absence of a binding multilateral agreement on emissions reduction. Although alternative mechanisms such as border carbon adjustments can appear an attractive solution, the practical difficulties and potential costs of such measures should provide a strong incentive to find a globally coordinated solution.
- Trade and (long-term) investment integration can improve risk-sharing of hard-to-predict climate damages.

8.4. Fiscal and macroeconomic strategies

- Fiscal challenges and risks over the coming 50 years are large. On top of needed consolidation, structural reforms to save on costs (e.g. of education) and increase the resilience of public finances (e.g. pension systems) to shocks (e.g. from migration) are needed.
- Further global integration combined with an increasing reliance on mobile intangible inputs in growth will raise the social costs of taxing capital and other mobile factors for a single country. A shift of taxation towards more immobile tax bases would therefore be warranted. Global co-ordination on taxation would support fiscal positions and equity.

- With rising global integration, domestic shocks will increasingly be shared with trade partners. On average volatility may fall, lowering the need for stabilisation. At the same time, the stabilising properties of fiscal policies will diminish. Benefits from macroeconomic co-ordination are likely to rise.
- Increasing cross-border long-term investment integration would improve risk-sharing and lower risks of sudden reversals due to current account imbalances.

Notes

1. Among them, the complex and excessive build-up of imbalances within and between countries and sectors; an increasing global financial interdependence; and a lack of national, regional and global institutions that could deal with the related policy challenges in an effective and comprehensive way.
2. The cut-off date for data used in designing the scenarios is 15 April 2014. This means that recent PPP updates for emerging economies are not incorporated.
3. See Cournède et al. (2014).
4. On the positive side, income convergence may also entail preference convergence, which could simplify co-ordination.
5. Note that this measure of MFP growth is computed accounting for changes in the human capital input (for details of the methodology, see Johansson et al., 2013), hence growth will tend to be lower than in a measure that controls only for labour (unadjusted for human capital) and capital inputs. The MFP projections are a function of growth at the technological frontier, changes in product market regulations and convergence to the frontier. The presented numbers refer to MFP, which differs slightly from the concept of labour efficiency presented in the *Economic Outlook Long-term Database*. Specifically, log(MFP)=log(labour efficiency)*(labour share), with the labour share held constant at 2/3 in the long-term central scenario.
6. See Section 4 and Annex 1 on references to and evidence on income inequality and educational attainment as well as how rising per capita incomes seem to increase demand for less-educated workers and hence tend to lower earning inequality.
7. Potentially, a falling labour share in GDP could add to these distributional pressures, but such effects are not considered in the analysis. The labour share of GDP has fallen by 1.5 percentage points in the average OECD country between 1985 and 2010 and more than 5 percentage points in Germany, Ireland and New Zealand.
8. More specifically, the central scenario assumes that relationships between earning differentials on the one hand, and explanatory factors (multifactor productivity, the ratio of skilled to unskilled labour and product market regulation) on the other, remain the same going forward as they were the from the mid-1980s to the late 2000s. This means that technological progress is assumed to remain skill-biased to the same extent as experienced the last few decades. See Annex 1 for further details.
9. Given the important role that demographic factors play in determining current accounts, changing migration flows could also have an important impact going forward.
10. Fiscal consolidation takes time to significantly dampen imbalances, with much of the effect occurring after 2020.
11. Andrews and Westmore (2014) provide arguments and numerical analysis around an optimistic scenario.
12. In the very long run (beyond 2100), mean years of schooling are assumed to converge to 18 years.
13. Note however that a significant part of the rise in earning dispersion relates to within skill category and within occupations.
14. These conclusions are based on the "Partial multilateral" trade liberalisation scenario in Johansson and Olaberría (2014), based on multilateral cuts in tariffs (50%) and transactions costs (25%), relative to baseline.
15. See e.g. IMF (2007) and OECD (2011). Some studies do however find a larger effect on inequality from trade (See e.g. Autor and Dorn, 2013).

16. Effective patent systems are also highly dependent on strong courts and well-designed review mechanisms and may benefit in many emerging economies if stronger institutions develop in line with rising GDP per capita.

17. For example, the emergence of "patent thickets" – i.e. webs of overlapping IPRs (Shapiro, 2001) – can particularly hamper young firms with little bargaining power through having to pay licensing fees to multiple parties or having production held-up as they try to commercialise new technology (UK IPO, 2011; Cockburn et al., 2009).

18. Bloom et al. (2012) attribute at least one-half of the United States-Europe difference in labour productivity growth between 1995 and 2004 to superior management practices, which significantly raised the productivity of ICT capital in the United States. The key role of management skills for the transmission of frontier technologies is supported by the empirical analysis presented in Andrews and Westmore (2014).

19. At the same time, to the extent that the pace of technological progress will tend to slow as convergence takes place and structural change slows down, it may be the case that skill requirements will increase less rapidly than in recent decades.

20. The analysis in Braconier (2014) shows that improved educational performance in secondary schooling – measured as PISA scores – raises demand for education and enhances supply of tertiary education. A higher quality of entrants into tertiary education will make students' progress more easily, less likely to drop out, and will also affect peers ability to progress positively (Winston, 1999).

21. Braconier (2014) provides two alternative scenarios for graduation rates up to 2060 in terms of total direct costs and fiscal costs of expanding tertiary education. The scenarios are maintaining current levels of graduation, and expanding graduations in line with demand with either public or private funding.

22. This likely reflects that universities that rely more on co-payments become more focused on "delivery" of degrees, but may also encourage students to finalise studies quickly and discourage entry of students with low probabilities of completing university.

23. Total direct costs include costs relating to wage costs for staff and cost for buildings and equipment. They neither include living expenses nor foregone earnings of students.

24. The central scenario projects that educational attainment levels in emerging economies will grow rapidly, for example with mean years of schooling tripling from three to nine years in India between 1990 and 2060.

25. On the positive relationship between education and equity, de Gregorio and Lee (2002), Heckman (2005) and Koske et al. (2012) focus on different aspects. See also Causa et al. (2009) on the effects of education on social mobility.

26. These anchors are provided, respectively, by Poland 2011 (product market regulation), Austria 2007 (union coverage), France 2008 (employment protection) and Belgium 2008 (tax wedge).

27. To give a numerical example the assumed tightening in product market regulation would – based on the estimates presented in Johansson et al. (2013) – lower GDP by around 20% on average for the countries in Figure 21.

28. OECD (2009) reported scenarios to 2050, ten years before the forecast horizon of the long-term growth model.

29. As greenhouse gases are uniformly mixing in the atmosphere, there are huge free-rider issues hampering international mitigation policies: the benefits of local action are globally reaped, but costs are local.

30. The long-term trade-offs are likely less severe however, as unsustainable debt positions will eventually harm growth and redistributive capacity.

31. See Cournède et al. (2013) for ranking based on country characteristics.

32. See e.g. Sorensen (2004) for the benefits of global co-ordination on capital taxation and OECD (2009), page 87 on leakages related to restricting carbon emissions.

33. Given that knowledge based asset growth is highly reliant on the accumulation of mobile factors such as highly skilled labour, countries' ability to grow at the pace projected in the central scenario may depend on their ability to attract such factors. This could increase policy competition between countries, for example, through changes in the settings of income tax policy to attract skilled workers. Such a scenario has the potential to harm growth if it results in policy uncertainty or too much

reallocation of mobile factors and, in such a case, may benefit from cross-country co-ordination of policies.

34. See e.g. Frankel and Rose (1998), Calderón et al. (2003) and Dées and Zorell (2011) for evidence on trade integration and business cycle synchronisation.

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OECD Journal: Economic Studies
Volume 2015
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Trade patterns in the 2060 world economy

by
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This paper presents long-term trade scenarios for the world economy up to 2060 based on a modelling approach that combines aggregate growth projections for the world with a detailed computable general equilibrium sectoral trade model. The analysis suggests that over the next 50 years, the geographical centre of trade will continue to shift from OECD to non-OECD regions reflecting faster growth in non-OECD countries. The relative importance of different regions in specific export markets is set to change markedly over the next half century with emerging economies gaining export shares in manufacturing and services. Trade liberalisation, including gradual removal of tariffs, regulatory barriers in services and agricultural support, as well as a reduction in transaction costs on goods, could increase global trade and GDP over the next 50 years. Specific scenarios of regional liberalisation among a core group of OECD countries or partial multilateral liberalisation could, respectively, raise trade by 4% and 15% and GDP by 0.6% and 2.8% by 2060 relative to the status quo. *Finally, the model highlights that investment in education has an influence on trade and high-skill specialisation patterns over the coming decades. Slower educational upgrading in key emerging economies than expected in the baseline scenario could reduce world exports by 2% by 2060. Lower up-skilling in emerging economies would also slow down the restructuring towards higher value-added activities in these emerging economies.*

JEL classification codes: E23, E27, F02, F17, F47

Keywords: General equilibrium trade model, long-term trade and specialisation patterns, trade liberalisation

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The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Introduction

Global trade is undergoing rapid change through a fragmentation of production processes and the integration of emerging economies into the global market. These trends are affecting trade and industrial specialisation around the globe. To explore likely changes in global trade and specialisation patterns at the 2060 horizon, this paper combines the modelling of the aggregate growth trajectories of individual countries with a detailed modelling of global trade relationships and trade barriers at the sectoral level. Growth trajectories for the 34 current OECD economies and eight non-OECD G20 emerging countries rely on projections from the OECD long-term scenario model (Johansson et al., 2013) and are consistent with the long-term *OECD Economic Outlook* baseline (OECD, 2013). The OECD projections are used as an input in CEPII's MaGE model which provides growth projections for another 105 countries (Fouré et al., 2012, 2013). The reason for mixing two sets of projections is that this work is part of a broader OECD research agenda on long-term challenges in which a common set of growth projections for OECD countries are used to assess various long-term issues, not only trade ones (for details see OECD, 2014).[1]

CEPII's and OECD's long-term growth models rely on conditional convergence, in which each country is expected to converge to its own steady-state in the long run. The projections account for the main structural factors affecting potential growth in the future: socio-demographic dynamics, human and physical capital accumulation and productivity developments.[2] The CEPII and OECD models differ in some aspects. The OECD model highlights the link between structural policies and growth determinants, while the CEPII model emphasises energy use and efficiency as well female labour force participation. The OECD and CEPII growth projections are made consistent to obtain a baseline growth trajectory for 147 countries in real terms.

The paper then analyses how world trade and specialisation patterns will evolve along this baseline growth trajectory. To this end, country-specific baseline growth trajectories are used to design a dynamic baseline for a multisectoral CGE model of the world economy, MIRAGE-e (Fontagné et al., 2013). In addition to calibrating the CGE model to reproduce the baseline trajectories for GDP, saving and current account imbalances, the CGE dynamic baseline includes a detailed modelling of the sector-specific trajectory of productivity (in agriculture, manufacturing and services). Energy demands in the baseline are calibrated on the IEA scenario of future fossil energy prices. This way, MIRAGE-e provides a baseline projection for the allocation of production across sectors, for bilateral and sectoral trade flows, as well as for factor incomes. Whereas the baseline growth trajectories are country-specific (though with a constraint on the global investment-saving balance), the CGE baseline projections are defined at the regional level. The countries included in MIRAGE-e are aggregated into 26 regions or country groupings based on a detailed description of the economy of each region, with two categories of labour (skilled and unskilled) and 25 sectors.

Once this baseline growth trajectory and dynamic CGE baseline projection for the world economy has been constructed, the paper analyses an alternative baseline assuming slower

accumulation of human capital in three Asian emerging economies, to explore repercussions on growth, specialisation, trade and relative wages of skilled and unskilled labour and two stylised trade liberalisation scenarios. Two trade scenarios, a partial multilateral liberalisation and a full regional liberalisation, are compared with the baseline to explore in each case the impact on trade patterns and income distribution across skill levels.

The partial multilateral scenario assumes that world economies pursue a level-playing field for trade in goods and services, further cutting tariffs on goods on a multilateral basis, decoupling agricultural subsidies in all OECD countries, reducing non-tariff frictions to trade in goods, and letting regulatory obstacles to trade in services partially converge to those remaining in the EU in 2004. No assumption is made regarding the success or failure of the current Round of multilateral negotiations. Evolutions in tariffs, non-tariff barriers and frictions are considered to be the outcome of negotiation within the multilateral framework.

The full regional liberalisation scenario assumes developed economies firstly embark on an ambitious regional agreement (implemented progressively) fully phasing out tariffs, reducing regulatory obstacles to trade in services and frictions to trade in goods as above, but without decoupling of agricultural subsidies. This first phase of regionalism starting in 2014, would be extended to several other non-OECD countries from 2030 on, whereby major developing economies would embark in this liberalisation as well, though with less ambition regarding tariffs. In such a regional scenario, only 38 economies of the world (European Union, Canada, the United States, Mexico, EFTA members, Australia, New Zealand and Japan) are engaged in the full facilitation of trade in goods and services.

The remainder of this paper first describes our modelling approach and methodology in Section 2, while Section 3 describes in detail the assumptions underlying the baseline, the alternative baseline with slower skill accumulation in emerging economies and the two trade policy scenarios. Section 4 presents the results from the modelling exercise and Section 5 concludes.

2. Methodology

OECD long-term macroeconomic projections for 42 countries are combined with CEPII long-term projections for the remaining 105 developing economies. These projections provide a consistent set of country-specific variables to be introduced in a CGE: GDP, saving rates, skilled and unskilled labour supply, current account balances and energy efficiency. In addition, a common set of exogenous variables is used regarding demography, human capital and energy prices. These macro projections are used to draw scenarios for trade patterns at the 2060 horizon for the world economy split into 26 regions/countries and 25 sectors.

2.1. Combining models for the world economy

2.1.1. The OECD long-term model

The growth model developed by the OECD, documented in Johansson et al. (2013), is used to project growth to 2060 for the 34 OECD members and eight non-OECD G20 members. It derives potential output from a Cobb-Douglas production function featuring physical capital, human capital and labour. The two latter production factors are subject to a common technical progress.

While population projections are exogenous (from Eurostat and United Nations Population databases), labour force participation rates are projected using a cohort approach.

In practice the cohort approach assumes that the observed participation behaviour of individuals belonging to the most recent cohorts will continue in the future and this amounts to juxtapose constant age- and gender-specific entry and exit rates (varying with educational attainment). Special treatment is provided for retirement age, which embodies current and planned pension reforms and is indexed to changes in life expectancy over the long run, so as to maintain a constant share of active lives. Unemployment is assumed to converge towards the long-term level of unemployment (which is chosen to be the lowest level of Non-Accelerating Inflation Rate of Unemployment, NAIRU, between 2007 and 2013), at country-specific speeds that depend on labour market policies. Human capital is measured by average years of schooling of the adult population. Educational attainment of cohorts aged 25-29 is assumed to slowly converge to current best practice (Korea) over the long run at the average speed observed globally over the period 1960-2005, with attainment in Korea also gradually improving. Future educational attainment of the adult population is then projected using a perpetual inventory model and this projected stock of average years of schooling is converted into a measure of human capital assuming decreasing returns to education.

Total factor productivity (TFP) dynamics are governed by an estimated error-correction model featuring conditional convergence. TFP projections are driven by the global rate of technological progress and the speed of "catch-up" towards the country-specific steady-state level of TFP. Specifically, the country-specific long-run TFP level depends on the common global pace of technological progress and the country's regulations in product markets. The speed of convergence towards this long-run TFP level is country-specific as it depends on the degree of openness to trade. Greater openness to trade increases the speed of convergence towards the technological frontier, thus enhancing TFP growth.

Since in most developed economies, the ratio of capital to trend output has been relatively stable, the underlying projection for capital assumes a continuation of this stability in capital intensity.[3] The projections of the underlying capital-output ratio are then subject to influences from the real cost of capital, which varies mainly due to changes in real interest rates. Saving rates are estimated as a function of old-age and youth dependency ratios, life expectancy, fiscal balances, terms of trade, productivity growth, net oil balances and the availability of credit. Projected investment and saving patterns determine residually current account balances for the 42 countries covered.

A closure rule imposes a constant overall saving-investment imbalance for the 42 countries. Deviations from such a rule are reflected in changes of world interest rates that change the country-specific equilibrium capital stocks via the cost of capital. Other equilibrating mechanisms include risk premia on excessive public and external indebtedness, which also affect the country-specific costs of capital.

Policy-wise, the OECD baseline trajectory assumptions include:

- gradual convergence over the long run in product market regulations and institutions towards settings currently found in the average OECD country;
- stabilisation of debt levels at 60 % of GDP in countries with initial debt in excess of 60% while in countries with debt below 60%, debt is stabilised at the current level;
- gradual increase over the long run in financial market development to the current level in the United States, and;
- gradual increase over the long run in social spending in emerging economies to provisions similar to the average OECD country.

2.1.2. MaGE: CEPII's long-term model

Projections for 105 additional developing countries are obtained with the MaGE model proposed in Fouré et al. (2012, 2013). Based on a three-factor (capital, labour, energy) and two-technical progress (capital-labour and energy-specific) production function, MaGE is a supply-side oriented macroeconomic growth model, defined at country level for 147 countries (although only 105 are covered in this projection exercise as the other are covered by the OECD projections). It was built in three steps: production factor and productivity data were collected for the 1980-2009 period drawing on World Bank, United Nations and International Labour Organization data; behavioural relations for factor accumulation and productivity growth were estimated; and these relations were used to project GDP.

Supply is modelled as a CES production function of energy and a Cobb-Douglas bundle of capital and labour. In MaGE, technological progress includes energy efficiency and TFP. It is derived theoretically, and estimated econometrically at the macroeconomic level.

Behavioural relations are estimated for the education level, female participation to the labour force, capital accumulation and the two forms of efficiency improvements. The labour force projection starts from UN population projections, split across 5-year age groups. For each of these age groups, education is estimated and labour force participation is derived in the following way. While male labour force participation follows the logistic relation determined by the International Labour Organization projections (and therefore does not depend on education), female participation is assumed to change with education level (more education means less participation for the study-age women, while it enhances participation afterwards). Educational attainment, defined as the percentage of each age group having attained a secondary or tertiary diploma, is assumed to follow a catch-up process to the leaders. The catching-up has different speeds, depending on the region and age-group, while the leader levels for each age-group and educational level are composites of the different leader countries (i.e. Austria, Japan, the United States, Switzerland, France, Norway, New Zealand and Russia, depending on the education level and time period). In turn, these best-practice targets are assumed to continue to grow at their historical pace.

Investment in MaGE is a function of savings. It is modelled as a non-unitary error-correction relationship that differentiates long-term correlation between saving and investment and annual adjustments around this trend. Saving is a function of economic growth and the age structure of the population, consistent with the life-cycle hypothesis. Capital accumulates in MaGE according to a permanent-inventory process with a constant depreciation rate. The closure rule in MaGE imposes consistency between saving and investment at the global level.

Capital-labour TFP and energy efficiency are driven by catch-up to the best-performing countries. TFP catch-up is conditional on, and driven by, the educational level, while tertiary education fuels innovation (autonomous productivity improvements), secondary education is a prerequisite for imitation (catching-up). Energy efficiency catch up depends both on the distance to the technological frontier in energy use, and on the level of development, to reflect differences in sectoral structure across countries.[4]

2.1.3. Consistency between OECD and CEPII models

The OECD and MaGE modelling frameworks share certain essential characteristics (production function approach, conditional convergence, life-cycle savings, closure rule, etc.) but also differ in many respects. This partly reflects the different coverage of countries – with

OECD projecting growth for advanced and major emerging economies and MaGE projecting growth for a larger set of countries for which data may be scarce – and different focus – with OECD projections highlighting the role of policies and looking also at fiscal balances and MaGE projections giving a more detailed account of catching up processes in terms of education, female participation, energy efficiency and addressing the role of oil rents in determining GDP changes of major oil exporters. Projections with MaGE are also less demanding in terms of data, which facilitates the extension of the exercise to a larger set of countries. In sum, the OECD and MaGE are broadly similar but each is best suited to deal with advanced and developing economies, respectively. In view of differences in specification, particular care has been taken to exploit the complementarity and ensure consistency of the two sets of projections.

In practice, projections of GDP, labour force, education and current accounts for the 42 countries covered by the OECD long-term model are used as an input for MaGE. Some variables that are not available in OECD projections or not suited for MaGE specification are derived according to MaGE's estimated relationships. TFP for the 42 OECD and non-OECD G20 countries is recovered as the gap between the projected production factors (capital, labour and energy) and the GDP projected by the OECD model, but encompassing the effect of human capital accumulation in the technical progress.[5] For the remaining 105 countries, productivity levels, production factors and GDP are recovered using MaGE assumptions. Investment in the 105 countries adjusts to match the saving-investment balance at the global level. This ensures consistency between the closure rules of the two models, as the overall imbalance for the 42 countries covered by the OECD model is compensated by a symmetric overall imbalance for MaGE's 105 countries, with the global surplus or deficit of investment distributed to these latter countries proportionally to their contribution to global pre-rescaling investment levels.

2.2. From the macro to the sectoral level

The multi-sectoral CGE model has a recursive sequential dynamic set-up that is fed with the output of the OECD and MaGE aggregate growth models. Projections from these models are used to construct a dynamic baseline for MIRAGE-e (Fontagné et al., 2013; Decreux and Valin, 2007). MIRAGE-e relies on the same exogenous variables (population, energy prices) that are embodied in the macroeconomic models, but takes as additional exogenous variables the results from the macroeconomic projections, notably GDP, saving rates, current accounts, labour force, human capital formation and energy efficiency. Moreover, the distribution of human capital in the population is used to set the number of skilled and unskilled workers in MIRAGE-e, which distinguishes these two categories of labour, with the assumption that skilled workers correspond to people having obtained a tertiary level diploma. The global closure of MIRAGE-e is ensured by imposing that the share of each country/region in the global current account imbalance varies yearly according to the macro projections.

2.2.1. Supply in MIRAGE-e

On the supply side, each sector in MIRAGE-e is modelled as a representative firm, which combines value-added and intermediate consumption in fixed shares. Value-added is a bundle of imperfectly substitutable primary factors (capital, skilled and unskilled labour, land and natural resources) and energy. Firms' demand for production factors is organised as a Constant Elasticity of Substitution (CES) aggregation of land, natural resources, unskilled labour, and a bundle of the remaining factors. This bundle is a nested

CES aggregate of skilled labour, and another bundle of capital and energy. Finally, energy is a CES aggregate of energy sources (except for non-electricity energy production sectors, for which the share of each energy input is fixed). Energy consumption of the representative firm comprises five energy goods (electricity, coal, oil, gas and refined petroleum), which are aggregated in a single bundle that mainly substitutes for capital.

MIRAGE-e assumes full employment of primary factors, whose growth rates are set exogenously based on the macro projections on a yearly step, as detailed below.[6]

- Population, participation in the labour market and human capital evolve in each country (or region of the world economy) according to the demographics embedded in the macro projections. This determines the labour force as well as its skill composition (skilled/unskilled).[7] Skilled and unskilled labour is perfectly mobile across sectors, but immobile between countries.
- Natural resources are sector specific, while land is mobile not only between agricultural sectors but also between agriculture and other uses. Natural resources for the mining sector and land for agricultural sectors are set at their 2004 levels: prices adjust demand to this fixed supply. In the baseline, natural resources for fossil fuel production sectors adjust to match the imposed exogenous price target (taken from the International Energy Agency, 2012) for coal, oil and gas, and according to the energy demand projected by the model. By contrast, in the simulations, changes in demand for fossil energy sources influence their price, while natural resources are fixed at their baseline level. In practice environmental damages could hamper long-run growth. A recent OECD study undertook CGE-modelling-based assessment of environmental damages, using similar long-run projections for OECD countries as those used in this paper (OECD, 2015). This research showed that only agricultural and energy world trade patterns would be significantly altered by taking climate change into account. Therefore, as a first approximation, most of the results presented in this study would not be significantly affected by environmental feedback effects on growth.
- Installed capital is assumed to be immobile (sector-specific), while investments are allocated across sectors according to their rates of return. The overall stock of capital evolves by combining capital formation and a constant depreciation rate of capital of 6% that is the same as in the long-term growth models. Gross investment is determined by the combination of saving (the saving rate from the growth model, applied to the national income) and the current account. Finally, while total investment is saving-driven, its allocation is determined by the rate of return on investment in the various activities. For simplicity, and because of lack of reliable data on foreign direct investment at country of origin, host and sectoral levels, international capital flows only appear through the current account imbalances, and are not explicitly modelled.

2.2.2. Demand in MIRAGE-e

On the demand side, a representative consumer from each country/region maximises instantaneous utility under a budget constraint and saves a part of its income. Expenditure is allocated to commodities and services according to a LES-CES (Linear Expenditure System – Constant Elasticity of Substitution) function. This implies that, above a minimum consumption of goods produced by each sector, consumption choices among goods produced by different sectors are made according to a CES. This representation of preferences is well suited to the analysis as it is flexible enough to deal with countries at different levels of development.

Within each sector, goods are differentiated by their origin. A nested CES function allows for a particular status for domestic products according to the usual Armington hypothesis (Armington, 1969): consumers' and firms' choices are biased towards domestic production, and therefore domestic and foreign goods are imperfectly substitutable, using a CES specification. Armington elasticities (defined at sector level but common to all regions) are recovered from the GTAP database (Global Trade Analysis Project) and estimated by Hertel et al. (2007). Total demand is built from final consumption, intermediate consumption and investment in capital goods.

Efficiency in the use of primary factors and intermediate inputs is based on the combination of four mechanisms. First, agricultural productivity is projected separately, as detailed in Fontagné et al. (2013). Second, energy efficiency computed from the aggregate growth models is imposed on MIRAGE-e (it enters the capital-energy bundle). Third, a 2 percentage point growth difference between TFP in manufactures and services is assumed (as in van den Mensbrugghe, 2005). Fourth, given the agricultural productivity and the relation between productivity in manufacturing and services, MIRAGE-e recovers endogenously country-specific TFP from the exogenous GDP and production factors. Notice that TFP thus recovered from the baseline projections is subsequently set as exogenous in the alternative scenarios. Therefore, GDP becomes endogenous in such scenarios.

Dynamics in MIRAGE-e are implemented in a sequentially recursive way. That is, the equilibrium can be solved successively for each period, given the exogenous variations of GDP, savings, current accounts, active population and skill level coming from the growth models, as described above. For baseline projections, the time span is 56 years, the starting point being 2004. This version of MIRAGE-e assumes that all markets are in equilibrium at each period, with an assumption of generalised perfect competition.

MIRAGE-e was calibrated on the GTAP dataset version 7, with 2004 as a base year. As shown in Table 1, our data aggregation singles out all energy industries and combines other industries into main representative subsectors within the agriculture, manufacturing and services aggregates. For the regional aggregation, the main OECD member countries are retained, while other member countries are aggregated. Main emerging economies are also isolated whereas the rest of the world is aggregated on a geographical basis. Table 1 shows the composition of regions, highlighting which of them is fully described in the OECD long-term aggregate growth projections. For instance, all countries in the euro area, considered as a region in MIRAGE, were modelled individually using the OECD macroeconomic framework. In contrast, only one country (Israel) in the Middle-East region of MIRAGE was modelled by the OECD. Finally, North Africa is an example of a region in MIRAGE which has been modelled exclusively by MaGE.

Tariff data at the HS6 level corresponds to the *ad valorem* equivalents from the MAcMap HS6 database (Guimbard et al., 2012) and are aggregated to match our regional and sectoral decomposition using the reference group methodology (Bouët et al., 2008). Finally, the model includes international transaction costs and non-tariff measures (NTM) in services, modelled as an iceberg trade cost (i.e. cost of transporting a good that uses up a fraction of the good). Data for trade costs associated with delays were calibrated using a database provided by Minor and Tsigas (2008), who adopt the methodology in Hummels and Schaur (2012). NTM in services are *ad valorem* equivalents taken from Fontagné et al. (2011).

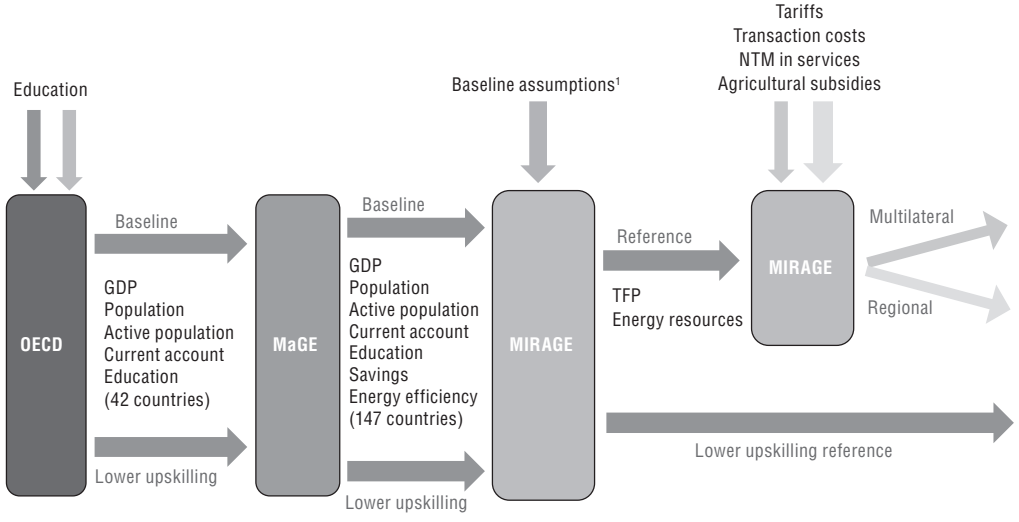
The way in which the OECD long-term model, MaGE and MIRAGE-e are related is summarised in Figure 1, which shows the different variables that the models exchange and

Table 1. **Sector and country aggregation in MIRAGE-e**

Regions	Sectors
OECD countries	**Primary**
Euro area[1]	Crops
United Kingdom[1]	Livestock
European Free Trade Agreement[1]	Other agriculture
Rest of European Union[1]	Other primary
Turkey[1]	**Energy**
United States[1]	Coal
Canada[1]	Oil
Mexico[1]	Gas
Chile[1]	Electricity
Japan[1]	Refined petroleum
South Korea[1]	**Manufacturing**
Australia and New Zealand[1]	Food
Non-OECD countries	Textile
Russian Federation[1]	Paper and publishing and wood products
Rest of Europe	Chemicals, rubber and plastics
Middle-East[2]	Iron and steel
North Africa	Metals
South Africa[1]	Metal products
Other African countries	Transport equipment
Brazil[1]	Electronic devices
Other Latin America[2]	Other minerals
China[1]	Other manufacturing
India[1]	**Services**
Indonesia[1]	Trade
Other ASEAN countries	Transport
Other Developing Asia	Finance, insurance and business services
Caspian	Public administration
	Other services

1. Regions fully included in the 42 OECD sample.
2. Regions with one country only in the 42 OECD sample (Argentina and Israel).

Figure 1. **Description of the models and assumptions**



1. See Table 2.

Note: Vertical arrows show scenario assumptions, while horizontal arrows indicate variable flows between the models.
Source: Authors' calculations.

the point at which assumptions are introduced (see Section 3 for details). Notice that two alternative sets of assumptions on educational catch-up lead to two alternative baseline scenarios. Accordingly, two alternative baselines are compared in the education scenario.

However, trade liberalisation scenarios (regionalism versus multilateralism) are implemented as trade policy shocks in the baseline with high education only. Details on assumptions underlying these simulations are described in the next sections.

3. Education baseline alternative and trade liberalisation scenarios

The main objective of this paper is to investigate the driving forces of trade and specialisation patterns at the 2060 horizon. In order to do this a coherent baseline scenario for the world economy is constructed, based on the evolution of major determinants of growth (such as demography, physical and human capital accumulation and energy availability). This framework integrates available information on preferential trade agreements already signed. After calibrating MIRAGE-e in order to reproduce the long-term trade to income elasticities projected in the growth baseline trajectory, we obtain a baseline for the CGE that is shocked using the two scenarios already mentioned: full regional trade liberalisation versus partial multilateral liberalisation.

3.1. Baseline assumptions

When projecting trade patterns, it is important to rely on a model that is able to reproduce some basic stylised facts such as the trade-to-income elasticity. Here we follow the methodology described in Fontagné and Fouré (2013) to make the model mimic this elasticity. As shown in Table 2, four main drivers of this elasticity are tariffs, fossil-fuel energy prices, transaction costs for goods and TFP in the transportation sector. While energy prices are drawn from the International Energy Agency projections to 2035 (these are extended linearly to 2060 in MIRAGE), the three remaining parameters need to be calibrated to reproduce past evolutions of world trade.

Table 2. **Baseline scenario assumptions**

Variable	Baseline assumption
Energy prices (coal/oil/gas)	IEA (2012)
Transaction costs for goods	-25% in 2035 (-45% in 2060); (Fontagné and Fouré, 2013)
TFP in transports	+2% annual growth (compared with services); (Fontagné and Fouré, 2013)
Free Trade Agreements	EU28/ASEAN and partners
New Common Agricultural Policy	-75% factor subsidy in EU in 2005 (crops and other agriculture) -50% factor subsidy in EU in 2005 (livestock)

Determining a reference scenario for drivers such as transaction costs or TFP in the transportation sector is a difficult exercise, as they summarise a large variety of determinants. Productivity in transports encompasses breakthroughs like containerisation. Product standards also influence the transaction costs (approximated here by the tariff-equivalent of time spent in duties), along with the administrative organisation of duties and other related factors.

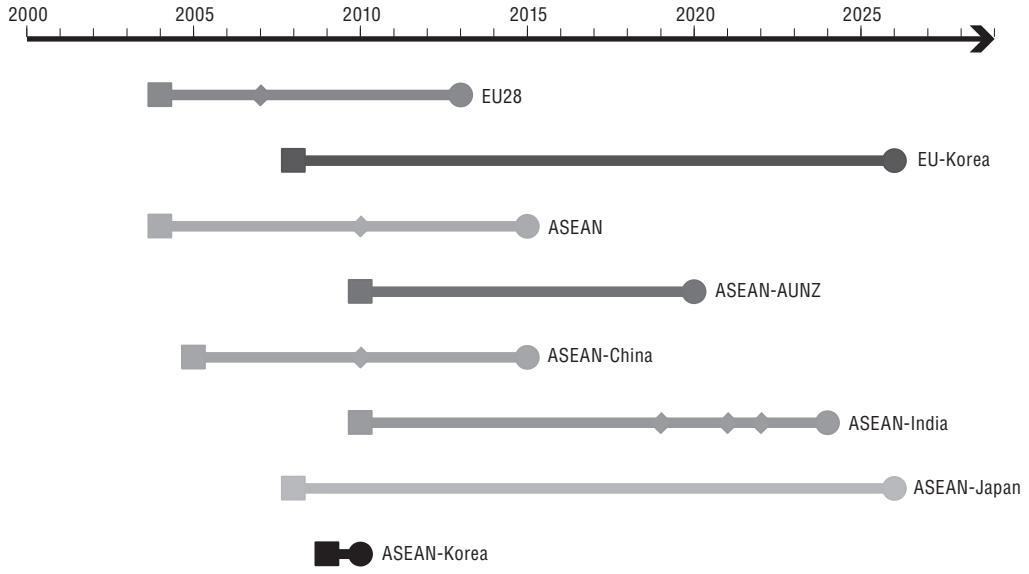
To proceed, the four drivers are calibrated using trajectories similar to those observed over the past 50 years. This implies adding a 2% additional TFP growth in transportation (compared with other services), in line with estimations by Wolff (1999) on years 1958-87. Finally it is necessary to calibrate a 25% decrease in transaction costs for goods, to recover a long-term elasticity in line with the observed one.

Then, since the trade liberalisation scenarios will consider scenarios on agricultural subsidies, the implemented reforms of the Common Agricultural Policy (CAP) of the

European Union acted in 2003 and taking into effect in 2005 are incorporated in the model. This is done in a simplified form (due to the sectoral aggregation), based on Gouel and Laborde (2007).

Finally, the MIRAGE-e baseline includes Free Trade Agreements (FTAs) that are already planned at the time of writing, using the WTO database on regional trade agreements.[8] This results in two FTAs (enlargement of the European Union to 27 and then 28 members, plus implementation of the ASEAN treaties) and six bilateral regional agreements (between EU and Korea, and the so-called ASEAN+6 agreements). These agreements are implemented at the Harmonized commodity Description and Coding System 6 (HS6) level using MAcMap for 2004. The timing for implementation is summarised in Figure 2.

Figure 2. **Baseline free trade agreements**[1]



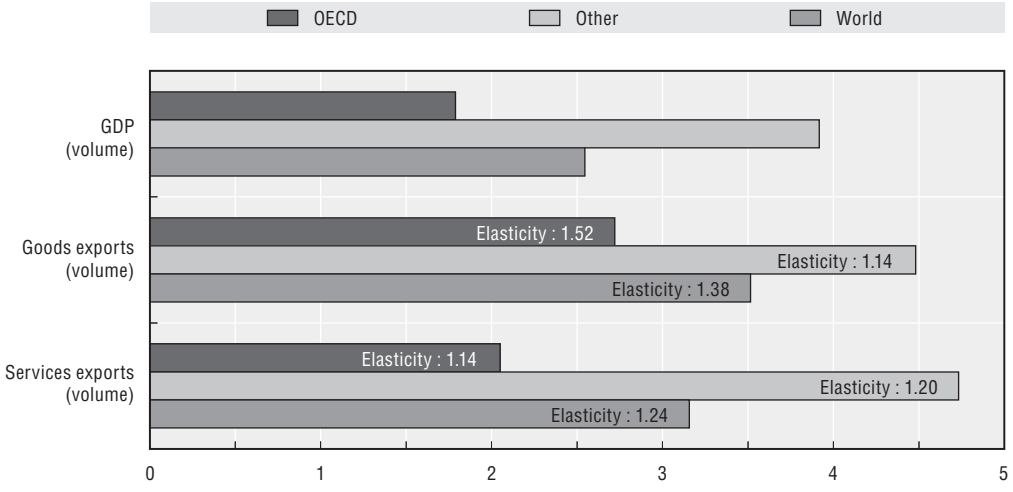
1. The Association of Southeast Asian Nations (ASEAN) consists of Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Cambodia, Laos, Myanmar (Burma) and Vietnam. AUNZ denotes Australia and New Zealand.

Source: Authors' calculations.

The implementation of these FTAs is two-fold.[9] First, it consists in the progressive abolition of tariff duties among the participants. For each step of each agreement, the tariff reduction is linearly implemented at the HS6 commodity level for all countries, and the results are aggregated to our mapping described in Table 1. Second, the external tariff (imposed on non-FTA members) of the FTA members is homogenised. Concerning the European Union, it is assumed that Croatia adopts pre-existing European tariffs in 2013, whereas for the ASEAN it is assumed that all members adopt the average tariff at the end of the implementation (2015).

Together these assumptions imply that the model projects an elasticity of world trade to world GDP of around 1.4 for goods (as compared with 2.8 during the 1990s and with 1.6 between 1950 and 2009) and 1.2 for services (Figure 3). This lower elasticity for services is coherent with the assumptions, since the baseline projection does not include scenarios on NTM in services. This lower responsiveness of trade to GDP as compared with the one during the 1990s partly reflects that the intensity of fragmentation of global value chains that occurred in the last decades is hypothesised to slow down as there are likely physical limits

Figure 3. **Growth of GDP, exports in goods and services and income elasticities, 2012-60**[1]



1. Goods and services exports including intra-trade.
Source: Authors' calculations.

on how much a product can be fragmented (Fontagné and Fouré, 2013). This is consistent with a recent study by Constantinescu et al. (2015) which suggested that the slowdown in trade in the 2000s was partly due to a structural change in the trade-GDP relationship.

3.2. Education baseline variant scenario

Given that long-term growth trajectories are likely to be influenced by the skill distribution, as emphasised in Fontagné and Fouré (2013), it is worth comparing our central baseline with one in which skill developments are different. Since a more educated population is likely to influence TFP, the three steps constituting our modelling exercise (i.e. the OECD model, the MaGE and the MIRAGE baseline) are recomputed with a different configuration of skills (so-called lower up-skilling scenario). In this lower skill scenario, human capital upgrading in key emerging economies is weaker than in the baseline scenario.

Changes in the stock of human capital influence aggregate growth, especially in developing economies, and affect trade patterns across countries. Among the main developing countries, the Asian ones have exhibited large improvements in terms of human capital accumulation and technological progress (Fouré et al., 2012), while remaining at a relatively low level of productivity, leaving room for the large improvements that occur in our projections. Therefore, the low-skill scenario focus on the three largest Asian developing countries – China, India and Indonesia, hereafter called CII economies – and implement an alternative baseline in which the educational attainment of the cohort aged 25-29 will converge to the frontier level of education at a speed that is 50% slower than assumed in the baseline macro projections. As a result, by 2060 average years of schooling are around 1.2 years lower in these three countries as compared with the baseline.

3.3. Trade liberalisation scenarios: Regionalism versus multilateralism

Despite reductions in market- and non-market barriers to trade during the last decades, particularly for industrial products, significant barriers still remain at the global level. These barriers go beyond tariffs on goods. Regulatory obstacles to trade in services,

agricultural subsidies and transaction costs on goods remain large. While trade liberalisation can take different forms, the approach in this paper is to describe two stylised alternative trade facilitation scenarios as summarised in Table 3. In the partial multilateral liberalisation scenario, applied tariffs on goods are linearly halved and there is a further 25% reduction in international transaction costs relative to baseline. Moreover, outside the EU regulatory obstacles to trade in services partially converge towards current EU levels, while EU further implements its internal market for services (leading to a 10% decrease of barriers to trade in services among member states over the long run). Coupled agricultural subsidies are phased out in the OECD, beyond Europe.

Table 3. **Trade policy scenarios**

Variable	Partial multilateral liberalisation	Full regional liberalisation
Tariffs	-50% in 2060 (compared with baseline scenario)	-100% in 2060 in the FTA area -50% in 2060 with partners (from 2030)
Transaction costs for goods	-25% in 2060	-25% in 2060 in the FTA zone
NTM in services	-10% in 2060 among EU members. Half convergence in 2060 to average intra-EU level between other countries.	-10% in 2060 among EU members. Half convergence in 2060 to average intra-EU level for other countries inside FTA area.
Coupled agricultural subsidies	-50% in 2060 for EU, US, Japan, Korea, Canada, EFTA.	No change

The full regional liberalisation scenario considers two horizons. The large FTA area comprising NAFTA, the European Union, Australia/New Zealand, Japan and Korea is completed by 2060. This is a long process, but the zone is very large and diverse. Some of its members are potentially attached to agricultural subsidies, which are eventually not phased out as opposed to the multilateral scenario. Tariffs are phased out, while progress in terms of market access for services and transaction costs is now limited to the borders of the FTA. From 2014 to 2030, trade liberalisation is strictly limited to the wide region so-defined. Then, from 2030 on, this region reduces tariffs on a bilateral and reciprocal basis with a series of preferred partners, including the BRICs, South Africa, ASEAN and Chile. Neither trade in services nor transaction costs are concerned.

These scenarios are designed to allow for comparison between a full liberalisation between a small number of (developed mostly OECD) countries, along with bilateral agreements, and a liberalisation resulting from global multilateral negotiations, while keeping assumptions simple to be able to trace their implications. Indeed, a multilateral framework is likely to lead to a less ambitious agreement (as demonstrated by the tensions on the Doha agenda) both in terms of tariff reduction and non-tariff measures.

4. Results

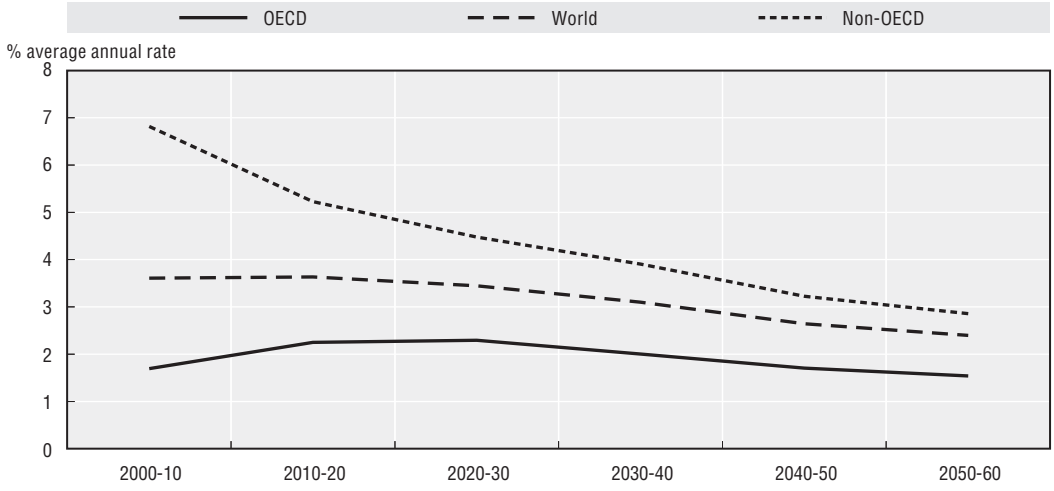
4.1. Baseline long-run GDP and trade scenario

4.1.1. Global growth will be sustained by emerging economies

Over the next half century, world GDP is projected to grow on average around 3% per year with declining rates in many countries. Up until 2030, world growth will be sustained by a rising weight of China and India with high, albeit declining, growth while after 2030 fast growth in Africa is expected to support world growth. The OECD trend GDP growth is projected at about 2% annually until 2050-60, and growth in emerging economies will

continue to outpace the OECD, but the difference will narrow over coming decades as income levels in emerging economies catch up to those in the OECD (Figure 4). As a result, the next 50 years will see major changes in the relative importance of countries or regions in global GDP.

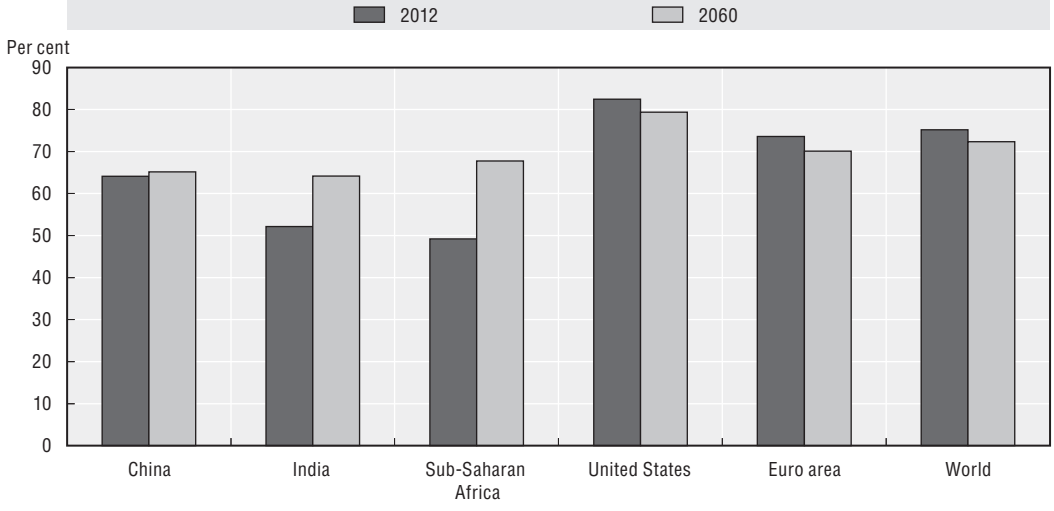
Figure 4. **Growth in real GDP over the next 50 years**[1]



1. World GDP refers to 147 countries.
Source: Authors' calculations.

Concerning the composition of GDP, two forces are at play. Relative prices change due to overall differences in TFP (relative prices of manufactured goods decrease) while, in developing countries, preferences shift toward services. By 2060, services will represent a lower share of world consumption but a higher share of consumption in developing economies (Figure 5).

Figure 5. **Share of services in consumption, selected countries, 2012 and 2060**



Source: Authors' calculations.

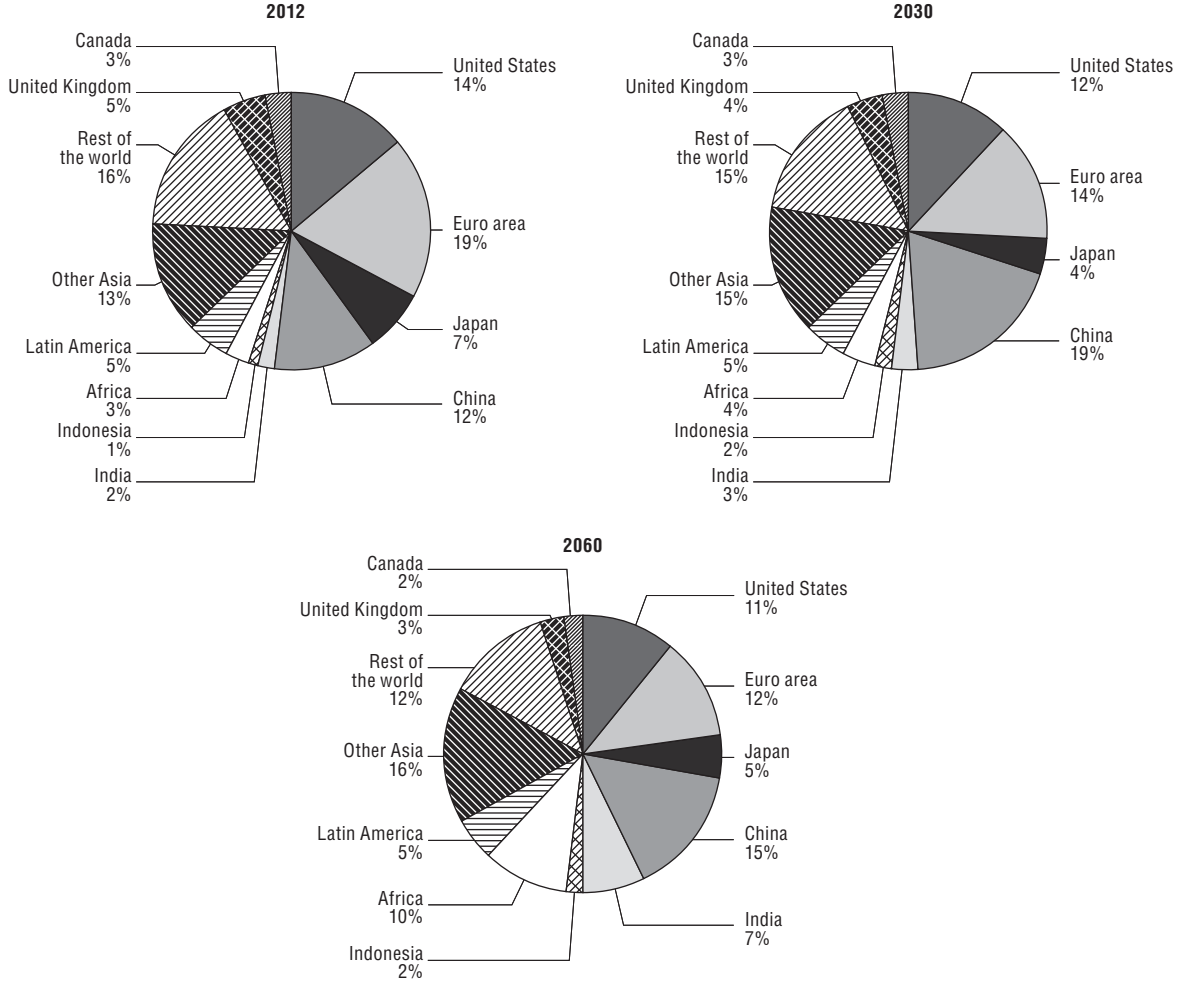
4.1.2. Continuing globalisation over the next half century

Growth in trade (gross exports of goods and services) is expected to continue to outpace GDP growth over the next 50 years with world trade estimated to grow at around 3.5% annually (compared with 6.9% over the period 1990-2007).

In terms of geographical distribution, there will be large shifts in trade patterns, reflecting among other things uneven developments in income across the globe as well as changes in comparative advantages (Figure 6). China and India are projected to gain market shares in world trade over the next half century, although the rapid growth in China's trade share is expected to slow down after 2030, as GDP growth is slowing. Likewise, Africa, Indonesia and other Asian economies are projected to experience sizeable increases in trade shares, especially after 2030, reflecting rapid growth leading to larger economic size combined with low production costs. These gains in trade shares of emerging and developing economies are mostly at the expense of Euro area members. From having accounted for 19% of world exports in 2012, the Euro area's market share in exports is expected to fall to approximately 12% by 2060. However, given the increase of world imports

Figure 6. **The geographical distribution of trade will shift**

Gross exports as a share of world exports (volume), %



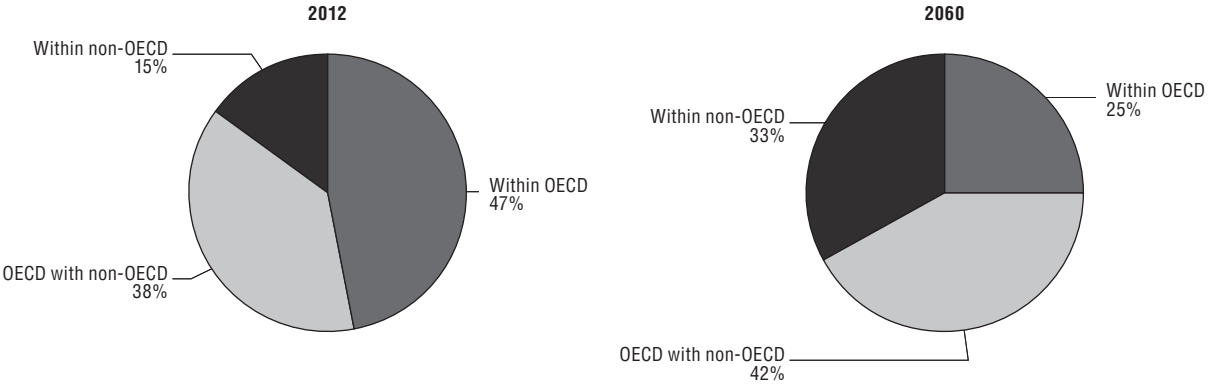
Source: Authors' calculations.

over that period, Euro area exports are expected to triple despite such reduced market share. By contrast, some OECD economies, including the United States and Canada, are projected to see their trade shares decrease only slightly, reflecting comparatively more favourable growth projections than the euro area.

The changing geographical distribution of trade is matched by changes in the relative importance of different sets of trading partners (Figure 7). Trade volumes are driven, among other things, by gravity factors including size of economies, distance or language. Consistent with this, the projections of the CGE model suggest that the expected shift of wealth creation from OECD to non-OECD countries will have important implications for trade patterns. While in 2012 about half of total trade in bilateral terms took place within the OECD area, the importance of bilateral trade among OECD members is expected to nearly halve by 2060. Instead, by 2060 trade among non-OECD economies will more than double, to account for approximately one-third of global trade. For instance, trade among Asian economies increases from around 6% to 16% over the projection period. At the same time, OECD economies will increasingly import products from non-OECD economies, whereas the share of global imports of non-OECD from OECD countries will remain more or less unchanged. All in all, over the next 50 years the geographical centre of trade is projected to move away from OECD towards non-OECD countries.

Figure 7. **A growing share of bilateral trade will occur between different non-OECD countries**

Share of global gross exports (volume), %



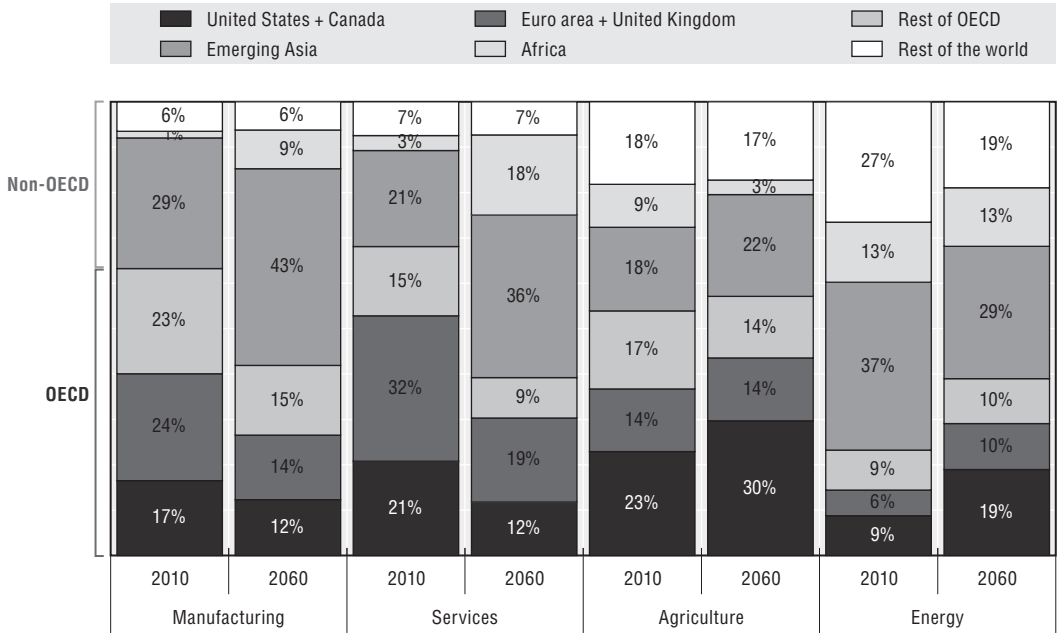
Source: Authors' calculations.

4.1.3. *Globalisation and income convergence will influence trade patterns*

The relative importance of different countries and regions in specific markets is set to change markedly over the coming decades, driven by diverging growth performance, changes in relative productivity and production prices as well as a reorientation of consumption in emerging economies towards services (Figure 8). Notably, China, India, other Asian economies and Africa are projected to become the dominant players in manufacturing, while most OECD countries are expected to lose ground. For instance, Japan, Korea and the United States are set to lose their comparative advantage in electronics to China and other Asian countries (see Appendix A, Figure A.1), who could account for as much as 70% of world exports in electronics by 2060. However, the long-run trends for detailed sectors should be interpreted with caution, given that the model-based scenario cannot foresee and incorporate major shifts in consumer preferences or technological breakthroughs.

Figure 8. **The relative importance of different countries in specific industries is expected to change**[1]

Countries shares in world exports (volume), 2010 and 2060



1. Manufacturing includes chemicals rubber and plastic, electronics, food, iron and steel, metal products, other manufacturing, other metals, other minerals, paper and wood, textiles, transport equipment. Service includes business service, transport service, wholesale and retail, public administration and other services. Agriculture includes livestock, rice and crops, other agriculture and other mining. Energy includes coal, crude oil, electricity, gas and refined oil.

Source: Authors' calculations.

Emerging and developing economies' (e.g. China, India and Africa) world market shares will increase significantly even in service trade, as a result of a shift towards more advanced activities as these economies become wealthier, combined with a larger economic size. The gain in service trade shares in China and India is mostly at the expense of the Euro area, the United States, Japan and the United Kingdom. This tendency could be further reinforced by the possibility that some tasks performed by service sectors are offshored to low-wage countries.

In the energy sector, a marked shift in the global distribution of trade is expected to occur over the next half century. The trade share of the United States in world energy exports is expected to more than triple by 2060, at the expense of the Middle East and the Russian Federation. These large expected gains are consistent with recent investments in technologies to extract and develop new sources of shale gas and oil, as compared with the exhaustion of conventional natural reserves in other parts of the world (e.g. IEA, 2012). Alongside the increase in energy trade, the United States maintains competitiveness in complementary industries such as chemicals (see Appendix A, Figure A.1). However, it should be noted that the energy sector is subject to large geopolitical and technological uncertainty over the next half century, making projections particularly vulnerable to unpredicted events.

In agriculture, the United States and other Asian countries are expected to remain competitive and their trade share in agricultural exports will increase mostly at the expense of Africa and Latin America.

4.1.4. *The industrial structure in emerging economies gradually becomes similar to that of the OECD*

In parallel with the changing trade patterns, the industrial structure (measured as value-added shares of specific sectors in total value-added) will evolve differently across countries and regions depending on changing patterns of domestic and international demand, differences in the accumulation of production factors across countries, the allocation of factors across sectors within countries and countries' international competitiveness. One general trend that stands out in the baseline projection is that most significant changes will occur in emerging economies, whereas the industrial structure will remain relatively stable in OECD countries over the next half century (Figure 9). This largely reflects the development process in lower-income countries with income and living standards catching-up towards levels of higher-income OECD countries, which results in changing domestic demand and consumption structure. Projections also show that trade costs remain large enough in certain industries to prevent a full shift of industrial activities to emerging economies away from OECD.

The industrial structure in fast-growing emerging countries will become more similar to the one in OECD economies. In emerging countries, past trends are expected to continue over the projection period and the industry mix will continue shifting towards services away from manufacturing, typically low-skilled (e.g. textile, food production, etc.). China and India are projected to experience marked increases in the contribution of financial and business services, wholesale and retail and transport services to value added as domestic demand for these services increases with income and shift in comparative advantage (Figure 9). This increased similarity among OECD and emerging countries implies that intra-industry trade should account for a larger share of trade over the next half century, contrasting with the recent decline associated with the large contribution of highly specialized emerging economies to world exports.

Despite the general reorientation towards services, manufacturing industries are still expected to remain important in emerging economies. For instance, in China, Indonesia and other Asian countries the contribution of the auto industry to value-added will increase over the next 50 years. Likewise, electronics is projected to account for an increasing share of GDP in China, reflecting strong competitiveness in this sector.

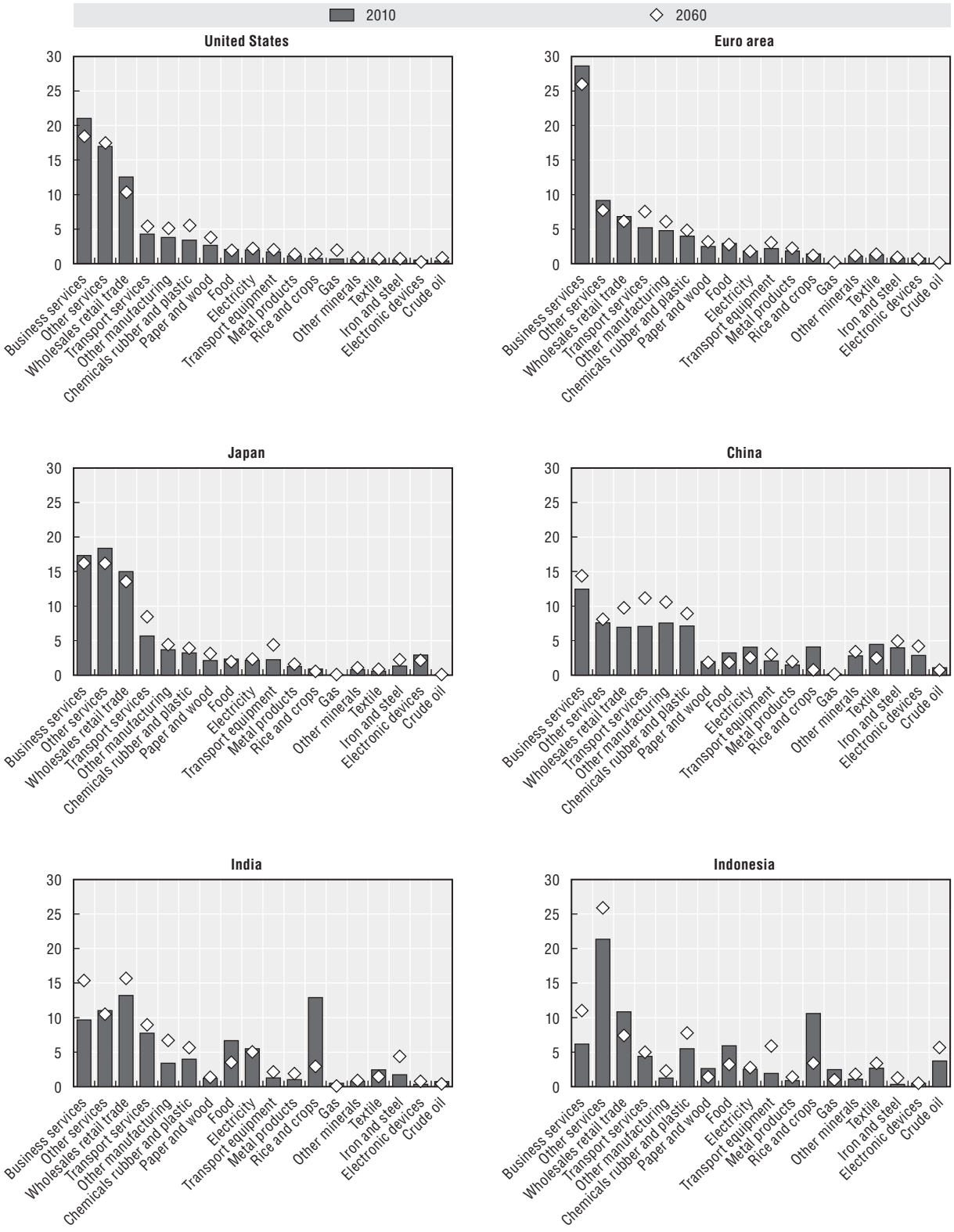
4.1.5. *Income convergence will influence wage inequality among and within countries*

Over the next 50 years income gaps among countries will narrow. Rapid GDP growth in emerging economies is matched by a tendency of GDP per capita to converge across countries. Between now and 2060, GDP per capita (measured in 2005 PPPs) in India, the Philippines and some African countries will increase by more than 7 times, while the increase is around five times in Indonesia and China (see Johansson and Olaberría 2014; OECD, 2014 for details). Over the same period, living standards will roughly double in the highest-income OECD countries. This will lead to a richer and more equal distribution of world income among countries, which will push in the direction of falling absolute poverty.

Furthermore, across countries the relative wage of skilled to unskilled labour will change over the next half century, with implications for trade patterns. The distribution of wages across differently skilled workers within countries depends on the supply and demand for skills, the extent of skill-biased technological change, the composition of consumption demand and institutional settings in labour markets and educational systems.

Figure 9. **Industrial structure is set to change in emerging economies**

Value-added shares of key industries by country, 2010 and 2060



Source: Authors' calculations.

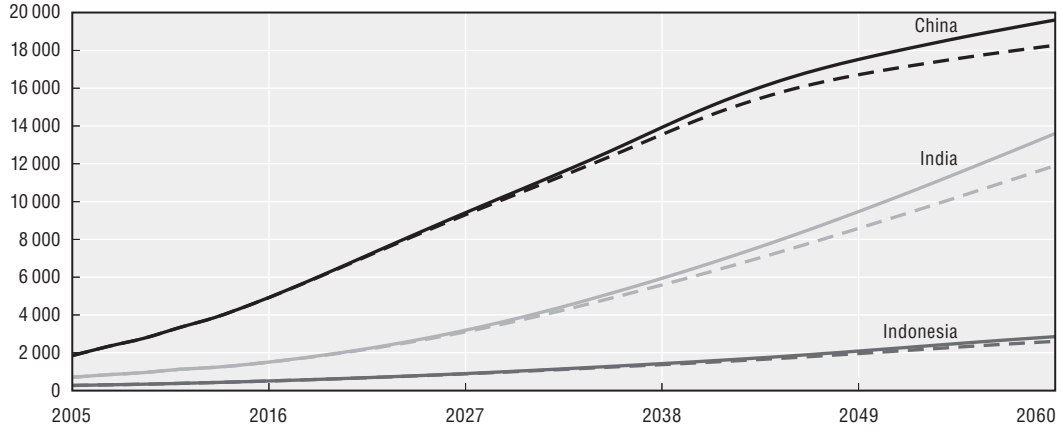
The projected framework can only account for the influences of the relative supply of different skills and demand effects due to changing income levels and specialisation patterns, but not the effect of skill-biased technical change and institutional settings. Over the next half century educational attainment will continue to improve, increasing the supply of skilled labour. This leads to downward pressure on the skill premium in the model framework. However, as shown in Braconier et al. (2014) continued skill-biased technological progress, with rapidly rising demand for higher skills, is likely to outpace the increase in the supply of skills, leading to increased wage inequality over the next 50 years.

4.2. The speed of up-skilling in emerging economies influences GDP, trade and specialisation

The speed of up-skilling has important implications for trade and specialisation across countries. To highlight this, this section compares the baseline GDP and trade projection with one in which CII economies are assumed to approach the global frontier level of education much more slowly than in the baseline scenario as described in Section 3.2. Slower accumulation of human capital influences aggregate growth and by 2060 results in a decrease in real GDP by 7% for China, 12% for India and 9% for Indonesia relative to baseline (Figure 10). This underlines the importance of skill accumulation for the development of these countries. There is also a more limited indirect impact in terms of GDP for other countries (less than 0.5%) channelled through capital markets, because lower GDP means less savings and investment.[10]

Figure 10. **Slower up-skilling reduces real GDP, 2005-60**[1]

Constant 2004 USD



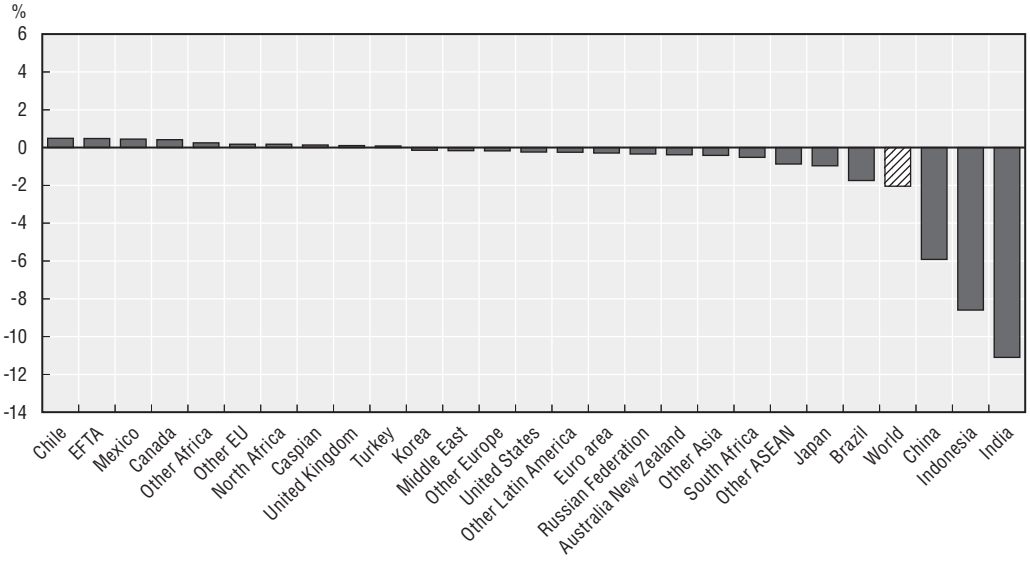
1. Plain line: baseline scenario; dashed line: lower up-skilling scenario.
Source: Authors' calculations.

The reduction in aggregate growth due to slower accumulation of human capital in emerging economies affects trade across countries especially in CII economies (Figure 11). Indeed, world trade is some 2% lower by 2060 in the slower upskilling scenario as compared with the baseline, mainly driven by decreases in CII economies exports (ranging between 6-11%).

Slower upskilling in CII economies implies that the reorientation of trade and production towards higher value-added manufacturing and services away from lower-skill

Figure 11. **Effects on trade of lower upskilling in emerging economies, 2060**

% change in volume of gross exports as compared with the baseline by 2060



Source: Authors' calculations.

activities occurs at a slower pace than in the baseline. For instance, in India and Indonesia by 2060 exports of business services and electronics would be 25% and 10% lower, respectively, whereas exports of agricultural goods (e.g. other agriculture, rice and crops, livestock) would be 5% and 15% higher, respectively, compared with the baseline (Figure 12). By contrast, slower upskilling in CII economies implies that advanced economies (e.g. the United States, Japan and the Euro area) maintain their relative competitiveness in products that are intensive in human capital, such as electronics, business services and other manufacturing.

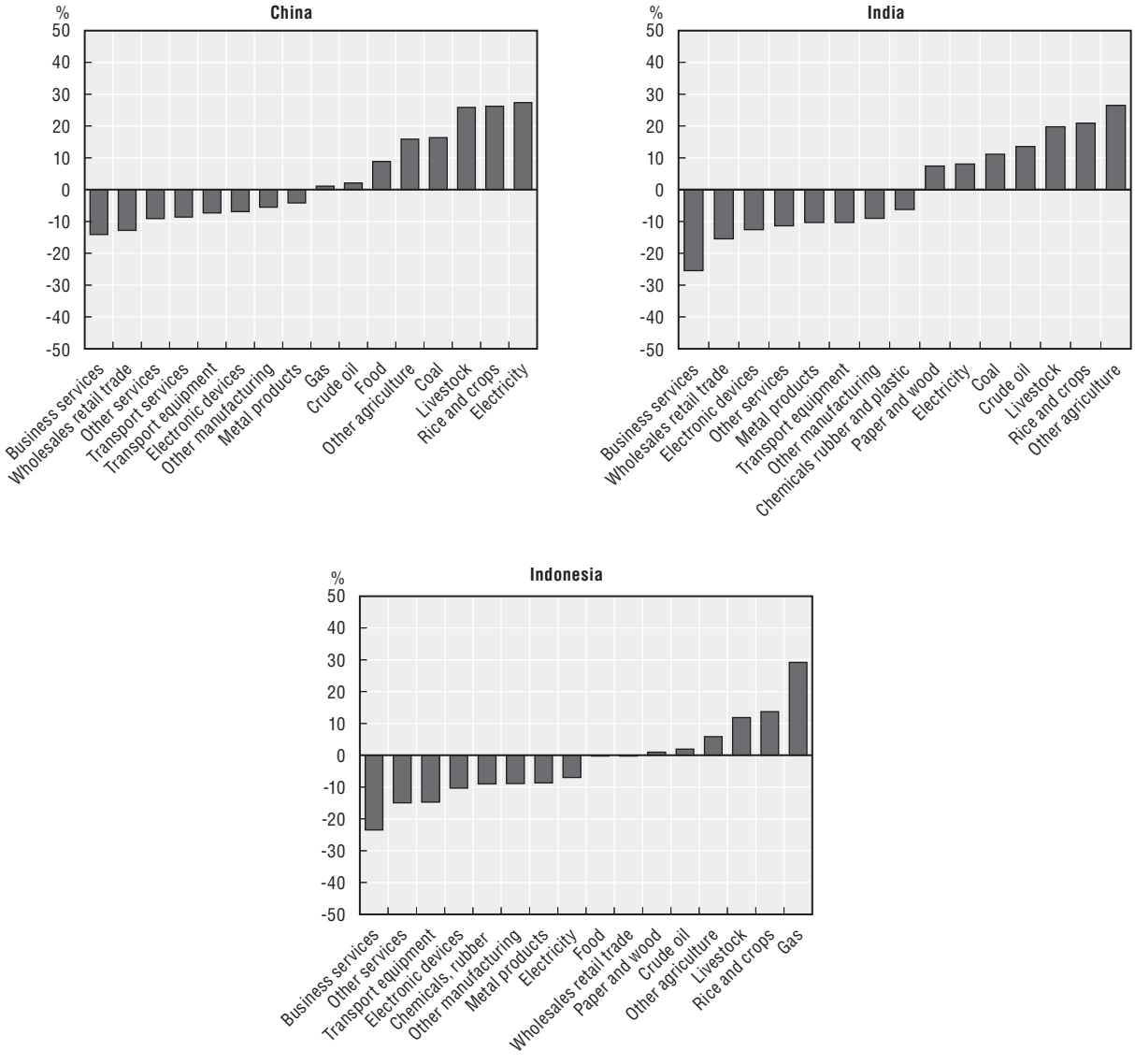
Such a change in export specialisation is driven by developments in skilled and unskilled wages triggered by the slower upskilling in CII economies, which translate into variations in production prices. Slower upskilling in CII economies leads to a shortage of skilled workers relative to unskilled workers, which will increase the relative wage of skilled to unskilled labour as compared with the baseline. As shown in Figure 13, sector production price will vary according to skill intensity, with less skill-intensive sectors facing a decrease in their price and more skill-intensive ones an increase. Differences in the variation of production prices reflect cross-country differences in sectoral demand and factor endowments. In addition, changes in relative wages are not fully translated into changes in production prices due to substitution with other production factors. The induced change in production prices reshape a country's competitiveness influencing trading partners' demand for its goods (as well as for goods originating from all other countries).

4.3. Trade liberalisation can increase global trade and growth

This section gauges the impact of two stylised trade liberalisation scenarios on global trade, GDP, industrial structure and wage inequality over the next 50 years, compared with the baseline long-run scenario described above. As described in Section 3.3, one scenario considers strengthened regional integration among a set of current OECD economies

Figure 12. **Slower upskilling in China, India and Indonesia slows down their restructuring towards higher skilled activities**

% change in volume of industrial exports as compared with the baseline in 2060



Source: Authors' calculations.

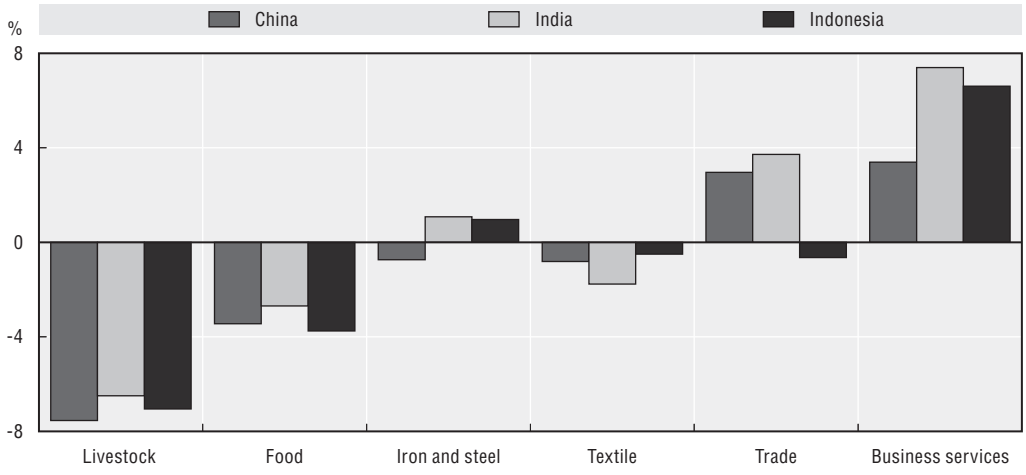
(e.g. the United States, Canada, Mexico, the European Union, Switzerland, Australia, New Zealand, Japan and Korea), the other scenario considers trade liberalisation on a global basis.

4.3.1. *Though gravity factors are key drivers of trade over the long-run, trade policies still matter*

As previously highlighted in Fontagné and Fouré (2013) over the next decades changes in GDP will be the main driver of world trade, while changes in trade policies are unlikely to lead to changes of comparable magnitude (Figure 14). For instance, world goods exports are projected to increase on average by some 3.5% annually over the next 50 years due to changes in GDP, demography and other gravity factors, while regional trade and global

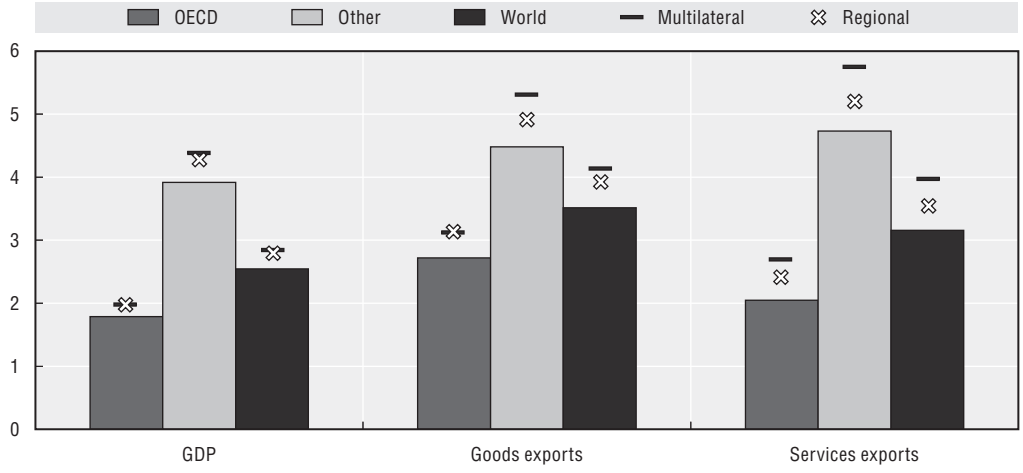
Figure 13. **Production prices: Selected sectors, 2060**

% deviation from baseline



Source: Authors' calculations.

Figure 14. **Growth in GDP, exports of goods and services (volume), 2012-60**



Source: Authors' calculations.

multilateral liberalisation would add around 0.1 and 0.3 percentage points to annual OECD export growth, respectively. Thus, the projections suggest that OECD countries would not be able to keep their current position in world trade simply by moving towards deeper regional integration.

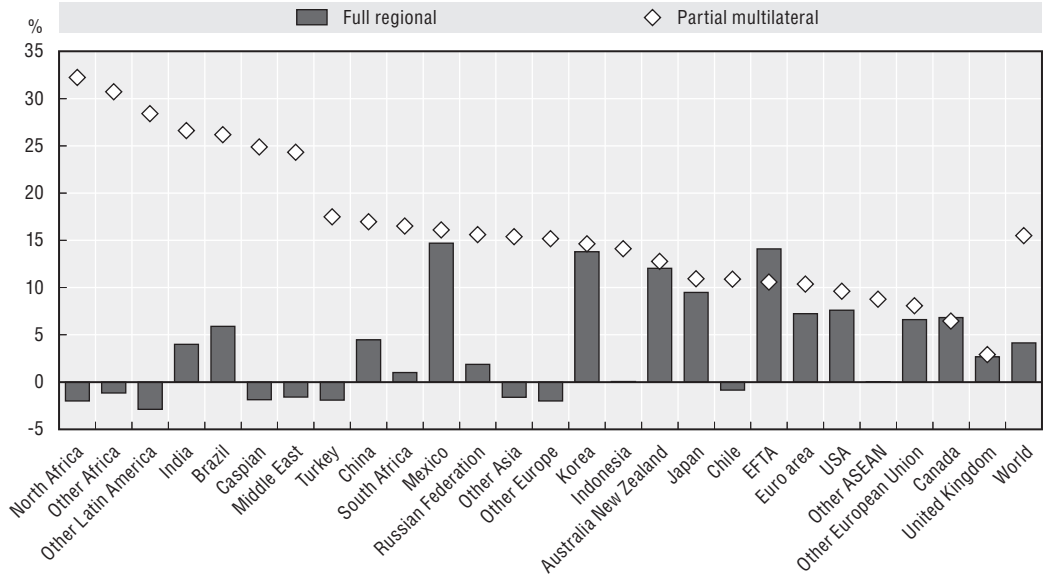
4.3.2. Unevenly distributed increases in trade from trade liberalisation

Projecting the alternative scenarios reveals mostly positive trade impacts across the globe but illustrates the different outcomes of regional versus multilateral approaches to trade liberalisation. World trade (exports) in the regional and partial multilateral liberalisation is 4% and 15% higher in 2060, respectively, but the gains are distributed unevenly across countries or regions in the two scenarios (Figure 15). While the effect of trade liberalisation in FTA members (mostly OECD economies) is to raise trade by around 7-8% in both scenarios, non-FTA members (mostly non-OECD countries) only enjoy sizeable increases in trade in the multilateral scenario. For these economies the increase in

trade is only about 1% in the regional liberalisation scenario despite the bilateral agreements they conclude with members of the large FTA area (NAFTA, the European Union, Australia, New Zealand, Japan and Korea). By contrast, multilateral liberalisation could raise their trade by 15% to 30%. An explanation for this is that non-tariff measures (transaction costs in goods and NTM in services) remain stable in the regional scenario, counteracting the reduction in tariffs. Nonetheless, as in the baseline, in both scenarios the bulk of all trade still occurs among non-OECD (non-FTA) countries or regions at the end of the projection period.

Figure 15. **Unevenly distributed increases in trade in liberalisation scenarios, 2060**

% increase in gross exports as compared with the baseline by 2060, (volume), %



Source: Calculations based on MIRAGE.

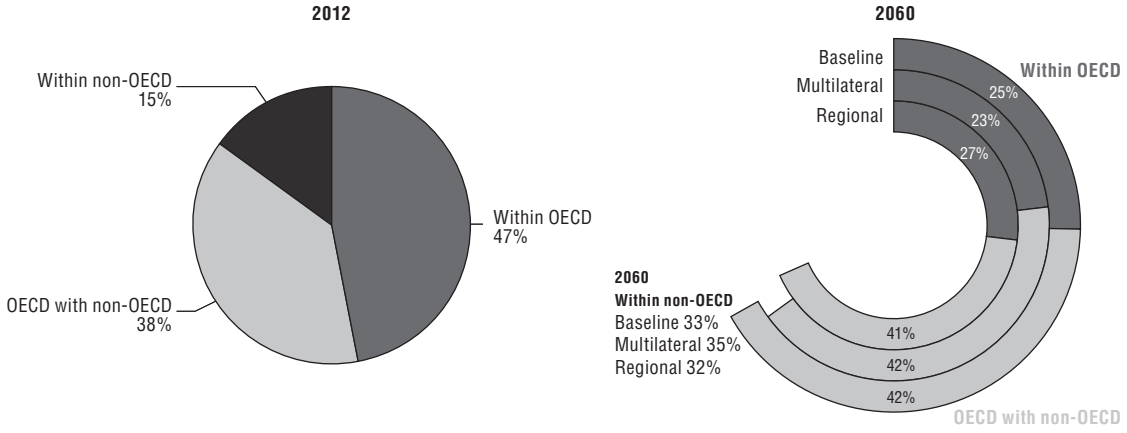
This asymmetry in the impact of liberalisation across OECD and non-OECD countries in the two scenarios can be explained by a reorientation of trade and by large trade diversion effects. In the regional liberalisation scenario, a share of potential trade will shift towards members of the FTA (OECD countries) away from non-members (non-OECD countries) (Figure 16). Part of this expansion of trade is replacing former trade of non-members with trade from regional members, as a result of the shift in relative market access conditions. As a result of this trade diversion some non-FTA countries will experience trade losses, particularly those in regions that do not sign a bilateral agreement with the FTA in 2030 (e.g. Africa, Latin America, the Middle East, etc.). By contrast, in the partial multilateral scenario trade is instead reoriented away from OECD countries towards the non-OECD area, reflecting comparatively larger reductions in tariffs than in OECD countries (i.e. given that initial tariff levels in the baseline are higher in non-OECD than in OECD), as well as stronger underlying growth performance in this area.

4.3.3. Trade liberalisation triggers moderate changes in trade specialisation and industrial structure

Trade liberalisation will increase international competition and induce a reallocation of resources across and within countries and industries. However, on the whole, the

Figure 16. **Reorientation of trade towards FTA partners**

Export shares in world trade based on bilateral gross exports, (volume), %



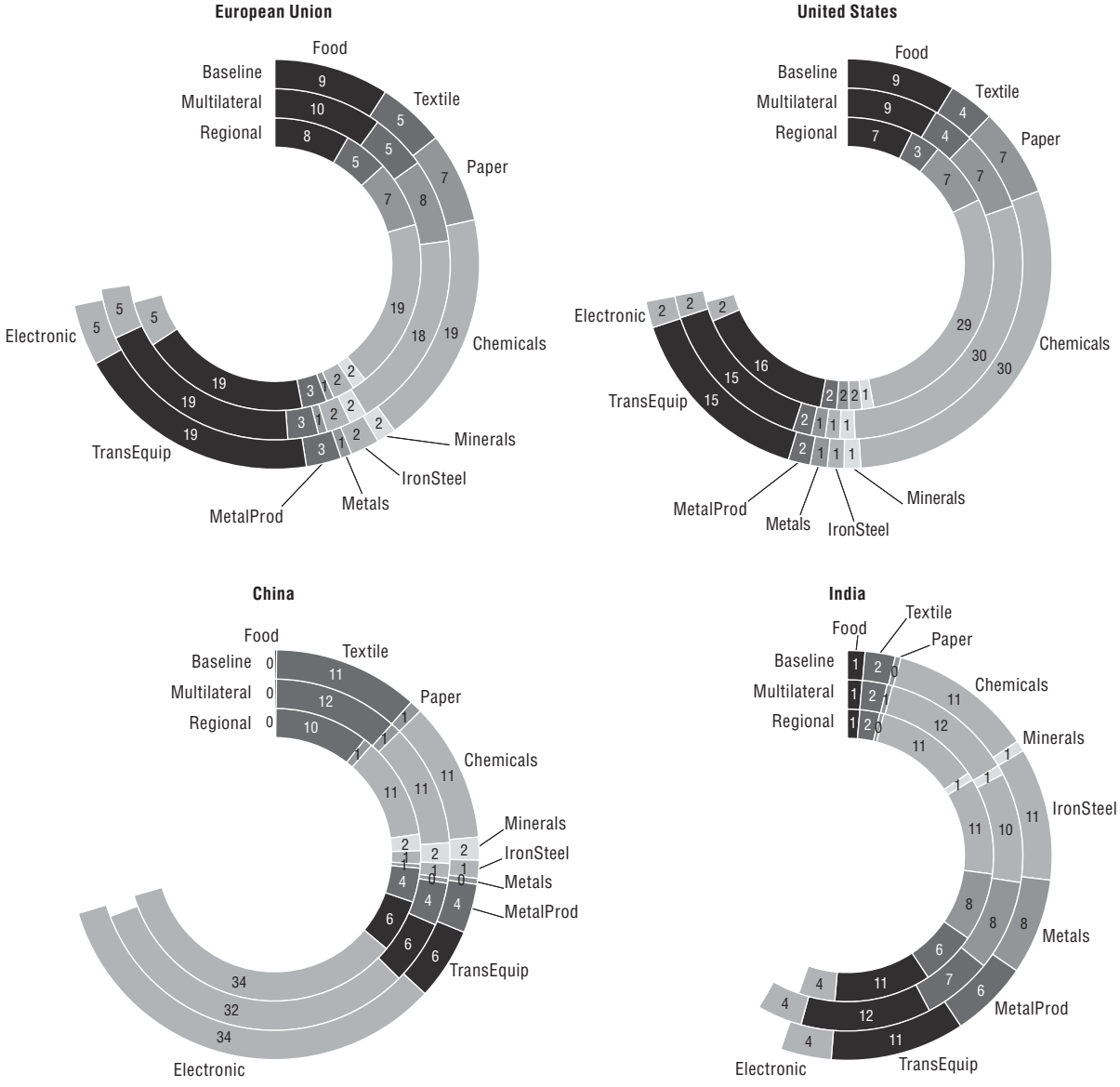
Source: Calculations based on MIRAGE.

change over time in the trade specialisation and, in turn, broad industrial structure triggered by deeper trade liberalisation in the two scenarios tends to be moderate compared with that which already occurs in the baseline. One explanation is that the implemented trade scenarios do not introduce any significantly differentiation in trade liberalisation among different sectors. Accordingly, countries' trade specialisation pattern are not expected to change considerably as compared to the one observed in the baseline (Figure 17). Overall, this suggests that a larger share of the trade-induced reallocation of activities occurs within rather than between industries.

However, the change in trade specialisation in China that occurs in the multilateral scenario deserves a comment. Even though the education level in China will improve significantly over the next 50 years, multilateral trade liberalisation will slightly reinforce the Chinese specialisation in (low-skill intensive) textiles (from 11% to 12%) at the expense of (higher-skill intensive) electronics (34 to 32%). This is a consequence of the initial tariffs that China is facing in developed markets in these two sectors. The tariff on textiles is the highest tariff for manufactured goods that China is facing in Canada (15.3%) and the United States (11.5%) and the second highest in the Euro area (10.9%), with these three regions being significant destinations for Chinese textile products (the share of Canada, the United States and the Euro area in Chinese textile exports are, respectively, 2.5%, 23.5% and 23.6%). By contrast, Chinese electronic devices are facing initially the lowest tariff in the same three regions as well as being widely exported to them. As a result, halving these two tariffs implies a larger gain in revealed comparative advantage for textiles than for electronics, hence influencing the Chinese export specialisation.

Turning to the change in the industrial structure induced by trade liberalisation some interesting patterns emerge. In both alternative scenarios, the industrial structure in the United States tends to shift over time towards agriculture (rice and crops) and food production away from other manufacturing (Figure 18). This reallocation comes about through increased international competitiveness in the export market, reflecting increasing comparative advantage of the United States in this sector due to the combination of abundant arable land with the removal of high levels of agricultural support in some countries in the multilateral scenario. By contrast, the removal of agricultural support in the European Union (in the multilateral scenario) tends to reorient activities in the Euro area

Figure 17. **Export specialisation in manufactured products, 2060, volume, %**



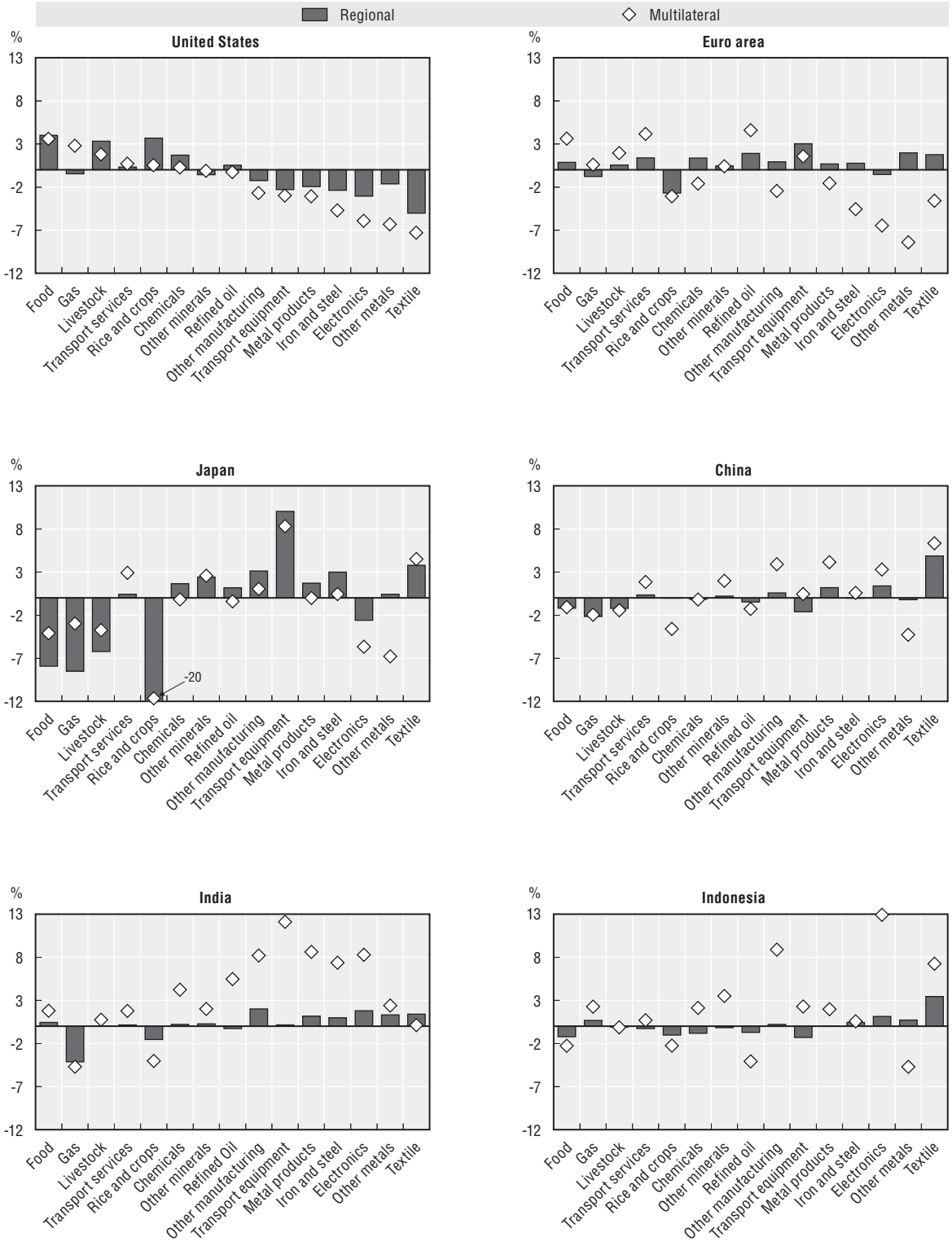
Source: Authors' calculations.

away from agriculture (rice and crops) towards manufacturing (e.g. the auto industry, transport services, textiles, food production). Similarly in Japan, in both scenarios, the activity moves away from agriculture and food production towards manufacturing, particularly transport equipment.

Among emerging economies, the change in industrial structure over the next half century is much more pronounced with partial multilateral liberalisation than with regional liberalisation, consistent with better market access and larger trade gains in the multilateral scenario. One common pattern is a shift towards manufacturing away from agriculture and food production. For instance, in India and Indonesia, by 2060 the value-added in the electronics sector would increase by more than 8% in the multilateral scenario, compared with baseline. Furthermore, multilateral liberalisation would increase the value-added of the

Figure 18. **Reallocation of industrial activities, 2060**

% increase in value added of industries as compared with the baseline in 2060



Source: Authors' calculations.

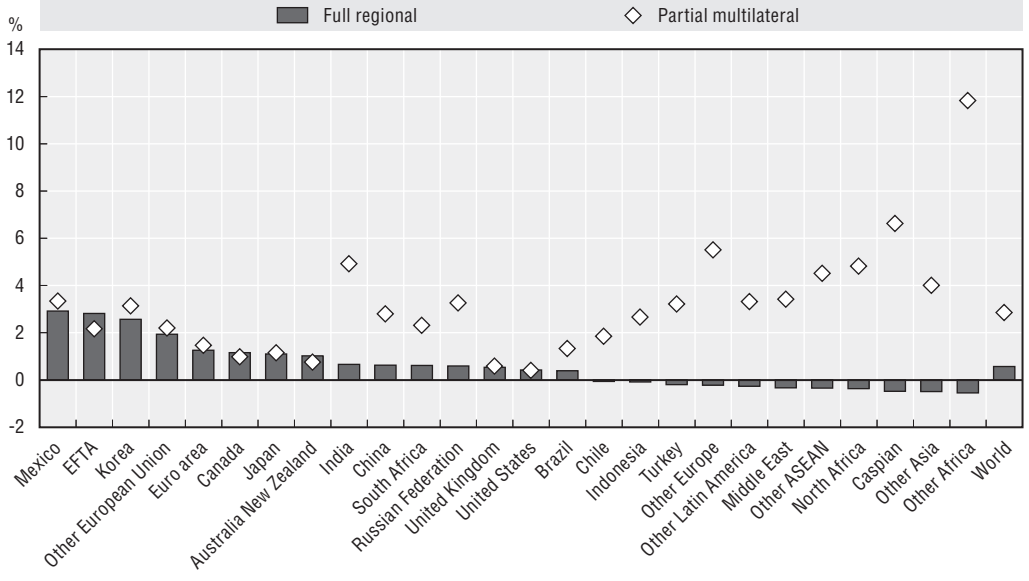
auto industry by around 12% in India compared with baseline, reflecting a stronger impact of India's competitiveness in labour-intensive low and medium-skilled manufacturing. Interestingly, even though China's export specialisation in electronics is reduced in the multilateral scenario as compared with the baseline, the value added share of electronics in total value added increases by 2060. This likely reflects a higher domestic demand for electronics, whose production relies less on foreign intermediate inputs.

4.3.4. *Trade liberalisation has a positive impact on real GDP, more so if liberalisation is multilateral*

In parallel with the increased trade integration and associated reallocation of resources across sectors to comparatively more efficient ones, long-term real GDP will increase relative to baseline. World GDP in the regional and partial multilateral liberalisation scenarios is 0.6% and 2.8% higher in 2060, respectively. But again, the gains in long-term GDP are unevenly distributed across the globe in the two scenarios. While the change in real GDP in most OECD countries is similar in the two scenarios, the gains are always greater for non-FTA members (mostly non-OECD countries) in the multilateral scenario. Multilateral liberalisation could raise long-term real GDP in India and other Asian regions by more than 4% by 2060 (relative to baseline) (Figure 19).

Figure 19. **Trade liberalisation increases GDP, 2060**

% increase in real GDP of trade liberalisation as compared with the baseline by 2060



Source: Authors' calculations.

The gains in terms of GDP illustrated here may appear modest compared with large changes observed as a result of growth fundamentals (e.g. demography, education, technical progress, etc.). However, it should be kept in mind that, while the MIRAGE-e projections capture only allocative gains, a better trade environment and level playing field are pre-conditions to reap the growth benefits of the mentioned fundamentals. Feedback effects of increased trade openness on growth in terms of acceleration of productivity catch-up (due to knowledge spillovers and diffusion of technologies) are not taken into

account in the multilateral liberalisation scenario modelled with MIRAGe-e. A separate exercise conduced with the OECD model suggests that global GDP would gain an additional 1.2% in 2060, due to these indirect growth effects of trade liberalisation.

4.3.5. *Trade liberalisation tends to increase wage gaps between skilled and unskilled labour*

Relative wages will be affected by trade liberalisation since the demand for different types of skills changes with specialization. Any excess demand or supply of skilled and unskilled labour would be absorbed in relative factor prices. Table 4 presents the change in the differential between growth in skilled and unskilled wages for the two trade liberalisation scenarios. A positive number means that skilled wages have increased faster than unskilled wages, thus within-country wage inequalities (the skill premium) increase. Overall, there is a tendency for the wage gap between skilled and unskilled workers to widen in both advanced and emerging economies in the trade liberalisation scenarios relative to baseline. All categories of labour income (skilled and unskilled) increase in most developing and developed economies as a result of multilateral liberalisation, expanding relative demand for skilled-intensive goods and services worldwide. This shift in consumption patterns increases the relative demand for skills at the global level.

Table 4. **Skilled and unskilled wage gaps**[1]

Percentage point change in the relative wage of skilled to unskilled as compared with baseline

Region	2030		2060	
	Multilateral	Regional	Multilateral	Regional
Euro area	0.20	0.10	0.79	0.41
United Kingdom	0.23	0.12	0.98	0.48
Other European Union	0.24	0.11	0.93	0.45
United States	0.07	0.01	0.24	0.03
Japan	0.14	0.15	0.55	0.63
Brazil	0.02	0.02[2]	0.21	-0.00
Russian Federation	-0.55	0.04	-3.56	0.25
India	0.15	0.02[2]	0.75	0.10
China	0.22	-0.09[2]	0.46	-0.03
South Africa	0.40	0.03	1.74	0.01
Chile	-0.16	0.02[2]	-0.64	0.02
Indonesia	0.32	0.00[2]	1.62	0.17
Other ASEAN	0.26	0.06[2]	0.89	0.00[2]
Turkey	0.11	0.05	0.26	0.26
Sub-Saharan Africa	1.39	0.03	5.20	-0.04[2]

1. A positive number means that wage inequality between skilled and unskilled labour has risen, that is skilled wage increases more that unskilled wage or unskilled wage decreases more that skilled wage.
2. Both skilled and unskilled wages are decreasing.

In most cases, upwards pressures on skill premia are stronger in the multilateral liberalisation scenario than in the regional one, reflecting greater reallocation of resources across industries and countries towards higher-skilled activities.[11] Generally, however, these additive pressures originating from trade liberalisation are moderate. Stronger pressures on skill premia are observed in European countries and Japan, as demand shifts from low-skilled sectors towards higher-skilled ones, as well in some other advanced economies (e.g. the United Kingdom and EFTA countries). Pressures on wages of skilled

workers are also significant in some developing economies such as Indonesia, India or South Africa due to the strong reorientation of production towards the relatively high-skilled electronic sector in combination with comparatively lower up-skilling than in some other emerging economies (e.g. China). Finally, a few developing economies display a decrease in both skilled and unskilled wages before signing bilateral agreements with FTA members in the regional liberalisation scenario (i.e. note 2 in Table 4). This is caused by the trade deviation associated with the implementation of the FTA.

5. Conclusion

This paper draws global trade and specialisation scenarios up to 2060, taking into account international spillovers. Scenarios of trade and specialisation over the next 50 years are based on a framework that combines long-term macro projections for the world economy with a detailed sectoral general equilibrium model (Mirage-e). The combination of aggregate growth projections with the more detailed description of the behaviour of consumers and firms provided by the Mirage-e model allows highlighting how countries' specialisation is shaped by global trends (e.g. ageing, skill enhancement, capital investment, technology diffusion, etc.). It also highlights how structural and macro policies implemented in each country will affect future trade and specialisation patterns, taking into account inter-linkages across countries.

The results of the exercise provide five main insights that can be useful to understand potential future developments of the world economy. First, the geographical centre of trade will continue to shift towards emerging economies. Fast GDP growth in China, India and other Asian countries is associated with gains in trade shares over the next half century. Thus, the share of global trade within the present OECD will decline from 50% in 2012 to 25% by 2060, while trade among non-OECD economies will account for approximately one-third of global trade.

Second, China, India and other Asian economies will continue to strengthen their role in manufacturing trade. For instance, by 2060 China and other Asian economies will account for the bulk of world exports in electronics. Significant shifts will also occur in services, with China and other emerging economies gaining large trade shares at the expense of the Euro area, the United Kingdom and the United States.

Third, in parallel with shifts in trade patterns the industrial structure in emerging economies will gradually become similar to that of the present OECD, whereas it remains fairly unchanged in OECD economies. In emerging economies, past trends are expected to continue over the next 50 years and the industry mix will continue shifting towards services away from manufacturing, typically low-skilled (e.g. textile, food production, etc.), driven by income gains and changing consumption patterns.

Fourth, trade liberalisation will contribute to higher growth. In particular, gradually removing tariffs, regulatory barriers in services and agricultural support, as well as reducing transaction costs on goods (e.g. costs of handling at customs) could increase global trade and GDP over the next 50 years. Specific scenarios of regional or partial multilateral liberalisation among a core group of OECD countries could, respectively, raise trade by 4% and 15% and GDP by 0.6% and 2.8% by 2060 relative to the *status quo*. However, the gains would be distributed unevenly across countries. Regional liberalisation would bring greater gains to members of the free-trade agreement, notably OECD countries, rather than to non-members, due to trade diversion.

Finally, investment in education is crucial for trade and high-skill specialisation patterns over the coming decades. In fact, slower educational upgrading in key emerging economies (i.e. China, India and Indonesia) than expected in the baseline scenario could reduce world exports by 2% by 2060, with decreases ranging between 6-11% in China, India and Indonesia. Lower up-skilling in emerging economies would also slowdown the restructuring towards higher value-added activities in these emerging economies.

Notes

1. The main results presented in this study would most likely be similar to the ones obtained if the macro economic projections for all countries were based on Fouré et al. (2013). This is because the projection methodologies for potential GDP are very similar in the two projections, including the assumptions on convergence parameters. The main difference would appear in the short and medium run, given that the OECD methodology assumes convergence of effective to potential output.
2. The long-run growth projections depend on various assumptions such as the speed of convergence to the long-run steady state. In this study the assumptions on key parameters shaping drivers of growth are informed by past trends and econometric estimates.
3. There are a number of countries where capital intensity has shown a definite recent trend and, where this is the case, the trend is assumed to gradually disappear so that the underlying capital-output ratio stabilises.
4. At early stages of development, economies rely largely on agricultural production, which is not very energy-intensive, while industrialisation leads to an intensification of energy use and the later change towards services reverses the trend. Conditioning the energy-efficiency catch-up to the level of development allows representing this stylised fact at the macro level.
5. The technical frontier in MaGE is not affected by this redefinition (see Section 2.2).
6. Accordingly, unemployment is only captured via its short-term impact on GDP of the 42 countries covered by OECD long-term projections, which is then reported in the endogenous TFP of MIRAGE-e.
7. In MIRAGE-e, contrary to MaGE, no gender distinction is made.
8. The information on FTAs was downloaded from: *http://rtais.wto.org/UI/PublicAllRTAList.aspx* at the end of 2012.
9. The detailed implementation is available from the authors upon request.
10. In the OECD model, this adjustment takes place through the price of capital, while in MaGE investment in the 105 countries is rescaled to match world savings.
11. It should be kept in mind that the model does not account for any feedback from skill premia to investment in education and the supply of skills, which could have implications for wage gaps. Also, any existence of shared rents between employers and employees in protected sectors prior to the trade liberalisation is not taken into account.

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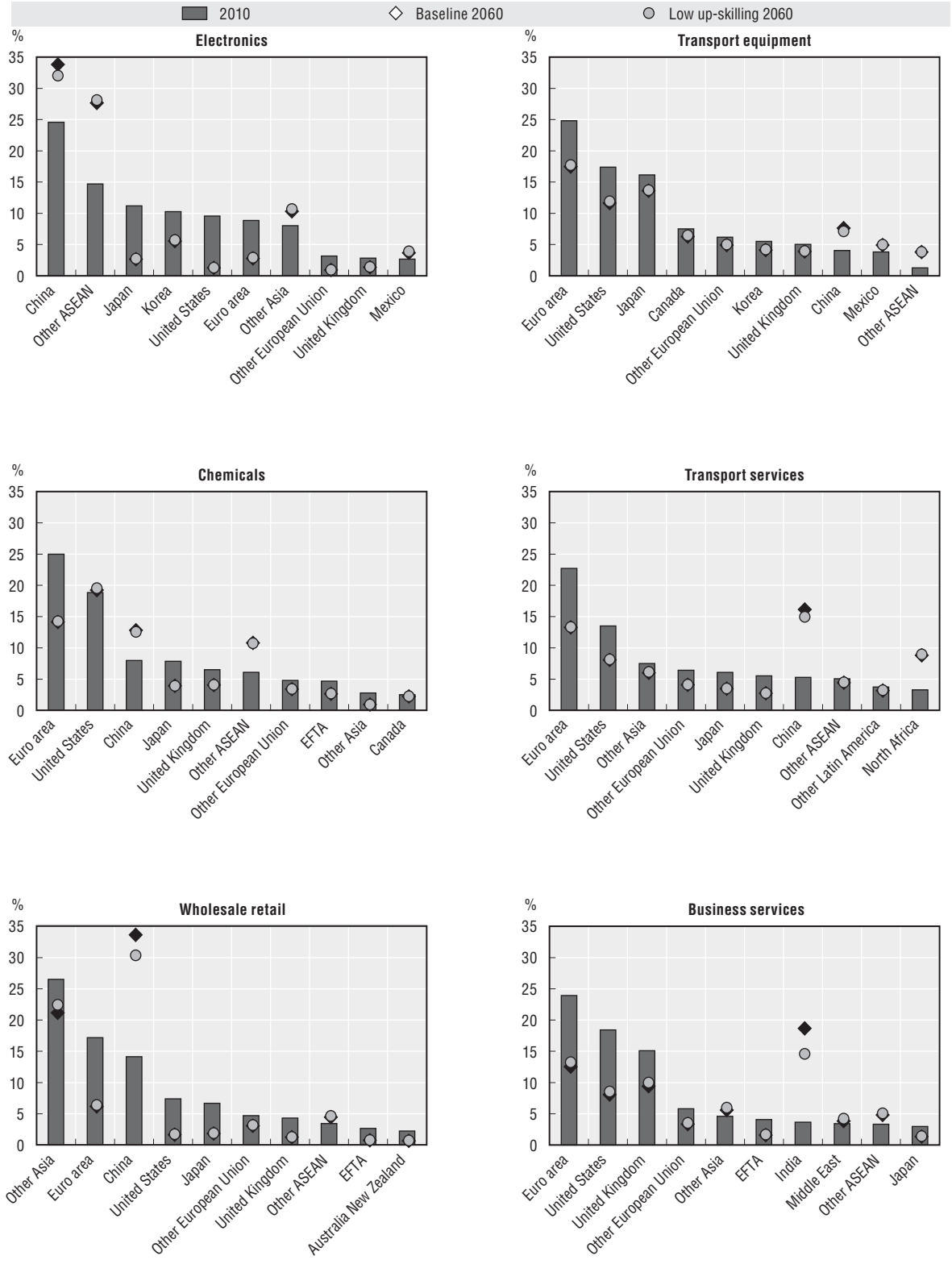
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APPENDIX A

Additional data

Figure A.1. **Trade shares in selected industries, 2010 and 2060**



Source: Authors' calculations.

OECD Journal: Economic Studies
Volume 2015
© OECD 2015

International migration: The relationship with economic and policy factors in the home and destination country

by
Ben Westmore*

This paper uses data of the high-skilled and low-skilled migrant stock between 92 origin and 44 destination countries to highlight the relationship between economic factors and international migration. It also attempts to uncover links with policy and demographic factors prevailing in the origin and destination countries. The analysis suggests that higher skill-specific wages in the destination are associated with more migration. This relationship appears to be particularly strong for migrants from middle-income countries, supporting theories of an inverted-U relationship between origin country economic development and the propensity to migrate. Policy differences between the destination and origin also appear important, for example in terms of regulations on businesses and labour markets, along with the relative quality of legal institutions. In some instances, the effects on high-skilled and low-skilled migrants differ markedly.

JEL classification codes: F22, J01, O15

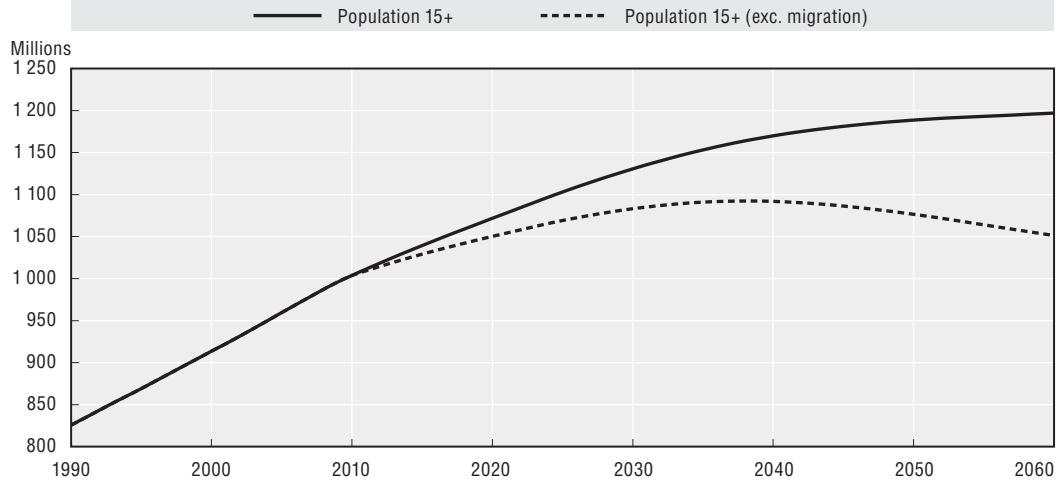
Keywords: International migration, labour economics, economic development, public policy

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The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Introduction

Population ageing will be a headwind to future global growth, with the share of the global working age population expected to decline over the period to 2060. In addition to policy movements which increase retirement ages in line with gains in life expectancy, the central scenario in the OECD long-term growth projections (Johansson et al., 2013 and OECD, 2014) assumes that inflows of migrant workers that can be well-integrated to the labour force will be one factor to mitigate ageing in most OECD economies. The OECD region has experienced steady inflows of immigrants in recent decades and the migration projections underlying the long-term central scenario suggest these trends will be extrapolated into the future (Figure 1).[1]

Figure 1. **Population and migration 2010-60**



Source: UN, Eurostat, OECD estimates.

While there may be some persistence in migration paths over time (Beine et al., 2011), due to diaspora or common attributes between a particular origin-destination country pair, migration flows are not guaranteed to mimic past patterns. Countries can rapidly undergo migration transitions, with a number of southern European and emerging Asian countries having shifted from net emigration to net immigration regions over the past few decades.

In some cases, an important catalyst for migration transitions has been changes in relative wages between countries. Taking Korea as an example, much of the decline in emigration and increased immigration through the late 1980s and early 1990s has been attributed to improvements in domestic labour demand and the resulting increase in wages relative to other countries (Fields, 1994). Similarly, recent work has suggested that comparatively strong future income growth in many non-OECD Asian countries could reduce the pace of net emigration (OECD, 2012; Hatton and Williamson, 2012).

The theoretical and empirical importance of expected income differentials in motivating international migration has been well documented (Harris and Todaro, 1970; Borjas, 1990; Hatton and Williamson, 2002; Mayda, 2007). An implication of the emphasis on *expected* income is that despite a positive wage differential, migration between a country pair may remain low if individuals in the low-income origin country anticipate significant relative improvements in future economic conditions (Mansoor and Quillin, 2007). For many, moving away from family and friends is not desirable and may be avoided unless the economic case for doing so will be sustained for the foreseeable future.

A body of recent work has emphasised that, for a given wage differential, the propensity to emigrate may not be the same across all countries. Specifically, there is evidence of a "migration hump" where emigration rates increase as economic development rises before declining at higher development levels (de Haas, 2010; Martin and Taylor, 1996). This may result from individuals in mid-development origins being less likely to face the financial constraints to migration experienced in low income countries, while a move abroad can offer a greater increase in opportunity than for populations from very high income nations.

Although relative wages are integral to many individuals' migration decision, the motives for migration can be very diverse. While some of these are difficult to quantify and hence introduce into empirical models (e.g. social attitudes), factors such as the relative age profile, education level and institutional setting, as well as common origin/destination links in terms of language, geography and colonial ties can be accounted for (Bauer and Zimmerman, 1999). Policy settings may also play a role, especially those regarding tax and benefit systems (Kureková, 2013) and the structural policies that govern the product and labour markets. Furthermore, specific migration and immigrant integration policies may impact the number of people travelling along a particular migrant path.

In this work, the role of destination to origin country wage differentials are incorporated into an empirical model that attempts to explain bilateral migration between a large number of country pairs (see Section 2 for the empirical model and Section 3 for the estimation strategy). There is also some attempt to identify any discernible relationships between migration and various demographic and policy factors.

2. Empirical model

The empirical model is based on the theory of agents maximising their utility by deciding whether or not to migrate and then, in the event they move, their optimal destination. It closely follows the theoretical foundation outlined by Beine and Parsons (2013) which builds on an extensive literature. $N_{i,t}$ is the size of the native population in country i at time t and at each period the native population chooses their optimal location among a set of n alternative destinations that include their home country. The number of native-born people choosing the optimal destination j is denoted $N_{ij,t}$. An individual's utility is log-linear in income and, for someone born in country i and staying in country i at time t, it is given by:

$$u_{ii,t} = \ln\left(w_{i,t}\right) + A_{i,t} + \varepsilon_{i,t} \quad [1]$$

where $w_{i,t}$ refers to the wage in country i at time t, $A_{i,t}$ denotes other attributes of country i and $\varepsilon_{i,t}$ is an iid extreme-value distributed random error term. The utility derived by an individual migrating from country i to country j at time t is given by:

$$u_{ij,t} = \ln\left(w_{j,t}\right) + A_{j,t} - C_{ij,t} + \varepsilon_{i,t} \quad [2]$$

where $C_{ij,t}$ represents the migration costs associated with moving from *i* to *j* at time *t*. The assumed properties of the error term and the results in McFadden (1984) can be applied to obtain an expression for the probability that an individual born in country *i* will move to country *j*:

$$\Pr\left[u_{ij,t} = \max_{k} u_{ik,t}\right] = \frac{N_{ij,t}}{N_{i,t}} = \frac{\exp\left[\ln\left(w_{j,t}\right) + A_{j,t} - C_{ij,t}\right]}{\sum_{k}\exp\left[\ln\left(w_{k,t}\right) + A_{k,t} - C_{ik,t}\right]} \quad [3]$$

This allows the bilateral migration rate between *i* and *j* to be written as:

$$\frac{N_{ij,t}}{N_{ii,t}} = \frac{\exp\left[\ln\left(w_{j,t}\right) + A_{j,t} - C_{ij,t}\right]}{\exp\left[\ln\left(w_{i,t}\right) + A_{i,t}\right]} \quad [4]$$

where $N_{ij,t}$ is the number of migrants from country *i* to country *j* at time *t*. By taking logs, an expression for the bilateral migration rate is derived:

$$ln\left(\frac{N_{ij,t}}{N_{ii,t}}\right) = ln\left(\frac{w_{j,t}}{w_{i,t}}\right) + A_{j,t} - A_{i,t} - C_{ij,t} \quad [5]$$

From this theoretical model, a flexible estimation equation that includes both origin and destination country fixed effects is defined. Origin country fixed effects absorb the denominator of the dependent variable in equation 5. The available data differentiates between high and low-skilled migrants, allowing separate estimations to be performed on skill-specific dependent variables:

$$ln\left(N_{ij,s,t}\right) = W_{ij,s,t} + \alpha_{j,t} + \alpha_{i,t} - C_{ij,t} + \epsilon_{ij,t} \quad [6]$$

where w_{ij} represents the wage ratio specific to skill-level *s*, the variable α_j reflects destination country fixed effects and α_i origin country fixed effects. As is common in the related literature, the costs of migration between a particular origin-destination country pair are captured by a series of gravity variables specific to the bilateral pair. These take the form of dummy variables for a country pair with a common language, a common border and colonial ties as well as a measure of geographical distance. The variable ϵ is an iid error term.

The inclusion of origin and destination country fixed effects reduces the potential for omitted variable bias in the estimated coefficients. In particular, unobserved factors specific to the sending or receiving country are controlled for, including conflict in the origin or general attitudes or policies in the destination country toward accepting refugees. However, it makes the identification of factors associated with bilateral migration more challenging as they cannot be included as origin or destination-country-specific variables. As discussed, the relationship between the migration decision and relative institutional and policy factors between country pairs is of particular interest. Consequently, similar to the variables capturing wages and migration costs, these factors are included as cross-terms defined as either a ratio of conditions in the destination and origin country or through dummy variables (see Data Annex for more details). The estimated effects from all coefficients are averages across migrants with common skill level between all bilateral country pairs.

3. Data and estimation strategy

The analysis is undertaken over a broad country sample that includes both OECD and non-OECD countries. Much of the past work in the field has focused on migration to OECD destinations however, this work attempts to capture potential influences on migration to and from both OECD and non-OECD countries.

Bilateral migrant stocks are taken from an updated World Bank sponsored data set documented by Docquier et al. (2012).[2] The data are for migrants aged 25 and above and are based on country of birth instead of citizenship. These data are appealing because they decompose bilateral migration stocks by skill level and are available for two cross-sections in time (1990 and 2000). High-skill migrants are defined as those with college or post-secondary education and low-skill migrants are those with a level of schooling up to and including upper-secondary education. A number of the observations in the original data set are imputed from a pseudo-gravity model similar to the estimation equation presented above (Equation 6). In order to avoid bias in the estimated coefficients, all such observations are omitted from the regression analysis.

The data sources of the policy and demographic variables are detailed in the Data Annex. A trade off from the broad country sample is that, in some cases, indicators for the explanatory variables are chosen due to country coverage despite being lower quality than comparable measures that are only available for OECD members. The available time horizon for some of the policy indicators is confined to the 1990s. While caution should be exercised in definitively attributing causality given the available data, the 2000 migrant stock is taken as the dependent variable in the base specification. This is more stable than the migrant flow and should better reflect structural factors.

Nevertheless, the availability of the 1990 cross-section allows a specification which includes the 1990 stock as an independent variable to be estimated as a robustness test (discussed in Section 4). This is equivalent to modelling the 1990 to 2000 migrant flow. One appeal of such a specification is that it takes into account diaspora effects, the influence of social or family networks that may draw migrants from a specific origin to a specific destination country. While these are not explicitly captured in the base specification, they are likely to be highly correlated with a number of the gravity factors that are included.

Around 30% of the bilateral migrant stocks in the dataset equal zero.[3] This complicates the analysis given that the dependent variable is in log form. Some past work either omits observations that equal zero from the sample or adds one to all observations before taking the log and estimating with Ordinary Least Squares. However, such techniques can lead to inconsistent estimates of the parameters of interest. To avoid this problem, an estimator that has identical first-order conditions to the Poisson pseudo-maximum-likelihood estimator is used (for further details, see Santos Silva and Tenreyro, 2006).

Gravity variables are taken from CEPII's *GeoDist* database, specifically; i) the language dummy is for a pair of countries with a common language spoken by at least 9% of the population, ii) the colonial ties dummy is for any country pair that have ever had a colonial link, and iii) the distance variable is a measure of the distance between two countries, taking into account the geographical distribution of the population inside each (Mayer and Zignago, 2005).

Wage data are taken from Grogger and Hanson (2011) and are used due to their broad country coverage and the fact that they approximately differentiate between the high skill (HS) and low skill (LS) wage level. Specifically, high skilled wages are taken as the 80th percentile of the wage distribution and low skilled wages the 20th percentile. This measure has obvious limitations. For example, it is not uncommon for migrants with post-secondary education to earn in the bottom half of the wage distribution. The wage data relate to the period 1988-2000.

With the available data, the base specification of the regression analysis can be conducted on the migrant stock between 92 origin countries and 44 destinations, which is a large number of bilateral pairs relative to past studies in this field. The majority of the destinations are developed (i.e. "North") countries, though one-quarter of the sample are from outside the OECD (i.e. "South"; Appendix 1). The origin countries are an eclectic mix of both North and South areas.

4. Estimation results

4.1. Economic factors

The estimation results provide evidence that, holding the relative aggregate unemployment rates constant, bilateral migrant stocks are positively associated with the ratio of wages in the destination to origin country. Despite the absence of perfect indicators for high and low skilled wages, there is some indication that skill specific wage differentials are important for the migration decision: high (low) skilled migration appears to reflect differentials at the upper (lower) end of the wage distribution (Column 1, Tables 1 and 2). The estimated coefficient on the relative unemployment rate variable (Tables 1, 2 and 3) suggests a negative relationship between migration and the proportion of the labour force in the destination country that is unemployed.

Consistent with past literature, the results provide some support for an inverted U-relationship between the level of economic development in the origin country and the propensity to emigrate. These results highlight the relationship through the wage channel: migration from middle income countries appears to be more sensitive to wage differentials between destination and origin countries than migration from either low income or high income countries. Initially, this is identified through interaction variables between the wage differential term and dummy variables for middle-income countries and high income countries (Column 2 of Tables 1, 2 and 3).[4] Then, the robustness of this relationship is tested by including two interaction terms between; i) the wage differential and a continuous indicator of GDP per capita and ii) the wage differential and the square of GDP per capita. The positive and significant coefficient on the *Average Wage*GDP per capita* term coupled with the significantly negative coefficient on the *Average Wage*(GDP per capita)*^2 term supports the posited heterogeneous relationship with wage differences (Column 3 of Tables 1, 2 and 3).[5] The inverted-U relationship appears to hold in the case of both the high skilled and low skilled migrant stock.

When the bilateral stock of migrants at 1990 is included as an independent variable, the estimated coefficient is highly significant with a value of around 0.8 (Column 12 of Tables 1, 2 and 3). The inclusion of the variable has no impact on the statistical significance of the wage term and it is only for high skilled workers that the estimated wage coefficient is statistically lower than in the base specification. Appendix 2 reports the results when the inverted-U specification is estimated, controlling for the 1990 migrant stock. These indicate that, when modelling the migrant flow between 1990 and 2000, the differential sensitivity of migrants to relative wage differences depending on origin is only discernible for the low skilled.

4.2. Gravity factors

Consistent with past empirical work, gravity factors are estimated to have a strong relationship with migrant stocks. In particular, the results indicate a link between higher

migrant stocks and bilateral pairs of countries with a shared border, a common language spoken and a colonial relationship. There is also a statistically significant relationship between geographic proximity of a country pair and the migrant stock, as highlighted by the negative coefficient on the distance term. The results in Column 12 indicate that the inclusion of the 1990 migrant stock term causes the coefficients on a number of the gravity factors to become statistically insignificant (i.e. shared border, colonial ties, distance). This suggests a degree of multicollinearity between these factors and the size of the existing bilateral migrant stock and that the gravity variables in the base specification go some way to capturing diaspora effects.

4.3. Relative demographic factors and government policies

There are various demographic factors that may be associated with bilateral migration. The results in Column 4 support past evidence that migration decreases with the average age in the sending region (Bauer and Zimmerman, 1999; Hatton and Williamson, 2012), though the coefficient is not statistically significant for low skilled migrants. While the estimated relationship may reflect that populations are less likely to migrate abroad as they become older, it could also be influenced by more liberal immigration policy in some destination countries that face a declining working age population.

The results in Column 5 suggest that higher average years of schooling in the destination relative to the origin country is associated with lower bilateral migration. This accords with human capital theories of migration that argue that more educated individuals should exhibit a higher migration probability, as education improves the ability to collect and process information about destinations and reduces the risk of the move (Bauer and Zimmerman, 1999). Comparing the results for the different skill classes, the effect is statistically higher for low skilled workers. This may be surprising given that higher average education in the origin should raise the stock of potential high skilled migrants. However, the higher sensitivity of low skilled migration to increasing education may reflect the large number of migrants from developing countries in the sample for whom insufficient pre-tertiary education is a constraint to international mobility.

There also appears to be some relationship between the migrant stock and relative tax and benefits systems. For both skill classes, there appears to be a significant positive relationship between immigration and relative government transfers as a share of GDP (Column 6). This is consistent with existing work which finds that countries with less generous welfare states have significantly higher shares of their workers leaving to work abroad (Kureková, 2013). Column 7 presents the results of a specification that further investigates this effect by including a dummy variable that equals 1 when social security systems in the destination country are relatively generous. The estimated coefficient suggests a positive relationship with migration, with the effect statistically stronger for low skilled workers.

Controlling for the generosity of government benefits, Column 6 suggests a negative link between relative tax rates and migration of low skilled workers, though the coefficient is not significant for high skilled migrants. While a negative relationship between migration and the relative tax rate in the destination is to be expected, a more pronounced impact for low skilled workers is not easily explained. This is especially true given that the tax rate variable relates to the highest marginal income tax rate which is likely to be more relevant for high skilled workers.

Restrictive business regulations in the destination relative to the origin country are estimated to be associated with less migration of both high skilled and low skilled workers (row 18 in Column 8). While care must be taken in drawing strong conclusions based on dummy variables in a cross-section panel, prospective migrants that aim to start a business in the destination country may indeed be deterred by regulatory hurdles. More generally, the negative coefficient may reflect that countries with more onerous regulations are less dynamic and biased towards incumbents. There is also evidence that stronger and more impartial legal systems are associated with higher immigration, highlighting the potential importance of well-developed institutions to migrants.

The relationship between labour market regulations and migration may depend on the type of regulation and the migrants' skill level. Column 9 reports the estimated coefficients from a specification with a dummy variable based on a broad measure of labour market regulation (see Data Annex for more details). The results suggest that relatively strict labour market regulations in the destination country are associated with higher migration of both high skilled and low skilled workers. However, the inclusion of a variable that specifically relates to the level of protection of part-time workers (Column 10) suggests that a relative increase in this type of regulation in the destination is associated with a decline in the migrant stock of low skilled workers. This may reflect that low skilled migrants are often employed on temporary contracts. As such, an increase in the regulations around such contracts could impede the flow of low skilled immigrants.[6]

All the regressions also control for bilateral dummy variables that reflect the presence of a free trade agreement (FTA) between the origin and destination country (*FTA dummy*) and whether both countries were signatories to the Schengen Agreement when it was initially implemented (*Schengen dummy*). In general, the estimated coefficients on these dummies are not statistically significant. However, there is some indication of a significant effect of an FTA for high skilled migrants in the flow specification (Table 2, Column 12). This may reflect the increasing incidence of FTAs over the recent period and the positive relationship between such agreements and migrant flows.

4.4. *Unreported regressions*

Unreported regressions included dummy variables for the stance of immigration policy in the destination and origin countries (constructed from the UN World Population Policies Database).[7] However, no discernible relationship with the dependent variables of interest was found. There was also no estimated relationship between relative levels of inequality (measured by the Gini coefficient) and migrant stocks, contrary to some existing theories (Martin and Taylor, 1996). Indicators of relative political stability (mostly sourced from the Polity IV database) and other measures of wellbeing (e.g. hospital beds per capita) were also included but not found to be statistically significant.

The robustness of the results was tested by running the regressions on varied country samples. In general, this led to very little change in the sign and magnitude of the estimated coefficients, with only a few instances when an estimated coefficient changed its level of statistical significance. This is highlighted in Tables 1-3, in which a lack of data availability for some explanatory variables resulted in significant changes in the country sample between specifications.

Table 1. **Total migrant stock estimation results**

Dependent variable = log(Total migrant stock)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Shared border	0.70***	0.61***	0.66***	0.63***	0.51**	0.57**	0.59**	0.65***	0.68***	0.69***	0.63***	0.03
		(3.02)	(2.62)	(2.85)	(2.60)	(2.14)	(2.41)	(2.42)	(2.82)	(3.03)	(2.95)	(2.76)	(0.51)
(2)	log(distance)	-0.76***	-0.77***	-0.72***	-0.78***	-0.69***	-0.72***	-0.65***	-0.64***	-0.64***	-0.61***	-0.69***	-0.06
		(7.37)	(7.95)	(6.97)	(6.71)	(6.49)	(7.47)	(6.24)	(5.90)	(6.22)	(5.41)	(6.75)	(1.58)
(3)	Common language	1.09***	1.10***	1.05***	1.05***	1.12***	1.16***	1.02***	1.09***	1.04***	1.01***	1.09***	0.28***
		(6.44)	(6.59)	(6.16)	(6.17)	(6.45)	(6.38)	(5.63)	(6.06)	(6.12)	(5.77)	(6.48)	(6.31)
(4)	Average wage	0.04	0.06*										0.06***
		(1.21)	(1.79)										(3.65)
(5)	Colonial ties	1.13***	1.19***	1.20***	1.19***	1.17***	1.16***	1.20***	1.17***	1.19***	1.24***	1.20***	0.01
		(5.95)	(6.47)	(6.47)	(6.33)	(5.94)	(6.24)	(6.10)	(6.00)	(6.03)	(6.38)	(6.48)	(0.10)
(6)	Unemployment rate	-0.71***	-0.69***	-0.76***	-0.76***	-0.77***	-0.86***	-0.83***	-0.94***	-0.94***	-0.89***	-0.8***	-0.02
		(4.90)	(4.70)	(5.02)	(4.93)	(4.45)	(4.49)	(4.90)	(4.97)	(5.08)	(5.25)	(4.69)	(0.35)
(7)	Schengen dummy	0.35	0.41	0.38	0.41	0.35	0.36	0.43	0.48	0.43	0.34	0.52	0.01
		(0.90)	(1.06)	(0.98)	(1.06)	(0.95)	(0.88)	(1.14)	(1.29)	(1.16)	(0.92)	(1.38)	(0.12)
(8)	FTA dummy	-0.04	-0.01	0.05	0.06	0.21	0.12	0.15	0.26	0.26	0.19	0.14	0.15**
		(0.20)	(0.03)	(0.24)	(0.28)	(0.95)	(0.59)	(0.72)	(1.16)	(1.23)	(0.84)	(0.62)	(2.13)
(9)	Average wage * High income dummy		-0.66										
			(1.13)										
(10)	Average wage * Middle income		0.46**										
			(2.54)										
(11)	Average wage * GDPpc origin			0.17***	0.16***	0.14***	0.22***	0.17***	0.21***	0.21***	0.18***	0.21***	
				(4.13)	(3.89)	(3.39)	(5.24)	(3.77)	(5.10)	(5.40)	(3.86)	(5.12)	
(12)	Average wage * (GDPpc origin)^(2)			-0.005***	-0.004***	-0.005***	-0.005***	-0.004***	-0.005***	-0.005***	-0.005***	-0.005***	
				(3.92)	(3.14)	(3.93)	(4.66)	(3.58)	(4.59)	(4.62)	(3.97)	(4.59)	
(13)	Age				4.40**								
					(2.12)								

Table 1. **Total migrant stock estimation results** *(cont.)*

Dependent variable = log(Total migrant stock)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(14)	Education					-0.84***							
						(2.85)							
(15)	Income tax rate						-2.73***						
							(2.73)						
(16)	Government transfers						0.16***						
							(3.85)						
(17)	Social security dummy							0.49**					
								(2.42)					
(18)	Business regulations dummy								-0.49**				
									(2.26)				
(19)	Labour market regulation dummy									0.47**			
										(2.31)			
(20)	Alternative employment contracts dummy										-0.59**		
											(2.43)		
(21)	Legal integrity dummy											0.32	
												(1.39)	
(22)	log(Total migrant stock 1990)												0.82***
													(38.72)
(23)	Constant	15.52***	15.36***	14.56***	10.08***	16.66***	17.72***	13.59***	14.53***	14.18***	13.59***	14.81***	1.88***
		(15.18)	(16.46)	(14.81)	(4.45)	(14.52)	(11.92)	(12.76)	(13.08)	(13.09)	(12.59)	(14.05)	(3.49)
	Observations	4 004	4 004	4 004	4 004	2 847	3 053	2 720	2 772	2 772	2 680	3 311	4 004

*** p < 0.01, ** p < 0.05, * p < 0.10.

Note: t-statistics in parentheses. The regressions are estimated with origin and destination country fixed effects and robust standard errors. Consistent with the model outlined in Section 2, the independent variables are defined as a ratio between the destination and origin country. All data sources and definitions are provided in the Data Annex.

Table 2. **High skilled migrant stock estimation results**

Dependent variable = log(High skilled migrant stock)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Shared border	0.40**	0.34*	0.37**	0.35*	0.23	0.35*	0.34*	0.37**	0.36**	0.37**	0.36*	0.06
		(2.15)	(1.88)	(1.98)	(1.82)	(1.26)	(1.87)	(1.84)	(2.02)	(2.03)	(1.97)	(1.95)	(0.81)
(2)	log(distance)	-0.64***	-0.65***	-0.62***	-0.66***	-0.55***	-0.59***	-0.56***	-0.55***	-0.55***	-0.56***	-0.59***	-0.03
		(6.20)	(6.65)	(5.81)	(5.65)	(5.12)	(5.54)	(5.16)	(4.95)	(5.20)	(5.05)	(5.50)	(0.55)
(3)	Common language	0.96***	0.97***	0.93***	0.94***	1.02***	0.98***	0.91***	0.95***	0.91***	0.91***	0.96***	0.30***
		(7.17)	(7.27)	(6.92)	(7.18)	(7.30)	(6.89)	(6.30)	(6.86)	(6.95)	(6.45)	(7.22)	(4.73)
(4)	HS wage	0.07**	0.06**										0.03**
		(2.41)	(2.37)										(2.32)
(5)	Colonial ties	1.08***	1.14***	1.13***	1.13***	1.07***	1.12***	1.09***	1.11***	1.15***	1.10***	1.13***	0.11
		(7.19)	(7.71)	(7.53)	(7.61)	(7.05)	(7.46)	(6.99)	(7.34)	(7.13)	(7.10)	(7.60)	(1.55)
(6)	Unemployment rate	-0.53***	-0.56***	-0.62***	-0.61***	-0.6***	-0.65***	-0.64***	-0.74***	-0.7***	-0.69***	-0.63***	-0.04
		(4.14)	(4.25)	(4.67)	(4.66)	(3.94)	(3.77)	(4.47)	(4.52)	(4.47)	(4.84)	(4.19)	(0.62)
(7)	Schengen dummy	0.27	0.30	0.32	0.35	0.32	0.33	0.36	0.49*	0.47*	0.32	0.49*	0.15
		(1.00)	(1.12)	(1.20)	(1.31)	(1.22)	(1.22)	(1.30)	(1.83)	(1.79)	(1.20)	(1.70)	(1.58)
(8)	FTA dummy	-0.11	-0.08	-0.02	-0.04	0.18	0.05	0.06	0.13	0.14	0.04	0.07	0.28***
		(0.63)	(0.46)	(0.09)	(0.20)	(0.96)	(0.29)	(0.31)	(0.68)	(0.76)	(0.23)	(0.39)	(2.69)
(9)	HS wage * High income dummy		-0.75										
			(1.40)										
(10)	HS wage * Middle income		0.26*										
			(1.91)										
(11)	HS wage * GDPpc origin			0.08**	0.07*	0.05	0.11***	0.09**	0.11***	0.11***	0.07*	0.10***	
				(2.13)	(1.95)	(1.22)	(3.02)	(2.15)	(2.90)	(2.99)	(1.73)	(2.81)	
(12)	HS wage * (GDPpc origin)^(2)			-0.002**	-0.002*	-0.002*	-0.003***	-0.002**	-0.003***	-0.003***	-0.002**	-0.003***	
				(2.23)	(1.87)	(1.81)	(2.75)	(2.26)	(2.87)	(2.61)	(2.01)	(2.71)	
(13)	Age				4.12***								
					(3.04)								

Table 2. **High skilled migrant stock estimation results** *(cont.)*

Dependent variable = log(High skilled migrant stock)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(14)	Education					-0.44**							
						(2.11)							
(15)	Income tax rate						-0.74						
							(0.89)						
(16)	Government transfers						0.07**						
							(2.04)						
(17)	Social security dummy							0.30*					
								(1.72)					
(18)	Business regulations dummy								-0.42**				
									(2.32)				
(19)	Labour market regulation dummy									0.45**			
										(2.53)			
(20)	Alternative employment contracts dummy										-0.02		
											(0.08)		
(21)	Legal integrity dummy											0.36**	
												(2.06)	
(22)	log(High skilled migrant stock 1990)												0.74***
													(20.26)
(23)	Constant	13.46***	13.62***	13.59***	9.26***	14.98***	14.74***	12.84***	14.05***	13.66***	13.21***	14.18***	2.30***
		(13.21)	(15.39)	(13.61)	(6.18)	(13.11)	(9.99)	(11.60)	(12.18)	(12.08)	(12.43)	(13.05)	(3.41)
	Observations	4 004	4 004	4 004	4 004	2 847	3 053	2 720	2 772	2 772	2 680	3 311	4 004

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Note: t-statistics in parentheses. The regressions are estimated with origin and destination country fixed effects and robust standard errors. Consistent with the model outlined in Section 2, the independent variables are defined as a ratio between the destination and origin country. All data sources and definitions are provided in the Data Annex.

Table 3. **Low skilled migrant stock estimation results**

Dependent variable = log(Low skilled migrant stock)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Shared border	0.85***	0.83***	0.85***	0.83***	0.69***	0.76***	0.78***	0.82***	0.87***	0.89***	0.82***	0.01
		(3.35)	(3.34)	(3.32)	(3.15)	(2.62)	(2.83)	(2.77)	(3.17)	(3.57)	(3.23)	(3.15)	(0.16)
(2)	log(distance)	-0.86***	-0.91***	-0.90***	-0.93***	-0.88***	-0.92***	-0.82***	-0.84***	-0.84***	-0.78***	-0.88***	-0.11***
		(7.86)	(8.98)	(8.24)	(7.62)	(7.81)	(9.04)	(7.34)	(7.28)	(7.82)	(6.71)	(8.23)	(2.74)
(3)	Common language	1.11***	1.14***	1.15***	1.14***	1.20***	1.29***	1.12***	1.22***	1.16***	1.13***	1.20***	0.25***
		(5.88)	(6.43)	(6.02)	(5.98)	(6.30)	(6.46)	(5.56)	(5.99)	(6.10)	(5.66)	(6.36)	(5.33)
(4)	LS wage	0.02**	0.03***										0.02***
		(2.04)	(2.96)										(2.89)
(5)	Colonial ties	1.19***	1.18***	1.21***	1.20***	1.16***	1.13***	1.22***	1.15***	1.15***	1.23***	1.21***	-0.01
		(5.40)	(5.43)	(5.64)	(5.55)	(5.10)	(5.25)	(5.40)	(5.01)	(5.09)	(5.47)	(5.71)	(0.07)
(6)	Unemployment rate	-0.78***	-0.74***	-0.79***	-0.78***	-0.82***	-0.93***	-0.89***	-1***	-1.02***	-0.95***	-0.84***	-0.05
		(4.52)	(4.27)	(4.35)	(4.31)	(3.99)	(4.07)	(4.26)	(4.37)	(4.53)	(4.61)	(4.15)	(0.83)
(7)	Schengen dummy	0.39	0.44	0.41	0.42	0.37	0.36	0.45	0.47	0.44	0.31	0.61	0.00
		(0.92)	(1.11)	(0.99)	(1.02)	(0.93)	(0.82)	(1.14)	(1.15)	(1.08)	(0.78)	(1.52)	(0.07)
(8)	FTA dummy	-0.09	-0.20	-0.13	-0.11	0.07	-0.08	-0.02	0.05	0.07	0.02	-0.05	0.10
		(0.39)	(0.98)	(0.58)	(0.51)	(0.29)	(0.38)	(0.07)	(0.24)	(0.29)	(0.10)	(0.21)	(1.26)
(9)	LS wage * High income dummy		-0.81										
			(1.54)										
(10)	LS wage * Middle income		0.66***										
			(3.96)										
(11)	LS wage * GDPpc origin			0.14***	0.13***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.16***	
				(4.67)	(4.72)	(3.99)	(5.29)	(4.03)	(4.99)	(5.00)	(4.37)	(5.00)	
(12)	LS wage * (GDPpc origin)^(2)			-0.004***	-0.003***	-0.005***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	-0.004***	
				(4.42)	(3.74)	(5.21)	(4.87)	(4.03)	(4.27)	(4.53)	(4.47)	(4.63)	
(13)	Age				2.40								
					(1.25)								

Table 3. **Low skilled migrant stock estimation results** *(cont.)*

Dependent variable = log(Low skilled migrant stock)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(14)	Education					-1.12***							
						(3.39)							
(15)	Income tax rate						-4.20***						
							(4.01)						
(16)	Government transfers						0.18***						
							(4.44)						
(17)	Social security dummy							0.57***					
								(2.60)					
(18)	Business regulations dummy								-0.47*				
									(1.95)				
(19)	Labour market regulation dummy									0.53**			
										(2.27)			
(20)	Alternative employment contracts dummy										-0.68***		
											(2.81)		
(21)	Legal integrity dummy											0.47*	
												(1.73)	
(22)	log(Low skilled migrant stock 1990)												0.84***
													(42.27)
(23)	Constant	15.91***	16.11***	15.36***	12.97***	18.21***	21.32***	14.18***	16.39***	16.23***	14.32***	16.45***	2.80***
		(16.05)	(17.01)	(16.12)	(6.20)	(16.28)	(14.76)	(13.88)	(14.89)	(15.28)	(14.00)	(15.98)	(5.25)
	Observations	4 004	4 004	4 004	4 004	2 847	3 053	2 720	2 772	2 772	2 680	3 311	4 004

*** p < 0.01, ** p < 0.05, * p < 0.10.

Note: t-statistics in parentheses. The regressions are estimated with origin and destination country fixed effects and robust standard errors. Consistent with the model outlined in Section 2, the independent variables are defined as a ratio between the destination and origin country. All data sources and definitions are provided in the Data Annex.

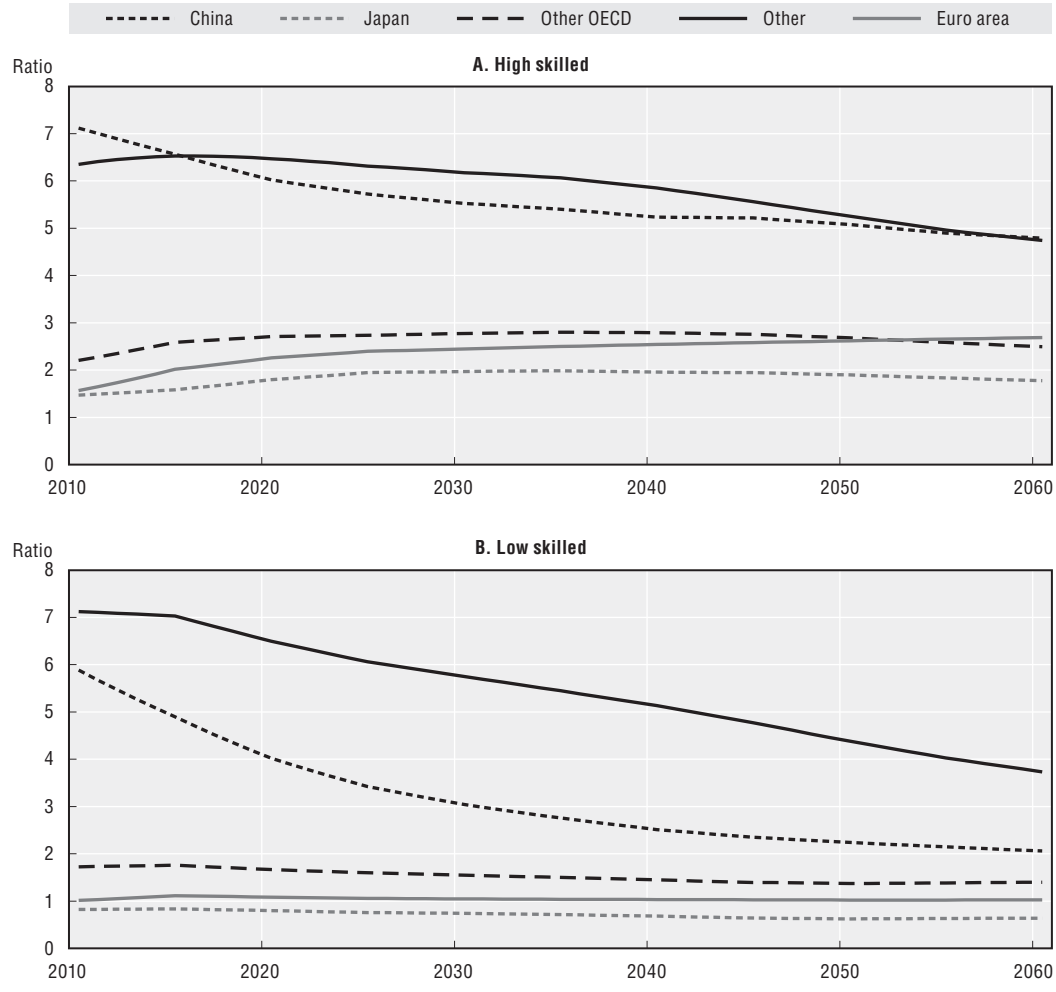
5. Discussion

Given the central role of wage differentials in both the theoretical model and empirical results presented, expected wage developments could provide information about likely future migration patterns. Even so, any such exercise is only a partial analysis using a static model. Other difficult-to-predict migration determinants (i.e. origin-country conflict) have historically proven to be at least as important as economic ones.

Recent work projected skill-specific wage profiles that are consistent with the OECD long-run growth forecasts for all the countries in the regression sample using a computable general equilibrium model (Chateau et al., 2014).[8] For both high skilled and low skilled workers, the wage differential between China and the US is expected to markedly narrow (Figure 2). Significant wage convergence with the most advanced economies is also expected for some other countries in Asia, Eastern Europe and North Africa. In contrast, high skilled wage growth in the euro area is projected to be slower than in the US, while the wage gap for the low skilled between the euro area and US is expected to remain broadly unchanged.

Figure 2. **Wage projections for high- and low-skilled labour, 2010-60**

US wage level as a proportion of other regions



Source: OECD estimates.

Combining these relative wage projections with the estimated coefficients in Tables 1-3 highlights the potential for future migration transitions. All else equal and assuming reverse causality does not bias the estimated coefficients, significant wage convergence for many traditional migrant source countries implies that the pace of South to North migration may slow or even reverse. This is the case even when accounting for the inverted-U relationship discussed earlier (Westmore, 2014). These trends could be exacerbated by convergence (i.e. an increase) in the relative education level, the relative integrity of the legal system and the relative generosity of government benefits in many traditional migrant source countries over the forecast period (given the estimated coefficients on the relevant policy and demographic factors in Tables 1-3 and notwithstanding potential reverse causality). Nevertheless, projections of these non-wage factors for the countries in the sample are not available.

The inherent uncertainty of long-term wage projections must nonetheless be acknowledged. The projections derived from the OECD long-run growth forecasts contrast materially with those presented in recent work by Docquier and Machado (2014) that lead them to very different conclusions about future migration patterns.

6. Conclusion

Sustaining future working age populations will rely on international immigration flows for many OECD countries. In this context, an understanding of the potential impact on international migration of changes in economic, demographic and policy factors is important. The model presented here highlights a number of such factors based on migration data for both OECD and non-OECD countries. Skill-specific wage differentials between countries have a discernable relationship with migration. Moreover, there is evidence that wage differentials are relatively more important for migrants deriving from middle income countries.

On top of wages, and the gravity and demographic influences highlighted by past work, the empirical results suggest that cross-country differences in structural economic policies may also be related to international migration. Less strict regulations on businesses, as well as stronger and more impartial legal systems, may be associated with higher immigration. Likewise, immigration may be positively related to the generosity of government benefits, but perhaps particularly so for low skilled migrants. The impact of policies could depend on the specific type of regulation. For example, while stricter labour market regulations are associated with higher migration, the opposite is true for low skilled migrants in the case of regulations pertaining to part-time workers.

Nevertheless, the analytical framework presented in this paper is static in nature and allows for only limited heterogeneity among migrants. Future work continuing to explore these relationships in a time series context or by using more disaggregated data will help provide additional insights. For example, country-specific studies using micro data may give a better indication of the impact of government migration policy which was not discernible in this cross-country study. To the extent that there is correlation between the government stance on migration and broader economic policies, such work may improve the precision of the estimated effects of the structural policies included in this analysis.

Data Annex

Bilateral migrant stocks: As discussed in Section 3, the migrant stock data decompose bilateral migration stocks by skill level and are available for two cross-sections in time (1990 and 2000). They are compiled by combining:

- Migration stocks for the 34 OECD member countries (from all 195 other countries) from an earlier dataset described in Docquier, Lowell and Marfouk (2009).
- Migration stocks for 42 non-OECD countries in 2000 and 27 countries in 1990 are collected from national statistical offices, publicly available censuses and, for the 6 Gulf Cooperation Council countries, labour force surveys. These data comply with the methodology used to construct the data for OECD countries.
- Data for the remaining countries are imputed from estimated coefficients derived from a gravity model. However, as discussed in Section 3, these data are omitted from the regression analysis.

Gravity factors: These data are described in Section 3 and can be downloaded from: *www.cepii.fr/anglaisgraph/bdd/distances.htm*.

Average wage: The variable is defined as a ratio of the average wage between the destination and origin country. The wage data are described in Section 3 and can be downloaded from: *http://harrisschool.uchicago.edu/research/data/migration-data*. To construct these data, Grogger and Hanson (2011) rely on two sources: 1) Combining Gini coefficients from the WIDER World Income Inequality Database with GDP per capita from the World Development Indicators; and 2) Freeman and Oostendorp (2000) who collected information on earnings from the International Labor Organization's October Inquiry Survey.

Unemployment rate: The variable is defined as a ratio of the average unemployment rate between the destination and origin country in the 1990 to 2000 period, taken from the World Development Indicators (*http://data.worldbank.org/data-catalog/world-development-indicators*).

Schengen dummy: Equals 1 if both the destination and origin country were signatories to the Schengen agreement when it was first implemented (Belgium, Germany, France, Luxembourg, Netherlands, Spain and Portugal).

FTA dummy: Equals 1 if a free trade agreement existed between the origin and destination country as at 2000.

Age: A ratio of the average median age of the total population between the destination and origin country in the 1990-2000 period taken from *UN World Population Prospects: The 2012 Revision*.

Education: A ratio of the Barro-Lee measure of average years of schooling between the destination and origin country in the 1990-2000 period (Barro and Lee, 2013).

Income tax rate: A ratio of the top average marginal income tax rates between the destination and origin country taken from the Economic Freedom of the World Database in the 1990-2000 period.

Government transfers: A ratio of average government transfers and subsidies as a per cent of GDP between the destination and origin country taken from the *Economic Freedom of the World Database* in the 1990-2000 period.

Social security dummy: Based on a composite indicator of social security laws that takes into account government benefits relating to old age, disability, death, sickness, unemployment and health as at 1997, sourced from Botero et al. (2003). The variable equals 1 if social security laws are more generous in the destination than the origin country.

Business regulations dummy: Based on a measure from the *Economic Freedom of the World Database* that increases with the level of regulation (average in the 1990-2000 period). The measure takes into account i) administrative requirements, ii) Bureaucracy costs, iii) Cost and duration to start a business, iv) incidence of extra undocumented payments v) Licensing restrictions and vi) Cost of tax compliance. The variable equals 1 if business regulations are more stringent in the destination than the origin country.

Labour market regulation dummy: Based on a measure from the *Economic Freedom of the World Database* that increases with the level of regulation (average in the 1990-2000 period). The measure takes into account hiring and firing regulations, the minimum wage, extent of centralised collective bargaining, hours' regulations, mandated cost of worker dismissal and the presence of military conscription as at 1997. The variable equals 1 if labour market regulations are more stringent in the destination than the origin country.

Alternative employment contracts dummy: Based on a measure from Botero et al. (2004) that captures the level of protection of part-time workers as at 1997. The variable equals 1 if there is greater protection of part-time workers in the destination than the origin country.

Legal integrity dummy: Based on a measure from the *Economic Freedom of the World Database* that increases with the legal systems strength and impartiality and observance of the law (average in the 1990-2000 period). The variable equals 1 if legal integrity is judged to be higher in the destination than the origin country.

Notes

1. Population projections in the central scenario are taken from Eurostat for some European countries (Austria, Belgium, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, UK, Hungary, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Sweden, Switzerland, Poland and Norway) or the United Nations Population Division otherwise.
2. Illegal immigrants, which can be a considerable share of the migrant stock in some cases, are unlikely to be included for most countries (Docquier et al., 2009). To the extent that most of these immigrants are low skilled, it is likely that the stock of low skilled migrants in some countries is significantly underestimated.
3. The proportion of zeros is roughly the same across both the high skilled and low skilled migrant stock data. Some statistical agencies report a zero when the migrant stock is below some threshold value. As such, a zero may not reflect the total absence of migrants along a particular path.
4. The high income dummy is defined as countries in the top 10% of the cross-country GDP per capita distribution. The middle income dummy is defined as countries above the top 60% and below the top 10% of the cross-country GDP per capita distribution. The cut off points for these variables were chosen with reference to the bivariate analysis of De Haas (2011) which suggests that emigrant stocks begin to rise for countries with USD PPP GDP per capita in 2005 above USD 5 000, with countries transitioning to net immigration countries as GDP per capita rises above USD 20 000.
5. This interpretation is consistent with past empirical work examining the presence of inverted-U relationships (e.g. Guellec and van Pottelsberghe, 2003). It should be noted that the data validates a slightly different form of U-shaped relationship than outlined in much of the theoretical literature. Here, migrants' sensitivity to changes (positive or negative) in relative wages increases

when they come from a middle income country, emphasising the role of aspirations as well as capability in motivating economic migration as countries develop (De Haas, 2011).

6. Whether this is a result of lower demand or supply of low skilled migrant workers may depend on the specific change to the part-time worker regulations.
7. For example, a dummy variable equal to 1 if the destination country immigration policy was reported to be aiming to lower immigration (in the 1976-1996 period) at the same time as the origin country policy stance was aiming to lower emigration.
8. The definition of skilled workers here is people that have obtained a tertiary-level diploma.

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APPENDIX 1

Countries included in the base specification of the regression analysis

Origin countries (92)	Australia, Armenia, Austria, Azerbaijan, Bahamas, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Hong Kong, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guyana, Honduras, Hungary, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Korea, Kyrgyzstan, Latvia, Lesotho, Lithuania, Luxembourg, Macedonia, Madagascar, Malaysia, Mali, Mauritius, Mexico, Moldova, Nepal, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Russia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Swaziland, Sweden, Switzerland, Thailand, Trinidad and Tobago, Turkey, Uganda, Ukraine, United Kingdom, United States, Venezuela, Vietnam, Zambia, Zimbabwe
Destination countries (44)	Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macedonia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, Venezuela.

APPENDIX 2

Inverted-U relationship in the presence of a lagged dependent variable

Dependent variable	log(Total Mig. Stock)	log(HS Mig. Stock)	log(LS Mig. Stock)
	(1)	(2)	(3)
Shared border	0.05	0.06	0.06
	(0.93)	(0.94)	(1.08)
log(distance)	-0.05	-0.04	-0.12***
	(1.40)	(0.65)	(3.06)
Common language	0.27***	0.30***	0.25***
	(6.28)	(4.98)	(5.47)
Colonial ties	0.03	0.09	0.007
	(0.39)	(1.22)	(0.09)
Unemployment rate	-0.06	-0.05	-0.07
	(1.22)	(0.75)	(1.15)
Schengen dummy	-0.004	0.13	-0.02
	(0.07)	(1.33)	(0.27)
FTA dummy	0.18**	0.26**	0.11
	(2.45)	(2.49)	(1.34)
Wage * GDPpc origin	0.02	-0.03	0.03**
	(0.95)	(1.45)	(2.47)
Wage * (GDPpc origin)^(2)	-0.001***	0.0002	-0.002***
	(3.33)	(0.31)	(8.17)
log(Total migrant stock 1990)	0.83***	0.75***	0.84***
	(38.81)	(20.36)	(44.06)
Constant	2.45***	2.80***	3.00***
	(5.30)	(4.59)	(5.72)
Observations	4 004	4 004	4 004

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Note: t-statistics in parentheses. The regressions include country and time fixed effects and robust standard errors. The "Wage" variable refers to the average wage, high skilled wage and low skilled wage in columns 1, 2 and 3, respectively.

OECD Journal: Economic Studies
Volume 2015
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Experience and the returns to education and skill in OECD countries: Evidence of employer learning?

by
Stijn Broecke*

Using the Survey of Adult Skills (PIAAC), this paper documents how the returns to education and skill change with experience for a sample of 22 OECD countries. It does this within the framework of the Altonji and Pierret (2001) employer learning model, and therefore also tests the relevance of this theory in a wide range of countries using comparable data and a consistent methodology. Significant heterogeneity is found in the experience profiles of the returns to education and skill across countries, and convincing evidence in support of the employer learning theory is only found in a sub-set of the countries analysed. While these countries vary significantly from one another in terms of their labour market institutions and educational systems, the analysis does seem to suggest that employer learning is most common in those countries where employment protection legislation on temporary contracts is weak. This is consistent with a model in which temporary contracts allow employers to test and learn about young workers, and give them the flexibility to adjust wages in line with observed productivity.

JEL codes: J24, J32, D83

Keywords: Employer learning, returns to education, returns to skill

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Useful comments were received from Glenda Quintini, William Thorn, Marco Paccagnella, as well as from Michele Pellizzari and Vincenzo Spiezia and participants at the IZA/OECD/World Bank Workshop on Cognitive and Non-Cognitive Skills and Economic Development, held in Bertinoro, Italy, 3-4 October 2014. This work should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and remaining errors are those of the author.
Note by Turkey
The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
Note by all the European Union Member States of the OECD and the European Union
The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

1. Introduction

As part of its Programme of International Assessment of Adult Competencies (PIAAC), the OECD recently carried out the Survey of Adult Skills – an international survey conducted in 24 countries which measures the literacy, numeracy and problem solving skills of adults aged 16 to 65. The release of these data has sparked a flurry of research on the role of skills in determining labour market outcomes, including their impact on: wages (Hanushek et al. 2015), the school-to-work transition (OECD, 2014), mismatch (Pellizzari and Fichen, 2013; Levels, van der Velden and Allen, 2013) and wage inequality (OECD, 2015). This is not surprising, given that very few datasets contain such rich information on cognitive skills, let alone on an internationally comparable basis.

One key finding to emerge from this research is that, in many OECD countries, the return to skill tends to increase with age (OECD, 2014; Hanushek et al., 2015). In other words: for the same level of skill, older workers obtain a higher wage premium than younger ones. While there might be an issue of fairness at stake, this finding also has implications in terms of efficiency if workers are not rewarded according to their productivity, which in turn is determined by what they can do – i.e. their skills. Indeed, if individuals do not see their skills appropriately rewarded in the labour market, this might act as a disincentive to invest in skills. Also, if wages do not adequately reflect productivity, then labour resources may not be allocated to their most productive use.

One possible (and popular) explanation for why workers might not be rewarded according to their true skills/productivity is that employers simply do not observe these. This might be particularly true for young workers, who have just left school and have no or little work experience. Assessing the true productivity of such workers is difficult for employers, unless they invest significant resources in pre-screening tests. Employers might therefore set initial wages to reflect only easily observable characteristics of productivity, such as educational attainment. As workers accumulate experience in the labour market, however, employers learn about (and reward) additional elements of productivity that were initially unobserved. This is the theory of employer learning developed by Farber and Gibbons (1996), and is one possible explanation for why the return to skill varies across age groups. Using data from the US National Longitudinal Survey of Youth (NLSY), and using individuals' scores on the Armed Forces Qualifying Test (AFQT) as a proxy for true ability/productivity, Farber and Gibbons (1996) present evidence that is consistent with their model's predictions.

A subtle variant of this theory was developed by Altonji and Pierret (2001), who argued that employers set starting wages by statistically discriminating among young workers on the basis of their easily observed characteristics. However, as employers learn about the true quality of workers, wages are increasingly interconnected with correlates of productivity which were initially hard to observe (such as individuals' true skills), while the return to easily observable characteristics (such as educational qualifications) falls. Also using NLSY data (for men only) they find evidence that employers in the United States statistically discriminate on the basis of education.[1]

Starting with the analytical framework developed by Altonji and Pierret (2001), the present paper uses the Survey of Adult Skills to analyse how the returns to education and skill vary with experience across 22 OECD countries. It also looks at how these two variables contribute to the explained variance in wages as workers gain additional experience in the labour market. A key contribution of the paper is therefore that it tests the theory of employer learning across a large number of countries, using a consistent methodology and comparable data. This is important because, as suggested by Hanushek and Zhang (2006), employer learning may be a characteristic very specific to some countries.[2] If this is the case, then labour markets in different countries may function very differently, and the signals that employees send to employers as well as the characteristics which get rewarded in the labour market may vary substantially, with potential implications for both education and labour market policy.

The paper finds strong evidence in favour of the theory of employer learning (i.e. consistent with the model developed by Altonji and Pierret, 2001) in only a handful of countries. The paper then attempts to link the possible presence of employer learning with the existence of certain labour market policies/institutions and characteristics of the education system, but finds very little evidence that employer learning is more prevalent in certain types of labour markets/education systems than in others. One exception is that employer learning is most readily detected in countries with weak employment protection legislation on temporary contracts. This is consistent with a model in which temporary contracts allow employers to test and learn about young workers, and give them the flexibility to adjust wages in line with observed productivity. Overall, however, the exploratory analysis on institutions suggests that employer learning may arise in different countries for different reasons, and that it is more the complex interactions between different institutions and policies that might matter. Another possibility which cannot be dismissed is that, in some countries at least, the changing returns to skill and education with experience might be due to forces other than employer learning.

The remainder of this paper proceeds as follows. Section 2 briefly describes the ELSD model developed by Altonji and Pierret (2001) and reviews the literature on the topic. Section 3 offers some more detail on the Survey of Adult Skills as well as some descriptive statistics. Section 4, on results, begins with a visual exploration of the returns to education and skill across the 22 countries examined, followed by a set of more formal regressions and analyses of variance. Finally, Section 5 discusses the findings in light of the countries' education and labour market institutions, and offers some concluding remarks.

2. Employer learning and statistical discrimination

According to the ELSD hypothesis developed by Altonji and Pierret (2001), employers cannot observe the true productivity of young workers at the time of hiring and, instead, use information on education as an indicator of their unobserved productivity to set initial wages. Educated youths are therefore rewarded more highly in line with their qualifications and regardless of actual productivity. With experience, however, the true productivity of workers emerges and employers set wages more in line with this observed productivity. Altonji and Pierret's (2001) model therefore assumes that wages change over time not just because productivity changes with experience, but also because firms learn about errors in their initial assessment of worker productivity. As a result, the role of education in determining wages should fall as workers gain more experience, whereas the return to unobservable determinants of productivity (like skills) should increase.

To test this hypothesis, Altonji and Pierret (2001) specify the following wage equation:

$$W_{i,X} = \beta_0 + \beta_S S_i + \beta_Z Z_i + \beta_{S,X}(S_i \cdot X_i) + \beta_{Z,X}(Z_i \cdot X_i) + H(X_i) + \mu_{i,X} \quad [1]$$

Where *W* is the (log of) wages of individual *i* with *X* years of experience; *S* refers to years of schooling (a determinant of productivity observed by both the employer and the econometrician); *Z* is a correlate of productivity not initially observed by employers but available to the econometrician (like some unobserved test score); *H(Xi)* is an experience profile which captures how wages evolve with experience (including human capital accumulation) and which is assumed to be independent of *S* and *Z* (a point which will be further discussed below); and the interactions $S_i \cdot X_i$ and $Z_i \cdot X_i$ capture how the return to *S* and *Z* evolve with experience.

Altonji and Pierret (2001) then develop a number of testable propositions for their model of employer learning. The key one states that the return to the unobservable correlates of productivity should be increasing with experience (i.e. $\beta_{Z,X}$ is positive) while the return to observable correlates of productivity should be falling (i.e. $\beta_{S,X}$ is negative). This follows from the fact that *S* and *Z* are correlated and, therefore, that *S* will get less of the credit for explaining wages as employers learn more about (and set wages based on) *Z*.[3]

The predictions of this theory have since been tested for a number of OECD countries and evidence consistent with employer learning has been found in: Australia (Cheung, 2010), Canada (Pan, 2005), for university graduates in Chile (Bordón, 2013), Germany (Bauer and Haisken-DeNew, 2001), for some women in New Zealand (Gill, 2012), Switzerland (Falter, 2007), and the United Kingdom (Galindo-Rueda, 2002); while Lange (2007) cites evidence for three developing countries as well (Ghana, India and Pakistan).

The theory has also been tested on a number of different sub-groups, mostly defined on the basis of educational attainment or occupation. Arcidiacono, Bayer and Hizmo (2010) find favourable evidence in the case of high school graduates, but not for college graduates who they find tend to be paid in accordance with their ability from the beginning of their careers. Light and McGee (2013), however, show that this result hinges on how the start date of graduates' careers is defined. Using career start dates tied to permanent rather than first-observed school exit, they find that employer learning is equally evident for high school and college graduates. Looking at different occupational categories, Bauer and Haisken DeNew (2001) find that employer learning in Germany only takes place for blue-collar workers at the lower end of the wage distribution – although Galindo-Rueda (2002) finds stronger evidence in the case of white-collar workers in the United Kingdom.

Other authors have tested the theory on a range of different skills. Pasche (2009), for instance, finds that employer learning and statistical discrimination takes place with non-cognitive as well as cognitive ones (a finding confirmed by Petre, 2013). Similarly, Light and McGee (2012) separate skills into various types and conclude that, although employer learning exists for each skill type, the extent of it depends both on the type of skill as well as its importance.

Two important extensions to the theory were brought by Schönberg (2007) and Lange (2007), respectively. Schönberg (2007) asks whether employer learning is symmetric (all employers have the same information about workers' productivity) or asymmetric (the current employer has private and more/better information about workers' productivity) – and finds that learning is mostly the former (i.e. public – Farber and Gibbons, 1996).

Lange (2007) investigates the speed of employer learning and finds that employers learn quickly. He estimates that it takes on average three years for any initial expectation error on the part of employers about workers' productivity to decline by approximately 50%. Pasche (2009) estimates that the speed of employer learning is even faster when non-cognitive abilities are included on top of cognitive ones as proxies for productive ability. As pointed out by Pasche (2009), rapid employer learning matters, as it "is a key component of a meritocratic labour market". Finally, Mansour (2012) finds that the speed of employer learning varies across occupations: in some, employers learn about their workers' productivity over time, as suggested by the employer learning literature, while in other occupations employers appear to acquire enough information about worker productivity at the time of hire so that little learning takes place subsequently.

3. Data

The data that will be used to test for employer learning come from the Survey of Adult Skills – a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC) – which, in 2011/12, assessed the proficiency of around 166 000 adults (aged 16-65) from 24 countries[4] in literacy, numeracy and problem solving in technology-rich environments. In addition to the skills assessments, a range of background information was collected including: labour market status, wages, education, experience, and demographic characteristics. The achieved samples range from around 4 500 in Sweden to nearly 27 300 in Canada. In this paper, the focus is only on the 22 OECD countries in the sample (i.e. excluding the Russian Federation and Cyprus).

In the analysis that follows, years of education will be used as the observable correlate of productivity (S) and the PIAAC numeracy test scores will be used as a proxy for the unobservable ability of workers (Z).[5] To facilitate the interpretation of the results, both these variables will be standardised (by country) to have mean zero and a standard deviation of 1. The (hourly) wage variable (W) used is measured in PPP corrected USD, includes bonuses, and is for wage and salary earners only (i.e. the self-employed are excluded). The measure of actual work experience collected by PIAAC is used for X.[6]

Table 1 below provides some descriptive statistics on each of these variables and for each of the 22 countries included in the analysis, along with sample sizes. The sample is restricted to employed individuals and, in each country, wages are trimmed to exclude the top and bottom percentiles.[7] In addition, the sample is limited to individuals with less than 44 years of experience in order to avoid very small cell sizes for older age groups. These restrictions will be applied throughout the analysis contained in this paper. The table shows that skills proficiency is highest in Japan, the Nordic countries, Flanders and the Netherlands, while it is lowest in Italy and Spain. The average years of education range from a low 11.4 in Italy to a high 15.4 in Ireland, while experience ranges between 14.7 years (Korea) and 20.4 years (Denmark). Finally, hourly wages are highest in Norway and Denmark (around PPP USD 24) and lowest in the Czech and Slovak Republics (around PPP USD 9).

Before proceeding with the analysis, two important caveats of using the PIAAC data for testing employer learning should be mentioned. The first is that the data are not longitudinal but cross-sectional in nature, which means that possible cohort effects cannot be disentangled from the effect of experience on wages. While this is a weakness shared in most of the literature on the returns to education (and skills), the results of this study do need to be interpreted in this light.

Table 1. **Descriptive statistics**

Country	N	Skill	Years of education	Experience	Wages (PPP $US)
Australia	5 221	275	14.8	18.2	19.4
		(-48.7)	(-2.4)	(-11.7)	(-14.7)
Austria	3 536	280	12.2	19.1	19.5
		(-44.4)	(-2.6)	(-11.1)	(-10.6)
Canada	18 371	272	13.6	19.5	20.9
		(-49.4)	(-2.5)	(-11.6)	(-16.6)
Czech Republic	3 387	280	13.5	19.0	9.3
		(-39.5)	(-2.5)	(-11.2)	(-6.0)
Denmark	4 872	286	13.0	20.4	24.0
		(-45.5)	(-2.6)	(-11.9)	(-10.0)
England/N. Ireland (UK)	5 520	270	13.2	19.3	18.3
		(-49.1)	(-2.3)	(-11.6)	(-16.5)
Estonia	4 987	278	12.6	18.7	11.4
		(-40.8)	(-2.6)	(-11.6)	(-53.1)
Finland	3 657	291	13.0	19.3	19.7
		(-44.5)	(-2.9)	(-11.8)	(-8.3)
Flanders (B)	3 224	287	13.0	20.1	22.8
		(-45.2)	(-2.6)	(-11.0)	(-11.6)
France	4 318	262	11.9	19.1	15.9
		(-51.4)	(-3.4)	(-11.6)	(-8.2)
Germany	3 759	278	13.9	19.6	19.3
		(-47.1)	(-2.5)	(-11.8)	(-11.9)
Ireland	3 452	265	15.4	17.5	21.6
		(-46.7)	(-2.9)	(-10.9)	(-12.2)
Italy	2 746	256	11.4	17.7	16.3
		(-45.9)	(-3.8)	(-10.7)	(-9.5)
Japan	3 634	292	13.3	18.9	16.8
		(-40.1)	(-2.3)	(-11.5)	(-17.1)
Korea	4 219	264	13.1	14.7	19.1
		(-41.2)	(-3.1)	(-10.4)	(-21.3)
Netherlands	3 691	288	13.7	18.6	21.8
		(-44.2)	(-2.5)	(-11.2)	(-11.4)
Norway	3 720	286	14.5	18.7	24.9
		(-48.2)	(-2.4)	(-11.6)	(-22.3)
Poland	4 650	267	13.4	16.8	9.7
		(-45.1)	(-2.9)	(-11.5)	(-8.1)
Slovak Republic	3 187	286	13.8	18.6	8.8
		(-38.5)	(-2.6)	(-11.3)	(-6.3)
Spain	3 182	256	12.2	17.5	15.4
		(-44.9)	(-3.5)	(-10.6)	(-10.6)
Sweden	3 157	288	12.6	19.9	19.0
		(-47.4)	(-2.3)	(-12.0)	(-7.0)
United States	3 242	260	13.8	19.1	20.7
		(-52.8)	(-2.9)	(-11.8)	(-14.9)

Note: Standard deviations in parentheses. Number of observations (N) reflects total employed population in each country, with top and bottom 1% of wage earners removed. Actual number of observations for the means and standard deviations calculated in subsequent columns may vary due to missing values.
Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

A second caveat is that the proxy of unobservable ability used (i.e. numeracy proficiency) is measured at the time of the survey – and therefore simultaneously with wages – and not prior to entering the labour market, as it is in the US National Longitudinal Survey of Youth (and in the Farber and Gibbons, 1996 and Altonji and Pierret, 2001 papers). This measure does not therefore correspond exactly to the notion of individual characteristics that are

unobservable to the employer at the time of hiring and that are learned over time. Indeed, it will reflect both the skill level at the time of hiring (or entry in the labour market) and the skills accumulated over the professional life. However, this need not pose too much of a problem as long as the skills acquired on the job are captured entirely by the experience profile $H(X)$. Indeed, the controls for experience included in equation [1] mean that the skill variable will reflect that component of skill that is orthogonal to experience – i.e. the component that employers did not observe prior to hiring.[8] However, as mentioned above, one potential problem does arise if $H(X)$ depends on S and Z (such as might happen when the most skilled/educated receive more on-the-job training or benefit more from it), in which case the coefficients $\beta_{S,X}$ and $\beta_{Z,X}$ may reflect more than just the effect of employer learning. This is an issue which we shall return to below.

4. Results

4.1. *Visualising the returns to education and skill with experience*

To set the scene, we start with a visual exploration of how the returns to education and skills change with experience. To do this, the returns to years of education and skill are estimated flexibly at each level of experience by regressing log wages (W) on years of schooling (S) and numeracy proficiency (Z), interacted with a complete set of experience dummy variables (D_X) taking the value of one if experience is X and zero otherwise:

$$W = \beta_0 + \sum_X \beta_{S,X}(S \cdot D_X) + \sum_X \beta_{Z,X}(Z \cdot D_X) + \varepsilon \qquad [2]$$

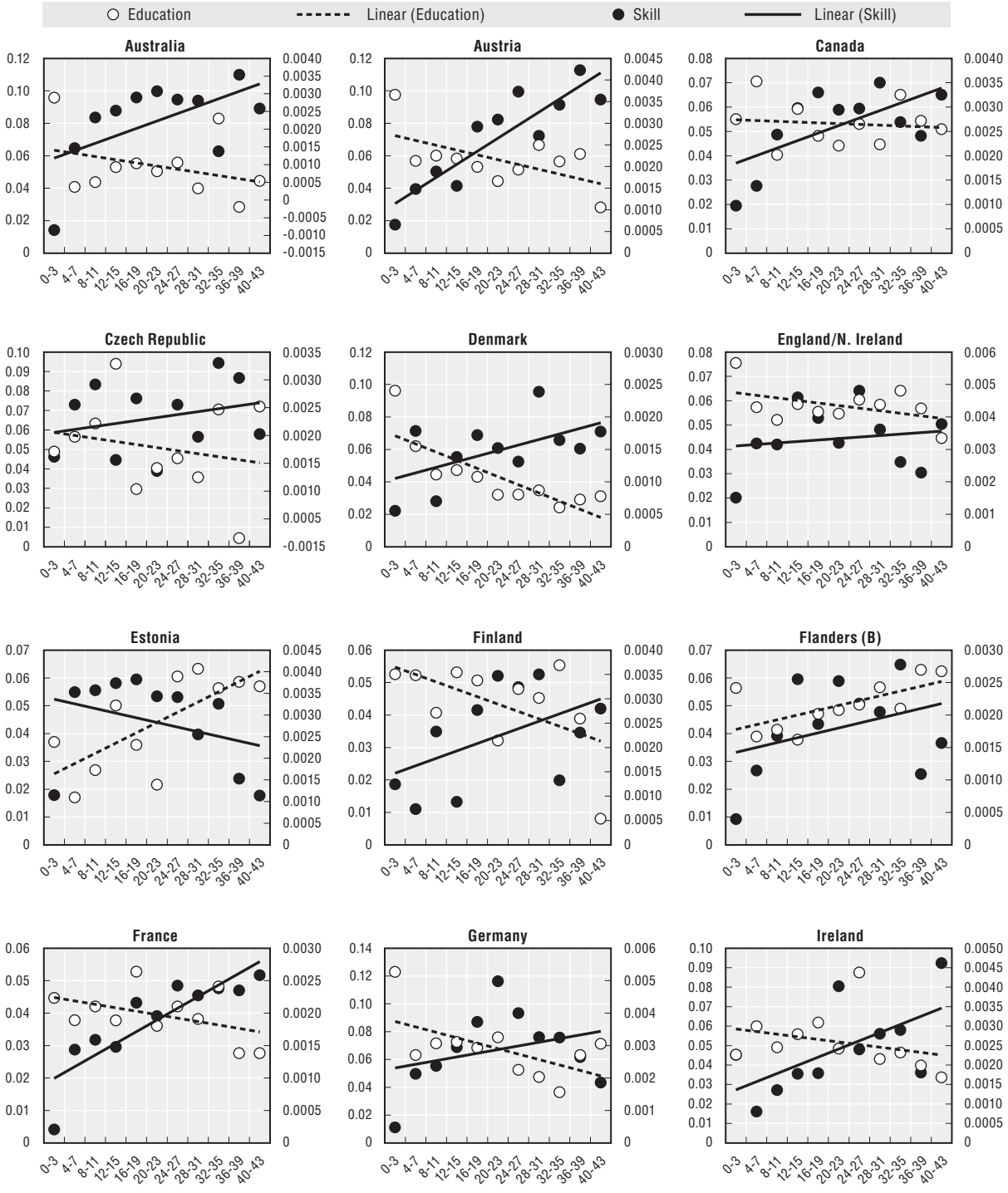
This regression is run separately for each country, and the estimated coefficients on S and Z are subsequently plotted against experience (X) to provide a picture of how the returns to schooling and skills evolve as individuals gain more experience in the labour market. To reduce the amount of noise, experience is grouped into classes of 4 years each. The results of this analysis are shown in Figure 1 which, for each of the countries in the sample, plots the return to both education and skills at each level of experience. The white dots and dashed lines represent the returns to education, while the dark dots and dark lines are for the returns to skill. The straight lines are simple linear OLS regressions of the returns to education and skills, respectively, on experience.

In line with the predictions of the employer learning model, the return to skill appears to increase in most countries (with the exception of Estonia and Poland) – although the line seems relatively flat in some of them (e.g. England/Northern Ireland, Italy, Korea and Spain). Again consistent with the ELSD model, the return to education appears to fall in most countries, although there are more exceptions this time, including: Estonia, Flanders, Italy, Japan, Korea, Poland, Slovak Republic and Spain. In the next sub-section, more formal tests of the ELSD hypothesis are run.

4.2. *A formal test of employer learning*

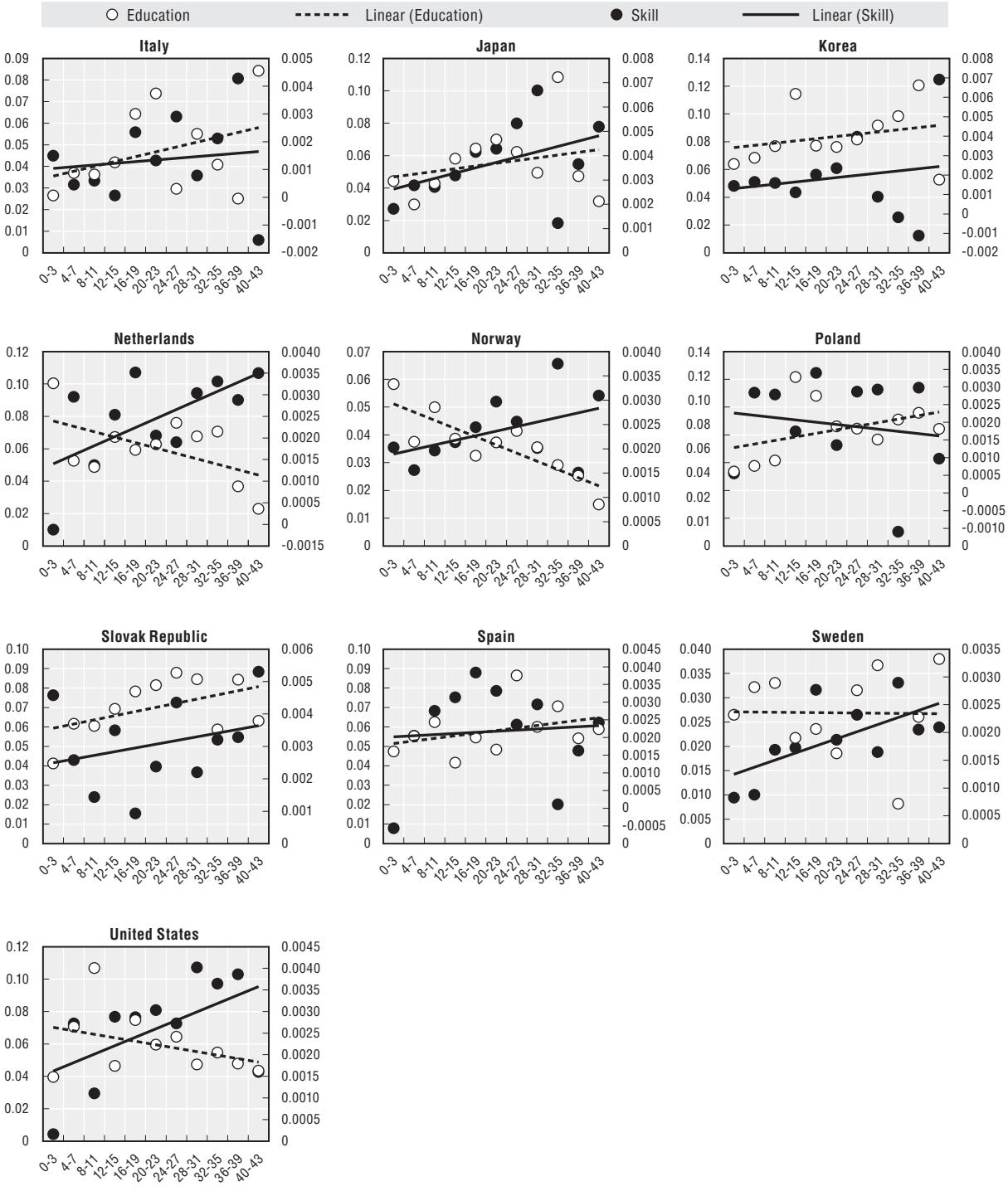
This sub-section applies the more formal test of employer learning proposed by Altonji and Pierret (2001) to the PIAAC data. The results are presented in Table 2. In addition to the controls shown in equation [1], the regressions also include controls for gender and whether the individual was foreign-born or not.[9] Following Altonji and Pierret (2001), experience is instrumented using potential experience[10] in order to attenuate potential measurement error in the actual experience variable (which would lead to downward bias in the estimates).[11] The PIAAC probability weights are used throughout and all standard errors are estimated using robust regression.

Figure 1. **The returns to education and skill proficiency with experience, by country**



The first panel of Table 2 shows just the returns to education, and how these change with experience (i.e. this is a version of equation [1] without controls for skill and its interaction with experience). As expected, the return to education is positive in every country and averages 27.8% for a standard deviation increase in years of education and for a worker with no experience.[12] The results also show that the returns to education fall with

Figure 1. **The returns to education and skill proficiency with experience, by country** *(cont.)*



experience in all but three of the countries even in the absence of a control for skill (although this fall is statistically significant in only 12 of them). While in the models of Farber and Gibbons (1996) and Altonji and Pierret (2001) the return to education is assumed to remain constant (regardless of experience), there are good reasons to believe that this return might fall, even in the absence of employer learning. Indeed, the negative experience

Table 2. **How the returns to education and skill change with experience**

PANEL A: EDUCATION

	Years of education		Years of education x experience		Skill		Skill x experience	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Australia	0.297	0.0185***	-0.00448	0.000765***				
Austria	0.317	0.0156***	-0.00470	0.000795***				
Canada	0.286	0.0131***	-0.00254	0.000592***				
Czech Republic	0.248	0.0305***	-0.00281	0.00166				
Denmark	0.294	0.0128***	-0.00588	0.000546***				
England/N. Ireland (UK)	0.220	0.0207***	-0.000971	0.00106				
Estonia	0.244	0.0206***	-0.00277	0.000915**				
Finland	0.236	0.0147***	-0.00223	0.000681**				
Flanders (B)	0.220	0.0174***	-0.000427	0.000865				
France	0.327	0.0215***	-0.00398	0.000922***				
Germany	0.402	0.0189***	-0.00654	0.000963***				
Ireland	0.317	0.0361***	-0.00216	0.00168				
Italy	0.202	0.0366***	0.00231	0.00193				
Japan	0.179	0.0187***	0.000140	0.00107				
Korea	0.414	0.0366***	-0.00688	0.00238**				
Netherlands	0.345	0.0177***	-0.00522	0.000838***				
Norway	0.238	0.0150***	-0.00400	0.000852***				
Poland	0.295	0.0254***	-0.000487	0.00134				
Slovak Republic	0.229	0.0299***	0.00138	0.00141				
Spain	0.310	0.0262***	-0.00131	0.00147				
Sweden	0.126	0.0155***	-0.000290	0.000731				
United States	0.372	0.0311***	-0.00301	0.00141*				

PANEL B: EDUCATION AND SKILL

	Years of education		Years of education x experience		Skill		Skill x experience	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Australia	0.270	0.0219***	-0.00550	0.000916***	0.0663	0.0255**	0.00231	0.00112*
Austria	0.298	0.0186***	-0.00581	0.000909***	0.0304	0.022	0.00342	0.000988***
Canada	0.245	0.0140***	-0.00362	0.000643***	0.0936	0.0156***	0.00180	0.000724*
Czech Republic	0.217	0.0331***	-0.00329	0.00183	0.0625	0.0309*	0.000569	0.00177
Denmark	0.272	0.0134***	-0.00611	0.000568***	0.0554	0.0156***	0.000407	0.000682
England/N. Ireland (UK)	0.167	0.0217***	-0.00122	0.00105	0.150	0.0256***	0.000931	0.00109
Estonia	0.178	0.0221***	-0.00160	0.000998	0.133	0.0197***	-0.00197	0.00101
Finland	0.218	0.0186***	-0.00289	0.000801***	0.0293	0.0217	0.00256	0.000886**
Flanders (B)	0.178	0.0200***	-0.000589	0.000986	0.0479	0.0185**	0.00192	0.000928*
France	0.278	0.0247***	-0.00420	0.00103***	0.0586	0.0181**	0.00169	0.000821*
Germany	0.356	0.0203***	-0.00749	0.00105***	0.0997	0.0241***	0.00189	0.00115
Ireland	0.275	0.0357***	-0.00293	0.00164	0.0654	0.0384	0.00291	0.00221
Italy	0.196	0.0388***	0.00119	0.00202	0.0106	0.0287	0.00260	0.0015
Japan	0.135	0.0205***	-0.000520	0.00119	0.0959	0.0237***	0.00131	0.00119
Korea	0.377	0.0397***	-0.00653	0.00262*	0.0914	0.0355*	-0.00142	0.00232
Netherlands	0.331	0.0218***	-0.00683	0.000959***	0.0499	0.0265	0.00276	0.00106**
Norway	0.196	0.0147***	-0.00403	0.000879***	0.0961	0.0189***	0.000375	0.000871
Poland	0.256	0.0252***	-0.000255	0.00133	0.102	0.0221***	-0.00105	0.00127
Slovak Republic	0.183	0.0311***	0.00132	0.00158	0.138	0.0340***	-0.000761	0.00157
Spain	0.278	0.0307***	-0.00161	0.00175	0.0729	0.0345*	0.000986	0.00181
Sweden	0.105	0.0152***	-0.000968	0.000707	0.0492	0.0178**	0.00173	0.000745*
United States	0.315	0.0383***	-0.00461	0.00170**	0.0976	0.0353**	0.00240	0.00151

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

slope on education is consistent with a human capital story in which knowledge obtained in school depreciates over time unless one receives training. It is also consistent with an alternative model in which more educated workers receive more training and, as they gain more experience, employers increasingly base their beliefs about worker productivity on the cumulative amount of training they receive (and less on initial years of education).

The results in Panel A of Table 2 therefore suggest that the test for employer learning needs to be adjusted somewhat. In particular, a fall in the return to education cannot by itself be interpreted as evidence in favour of the employer learning hypothesis. Instead, it needs to be the case that the fall in the return to education is caused by the introduction into the regression of unobservable correlates of productivity (such as numeracy skills) which employers learn more about as time passes. Only if the fall in the return to education with experience is greater once the control for skill and its interaction with experience have been introduced into the regression, can one interpret the evidence as favourable to the employer learning hypothesis. In addition, it is possible that the return to education increases with experience, but that this increase is smaller once unobservable correlates of productivity are included in the regression, and this may also be interpreted as evidence consistent with the employer learning hypothesis.

The second panel of Table 2 adds these additional skills controls to the regression, and Table 3 shows the results of a Wald test of the equality of coefficients on the education*experience interaction variables from the first and second panels of Table 2. While Table 2 now shows that the return to education falls with experience in exactly half of the countries, the key finding is contained in Table 3: once we control for skill and its interaction with experience, the return to education falls even more (or increases less) in nine of the 22 PIAAC countries. However, we observe a simultaneous increase in the return to skill with experience in only six of them. The countries where we find the strongest evidence, consistent with the theory of employer learning, are: Australia, Austria, Canada, Finland, the Netherlands and Sweden. There are also some countries where some weaker evidence in favour of the ELSD hypothesis can be found. For example, in France the return to education (skill) decreases (increases) with experience, but the fall in education with experience is not greater when we include controls for skill. In both Germany and the United States, we do find that the return to education falls with experience (and that this fall is greater when controls for skill are included in the regression) – however, while the return to skill increases with experience, this increase is not statistically significant.[13]

Before closing this section, it is worth returning to an important assumption discussed at the very beginning of this paper, namely that on-the-job training is independent of both S (schooling) and Z (ability). This may not be an entirely realistic assumption as existing research shows that more educated and more able workers receive more training (Blundell et al., 1999; Leuven, 2005). If this is the case, then the coefficient on the interaction between ability and experience, β_{ZX}, would overstate the effect of learning on wages. Similarly, this would attenuate the expected decline in the return to education with experience (β_{SX}), which could even turn positive. One might argue, therefore, that the positive coefficients on skill are due to the positive association between this variable and training intensity, and not to employer learning. However, even under this hypothesis, one would not expect to see a negative coefficient on the interaction between experience and education, and the decline in the returns to education with experience would therefore be the most compelling evidence of employer learning.

Table 3. **Wald test of the equality of the coefficients on education interacted with experience, before and after controlling for skill and its interaction with experience**

	Chi2	Prob > chi2
Australia	4.60	0.032
Austria	5.70	0.017
Canada	12.15	0.001
Cyprus	0.16	0.686
Czech Republic	0.22	0.639
Denmark	0.76	0.383
England/N. Ireland (UK)	0.27	0.605
Estonia	6.25	0.012
Finland	3.23	0.072
Flanders (B)	0.11	0.740
France	0.17	0.740
Germany	3.00	0.083
Ireland	0.70	0.402
Italy	1.86	0.173
Japan	1.04	0.307
Korea	0.10	0.752
Netherlands	14.15	0.000
Norway	0.01	0.917
Poland	0.20	0.655
Russia	0.74	0.390
Slovak Republic	0.01	0.926
Spain	0.13	0.714
Sweden	5.45	0.020
United States	3.22	0.073

Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

While it is difficult to fully control for the impact of cumulative training (not least because the PIAAC data do not contain such information), it is possible to test whether the results obtained above are robust to the inclusion of a variable capturing formal, job-related education and training received over the past 12 months. The results of this analysis are presented in Table 4, along with the Wald tests which compare the coefficients on the interaction between education and experience from these regressions, with those obtained from a regression without skill and its interaction with experience (the latter results not being reported). The results show that the main conclusions reached so far are unaffected once training is controlled for. The findings keep suggesting the strongest evidence in favour of the employer learning model in Australia, Austria, Canada, Finland, the Netherlands and Sweden, and with weaker evidence this time in the case of the United States only. In all these countries (including the United States), the fall in the return to education with experience is greater once controls for ability are included in the regression.

4.3. *Analysis of variance*

This section offers an alternative and complementary analysis of the importance of education and ability in determining wages as workers gain experience in the labour market. Instead of focusing on the coefficients on skill and education, it looks at the proportion of the variance in wages that can be explained by these variables for groups of workers with different levels of experience. While the analysis presented here is merely exploratory (much in the same way as the visual analysis was), it does offer additional evidence to support the

Table 4. **How the returns to education and skill change with experience, controlling for training**

	Years of education		Years of education x experience		Skill		Skill x experience		Wald test	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.	Chi2	Prob > chi2
Australia	0.217	0.0217***	-0.00365	0.000917***	0.0808	0.0246**	0.00217	0.00107*	2.79	0.0950
Austria	0.206	0.0191***	-0.00177	0.000932	0.0719	0.0218***	0.00255	0.000988*	4.29	0.0384
Canada	0.189	0.0151***	-0.00224	0.000699**	0.124	0.0157***	0.00172	0.000728*	7.14	0.0075
Czech Republic	0.167	0.0341***	-0.00109	0.00184	0.0795	0.0318*	0.000662	0.00177	0.09	0.7699
Denmark	0.216	0.0150***	-0.00440	0.000628***	0.0850	0.0152***	0.00000252	0.000689	0.24	0.6222
England/N. Ireland (UK)	0.145	0.0225***	-0.000551	0.00108	0.163	0.0249***	0.000857	0.00111	0.18	0.6729
Estonia	0.0968	0.0229***	-0.000127	0.00105	0.180	0.0206***	-0.00250	0.00106*	7.84	0.0051
Finland	0.188	0.0175***	-0.00265	0.000773***	0.0574	0.0218**	0.00256	0.000901**	3.22	0.0727
Flanders (B)	0.140	0.0200***	0.000619	0.00101	0.0655	0.0178***	0.00179	0.000914	0.15	0.6973
France	0.225	0.0236***	-0.00257	0.00101*	0.0779	0.0180***	0.00148	0.000842	0.21	0.6487
Germany	0.272	0.0236***	-0.00430	0.00118***	0.146	0.0248***	0.000660	0.00118	1.58	0.2092
Ireland	0.274	0.0427***	-0.00329	0.00188	0.0852	0.0395*	0.00253	0.00224	1.08	0.2977
Italy	0.199	0.0357***	0.000266	0.00191	0.0371	0.0279	0.00224	0.00151	1.91	0.1668
Japan	0.121	0.0228***	0.000522	0.00132	0.131	0.0231***	0.000974	0.00123	1.29	0.2556
Korea	0.352	0.0427***	-0.00414	0.0028	0.118	0.0345***	-0.00186	0.00232	0.10	0.7536
Netherlands	0.292	0.0224***	-0.00546	0.000995***	0.0713	0.0247**	0.00241	0.00104*	10.71	0.0011
Norway	0.163	0.0157***	-0.00310	0.000938***	0.120	0.0184***	0.000385	0.000865	0.11	0.7421
Poland	0.215	0.0235***	0.000632	0.00127	0.121	0.0223***	-0.00147	0.00126	0.16	0.6881
Slovak Republic	0.148	0.0301***	0.00257	0.00153	0.150	0.0342***	-0.00109	0.00157	0.01	0.9365
Spain	0.258	0.0320***	-0.00152	0.00182	0.119	0.0349***	0.000626	0.00184	0.08	0.7707
Sweden	0.0896	0.0142***	-0.000688	0.000699	0.0690	0.0182***	0.00166	0.000767*	5.02	0.0251
United States	0.272	0.0370***	-0.00338	0.00170*	0.128	0.0348***	0.00189	0.00155	2.78	0.0954

Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

conclusions reached so far – i.e. that the evidence in favour of employer learning is strongest in countries like Australia, Austria, Canada, Finland, the Netherlands and Sweden.

In a regression model, a variable's importance can be assessed through its coefficient, but also through its contribution to the overall variance in the dependent variable. Indeed, a large coefficient does not necessarily translate into a large R-squared, and both pieces of information are therefore useful in deciding on the relative importance of explanatory factors. To analyse the contribution of education and skills to the variance in wages across individuals, a methodology developed by Fields (2003) is used, which was originally designed to analyse the level of income inequality in a country and its change over time. Fields' approach consists in decomposing the explained portion of the regression (R-squared) into weights for each of the factors. The decomposition is "exact" in the sense that the variance of W is decomposed exactly into the sum of components attributable to each explanatory variable and the residual.

Starting with a simple regression of wages on education and skills:

$$W = \beta_0 + \beta_S S + \beta_Z Z + \varepsilon \quad [3]$$

And denoting the resulting parameter estimates as:

$$(\hat{\beta}_0\, \hat{\beta}_S\, \hat{\beta}_Z) \quad [4]$$

The portion φ of the total variance explained by each variable can simply be expressed as:

$$\varphi(S) = \frac{cov[S\hat{\beta}_S, W]}{var(W)} \quad [5]$$

And

$$\varphi(Z) = \frac{cov[Z\hat{\beta}_Z, W]}{var(W)} \quad [6]$$

And the contribution θ of each variable to the explained variance can be obtained simply by dividing each φ by the total explained variance (R-squared):

$$\theta(S) = \frac{\varphi(S)}{R^2} \quad [7]$$

And:

$$\theta(Z) = \frac{\varphi(Z)}{R^2} \quad [8]$$

Where by construction the θ's sum to 100%.[14] In this paper, however, the interest will be in the φ's – i.e. the contribution of education and skills to the total (explained and unexplained) variance in wages.

In what follows, the sample for each country is divided into two different experience groups: "low" experience (0-15 years) and "high" experience (16-43 years), and the variance decomposition is applied to each of these groups separately. Table 5 presents the results from this analysis. Panel A shows the decomposition of variance when just years of education are included in the regression, while Panel B shows the decomposition when skills are also added. In both Panels A and B, the variance in wages explained by education falls with experience in 13 out of the 22 countries, while Panel B shows that the variance in wages explained by skills increases with experience in 18 of the countries. Importantly, in those countries where the variance in wages explained by education falls, the fall is much greater once skills are also included in the regression. Consistent with the coefficient analysis of the previous section, the greatest drops in the variance explained by education once skills are included in the models are in: Australia, Austria, Canada, Finland, France, Germany, the Netherlands, Sweden and the United States. In these countries the variance in wages explained by education is 17% lower for the more experienced group without control for skills (dropping from 22% to 18%) and 35% lower with control for skills (dropping from 19% to 11%), while the proportion of variance explained by skill is 178% higher for the more experienced group (increasing from 5% to 13%).

4.4. *Labour market institutions and education system characteristics*

In this final section, an attempt is made to try and understand whether the presence of employer learning (or at least evidence consistent with it) is systematically associated or not with certain labour market and education institutions/policies/characteristics. Indeed, implicit in some of the literature is that employer learning is the hallmark of efficient labour markets, where "efficient" is taken to mean "flexible" – i.e. with limited employment protection, and no or little collective bargaining and/or wage regulation (Bauer and Haisken-DeNew, 2001; Hanushek and Zhang, 2006). In such labour markets, it is argued, employers have the freedom to "learn" about the true productivity of workers and adjust their wages accordingly – contrary to more "rigid" labour markets, where employers supposedly have less leeway in adjusting wages since these are set either by collective agreements or high minimum wages. Sometimes, and given the relationship between employer learning and signalling theories of education, such arguments have been supplemented with assumptions around how education systems function. In particular, it has been hypothesised that in systems that are more vocational and/or where there is less

Table 5. **The proportion of (total) variance in wages explained by education and skill proficiency**

%

PANEL A: EDUCATION

	Proportion of variance in wages explained by:					
	Education			Skill		
	Experience = 0-15 years	Experience = 16-43 years	% change	Experience = 0-15 years	Experience = 16-43 years	% change
Australia	17	15	-10			
Austria	28	18	-35			
Canada	21	15	-29			
Czech Republic	12	11	-8			
Denmark	37	11	-71			
England/N. Ireland (UK)	15	14	-6			
Estonia	6	6	12			
Finland	22	19	-12			
Flanders (B)	17	19	15			
France	16	20	20			
Germany	33	17	-50			
Ireland	8	15	79			
Italy	15	14	-10			
Japan	11	11	0			
Korea	13	14	8			
Netherlands	24	20	-19			
Norway	25	9	-63			
Poland	17	27	64			
Slovak Republic	12	18	54			
Spain	21	24	11			
Sweden	12	10	-12			
United States	25	24	-5			
	22	18				

PANEL B: EDUCATION AND SKILL

	Proportion of variance in wages explained by:					
	Education			Skill		
	Experience = 0-15 years	Experience = 16-43 years	% change	Experience = 0-15 years	Experience = 16-43 years	% change
Australia	14	10	-28	6	11	94
Austria	26	13	-49	4	13	254
Canada	18	9	-48	6	14	118
Czech Republic	9	8	-14	5	5	14
Denmark	33	7	-78	5	6	31
England/N. Ireland (UK)	11	10	-11	15	15	-3
Estonia	3	4	27	6	5	-16
Finland	19	13	-30	4	14	207
Flanders (B)	13	13	7	7	10	57
France	12	13	9	6.6	10.8	64
Germany	31	11	-65	3.6	12.0	236
Ireland	6	11	70	4.2	7.6	80
Italy	13	11	-13	4.3	4.7	9
Japan	6	7	2	9.6	9.2	-5
Korea	12	12	1	2.0	3.2	63
Netherlands	22	13	-40	2.4	12.0	390
Norway	20	5	-73	10.3	11.5	11
Poland	14	24	70	4.4	4.5	1
Slovak Republic	9	15	68	6.4	5.6	-13
Spain	18	18	3	6.0	8.9	48
Sweden	9	5	-43	5.1	13.9	172
United States	20	15	-23	8.6	14.9	73

Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

variability in the quality of education, true productivity is more easily observed by employers at the point of hiring, and so there would be less need for employer learning (Bauer and Haisken-DeNew, 2001).

Even a very basic look at the data, however, suggests that the true story may be more complicated than what has been maintained in the literature to date. Table 6 explores differences across countries in terms of: educational systems (quality variability and prevalence of vocational education); the cost of hiring (the minimum wage as a proportion

Table 6. **Labour market institutions and education system characteristics**

	Education		Cost of hiring		EPL		Wage bargaining		
	Quality variability[1]	VET[2]	Minimum wage[3]	Tax wedge[4]	Regular contracts[5]	Temporary contracts[6]	Coverage[7]	Level[8]	Co-ordination[9]
Australia	249	19	0.53	27	1.9	1.0	45	2	2
Austria	240	57	-	49	2.4	2.2	99	3	4
Canada	231	12	0.45	30	1.5	0.2	29	1	1
Czech Republic	244	74	0.36	42	2.7	2.1	41	1	2
Denmark	214	42	-	39	2.3	1.8	85	3	4
England/N. Ireland (UK)	245	-	0.47	32	1.6	0.5	31	1	1
Estonia	209	32	0.36	40	2.1	3.0	25	1	1
Finland	219	38	-	43	2.2	1.9	90	5	5
Flanders (B)	268	26	0.51	56	2.9	2.4	96	5	5
France	256	30	0.62	50	2.8	3.8	92	2	2
Germany	252	56	-	50	3.0	1.8	61	3	4
Ireland	219	13	0.48	26	2.1	1.2	42	1	3
Italy	241	32	-	48	2.8	2.7	85	3	3
Japan	242	-	0.38	31	2.1	1.3	16	1	4
Korea	254	-	0.42	21	2.2	2.5	10	1	3
Netherlands	242	32	0.47	39	2.9	1.2	84	3	3
Norway	231	32	-	38	2.3	3.4	74	3	4
Poland	234	58	0.47	36	2.4	2.3	29	1	1
Slovak Republic	261	68	0.47	40	2.3	2.4	35	2	2
Spain	228	8	0.44	41	2.3	3.2	73	4	4
Sweden	236	31	-	43	2.5	1.2	91	3	4
United States	233	-	0.38	31	1.2	0.3	13	1	1

1. Quality variability is defined as the score difference between the 90th and 10th percentile on the PISA 2012 mathematics test sat by 15-year-olds. *Source: PISA 2012*, Figure I.2.24.
2. VET is defined as the proportion of 25-64 year-olds whose highest qualification is upper secondary vocational upper secondary. *Source: OECD Education at a Glance 2013*, Table A1.5a.
3. Minimum wage is defined as the ratio of the minimum wage to the median wage of full-time workers. *Source:* Online *OECD Employment Database*. Data refers to 2012.
4. Tax wedge is defined as the difference between total labour costs to the employer and the corresponding net take-home pay for single workers without children, at average earnings levels, expressed as a proportion of total labour costs. *Source: OECD Taxing Wedges 2013*, Table 0.1.
5. Strictness of employment protection against individual and collective dismissal on regular contracts (2013) – on a scale from 0 (least restrictions) to 6 (most restrictions). *Source:* Online *OECD Employment Database*.
6. Regulation on temporary forms of employment – on a scale from 0 (least restrictions) to 6 (most restrictions). *Source:* Online *OECD Employment Database*.
7. Bargaining coverage = employees covered by collective (wage) bargaining agreements as a proportion of all wage and salary earners in employment with the right to bargaining, expressed as percentage, adjusted for the possibility that some sectors or occupations are excluded from the right to bargain. *Source:* Visser (2014).
8. The predominant level(s) at which wage bargaining takes place: 5 = Bargaining predominantly takes place at central or cross-industry level and there are centrally determined binding norms or ceilings to be respected by agreements negotiated at lower levels; 4 = Intermediate or alternating between central and industry bargaining; 3 = Bargaining predominantly takes place at the sector or industry level; 2 = Intermediate or alternating between sector and company bargaining; 1 = Bargaining predominantly takes place at the local or company level. *Source:* Visser (2014).
9. Co-ordination of wage-setting: 6 = state-imposed bargaining; 5 = state-sponsored bargaining; 4 = Inter-associational by peak; associations; 3 = Intra-associational ("informal centralisation"); 2 = Pattern bargaining; 1 = Uncoordinated bargaining. *Source:* Visser (2014).

of median wages and the tax wedge); employment protection legislation (EPL) on regular, as well as on temporary contracts; and some key characteristics of wage setting arrangements (the extent of bargaining coverage, the predominant level at which bargaining takes place, and the extent of co-ordination in wage setting). While it is true that in the countries traditionally seen as more liberal (e.g. Australia, Canada and the United States) the evidence presented in this paper was broadly consistent with employer learning and that in the more regulated countries (e.g. Italy and Spain) it was not, Table 6 shows that there are also plenty of exceptions.

Starting with the characteristics of education systems, there appears to be little systematic association between the latter and the possible presence of employer learning. One might argue (and previous research has) that in countries where education systems are more homogenous and produce students of similar ability there might be less need for employer learning. However, while the analysis in this paper has found evidence consistent with employer learning in countries with low quality variability (Finland and Canada), it has also done so for countries where this variability is much greater (Australia). Similarly, while evidence in favour of the ELSD hypothesis was uncovered in countries with a high proportion of students qualifying from vocational education and training (Austria), it was also found in countries with a relatively low incidence of vocational education and training (Canada and Australia).

High minimum wages could lower the ability of employers to reward the true productivity of workers through the wages they set. However, it is also possible that, while high minimum wages constrain employers at the beginning of workers' careers (when both productivity and wages tend to be low), wages diverge more rapidly afterwards to reflect the true productivity of workers as they gain experience in the labour market. There is some indication in Table 6 that the latter hypothesis is more likely: with the exception of the United States, none of the countries with very low minimum wages showed trends in wages consistent with employer learning. While several of the countries where evidence consistent with employer learning was detected do not have a statutory minimum wage (e.g. Finland, Austria, Sweden and Germany), a large part of the workforce in these countries is covered by wage floors specified in sector- or occupation-level collective agreements. Combined with high collective bargaining, such sector/occupation-based minimum wages can be seen as a functional equivalent of a binding statutory minimum wage and, indeed, are often set at higher levels than in countries that have a statutory minimum wage (Garnero, Kampelmann and Rycx, forthcoming).

Staying on the topic of hiring costs, Table 6 further indicates that differences in the tax wedge across countries make no difference to the likelihood of finding evidence consistent with the ELSD hypothesis. The tax wedge is relatively high in countries such as Austria, Sweden and Finland, while it is much lower in countries like Australia and Canada.

Employment protection legislation (EPL), on the other hand, may play a bit more of a role, particularly EPL on temporary contracts. Table 6 shows that evidence consistent with employer learning was found in countries with stringent EPL on regular contracts (the Netherlands) as well as in countries with laxer EPL (Canada and Australia). However, all countries where convincing evidence for employer learning was found tend to have low protection on temporary contracts. This may indicate that this type of contract gives employers more flexibility to experiment with young workers and allows wages to adjust more rapidly to true productivity as workers move from one temporary contract to another.

Indeed, wage adjustments are, presumably, easier to make when new contracts are drawn up than when workers and their employers are bound by open-ended contracts.

The final few columns in Table 6 look at a number of wage bargaining characteristics. While there does not appear to be any clear association between employer learning and the extent of co-ordination in wage bargaining, most countries that showed experience profiles in the returns to education and skills consistent with employer learning tend to have relatively high bargaining coverage. At the same time, none of the countries with decentralised wage bargaining (i.e. where bargaining takes place predominantly at the local or company level) exhibited trends in returns consistent with employer learning. While this is necessarily very speculative, it is possible that centralised wage bargaining (combined with high bargaining coverage) has an effect on starting wages that is similar to the effect of high minimum wages discussed above: while initially they constrain employers in how they reward young workers, the subsequent wage adjustments for more productive workers might be all the more marked.

So far, the discussion on labour market institutions and education systems has been purely qualitative. Table 7 therefore offers a slightly more formal treatment of the relationship between employer learning and these institutions. It shows the results of a series of simple regressions where the dependent variable is a dummy equal to one for the countries with the strongest and most consistent evidence for employer learning was found (i.e. Austria, Australia, Canada, Finland, the Netherlands and Sweden), and where

Table 7. **Employer learning, labour market institutions and education system characteristics**

		(i)	(ii)	(iii)	(iv)	(v)
Education	Quality variability	-0.00311				-0.00502
		(0.00689)				(0.00889)
	VET	0.00106				0.00568
		(0.00464)				(0.00678)
Cost of hiring	Minimum wage		1.757			1.955
			(1.852)			(2.242)
	No minimum wage		1.118			1.090
			(0.903)			(1.051)
	Tax wedge		-0.0113			-0.0193
			(0.0132)			(0.0223)
EPL	Regular contracts			0.219		0.0498
				(0.242)		(0.436)
	Temporary contracts			-0.251		-0.288
				(0.114)**		(0.132)*
Wage bargaining	Coverage				0.00543	-0.00583
					(0.00654)	(0.00866)
	Level				0.124	0.250
					(0.130)	(0.181)
	Coordination				-0.0984	-0.0495
					(0.129)	(0.179)
Constant		0.983	-0.190	0.254	0.114	1.282
		(1.638)	(0.844)	(0.476)	(0.236)	(1.811)
N		22	22	22	22	22
R2		0.012	0.119	0.208	0.119	0.482

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Note: Standard errors in parenthesis. N = number of observations.

Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

the explanatory variables are each of the labour market institutions and characteristics of education systems discussed so far. The institutions are first included one group at the time (i.e. education, cost of hiring, EPL and wage bargaining), while in the final column they are all included simultaneously.[15] Of course, one should bear in mind that these regressions are run on very small sample sizes (n=22), and also that institutions are likely to be highly endogenous (as well as strongly correlated to one another). The results from these regressions should therefore not be interpreted as causal links, but purely as interesting statistical correlations.

None of the labour market institutions or education system characteristics is significantly associated with the likelihood of finding evidence in favour of the employer learning hypothesis – with the exception of the strictness of employment protection legislation on temporary contracts. This is the case whether the regressions are run just with the EPL controls (column iii) or with all institutional controls included simultaneously (column v). While these findings need to be interpreted with extreme caution and are very tentative, one can certainly build a plausible story around how the ease of use of temporary contracts might allow employers more flexibility in learning about and rewarding young workers. The role of temporary contracts in facilitating employer learning could constitute an interesting area for future research.

5. Conclusion

This paper has used the Survey of Adult Skills to document how the returns to education and skill evolve with experience in a wide range of OECD countries, and it has done this using the employer learning and statistical discrimination framework developed by Altonji and Pierret (2001). The strongest evidence in support of this theory was found in Austria, Australia, Canada, Finland, the Netherlands and Sweden, while some weaker evidence was found also in France, Germany and the United States. With some exceptions, there is a large overlap between this list of countries and those where the previous literature had found evidence of employer learning. This is encouraging, but it also begs the question of why no (or very little) research on employer learning is available for the countries where this paper has found no evidence of employer learning (e.g. Italy, Spain, Japan, Korea – to cite just a few). Is this a case of publication bias? Indeed, one of the most interesting findings to emerge from the present paper is the large heterogeneity in the experience profiles of the returns to education and skills, and more research should focus on why this might be the case.

In addition, this paper has reiterated some of the difficulties of interpreting the rising (falling) return to skill (education) as evidence of employer learning and, in particular, the difficulty of ruling out other explanations for such trends, such as training. This challenge was already recognised by Altonji and Pierret (2001) themselves and, in recent research, Kaymak (2014) has shown that patterns previously interpreted as evidence in favour of employer learning are equally consistent with a model of skill formation in which workers differ in their learning ability and job training acts as a substitute for formal schooling.

The paper has also shown, albeit tentatively, that – with the possible exception of EPL on temporary contracts – there is no obvious relationship between labour market institutions and education system characteristics and "employer learning". This is not entirely surprising, given that similar associations between wage bargaining systems and the linking of pay to productivity more generally are difficult to establish (Eurofound, 2014) and, equally, that a robust relationship between differences in bargaining organisation and

differences in macro-economic performance is difficult to identify (OECD, 2004). This may be because "employer learning" arises in different countries for different reasons and that, while no single education or labour market institution can explain the presence of employer learning, the answer lies in the complex interaction between these institutions.

As a concluding comment, it is also not entirely clear that employer learning should necessarily be seen as a sign of efficient labour markets, as is often assumed in the literature. Countries in which no employer learning is observed could, in fact, be doing much better at signalling the true productivity of young workers to potential firms, making employer learning redundant. In fact, glancing back at Table 2, it is interesting to note that the return to skill in countries where no employer learning was found is initially (i.e. at experience = 0) much greater than in countries where employer learning was found. This may indicate that employers (or the systems) in those countries are better at rewarding true productivity from the outset. Again, we leave this as an interesting area for future research.

Notes

1. These theories are, of course, closely related to the theory of signalling. For example, Layard and Psacharopoulos (1974) and Psacharopoulos (1979) show that one prediction of the signalling model is that the partial effect of education on wages declines with labour market experience because employers gain better information over time about workers' true productivity.
2. Hanushek and Zhang (2006) use data from the International Adult Literacy Survey (IALS – a precursor to PIAAC). Their sample includes 13 countries: Chile, the Czech Republic, Denmark, Finland, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Sweden, Switzerland and the United States.
3. The Farber and Gibbons (1996) set-up is slightly different in that they only use the part of Z which is not correlated with S. Their model therefore predicts that the return to education should be independent of labour market experience ($\beta_{S,X} = 0$), while the return to skills should be increasing in experience ($\beta_{Z,X} > 0$).
4. 21 OECD countries: Australia, Austria, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland), and the United States; one region: Flanders (Belgium); as well as two non-OECD countries: Cyprus and the Russian Federation.
5. Instead of one proficiency score, PIAAC has 10 plausible values that need to be combined in a certain way to come up with correct estimates and standard errors. The OECD has created software tools to do analysis taking into account the complex sampling and assessment design of PIAAC, however the Stata tools currently available are not yet flexible enough to easily allow for the types of analyses carried out in this paper. Instead, the analysis presented here uses a single measure of numeracy proficiency, which is simply the average of the 10 plausible values. This approach is in line with Fichen and Pellizzari (2013). Other authors (e.g. Hanushek et al., 2015 and Allen, Levels and van der Velden, 2013) pick only the first of the plausible values as an indication of the individual's skill. A few robustness tests using the PIAAC replicates sample procedure (available upon request) indicated that the results were virtually identical.
6. The measure of experience refers to actual work experience and was collected as the number of years where at least six months were spent in paid work.
7. The sample includes both private and public sector workers. The main analysis has been re-run on the sub-sample of private sector workers only, but this makes no significant difference to the overall results obtained in the paper.
8. One may argue that, because skills as measured in the PIAAC data are dependent on experience, it would be appropriate to control for such dependence by regressing skill proficiency on experience first, and then using the residuals as an explanatory variable in the wage regression. However, the inclusion of the experience profile $H(X)$ in equation [1] has exactly the same effect on the skills variable Z – i.e. it purges the skills variable of the component acquired through experience.
9. Controls for industry and occupation have not been included, for two reasons. First, such variables are outcome variables, in the same way as wages are, and including them on the right-hand side of the equation would therefore create endogeneity. Second, it is not clear that controls for current

occupation and industry will adequately capture the effect on employer learning. Indeed, if one believes that such variables should be included as control variables, then it should be industry and occupation all along the career (or at least at the very beginning of the career) that are included. For example, Altonji and Pierret (2001) run a robustness check where occupation of the first job is included in the regression, on the grounds that some jobs are "dead-end jobs" and that the flow of information to employers is dependent on the type of job in which the worker begins his career. Unfortunately, information on occupation and industry at the beginning of individuals' careers is not available in the PIAAC data. When (current) industry and occupation are included in the regression, a number of the interactions between experience, on the one hand, and education and skills, on the other, turn insignificant. This is not surprising given the large number of additional control added to the regression (20 industry dummies and 9 occupation dummies). The interaction between education and experience turns insignificant in Canada, Finland, France, Korea and the United States. The interaction between skills and experience turns insignificant in Canada, Finland, France and Sweden. A simultaneous increase in the return to skills and fall in the return to education is observed only in Australia, Austria, and the Netherlands. Importantly, given the discussion later in this paper, the return to education falls more with experience in these countries once controls for skills are included in the regression.

10. Potential experience is defined as age minus years of education, minus the school starting age. The school starting age is six in all countries, except: in England/Northern Ireland and the Netherlands (where it is five), and in Estonia, Finland, Poland and Sweden (where it is seven).

11. Actual experience is regressed on potential experience, and a predicted value of experience is obtained. This is done by country. As a robustness check, models using potential experience are also run, and the results are presented in Annex A. In addition, models are run where experience is "discounted" by age. This is to allow for the possibility that the same level of experience is remunerated differently depending on the age of the worker. These results are also presented in Annex A. While there are some differences across these models in the significance of some of the coefficients, the countries where the patterns observed are consistent with the theory of ELSD remain the same: Australia, Austria, Canada, Finland, the Netherlands and Sweden. Again, weaker evidence consistent with the theory is found in France, Germany and the United States.

12. One standard deviation is equivalent to 2.7 years of education. The average return to education here obtained is therefore slightly higher than the return to education obtained in other studies. However it should be remembered that it is the return to education for individuals with zero experience. The return to education falls with experience, so the average return across all experience groups will necessarily be lower.

13. In most countries, the return to skill is positive even when experience is zero. This may seem at odds with the theory of employer learning, but does not have to be. Indeed, the coefficient on skill in the regression will be positive when skill is correlated with variables that are observed by the employer, but not by the econometrician.

14. For a more complete description of the decomposition the reader can refer to Fields (2004). In practice, the method can be applied in Stata with the user-written programme *ineqrbd* (Fiorio and Jenkins, 2007).

15. When the regressions are run one institution at a time (rather than including them in groups), the results obtained are exactly the same and the conclusions reached do not change.

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ANNEX A

Models with potential and "discounted" experience

PANEL A: Results using potential experience

	Years of education		Years of education x experience		Skill		Skill x experience			
	β	s.e.	β	s.e.	β	s.e.	β	s.e.	Chi2	Prob > chi2
Australia	0.247	0.0186***	-0.00439	0.000731***	0.0757	0.0214***	0.00185	0.000891*	4.6	0.032
Austria	0.294	0.0181***	-0.00495	0.000774***	0.0328	0.0213	0.00291	0.000841***	5.7	0.0169
Canada	0.237	0.0128***	-0.00292	0.000519***	0.0976	0.0143***	0.00145	0.000584*	12.15	0.0005
Czech Republic	0.219	0.0341***	-0.00305	0.00169	0.0622	0.0319	0.000527	0.00164	0.22	0.6392
Denmark	0.269	0.0131***	-0.00553	0.000514***	0.0556	0.0153***	0.000369	0.000617	0.76	0.3834
England/N. Ireland (UK)	0.165	0.0206***	-0.00103	0.00088	0.151	0.0245***	0.000783	0.00092	0.27	0.6048
Estonia	0.178	0.0222***	-0.00144	0.000897	0.133	0.0197***	-0.00177	0.000912	6.25	0.0124
Finland	0.219	0.0189***	-0.00259	0.000718***	0.0283	0.022	0.00229	0.000795**	3.23	0.0722
Flanders (B)	0.178	0.0204***	-0.000530	0.000887	0.0470	0.0189*	0.00173	0.000835*	0.11	0.7399
France	0.278	0.0245***	-0.00344	0.000846***	0.0589	0.0180**	0.00138	0.000673*	0.17	0.676
Germany	0.359	0.0206***	-0.00681	0.000952***	0.0989	0.0245***	0.00171	0.00105	3	0.0831
Ireland	0.261	0.0289***	-0.00209	0.00117	0.0798	0.0288**	0.00207	0.00157	0.7	0.4022
Italy	0.196	0.0388***	0.000900	0.00153	0.0106	0.0287	0.00196	0.00113	1.86	0.1726
Japan	0.134	0.0192***	-0.000402	0.00092	0.0976	0.0223***	0.00101	0.000921	1.04	0.3068
Korea	0.365	0.0358***	-0.00367	0.00147*	0.0889	0.0320**	-0.000797	0.00131	0.1	0.7518
Netherlands	0.322	0.0207***	-0.00549	0.000772***	0.0536	0.0253*	0.00222	0.000854**	14.15	0.0002
Norway	0.191	0.0137***	-0.00351	0.000765***	0.0967	0.0178***	0.000326	0.000759	0.01	0.9169
Poland	0.256	0.0248***	-0.000215	0.00112	0.101	0.0217***	-0.000886	0.00107	0.2	0.6549
Slovak Republic	0.183	0.0320***	0.00121	0.00144	0.139	0.0348***	-0.000697	0.00144	0.01	0.926
Spain	0.277	0.0299***	-0.00118	0.00128	0.0734	0.0337*	0.000725	0.00133	0.13	0.7135
Sweden	0.106	0.0156***	-0.000896	0.000654	0.0481	0.0182**	0.00160	0.000689*	5.45	0.0195
United States	0.302	0.0340***	-0.00374	0.00138**	0.104	0.0317***	0.00194	0.00123	3.22	0.0726

PANEL B: Results using "discounted" experience

	Years of education		Years of education x experience		Skill		Skill x experience			
	β	s.e.	β	s.e.	β	s.e.	β	s.e.	Chi2	Prob > chi2
Australia	0.390	0.0344***	-0.462	0.0698***	0.0208	0.0411	0.213	0.0851*	7.35	0.0067
Austria	0.427	0.0283***	-0.495	0.0651***	-0.0141	0.0338	0.246	0.0693***	7.62	0.0058
Canada	0.337	0.0206***	-0.294	0.0475***	0.0698	0.0243**	0.136	0.0533*	14.29	0.0002
Czech Republic	0.251	0.0421***	-0.237	0.111*	0.0639	0.0408	0.0214	0.102	0.11	0.7347
Denmark	0.343	0.0191***	-0.385	0.0411***	0.0597	0.0229**	0.0162	0.0512	0.45	0.504
England/N. Ireland (UK)	0.248	0.0331***	-0.182	0.0755*	0.103	0.0360**	0.138	0.0744	0.36	0.5472
Estonia	0.272	0.0296***	-0.329	0.0679***	0.104	0.0269***	-0.0241	0.0649	1.96	0.1616
Finland	0.244	0.0275***	-0.144	0.0634*	-0.00292	0.0315	0.196	0.0646**	4.16	0.0415
Flanders (B)	0.253	0.0264***	-0.105	0.0603	0.00852	0.0242	0.167	0.0547**	1.3	0.2537
France	0.444	0.0362***	-0.434	0.0732***	0.0110	0.0258	0.170	0.0550**	1.27	0.2592
Germany	0.415	0.0263***	-0.438	0.0635***	0.0881	0.0301**	0.129	0.0688	4.87	0.0273
Ireland	0.422	0.0639***	-0.285	0.149	0.0104	0.0687	0.251	0.164	0.86	0.3537
Italy	0.265	0.0712***	0.0263	0.177	0.0206	0.0442	0.0833	0.107	0.43	0.5115
Japan	0.185	0.0299***	-0.0754	0.0814	0.0489	0.0353	0.182	0.0834*	2.58	0.108
Korea	0.508	0.0630***	-0.572	0.205**	0.0841	0.0549	-0.0375	0.166	0.01	0.9069
Netherlands	0.510	0.0378***	-0.594	0.0831***	-0.00250	0.0406	0.238	0.0804**	9.92	0.0016
Norway	0.239	0.0202***	-0.244	0.0538***	0.0912	0.0271***	0.0327	0.0598	0.26	0.6094
Poland	0.287	0.0353***	-0.0694	0.0901	0.120	0.0282***	-0.0976	0.0771	0.65	0.4197
Slovak Republic	0.167	0.0436***	0.111	0.107	0.164	0.0470***	-0.0954	0.101	0.05	0.8173
Spain	0.376	0.0486***	-0.180	0.127	0.0381	0.0527	0.129	0.126	0.4	0.527
Sweden	0.123	0.0203***	-0.0620	0.0458	0.0266	0.0242	0.131	0.0498**	7.47	0.0063
United States	0.437	0.0637***	-0.370	0.134**	0.0507	0.0531	0.206	0.11	3.97	0.0463

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Source: Author's calculations based on the Survey of Adult Skills (PIAAC, 2012).

OECD Journal: Economic Studies
Volume 2015
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The dynamics of social expenditures over the cycle: A comparison across OECD countries

by
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This paper studies the cyclical behaviour of public social spending in 20 OECD countries observed over the period between 1982 and 2011. In view of the recent discussion on cutting the budget deficit, the paper pays particular attention to whether social spending is pro-cyclical or countercyclical, whether it changes asymmetrically during expansions and recessions and whether the asymmetric changes in social spending contribute to a drift in social expenditures over time. The links between social spending levels and key economic variables, such as economic growth, provide also a useful context for discussing current social expenditure trends. The estimates, based on a system-GMM estimator, suggest that an upward ratchet effect exists. The effect is robust to a large number of alternative specifications.

JEL classification: E32, E62, H50, I00

Keywords: Fiscal policy, economic cycles, social spending, ratchet effect

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The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Introduction

The financial, economic and social crisis has modified in many OECD countries the policy priorities and the contexts where policies were implemented. The crisis has also challenged the financing of social security systems and made the issue of effectiveness of social insurance systems and of redistribution even more important than before. In this landscape, social expenditures are a key variable. In some countries, there is particular urgency to securing additional revenues or finding short-term savings on the expenditure side. In others, the short-term budgetary situation appears sound considering the stage of the economic cycle. In these cases, measures to ensure the sustainability of government spending can arguably devote full attention to long-term structural challenges.

Historically, cuts in benefit expenditures during fiscal consolidation phases have been slow compared with the rapid spending growth during recessions. Recent OECD studies suggest, for example, that across OECD countries, a 10 percentage-point rise in the debt-to-GDP ratio in the previous year was associated with a 0.4% cut in real benefit spending in the past. Annual spending increases in a recession were typically ten times as large (see OECD, 2011; d'Addio et al., 2011).[1]

Addressing these long-term challenges is crucial as the larger part of current deficits is believed to be "structural" rather than "cyclical". In other words, on current policies, governments will still be spending more than they receive in revenues when the recovery is well entrenched (see e.g. Hercowitz and Strawczynski, 2004; 2005; Arze del Granado et al., 2010; Clements et al., 2010, Bontout and Lokajickova, 2013). The aim of the present study is then to test the impact of both cyclical and structural factors on social spending growth patterns.

In view of the recent discussion on cutting the budget deficit, the paper pays particular attention to whether social spending is pro-cyclical or countercyclical and whether it changes asymmetrically during expansions and recessions and whether the asymmetric changes in social spending contribute to a drift in social expenditures over time (i.e. there is a ratchet effect). The links between social spending levels and key economic variables, such as economic growth, provide also a useful context for discussing current social expenditure trends. To do so the paper uses data on (cash) social security benefits in 20 OECD countries over a 30-year period spanning between 1982 and 2011 (see Table A.1 in the appendix). The model is estimated using a system GMM to address endogeneity issues. The results show that an upward ratcheting effect exists, i.e. increases in recessions are not matched by equivalent reductions in expansions leading to increasing social spending over time.

The paper is organised as follows. After a short review of the literature (presented in Section 2) recent trends in social spending are analysed by linking them to developments in demographic and economic variables (Section 3). The econometric methodology is then illustrated in Section 4. Data and variables used are discussed in Section 5. Section 6 presents and discusses the estimation results and Section 7 presents some robustness checks. Some final comments are drawn in Section 8.

2. Review of the literature

Our paper belongs to the literature investigating the links between public spending and economic growth. However, and differently from the majority of studies in this area, it focuses only on public social spending.

The literature relevant to our analysis is built around Wagner's law (Wagner, 1883, 1890) on the one hand and on Keynesian Counter-Cyclical Policy Intervention Theory on the other hand (see Biehl, 1998; Durevall and Henrekson, 2011). According to Wagner (1883) "State expenditure may be higher, in absolute terms and as a percentage of national income" as the national per capita income increases. This "law of expanding public expenditures" is expected to hold over the long term and implies that causation runs from growth in national income to growth in public expenditures. The Keynesian literature, in contrast, generally sees public spending as a variable susceptible to affect economic activity. Thereby public expenditures are not the mere result of national income growth, but can be seen as a tool policy makers may use to correct (short-term) imbalances. Therefore, in this setting, causation runs from public spending growth to income growth. In this respect, Ansari (1993) suggests that the Keynesian formulation may also hold in the long run because public spending in a recession may be directed to finance areas which have a long-lasting impact on growth.

The views supported by Wagner's law and the Keynesian hypothesis have given birth to a large number of studies, both theoretical and empirical. Some have focused on the directions and patterns of causality (Landau, 1983; Ram, 1986, 1987; Sahni and Singh, 1984). Others have looked more closely into long-term relations and in particular on co-integration between the series of public expenditures and national income (Ansari, 1993). Even though Wagner's law was formulated with reference to total public spending, some studies have looked at specific types of social expenditures (e.g. Sahni and Singh, 1984). The results of these studies tend to suggest that different categories of public spending are likely to have different impacts on national income. For example Lindert (1996) highlighted the role of age and income distribution to explain patterns of growth in social spending. However, he found very little support for Wagner's law for some specific disaggregated items of public expenditure.

A number of alternative formulations have been proposed to analyse the link between increases of public spending and of national income. Fabricant (1952) and Brazer (1959) analysed the role played by income, urbanisation, and population density on public spending growth. Later studies have introduced also political variables, such as indicators of party competition, strength of particular parties and the turnout in the elections. Kittel and Obinger (2002), for example, empirically investigated the determinants of social spending including also the impact of parties and institutions. In doing so they discriminated among alternative approaches (e.g. catch-up, new and old politics approaches) using data for 21 OECD countries for the period spanning between 1980 and 1997 and found that "social spending dynamics have been driven by rising dependency ratios as reflected in rising unemployment and population ageing". In contrast, political variables were found to have little explanatory power even though: 1) the strength of conservative parties was significantly and negatively related to social spending increases; and 2) a temporal shift in partisan effects was reported but disappeared in the 1990s which saw an increase of fiscal consolidation efforts.

Studies of government expenditures have been carried out for many OECD countries (e.g. Canada, the United Kingdom, Germany, Italy, Japan, the United States) using either

cross-sectional or time-series data (e.g. Hercowitz and Strawczynski, 2004, 2005; and more recently Barbiero and Cournède, 2013).

The cyclicality of fiscal policy/public spending has been also extensively analysed. Fiscal policy has been shown to differ between developed and developing countries, tending to be pro-cyclical in developing countries and countercyclical or acyclical in industrialised ones (Alesina and Tabellini, 2005). In contrast, Gavin and Perotti (1997) suggested pro-cyclical fiscal policy in Latin America. Kaminsky et al. (2004), Talvi and Végh (2005) and Ilzetzki and Végh (2008) reached the same conclusion for many developing countries.[2] Pro-cyclical fiscal policy is considered as non-optimal both in neo-classical and (New-)Keynesian settings, hence various studies have tried to explain the puzzling result found by empirical investigations.

More recently, a vast literature has bourgeoned around the role of fiscal policies in periods of expansions and recessions (e.g. Baunsgaard and Symansky, 2009, Auerbach and Gorodnichenko, 2012a, b; Ilzetzki et al., 2013; Owyang et al., 2013). The recent evidence on the role of fiscal policy has highlighted that fiscal multipliers tend to be of higher magnitude during recessions because the probability for private demand to be crowded out by expansionary spending is much lower. In this respect, the limited action of monetary policy in an environment characterised by a zero-lower bound on interest rates and the constraints to individual consumption by a very tight access to credit have been reported to matter. International organisations have been very active on this front of research, highlighting the role of fiscal policy during the crisis and the fact that existing macro models consistently underestimated fiscal multipliers.[3]

Some other studies have taken a political economy approach to analyse cyclicality of public spending. This approach allows to account for the pressures of fiscal groups even though some authors have found that the correlation between (pro)cyclicality and the relative strength of political groups is relatively weak (Lane, 2003). Models looking at the role of financial market imperfections, of weak institutions and of demographic factors have also appeared.

2.1. Ratcheting and asymmetries over the cycle

Relevant to the analysis presented in our paper are the variants of Wagner's law as discussed in Peacock and Wiseman (1961) and Bird (1971, 1972). The first study presents the displacement effect hypothesis which suggests that the divergence between the desired level of public spending and taxation limits "*may be narrowed by large-scale social disturbances, such as major wars. Such disturbances may create a displacement effect, shifting public revenues and expenditures to new levels. After the disturbance is over new ideas of tolerable tax levels emerge, and a new plateau of expenditure may be reached, with public expenditures again taking a broadly constant share of gross national product, though a different share from the former one*" (Peacock and Wiseman, 1961). Wars and other social and political upheavals may thus displace tolerable tax rates and hence the level of government expenditures.

Similarly Bird (1971, 1972) provides a critical note to the displacement effect introducing the concept of a ratchet effect. Bird (1971) suggests that during economic downturns, the decline of public expenditures is slower relative to the decline in income per capita and hence public-spending-to-GDP ratios increase. In contrast, during economic upturns the growth in public expenditures is faster than the growth in per capita income. These trends will result in an asymmetric growth of spending to GDP ratios over recessions and

expansions and in particular public expenditures will increase more relative to GDP during economic downturns and will decrease less relative to GDP during expansions (see also Perotti, 1999). Most of this literature, however, has not focused directly on social spending expenditures but rather on total government consumption/spending or primary deficits.[4]

A considerable part of the literature has carefully considered the effects of political influence variables. For example, Tornell and Lane (1999) suggested a voracity effect arising from interactions between several influential groups which may lead to a public deficit during expansionary periods resulting in pro-cyclical fiscal policy. Talvi and Végh (2005) reported that political influences of lobbies to increase public spending may drive declines in tax rates and increases in public spending during upturns.[5] Hercowitz and Strawczynski (2004, 2005) postulated that high tax revenues in expansions make it difficult for governments to resist pressure from interest groups to reduce spending symmetrically. Other factors such as electoral cycles may affect social policy spending.

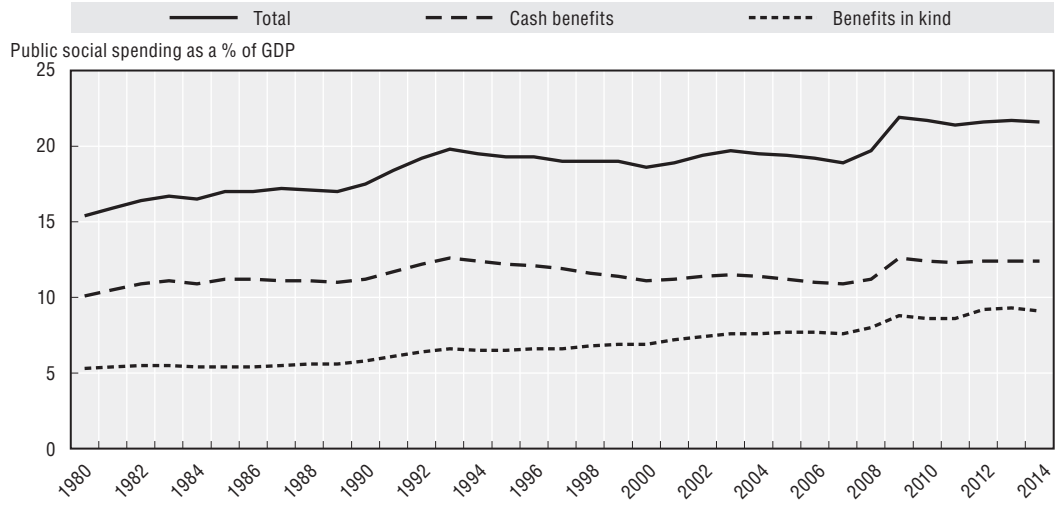
The political unpopularity of cutbacks to programmes that benefit large sectors of the population (pensions, health care, housing, sickness, and unemployment benefits) impose high political costs on incumbent governments. Governments tend then to spread the blame for reforms over a longer period of time. Myles and Pierson (2001) have shown, for example, that the prolonged rise in the government spending/GDP ratio over time in OECD countries may be partially explained by cyclical upward ratcheting due to asymmetric fiscal behaviour. Darby and Melitz (2008) have tested how social security benefits for health, retirement, incapacity, sickness and unemployment responded to the cycle and found that age- and health-related social expenditure, as well as incapacity and sick benefits, all react to the cycle as stabilisers. Potential explanations include pressures to encourage the use of early retirement or disability benefits during recessions. Arze del Granado et al. (2010) examined the cyclicality of health and education spending by allowing for asymmetry during bad and good times. Their results points to acyclicality in developed countries for total expenditures and for health and education in particular (while for developing countries all tend to be pro-cyclical). In addition, the results suggest that in developing countries total expenditures are pro-cyclical in both good and bad times, but more so during good times and that education and health expenditures follow an asymmetric pattern; they are pro-cyclical during good times and acyclical during bad times. A study by Afonso and Jalles (2013) finds evidence of counter cyclicality for social security spending, particularly in OECD countries, consistent with the operation of automatic stabilisers. The same study reports that education and health expenditures tend to be acyclical, a feature which tends to be driven by other structural factors.

Our paper belongs to this stream of literature and, in particular, it builds on Hercowitz and Strawczynski (2004) to investigate possible asymmetries in social spending responsiveness to the business cycle. In doing so it tries to provide answers to several questions: 1) Do countries vary social spending asymmetrically in expansions and recessions? 2) Is there a larger downward change during recessions rather than in expansions? 3) Is there a ratcheting effect in social spending?

3. Trends in social spending

Figure 1 illustrates the evolution of social spending as a percentage of GDP. The chart represents total (which includes both cash and in-kind) public social spending as derived from the *OECD Social Expenditure Database* (SOCX), over the years between 1980 and 2014.[6] These aggregate social spending data suggest that welfare states have expanded over the last 30 years (see Adema et al., 2011). The introduction of new social programmes and their

Figure 1. **Trends of social spending over time, % GDP**



Source: Based on *OECD Social Expenditure (SOCX) Database*, *www.oecd.org/els/social/expenditure* and the *OECD Economic Outlook Database* as in OECD (2014), *OECD Economic Outlook*, No. 96, November 2014, OECD Publishing.

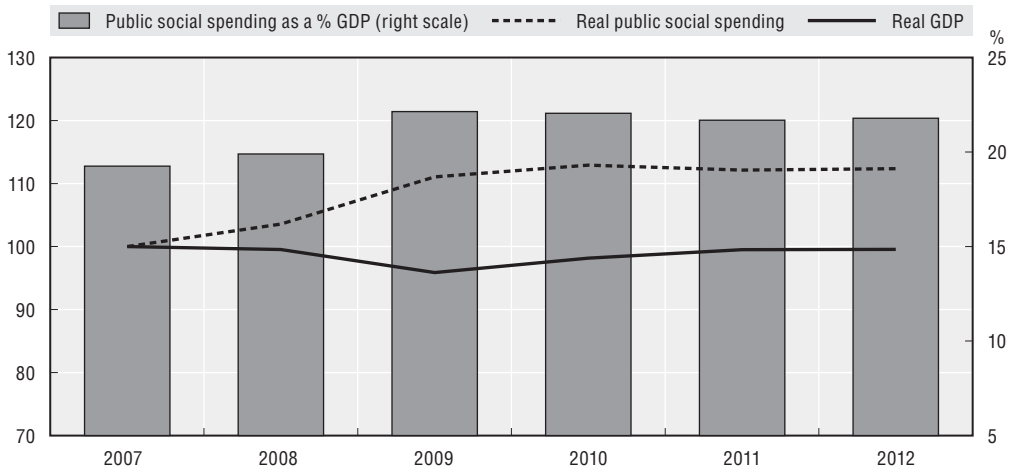
increased generosity were main drivers of this trend in the past (and in particular during the 1960s and 1970s). By contrast, recent increases have been mainly driven by population ageing (which has largely affected health and pension spending) and the crisis that many OECD countries are still experiencing (see also Bontout and Lokajickova, 2013; OECD, 2013).

Over the period of time depicted in Figure 1, public social spending in cash as a percentage of GDP increased by about 3 points while total public social spending (which includes spending on in-kind benefits) increased by more than 6 percentage points. Looking backward, public social expenditures increased by about 3 percentage points after the economic shocks in the early 1980s and 1990s and did not decline strongly afterwards. So far, there is little evidence that this trend will be different in the current crisis. On average across the OECD, total public social spending as a percentage of GDP increased by nearly the same amount over the years 2007-12.

Figure 1 shows increasing trends of public spending to GDP ratios. However it is well known that in an economic downturn, the increase may also be driven by GDP growing or declining. For this reason, Figure 2 depicts trends in public social spending both as a percentage of GDP, and in real terms together with GDP growth over the period 2007-12 using data from the *OECD Social Expenditures Database* (i.e. OECD SOCX). The chart shows that social spending in real terms (adjusted for changes in prices) increased significantly over the period considered. However, the increase was noticeable during the years 2008 and 2009, whereas real social spending has remained broadly constant afterwards. GDP growth shows an opposite trend over the years 2008 to 2009 when it declined significantly and stabilised after 2010.

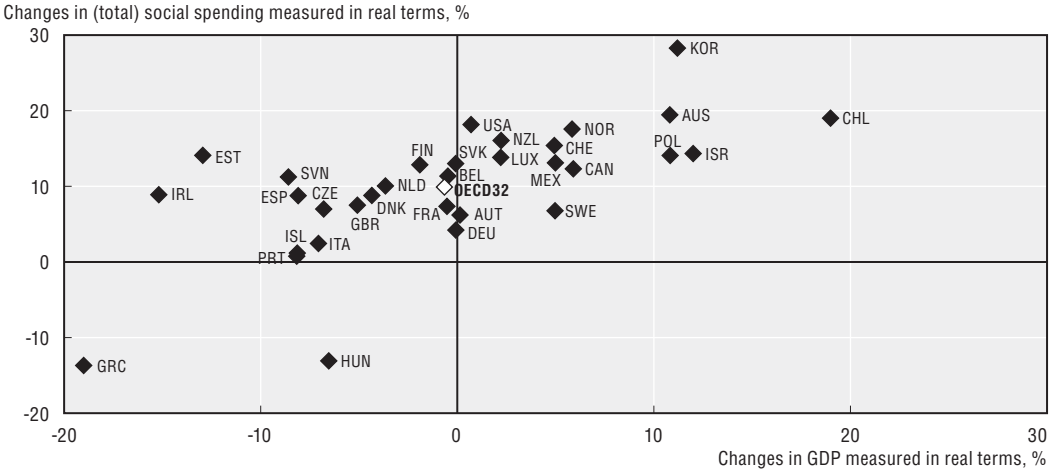
It is well known that averages hide country differences: different country responses are linked for example to the size of the economic shocks on GDP and to the inflation trends over the period 2007-12. Therefore, Figure 3 illustrates the changes in total social spending measured in real terms and the change in GDP in real terms that each OECD country has experienced over the period between 2007/08 and 2011/12. The data suggest that while real social spending has stabilised in most OECD countries, it is falling in Greece, Hungary, Iceland, Ireland and Portugal.

Figure 2. **Social expenditures to GDP ratios, 2007-12**



Source: OECD (2012a), *Social Spending During the Crisis*, Policy Brief, OECD Publishing.

Figure 3. **Trends in real public total social spending and GDP between 2007/08 and 2011/12**



Source: OECD (2013) and *OECD Social Expenditure (SOCX) Database*, *www.oecd.org/els/social/expenditure*.

The greater need for social support, mirrored in the increase in the number of beneficiaries of programmes related to unemployment, old-age and family benefits, has largely driven the increase in cash benefits among the working-age population. However, the timing of spending during the crisis varied across types of benefits:

- Spending on unemployment benefits for unemployment insurance and – to a lesser extent – unemployment assistance as a percentage of GDP rose from an average of 0.7% of GDP in 2007 to 1.1% in 2009. Larger increases are found in southern European countries. The increase was most pronounced in Iceland from 0.3% of GDP in 2008 to 1.7% in 2009, Ireland from 1.4% to 2.6% and Spain from 2.2% to 3.5%.
- Spending on Active Labour Market Programmes (ALMPs) was small in comparison: from 0.5% in 2007 to 0.6% of GDP in 2009.
- Public spending on family cash benefits increased on average by 0.3 percentage points between 2007 and 2009 which corresponds to a 10% increase in real terms. The largest

increases were found in countries with income-tested benefits such as Ireland and the United Kingdom but also in Korea, Greece, Portugal, and Iceland.

- Old-age benefits have also continued to rise in many countries. On average, real spending on old-age cash transfers grew at a rate of 4% per year in the OECD, and increased by 5% in 2010. The increase seems mainly driven by demographic developments rather than by the crisis.

4. The econometric model

4.1. *Cyclicality of spending and asymmetric reactions over the cycle*

To address the issue of interest to the paper, namely cyclicality in public spending, previous studies have used panel data with fixed effects, dynamics or both. The basic equation to estimate is generally written as:

$$\Delta g_{it} = \alpha_i + \varphi y_{it} + \gamma_t + \beta X_{it} + \varepsilon_{it} \quad [1]$$

where Δg is the change is public expenditure (or some sub-categories of public spending), α_i and γ_t are respectively the country-fixed effects and the time effects, φ is the coefficient which captures the degree of cyclicality of public expenditures by measuring the elasticity of the latter with respect to output growth (denoted by y_{it} in equation [1]). When $\varphi > 0$ public spending reacts pro-cyclically to output variations; when $\varphi > 1$ the response of social spending is more than proportionate to output fluctuations and when $\varphi < 0$ public spending responds counter-cyclically to output fluctuations. γ is a time trend capturing shocks common to countries at a given point in time, X_{it} contains a number of structural factors such as population structure, political influence factors and the interest payment on debt. To analyse social spending changes over time, we can use the error correction concept to assume that social spending is "growing to limits" (Flora, 1986). A lagged difference of the dependent variable allows then to check whether the stickiness of social spending matters.

As discussed in the previous section, some recent developments in the literature have shown that the response of public spending is likely to vary in bad and good times, respectively. Public spending may be then seen as an automatic stabiliser and its cyclical behaviour analysed in terms of the output gap.

In this respect, Hercowitz and Strawczynski (2004) define a binary indicator *d* such that

$$d_{it} = \begin{cases} 1 \, if \, \Delta lnY_{it} - \overline{\Delta lnY_{it}} > 0 \\ 0 \, if \, \Delta \ln Y_{it} - \overline{\Delta lnY_{it}} \leq 0 \end{cases} \quad [2a]$$

where $d_{it} = 1$ denoting a phase of expansion and $d_{it} = 0$ a phase of contraction; and the output gap as:

$$(\Delta lnY_{it} - \overline{\Delta lnY_{it}}) \quad [2b]$$

where lnY_{it} denotes the (log) GPD in real terms per capita and $(\overline{\Delta lnY_{it}})$ is the average (log) growth in country *i* over the observation period $t = 1, \ldots, T$.

Expansions and contractions in country *I* are thus identified as deviations of the output growth from the (country-specific) average (log) growth. Using these conventions, we can write the output gap in expansions and contractions, respectively, as:

$$I_t^E = (\Delta lnY_{it})^E = (\Delta lnY_{it} - \overline{\Delta lnY_{it}})(d_{it} = 1) \quad [3]$$

$$I_t^C = (\Delta lnY_{it})^C = \left(\Delta lnY_{it} - \overline{\Delta lnY_{it}}\right)(d_{it} = 0) \quad [4]$$

The relation between social spending and the cycle may then be written in a simple way as follows (see Hercowitz and Strawczynski, 2004):

$$\Delta g_t = \varphi_E I_t^E + \varphi_C I_t^C \quad [5]$$

where Δg_t is the change of social spending between t and t-1 measured in real terms and per capita; φ is the ratcheting coefficient; I^E and I^C were defined in [3] and [4]. As other authors before us, the equation is estimated in first difference rather than in levels because the latter may confound structural and cyclical effects. The specification in first-difference allows also to tackle the issue of (non)stationarity. We also introduce a one-year lag of cyclical variables together with the lag dependent variable to account for dynamic adjustments such that:

$$\Delta g_t = \alpha_i + \varphi_{11} I_t^E + \varphi_{12} I_{t-1}^E + \varphi_{21} I_t^C + \varphi_{22} I_{t-1}^C + \lambda \Delta g_{t-1} \varepsilon_{it} \quad [6]$$

where the ratcheting coefficient is defined as $\varphi = \varphi_E - \varphi_C = (\varphi_{11} + \varphi_{12}) - (\varphi_{21} + \varphi_{22})$. Allowing the elasticity of social spending to the output gap to be different in periods of economic downturns and upturns makes it possible to analyse both cyclicality and (a)symmetric reactions of public social spending.

Starting with cyclicality, if $\varphi_E = \varphi_C = \varphi$ and φ = 0 variations in social spending are unrelated to the cycle; by contrast when φ ≠ 0 they are related to the economic cycle. In particular: i) when φ > 0, social spending is mainly pro-cyclical with *g* increasing during expansions and decreasing during contractions; and ii) when φ < 0 social spending is mainly countercyclical. A so-called "ratchet-type" effect exists in public social expenditures when fluctuations in output growth are accompanied by more than proportionate increases in social spending. With respect to asymmetric behaviours, they arise when $\varphi_E \neq \varphi_C$.

The introduction of some explanatory variables in equation [6] deemed to affect public social spending growth over time, allows to write the following equation:

$$\Delta g_t = \alpha_i + \varphi_{11} I_t^E + \varphi_{12} I_{t-1}^E + \varphi_{21} I_t^C + \varphi_{22} I_{t-1}^C + \gamma \Delta g_{i,t-1} + \beta X_{it} + \varepsilon_{it} \quad [7]$$

4.2. Timing of adjustments

As Figures 1 to 3 suggest, public social spending has increased steadily in the OECD until the early 90s when it started declining to bounce back again around the period 2008-09 (see also Figure A.1 in the appendix for country-specific trends). Equation [6] may be then estimated allowing for different specifications of timing effects. We use first a dummy variable which distinguishes between four sub-periods: the first going from the year 1980 to 1990; the second going from the year 1991 to 2000, the third spanning between the years 2001 and 2006, and the last covering the years between 2007 and the end of the observation period. This nonparametric time trend, introduces more flexibility compared with a linear trend, which rests on the assumption of identical annual differences represented by the uniform slope coefficient of the time trend.

We also allow for timing effects determined by a temporal dummy capturing the effect of norms and (fiscal) rules which may have driven the (downward) adjustment process of public social spending in some OECD countries. To do so, we use a dummy variable (SGP_{it} or a_{it}) equal to $\begin{cases} 1 if\ t_i \geq t \\ 0 if\ t_i < 0 \end{cases}$ where t_i is the time at which the Stability and Growth Pact became binding in country *i*.

We also specify a model accounting for the interactions between a_{it} and expansions and contractions defined above in equations [3] and [4]. This new indicator w is such that:

$$w_{11} = (d_{it} = 1 \;\&\; a_{it} = 1); w_{10} = (d_{it} = 1 \;\&\; a_{it} = 0); \quad [8a]$$

$$w_{01} = (d_{it} = 0 \;\&\; a_{it} = 1); w_{00} = (d_{it} = 0 \;\&\; a_{it} = 0); \quad [8b]$$

With these new terms, we can write the following equation:

$$\Delta g_t = \alpha_i + \varphi_{11} I_t^E + \varphi_{12} I_{t-1}^E + \varphi_{21} I_t^C + \varphi_{22} I_{t-1}^C + \sum_{a=0,1;d=0,1} w_{a,d} + \gamma \Delta g_{i,t-1} + \varepsilon_{it} \quad [9]$$

A natural starting point of the analysis would be to estimate equations [6], [7] and [9] via a standard fixed-effects (FE) estimator. However, this estimation method would deliver unbiased estimates of the cyclicality of fiscal policy only if GDP were exogenous with respect to fiscal policy (see on this Arze del Granado et al., 2010). One source of endogeneity may be related to reverse causality as public social spending may affect economic output directly or indirectly. For example, fiscal policy may influence people's economic well-being and thereby also productivity or aggregate output (and GDP growth). Fiscal policy may also directly affect economic output (e.g. Ilzetzki and Végh, 2008). In these cases, the FE estimates would overstate the causal effect of growth on social spending. Endogeneity needs therefore to be addressed.

Consistent with some of the previous literature, we use an instrumental-variable estimator in the form of a System-Generalised Method of Moments (SYS-GMM) proposed by Blundell and Bond (2000) where the second and third lags of potentially endogenous variables (i.e. the real output and the lagged dependent variable) are used as an instrument for their current value (e.g. Lane, 2003; Galí and Perotti, 2003; Arze del Granado et al., 2010).

5. The variables and the data

The analysis uses macro data collected from different sources over a 30-year period spanning between the years 1982 and 2011 for 20 OECD countries.[7] Because cyclical variations in the sample are of utmost importance, we have decided to use social security cash benefits in real terms per capita and not as a ratio to GDP. The series is extracted from the *OECD Social Expenditures Database* (SOCX). The (log) real total social spending per capita in cash in first difference is thus the dependent variable.[8]

Different indicators of the output gap are built and subsequently used to identify phases of contractions and expansions as in Hercowitz and Strawczynski (2004).[9] First, we use the deviation of the output growth from its (country-specific) average over the observation period and based on it we identify phases of expansions and contractions as in equations [3] and [4]. Second, we use the deviations of the output growth from its country-specific MA(5) over the observation period and use it again to identify phases of contractions and expansions according to equations [3] and [4].[10] Third, we identify phases of contraction and expansion with a negative and a positive output growth, respectively. Data on output growth are extracted from the latest *OECD Economic Outlook Database* (see OECD, 2014). Figure A.1 in the Appendix illustrates trends of these variables over the observation period.

To identify phases of recessions and contractions, we use an additional indicator that we have built using the information on monthly recessions contained in the *OECD Composite Leading Indicators Database*. The indicator takes the value of 1 when 24 months of economic contraction are observed in a specific country and 0 otherwise.[11]

To control for some of the factors that may affect the composition and levels of (public) social spending over time we use various variable. First, we include in the regression the change in the (ln) share of children (aged between 0 and 14 years) and older people (aged 65 and over) in the total population (i.e. the dependency ratio). In countries relatively young, expenditures on education or on family benefits may be more important in relative terms than old-age benefits. These data are based on population estimates carried out by the United Nations (United Nations, 2013).

Second, we control for the influence of variations in the employment rates of women. Today, in OECD countries more than 60% of women aged 15-64 are in the labour market. In the last forty years, the female participation rate has increased by approximately 17 percentage points: from 45% in 1960 to more than 60% in 2013. In contrast, labour-market participation of men has declined by 3 percentage points on average over the same period. Women's participation in the labour market has become even more important in the light of population ageing. However, the literature has demonstrated that this relation depends on the welfare state regime. Higher labour-market participation of women may imply higher costs for family policies; for example in many northern European countries women have their place in the labour market so that the welfare state is both cash and service intensive to help them to combine family and work lives (Huber and Stephens, 2001). Higher female employment may ease the funding of the rising costs of welfare state expenditures, in particular the cost of pensions. Increased participation of women in the labour market may, therefore, have altered both the supply and demand of the welfare state.

We also test the sensitivity of our results to the inclusion of unemployment among the explanatory variables. However, given the strong relation between unemployment and the cycle (see Figure A.2 in the appendix), the Hodrick-Prescott country-specific trend of unemployment is used in the regressions. Labour market variables are derived from the *OECD Labour Market Indicators Database*. Finally, to capture the effect of borrowing constraints on public spending, we use the interest payment on debt which is derived from the *OECD Economic Outlook Database*.

Descriptive statistics of the variables are reported in Table A.2 in the appendix. Table A.3 reports precise sources and other information on the variables used.

It has become a standard practice in studies with time-series data to test for stationarity/unit roots in the relevant series to avoid spurious results. We adopt this approach here using first and second generation unit root tests for panel data in addition to the standard ADF test. The first generation panel unit root tests employed in this study are the Im-Pesaran-Shin (IPS) (2003) and the Maddala-Wu (1999) tests, respectively. The second generation test applied here are the Pesaran (2007) and Fischer-type Choi (2001) tests. The main difference between the two generations of tests lies in the cross-sectional independence assumption. Thus, while the first generation tests assume that all cross-sections are independent, the second-generation tests relax this assumption. The latter is then more useful for countries with similar characteristics as those belonging to the OECD. Results of the tests are reported in the appendix (Table A.4) and suggest that the hypothesis of a unit root can globally be rejected for the variables used in the analysis.

6. Discussion of the results

Table 1 below presents the coefficient estimates derived from the estimation of equation [6] by a one-step System-GMM estimator with robust standard errors (Blundell

Table 1. **Estimates of the basic specification**

	(1) MA(5)	(2) AVG	(3) GG
Output gap in times of expansions (φ_{11})	-0.506	-0.583	-0.542
	[0.183]***	[0.175]***	[0.249]**
L.(output gap in times of expansions) (φ_{12})	0.565	0.593	0.551
	[0.239]**	[0.166]**	[0.269]*
Output gap in times of contractions (φ_{21})	-1.084	-0.917	-0.876
	[0.203]***	[0.269]***	[0.148]***
L.(output gap in times of contractions) (φ_{22})	0.159	0.181	0.229
	[0.208]	[0.257]	[0.160]
L.(ΔTotal Public social spending cash)	0.204	0.214	0.218
	[0.051]***	[0.057]***	[0.055]***
Hansen p-value	0.87	0.89	0.93
AR(1)	0.01	0.01	0.02
AR(2)	0.27	0.33	0.33
N	600	600	600

Note: The models are estimated by one-step robust System GMM. The dependent variable is the first-differenced (ln) total public social expenditure in cash (in real terms and per capita) derived from the *OECD SOCX Database* for the period 1982-2011. The different columns present estimates associated to different definitions of the output gap used subsequently to define phases of contraction and expansion as in Hercowitz and Strawczynski (2004). In column (1) the output gap is defined as the deviation of the output growth from its MA(5) computed over the observation period in each country. In column (2) the output gap is defined as the deviation of the output growth from its average over the entire period of observation in each country. In column (3), we use a more restrictive definition of bad and good times, i.e. bad times display a negative output growth, while good times are periods of positive growth. Robust heteroskedastic–consistent standard errors are reported in brackets below each coefficient estimate. The Hansen test reported evaluates the validity of the instruments. AR(1) and AR(2) are the Arellano-Bond tests for first and second order auto-correlation. The constant and a linear time trend are estimated but are not reported in the table for parsimony; significance-levels. *, **, *** denote significance at the 10, 5 and 1% level, respectively.
Source: Author's calculation based on data described in Section 5.

and Bond, 2000).[12] The different columns of the table present the estimates obtained with alternative specification of the "cycle" indicator. In column (1) the output gap is defined as the deviation of the output growth from its country-specific moving average of order 5 [MA(5)]. In column (2) the output gap is defined as the deviation of the output growth from its average over the entire period of observation in each country. In column (3), we use a more restrictive definition of bad and good times, i.e. bad times are periods of a negative output growth, while good times are periods of positive growth.

Despite the different specifications of output gap and of expansions and contractions, coefficient estimates are stable. The values reported for AR(1) and AR(2) are the p-values for first and second-order autocorrelated disturbances in the first-differenced equation. These values suggest first-order autocorrelation and no evidence for significant second-order autocorrelation which points to a correct specification. Finally the Hansen test does not reject the validity of the instruments based on the second and third lags of potentially endogenous variables (i.e. output growth and the lagged values of the dependent variable). We have decided to retain the specification with output gap defined in terms of the deviation of output growth from its MA(5) (column 1) which, given the length of the observation period, might help to minimise measurement errors. Figure A.3 in the appendix illustrates trends for the latter variable and for the first-differenced (ln) total public social expenditure in cash (in real terms and per capita) which is the dependent variable.

The estimation shows a number of interesting features. First, the sum of coefficients during expansions ($\varphi_E = \varphi_{11} + \varphi_{12}$) is positive even though very close to zero. The negative sign of φ_{11} suggests a counter-cyclical fiscal policy. However this effect is more than offset

by the positive value of the coefficient φ_{12} in most specifications in line with the voracity hypothesis by Tornell and Lane (1999). Second, the estimated $\varphi_c = \varphi_{21} + \varphi_{22}$ is negative which suggests counter-cyclical fiscal policy in recessions. Third, the comparison of φ_{11} and φ_{21} indicates that despite its counter-cyclical behaviour, social spending reacts more strongly in periods of recession than expansion: the increase in recession periods is not offset by the reduction in periods of expansion. Estimates of φ_{12} and φ_{22} also suggest that increases tend to be slightly larger during period of expansion, while reductions (though not statistically significant) are likely to be weaker in periods of recession.

As discussed previously, ratcheting occurs if $\varphi_E \neq \varphi_C$ or in other words if $\varphi_E - \varphi_C \neq 0$ — which is the case for all specifications estimated. The coefficient estimates also suggest a very asymmetric cyclical pattern. The statistical significant coefficients on recessions is 1.084 in column (1), while the sum of the statistical significant coefficients on expansions is 0.051, which being relatively small implies that social spending per capita remains nearly constant after an expansion. Increases of public spending are thus generated by a ratchet-type effect: public spending on social benefits increases faster during recessions while it remains nearly constant during expansions as in Hercowitz and Straczwynski (2004).

Table 2 presents the estimates obtained allowing for differential path of adjustments of public social spending over time. A first specification uses period dummies as defined in Section 4.2, a second specification uses a dummy variable (also defined in Section 4.2) capturing the possible effect of the Stability and Growth Pact (SGP) on public social spending. The estimation of the specification including the latter variable is carried out on two different samples: a sample made by all countries (column 2) and a sample which only includes the European OECD countries where the SGP was binding (column 3). In both cases, the parameters' estimates suggest a downward adjustment of public spending taking place, as the estimates in column 1 suggests, in the most recent periods. Indeed, increases in public social spending have been smaller over time.

Concerning φ the conclusions are similar to those gathered from the analysis of Table 1. The cyclical pattern is again very asymmetric and there is an upward ratchet effect because larger spending during recessions is not offset by similar large reductions during expansions.

Table 3 displays the results when interactions between the timing effects and the cycle are included as in equation [9]. In columns (1) and (2) we interact the SGP dummy (defined in Section 4.2) with the indicator of the cycle used in Table 2. In contrast, in columns (3) and (4) we interact the SGP dummy with the indicator of protracted/short contractions built with monthly information on recessions gathered from the OECD *Composite Leading Indicators Database*. Columns (1) and (3) display the results based on the whole sample. Columns (2) and (4) display instead the estimates based on a sample which only includes the European OECD countries where the SGP was binding. The coefficient estimates are relatively stable across all the specifications estimated. However, the interactions with indicators for expansions and contractions do not deliver any statistical significant result for the full sample and will not be retained. In the "partial" sample, estimates in column 4 suggest instead that downward adjustments of public spending have mainly occurred when the SGP was binding both in expansions and recessions.

A final piece of the analysis accounts for some of the factors which may affect public social spending over time. Estimates are reported in Table 4 and are based on equation [7] estimated with a (one-step) system-GMM estimator using second and third lags of

Table 2. **Estimates with timing adjustment without interactions with the cycle**

	All countries with period dummies (1)	Entire sample (2)	Sample with selected countries (3)
Output gap in times of expansions (φ_{11})	-0.437	-0.629	-0.639
	[0.165]***	[0.170]***	[0.225]***
L.(output gap in times of expansions) (φ_{12})	0.687	0.582	0.654
	[0.354]*	[0.269]*	[0.407]*
Output gap in times of contractions (φ_{21})	-1.178	-0.968	-0.834
	[0.189]***	[0.205]***	[0.252]***
L.(output gap in times of contractions) (φ_{22})	0.191	0.165	0.146
	[0.190]	[0.203]	[0.167]
L.(ΔTotal Public social spending cash)	0.216	0.212	0.128
	[0.053]***	[0.052]***	[0.074]*
Time dummies: Reference is the period between 2007 and 2011			
1st period (1980-1990)	0.014		
	[0.004]***		
2nd period (1991-2000)	0.009		
	[0.003]***		
3rd period (2001-2006)	0.008		
	[0.003]***		
Adjustment dummy SGP		-0.015	-0.008
		[0.005]***	[0.003]**
Hansen p-value	0.85	0.84	0.87
AR(1)	0.01	0.01	0.02
AR(2)	0.20	0.20	0.50
N	600	600	330
P-value ($\varphi \neq 0$)	0.01	0.04	0.03

Note: The models are estimated by one-Step robust System GMM. The dependent variable is the first-differenced (ln) total public social expenditure in cash (in real terms and per capita) derived from the *OECD SOCX Database* for the period 1982-2011. The specification uses a definition of output gap based on the deviations of the output growth from its MA(5) over the observation period in each country. Column (1) specifies timing adjustments as period dummies, while columns (2) and (3) use a dummy variable equal to one when the Stability and Growth Pact (SGP) is binding and 0 otherwise in a specific country. The estimation of the specification including the SGP dummy variable is carried out on two different samples: a sample made by all countries (column 2) and a sample which only includes the European OECD countries where the SGP was binding (column 3). Robust heteroskedastic–consistent standard errors are reported in brackets below each coefficient estimate. The Hansen test reported evaluates the validity of the instruments. AR(1) and AR(2) are the Arellano-Bond test for first and second order auto-correlation. The constant is estimated but not reported in the table for parsimony; significance-levels. *, **, *** denote significance at the 10, 5 and 1% level, respectively.
Source: Author's calculation based on data described in Section 5.

endogenous variables as instruments (see Roodman, 2008). In addition to GDP and the lagged dependent variables, other variables are considered among the potentially endogenous variables, such as the employment rate of women. Indeed, labour-market participation of women may have a favourable impact on social spending by easing the funding of other social expenditures, such as those for pensions. At the same time, social spending may make it easier for women to participate in the labour market by allowing them to combine work and family life.

Starting with population structure, social spending is likely to grow as the share of children and older people grows because public spending related to child and family benefits on the one hand and on old-age on the other hand are likely to increase. The coefficient has the expected sign even though it is not statistically significant. Turning now to female employment, its coefficient is associated with a declining rate of (public) social spending. This result is very important because it implies that macroeconomic gains may

Table 3. **Results with cyclical effects and timing adjustments (equation [9])**

	Entire sample (1)	Sample with selected countries (2)	Entire sample (3)	Sample with selected countries (4)
Output gap in times of expansions (φ_{11})	-0.592	-0.356	-0.533	-0.492
	[0.375]	[0.491]	[0.275]*	[0.183]***
L.(output gap in times of expansions) (φ_{12})	0.379	0.538	0.559	0.244
	[0.371]	[0.473]	[0.449]	[0.332]
Output gap in times of contractions (φ_{21})	-0.942	-0.711	-0.783	-0.893
	[0.234]***	[0.275]***	[0.235]***	[0.226]***
L.(output gap in times of contractions) (φ_{22})	0.066	0.090	0.094	0.027
	[0.221]	[0.188]	[0.192]	[0.214]
Timing effects interacted with the cycle:				
SGP not binding, expansion/short contractions (w_{01})	0.003	0.001	-0.014	-0.024
	[0.010]	[0.010]	[0.011]	[0.014]
SGP binding, contraction/protracted contractions (w_{10})	-0.008	-0.000	-0.012	-0.024
	[0.008]	[0.007]	[0.008]	[0.012]**
SGP binding, expansion/short contractions (w_{11})	-0.017	-0.013	-0.017	-0.026
	[0.009]	[0.011]	[0.009]*	[0.009]***
L.(Δ.Total public social spending cash)	0.216	0.152	0.125	0.204
	[0.051]***	[0.069]**	[0.067]*	[0.048]***
Hansen p-value	0.85	0.88	0.78	0.81
AR(1)	0.00	0.02	0.02	0.03
AR(2)	0.23	0.53	0.25	0.59
N	600	330	600	330

Note: The models are estimated by one-step robust System GMM. The dependent variable is the first differenced (ln) total public social expenditure in cash (in real terms and per capita) derived from the *OECD SOCX Database* for the period 1982-2011. The different columns display results obtained when interactions between the timing effects and the cycle are included on two different samples. Columns (1) and (3) display the results based on the sample of all countries. Columns (3) and (4) display instead the estimates based on a sample which only includes the European OECD countries where the SGP was binding. In columns (1) and (2) we interact the SGP dummy (which is equal to one when the Stability and Growth Pact (SGP) is binding in a specific country and 0 otherwise) with the cycle indicator defined in terms of deviation of the output growth from its MA(5). In columns (3) and (4) we interact the SGP dummy with the indicator of protracted/short contractions built with monthly information on recessions gathered from the OECD *Composite Leading Indicators Database*. Periods of protracted recessions are defined as periods with recessions lasting for at least 24 months. Periods of short recessions/expansions are the complement of the former indicator. Robust heteroskedastic–consistent standard errors are reported in brackets below each coefficient estimate. The Hansen test reported evaluates the validity of the instruments. AR(1) and AR(2) are the Arellano-Bond test for first and second order auto-correlation. The constant is estimated but not reported in the table for parsimony; significance-levels. *, **, *** denote significance at the 10, 5 and 1% level, respectively.
Source: Author's calculation based on data described in Section 5.

be expected from policies aimed at increasing gender equity in the labour market (see also OECD, 2012b). For example, Aguirre et al. (2012) – expressing the GDP of a given country as a function of its labour productivity, the annual average of working hours per employed person, the employment rate and the share of the working-age population in the total population (which they refer to as the "youth dividend") – suggest that equalising female to male labour-force participation rates would result in a net increase of GDP between a low of 2-3% in Denmark and Sweden to a high of 27-34% in India and Egypt. Increases of 4-6% are reported for France, Germany, the United States, the United Kingdom and Spain; in Japan such an equalisation would increase GDP by 9%.

The sign on the lagged interest rate on public debt suggests that a decline in interest rates over time may favour social spending increases. Finally estimates of the lagged dependent variable are statistically significant and lower than 1 which is necessary for the stationarity condition to be satisfied.

Table 4. **Estimates of the "Full-specification"**

	Coefficients
Output gap in times of expansions (φ_{11})	-0.542
	[0.214]**
L.(output gap in times of expansions) (φ_{12})	0.303
	[0.169]**
Output gap in times of contractions (φ_{21})	-0.688
	[0.297]**
L.(output gap in times of contractions) (φ_{22})	0.017
	[0.242]
Δ.(Ln) Share of children and older people in the population	0.293
	[0.279]
L.(Interest on public debt)	0.014
	[0.004]***
Δ.(Ln)Female employment rate	-0.099
	[0.055]*
L.(Δ.Total public social spending cash)	0.300
φ (Ratcheting coefficient)	0.449
Hansen p-value	0.74
AR(1)	0.01
AR(2)	0.67
Number of observations	540

Note: The models are estimated by one-step robust System GMM. The dependent variable is the first-differenced (ln) total public social expenditure in cash (in real terms and per capita) derived from the *OECD SOCX Database* for the period 1982-2011.The output gap is defined in terms of deviation of output growth from its country-specific MA(5) computed over the observation period. Robust heteroskedastic–consistent standard errors are reported in brackets below each coefficient estimate. The Hansen test reported evaluates the validity of the instruments. AR(1) and AR(2) are the Arellano-Bond test for first and second order auto-correlation. The constant is estimated but not reported in the table for parsimony; significance-levels. *, **, *** denote significance at the 10, 5 and 1% level, respectively.
Source: Author's calculation based on data described in Section 5.

The estimates presented in Table 4 are used to compute predictions (in and out of sample) and are illustrated together with the actual values of the dependent variable, in Figure A.3 in the Appendix. The predictions calculated using these estimates provide generally a good fit with respect to actual values. The tendency to increase during recessions and of almost no decline during expansions results in cyclical ratcheting of public social spending.[13]

7. Robustness checks

A number of robustness checks have been performed. Estimates have been replicated for two sub-periods: before and after 1997. Moreover the total public social spending in real terms per capita, including cash and in-kind benefits has been used as the dependent variable (rather than the social security spending in cash). Finally, the Hodrick-Prescott unemployment trend has been used among the explanatory variables rather than the female employment rates.

- The first sets of results for the two sub-periods (before and after 1997) are displayed in columns (1) and (2) of Table 5. These results suggest that the distinction between the two sub-periods does not alter the conclusion of the paper. However, the smaller size of the samples affects the precision of the estimates and thereby their statistical significance.
- The second set of results (with the total public social expenditures as the dependent variable) is shown in column (3) of Table 5. In this case the counter-cyclical effect found

in times of expansion is not offset by a significant lagged positive value. Moreover, the counter cyclical reaction of social spending in recessions is smaller than what was reported in Table 3. These estimates then lead to a much smaller ratchet-type effect of total public social spending suggesting that cyclical reactions are likely to depend essentially also on the composition of public spending (see Afonso and Jalles, 2013).

- Finally, in column (4) which introduces the HP filtered trend of unemployment, the cyclical effects are of similar magnitude to those presented in Table 3. Predictions based on these estimates are also reported in Figure A.4 in the appendix.

Table 5. **Robustness checks**

	Before 1997 (1)	After 1997 (2)	Dependent variable: Total public social expenditures (cash and in-kind) (3)	(4)
Output gap in times of expansions (φ_{11})	-0.239	-0.342	-0.422	-0.426
	[0.460]	[0.201]*	[0.178]**	[0.215]**
L.(output gap in times of expansions) (φ_{12})	0.384	0.382	0.164	0.363
	[0.480]	[0.258]*	[0.132]	[0.263]*
Output gap in times of contractions (φ_{21})	-0.676	-0.519	-0.535	-0.651
	[0.516]	[0.386]*	[0.175]***	[0.302]**
L.(output gap in times of contractions) (φ_{22})	0.120	0.144	-0.117	0.053
	[0.686]	[0.192]	[0.155]	[0.212]
Δ.(Ln) Share of children and older people in the population	0.084	0.575	0.028	0.121
	[0.278]	[0.426]	[0.142]	[0.310]
L.(Interest on public debt)	0.042	0.011	0.006	0.014
	[0.023]**	[0.003]***	[0.004]	[0.004]***
Δ.(Ln)Female employment rate	-0.214	-0.272	-0.069	
	[0.254]	[0.158]*	[0.081]	
Δ.(Ln)Unemployment				0.115
				[0.040]***
L.(Δ.Total public social spending cash)	0.315	0.272	0.283	0.267
	[0.076]***	[0.160]*	[0.047]***	[0.059]***
Hansen p-value	0.95	0.91	0.94	0.87
AR(1)	0.02	0.01	0.04	0.03
AR(2)	0.56	0.68	0.25	0.94
N	240	300	540	537

Note: The models are estimated by one-step robust System GMM. The dependent variable in columns (1), (2) and (4) is the first-differenced (Ln) total public social expenditure in cash (in real terms and per capita). In column (3), the dependent variable is instead the first-differenced (Ln) total public social expenditures (in real terms and per capita) including both cash and in-kind benefits. Both are derived from the *OECD SOCX Database* for the period 1982-2011. Results in columns (1) and (2) refer to two sub-periods: before and after 1997. Finally, the Hodrick-Prescott unemployment trend has been used among the explanatory variables rather than the female employment rates for the estimates displayed in column (4). Robust heteroskedastic–consistent standard errors are reported in parenthesis below each coefficient estimate. The Hansen test reported evaluates the validity of the instruments. AR(1) and AR(2) are the Arellano-Bond tests for first and second order auto-correlation. The constant and time effects are estimated but not reported in the table for parsimony; significance-levels. *, **, *** denote significance at the 10, 5 and 1% level, respectively.
Source: Author's calculation based on data described in Section 5.

8. Conclusions

The analysis presented in this paper suggests that (1) public social spending in cash tends to increase steadily during periods of recession; and that (2) such increases are not counter-balanced by "equivalent" reductions during periods of expansion. This eventually leads to social spending displaying ratcheting behaviour implying real-term increases of social benefit spending compared with previous years, in spite of high deficits in most countries and very high debt levels in some.

As the estimates suggest, some variables are likely to influence significantly the path of social spending growth over time. For example, higher female labour-market participation may contribute to GDP growth, and is also likely to significantly contribute to containing social spending over time. Therefore countries may obtain macroeconomic gains if they allow higher gender equity in the labour market which might result in increased female labour-market participation. Moreover, high unemployment significantly affects patterns of social spending growth over time.

Even though social spending increases observed since 2008 result, to a large extent, from greater use of existing benefits and services, increasing joblessness also creates political pressures for governments to strengthen and adapt support policies, especially in countries where automatic stabilisers are less powerful. A severe downturn with far-reaching changes in labour-market conditions and earnings opportunities can produce individual risks that existing support systems were not designed to address. And large increases in the number of people facing such risks can expose structural deficiencies of social protection that are less apparent when economic conditions are favourable (e.g. a lack of benefit coverage for non-standard workers).

Since the onset of the crisis, the structure and adequacy of income replacement benefits have received increased attention, but social spending is more than an income-smoother. First, government transfers in cash or in kind do not only cushion cyclical income fluctuations, but are a major determining factor of long-term trends in inequality and poverty. Discussions of their appropriate role should therefore recognise concerns about observed trends towards more unequal societies. Second, some, but not all, areas of social protection have a distinct investment character, with evidence that shows attractive payoffs in later periods. For a balanced debate about fiscal consolidation strategies and a possible realignment of spending priorities, there is a need to properly account for future benefits of social programmes (or, equivalently, for future costs associated with programme cuts) and, more generally, for the efficiency of public spending.

Social expenditures bring important benefits, helping to protect people from the risk of poverty and providing them with the means to access basic services, adequate pensions and health protection. By doing so, social spending enhances people's opportunities to participate in the market, contributing thereby to increasing a country's aggregate demand. However, public social spending is made up of many heterogeneous variables, such as transfers for retirement or illness, unemployment benefits, family services, active labour-market policies and health expenditure. Each of these components is important for the economic development of a country and one of the aggregates which depends more closely on the economic situation of a country. A clear limitation of the paper is the use of aggregate social-security benefits (cash and in-kind). Distinguishing among the different components of social spending with future releases of the *OECD Social Expenditures Database* (SOCX) might help to fill this knowledge gap.[14]

Notes

1. Expenditures on services and in-kind benefits are not considered in these results.
2. See also Backus et al. (1995) and Talvi and Végh (2000).
3. See for example Fatas and Mihov, 2012; Furceri, 2010; Baum et al., 2012, Blanchard and Leigh, 2013; Végh and Vuletin, 2014. See also Cournède et al. (2013).

4. Furceri is an exception as he analyses more particularly the role of social spending as stabiliser (see Furceri, 2010).
5. Other reasons for pro-cyclical fiscal policies are identified in Alesina et al. (2008); Ilzetzki (2011); Calderón and Schmidt-Hebbel (2005) and Frankel et al. (2013).
6. This section draws on OECD (2013).
7. The countries included in the analysis are Australia, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Portugal, Sweden and the United States. However the estimates will be used to generate out-of sample predictions also for the other OECD countries.
8. For robustness checks, estimates based on the total public social spending (including both cash and in-kind benefits) extracted from the same database are also presented.
9. To avoid imposing particular parametrisations on the cycle we do not use (despite its usefulness) the output gap published by the OECD. See Koske and Pain (2008); Giorno et al. (1995); Tosetto (2008), Richardson et al. (2000) and Ollivaud and Turner (2014).
10. We thank one of the referees for this suggestion.
11. We thank one of the referees for this suggestion.
12. The models have also been estimated with a two-step robust system-GMM. The estimates are of the same magnitude and maintain their statistical significance. For example, the coefficient on the output gap in times of expansion corresponding to specification shown in column (1) is – with the sys-GMM estimated in two-steps – equal to -0.498 [SE 0.269]; the parameter φ_{21} is instead -0.979 [SE 0.481].
13. The Pesaran (2004) test for cross-section dependences does not allow to reject the null of cross section independence with a p-value of 0.945.
14. See Adema et al. (2011).

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APPENDIX

Tables and Figures

Table A.1. **Patterns of data observed over time**

Country code		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AUS	Australia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
BEL	Belgium	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CAN	Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CHE	Switzerland	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DEU	Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DNK	Denmark	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ESP	Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
FIN	Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
FRA	France	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
GBR	United Kingdom	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
GRC	Greece	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IRL	Ireland	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ITA	Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
JPN	Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LUX	Luxembourg	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NLD	Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NZL	New Zealand	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PRT	Portugal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SWE	Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
USA	United States	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total		11	11	17	18	18	19	19	19	19	19	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

Source: Author's calculation based on data described in Section 5.

Table A.2. **Descriptive statistics**

	Variable	N	Mean	Std. Dev.	Min.	Max.
1	Ln (Social security spending, cash per capita in real terms)	540	8.13	0.403	6.716	9.238
2	Ln (Social security spending cash and in-kind, per capita in real terms)	540	8.65	0.407	7.033	9.712
3	Ln (GDP per capita in real terms)	540	10.34	0.284	9.520	11.202
4	Growth rate of GDP	540	0.025	0.025	-0.089	0.113
5	Average growth rate over the observation period	540	0.024	0.007	0.013	0.044
6	MA(5) of growth rate over the observation period	540	0.024	0.017	-0.062	0.099
7	Indicator of short contractions/expansion (less than 24 months of contractions)	540	0.613	0.488	0.000	1.000
8	Indicator of protracted contractions (24 months of continued contraction)	540	0.387	0.488	0.000	1.000
9	Unemployment rate	539	0.075	0.034	0.104	0.214
10	Female employment rate	540	0.571	0.113	0.258	0.810
11	Share of people aged 0-14 and 65 and over in the total population	540	0.498	0.032	0.430	0.608
12	Interest on public debt	540	0.061	0.044	0.001	0.249
13	GAP1: Deviation from average growth	540	0.001	0.024	-0.108	0.069
14	GAP2: OECD output gap	478	0.001	0.028	-0.100	0.095
15	GAP3: Deviation from MA(5) growth	540	0.000	0.017	-0.089	0.052

Source: Author's calculation based on data described in Section 5.

Table A.3. **Sources of data**

	Variable	Source of data	Further information
1	Ln (Social security spending, cash per capita in real terms)	*OECD SOCX Database*	*http://dotstat.oecd.org/Index.aspx?DataSetCode=SOCX_AGG*
2	Ln (Social security spending cash and in-kind, per capita in real terms)	*OECD SOCX Database*	*http://dotstat.oecd.org/Index.aspx?DataSetCode=SOCX_AGG*
3	Ln (GDP per capita in real terms)	*OECD Economic Outlook Database*	Latest version No. 96 OECD (2014), *http://dotstat.oecd.org/inventory.aspx?datasetcode=EO96_OUTLOOK96*
4	Growth rate of GDP	*OECD Economic Outlook Database*	Latest version No. 96 OECD (2014), *http://dotstat.oecd.org/inventory.aspx?datasetcode=EO96_OUTLOOK96*
7/8	Indicator of short contractions/expansion and of protracted contractions	Based on the monthly indicator of recession from the *OECD Composite Leading Indicators Database*	*www.oecd.org/std/leading-indicators/41629509.pdf*
9	Unemployment rate	*OECD Labour Market Indicators Database*	*http://dotstat.oecd.org/Index.aspx?DataSetCode=LFS_SEXAGE_I_R*
10	Female employment rate	*OECD Labour Market Indicators Database*	*http://dotstat.oecd.org/Index.aspx?DataSetCode=LFS_SEXAGE_I_R*
11	Share of people aged 0-14 and 65 and over in the total population	United Nations	*http://esa.un.org/wpp/ASCII-Data/DISK_NAVIGATION_ASCII.htm*
12	Interest on public debt	*OECD Economic Outlook Database*	Latest version No. 96 OECD (2014), *http://dotstat.oecd.org/inventory.aspx?datasetcode=EO96_OUTLOOK96*
14	GAP2: Output gap	*OECD Economic Outlook Database*	Latest version No. 96 OECD (2014), *http://dotstat.oecd.org/inventory.aspx?datasetcode=EO96_OUTLOOK96*

Table A.4. **Results of the unit roots tests**

	Fischer-type Choi (2001), Modified Inverse Chi-squared		Im-Pesaran-Shin (2003), IPS		(A) Maddala and Wu (1999) Panel Unit Root test (MW)	(B) Pesaran (2007) CIPS test
D.Ln (Public social spending cash)	8.9764	(0.0012)	-2.2365	(0.0013)	-6.662 (0.00)	275.772 (0.00)
D.Ln (Public social spending, total)	9.6764	(0.0079)	-2.1028	(0.0017)	-6.366 (0.00)	281.816 (0.00)
D.Lngdp	7.5235	(0.0032)	-2.3452	(0.0094)	-3.848 (0.00)	251.88 (0.00)

Note: P-values in parenthesis. For Choi's (2001) test, the statistic reported is the modified inverse chi-squared. Under the null, all panels contain unit roots. MW test assumes cross-section independence. CIPS test assumes cross-section dependence is in the form of a single unobserved common factor. All the tests allow to reject the null of a unit root in the variables.
Source: Author's calculation based on data described in Section 5.

Figure A.1. **Output gap, different definitions**

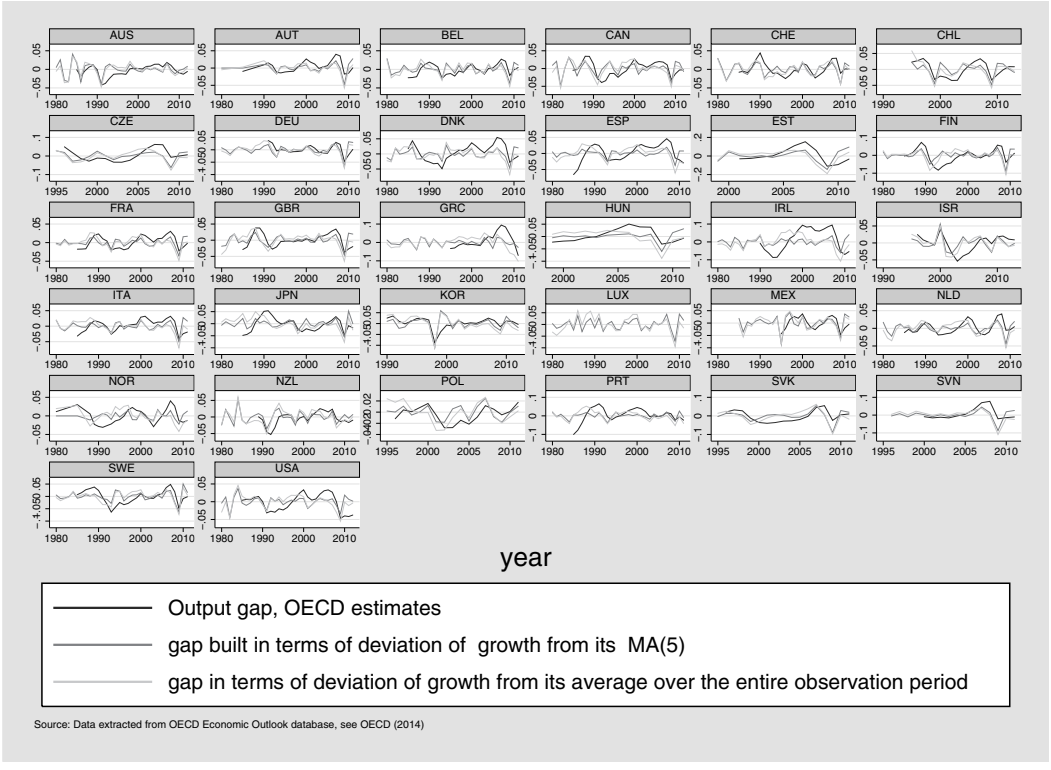
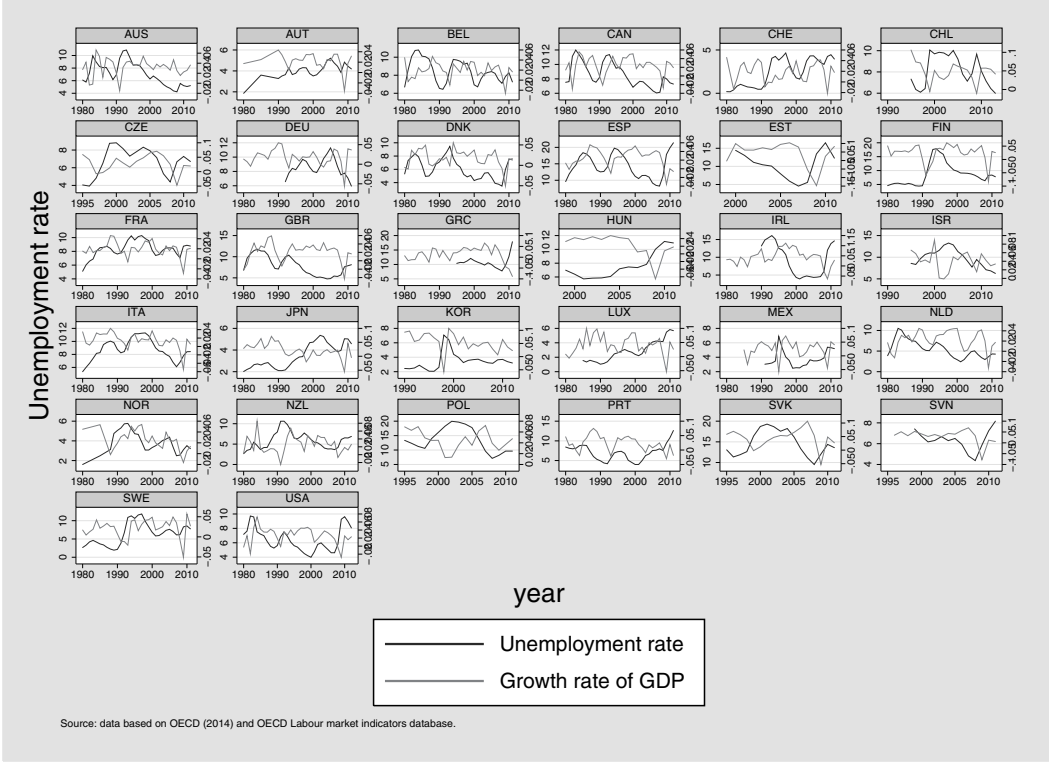
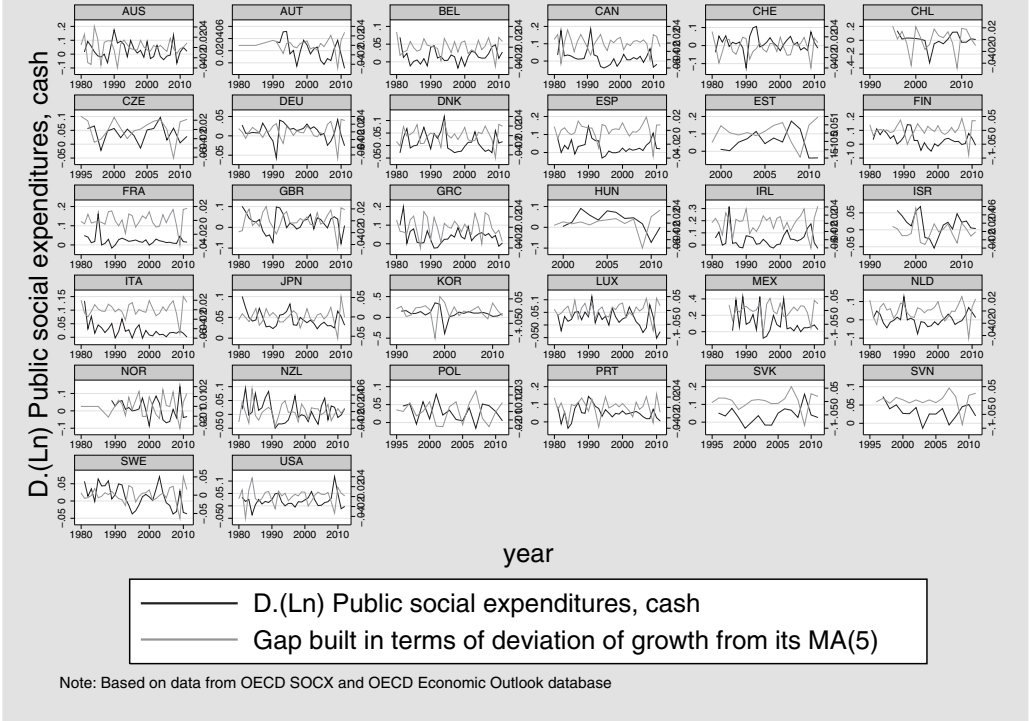


Figure A.2. **GDP growth and unemployment**



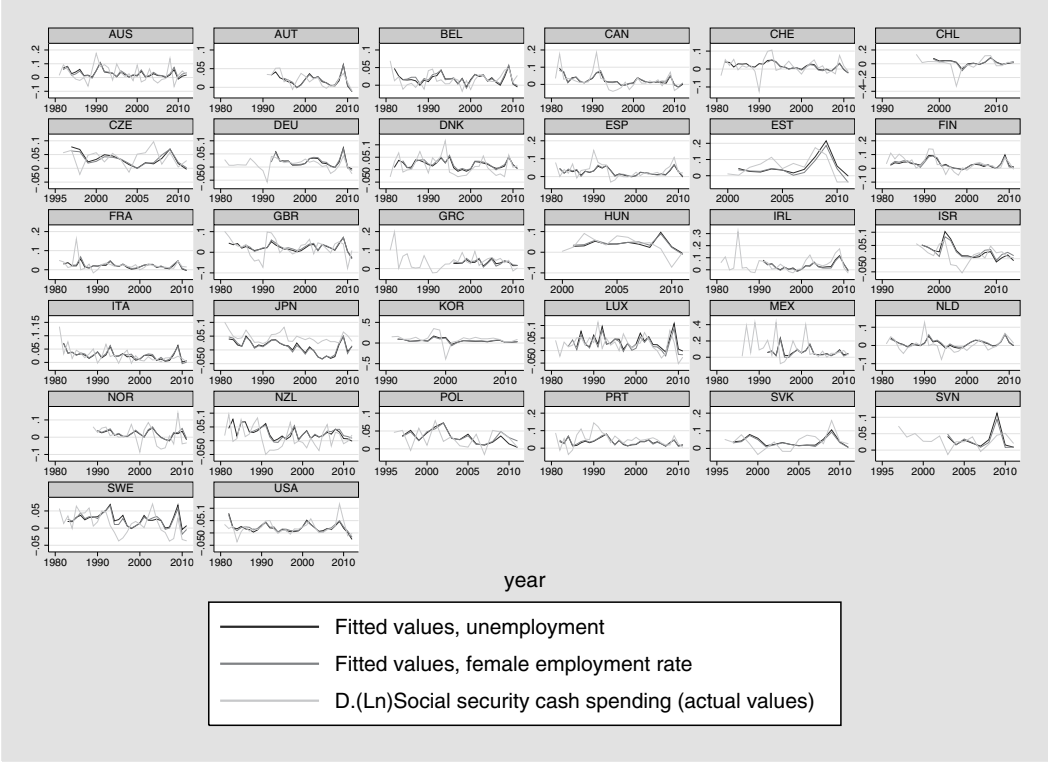
Source: data based on OECD (2014) and OECD Labour market indicators database.

Figure A.3. **Output gap and public social spending trends over time**



Note: Based on data from OECD SOCX and OECD Economic Outlook database

Figure A.4. **Actual and fitted values**



Source: Predictions based on estimates reported in Table 4 and column (4) of Table 5.

OECD Journal: Economic Studies
Volume 2015
© OECD 2015

Effects of economic policies on microeconomic volatility

by
Boris Cournède, Paula Garda *and* Volker Ziemann*

Economic policies shape how much people earn, as well as how stable their income and jobs are. The level and stability of earnings both matter for well-being. Standard economic aggregates do not measure accurately the economic uncertainty which households are facing. This paper shows that household-level economic instability is only very loosely related to macroeconomic volatility. It uses several household-level databases to document how structural reforms aimed at boosting growth influence household-level economic stability. Movement from less to more productive processes and firms is at the heart of economic growth, which suggests a trade-off between growth and micro-level stability. Certain policy changes boost growth but increase micro-level instability: they include reductions in tax progressivity or social transfers (including unemployment benefits), as well as moves from very to moderately tight restrictions on the flow of goods and services and on the firing of regular workers. However, the analysis also uncovers that moving to highly competitive policies in general reduces micro-level instability. This finding points to a case for comprehensive rather than marginal reform in tightly regulated countries, since a comprehensive agenda can deliver higher growth without the instability costs that a more marginal reform can entail.

JEL classification: D12, D22, J08, O40

Keywords: Stability, households, economic growth, reforms, microdata

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1. Introduction and conclusions

In the wake of the recent crisis, side-effects of growth-enhancing policies on other dimensions of well-being have been at the forefront of OECD analysis. An important dimension is the effect of growth-enhancing policies on economic volatility, which recent studies have assessed at the macroeconomic level (Sutherland et al., 2012; Ziemann, 2013; Sutherland and Hoeller, 2013). From a welfare perspective, volatility at the level of individual workers or households is even more relevant. The present paper investigates how microeconomic volatility, defined as job and firm turnover rates as well as fluctuations of earnings and income at the individual or household level, relates to macroeconomic volatility and growth, and how it is affected by economic policies and labour-market institutions.

The main findings are:

- Income volatility at the microeconomic level exceeds income volatility at the macroeconomic level as predicted by the law of large numbers. More surprisingly, microeconomic and macroeconomic income volatility seem to be uncorrelated across countries.
- Microeconomic income volatility tends to be lower in countries where income is more evenly distributed, partly because policies such as the tax and benefit system reduce both inequality and volatility of income.
- Firm turnover can reflect reallocation processes, which underpin economic growth. Firm turnover is in general greater in countries with lower levels of employment protection for permanent workers, better contract enforcement and lower public ownership.
- Microeconomic income volatility is driven by changes in jobs (including into or out of employment), working time or hourly earnings. As for firms, such volatility is not necessarily bad as it can reflect a more dynamic labour market with more job opportunities and higher social mobility. However, not all workers benefit from more dynamic labour markets, and especially displaced workers during recessions tend to suffer from long-term earnings losses.
- Empirical investigations yield the following results:
  - Relaxing employment protection legislation (EPL) for regular workers from high to moderate levels generally increases microeconomic volatility.[1] In contrast, reforms leading to very competitive settings can be expected to reduce volatility.
  - Easing product-market regulation (PMR) shows similar effects: microeconomic volatility typically increases when reform results in moderately tight settings and decreases when moving to very competitive settings.
  - Centralised and decentralised wage-bargaining systems reduce microeconomic earnings volatility while intermediate, sector-level arrangements tend to lead to higher microeconomic volatility.

- ❖ Higher replacement rates of unemployment benefits are associated with greater short-term volatility of individual earnings. This suggests that more generous unemployment insurance facilitates risk taking in the labour market, which can ease labour reallocation and boost growth.
- ❖ More spending on active labour market policies reduces gross worker flows, presumably by improving the matching process in hiring.

- Large changes in individual labour earnings are strongly attenuated in household disposable income.
  - ❖ Taxes are key levers in dampening the transmission of large changes in labour earnings to household disposable income.
  - ❖ Cash social transfers also reduce the transmission of shocks from labour earnings to household disposable income, but to a lesser extent.
- The "protection mechanisms" against large declines in labour earnings vary considerably across countries.
  - ❖ Taxes and transfers are as important shock absorbers as income of other family members in the Nordic countries.
  - ❖ Earnings from other family members are the most important smoothing source in southern European countries.
- Growth-enhancing reforms appear to bring countries closer to the maximum level of growth that has been observed across countries for a given level of volatility. In other words, growth-enhancing reforms can ensure that microeconomic volatility is not "wasted" and instead used to generate growth. This effect has been identified for expanding active labour market programmes, reducing employment protection for regular workers and lowering unemployment insurance replacement rates.

The remainder of this paper is organised as follows. Section 2 discusses the links between microeconomic volatility, growth and welfare, while Section 3 proposes a framework to identify different channels through which economic policies can influence volatility. Section 4 presents the data and measures of microeconomic volatility used throughout the study. Section 5 investigates the links between different indicators of microeconomic volatility and economic policies. Finally, Section 6 sheds some light on the trade-off between growth and volatility and how it is affected by economic policies.

2. Why is microeconomic volatility important?

Risk aversion implies that consumption uncertainty, as measured by the volatility of the unpredictable part of consumption (Jurado et al., 2015), reduces welfare. Due to the absence of comprehensive and harmonised micro-level consumption data over time and across countries, individual and household income data are used to proxy microeconomic volatility. Caution is therefore warranted when drawing policy prescriptions from the relationships found in the present study, due to possible influences of some policies (e.g. financial regulation) on the link between consumption and income volatility (Box 1).

Complex correlation patterns across individual earnings and consumption profiles drive a wedge between macroeconomic and microeconomic volatility. Consequently, macroeconomic volatility cannot accurately measure welfare-related volatility. As predicted by the law of large numbers, real disposable income volatility at the macroeconomic level is always much lower than average real disposable income volatility at the household

Box 1. **Consumption and income volatility**

It is well established that income and consumption changes are very strongly linked (Hall and Mishkin, 1982; Carroll and Summers, 1991; Dogra and Gorbachev, 2014). In theory, the pass-through of earning or income shocks to consumption mainly depends on the nature of the shock and the scope of insurance markets. Compared with transitory shocks, persistent income changes have been found to have substantially stronger effects on consumption (Hall and Mishkin, 1982) and life satisfaction (Bayer and Juessen, 2015). Unfortunately, the individual and household income data used throughout the study do not allow distinguishing across covered countries between i) transitory and persistent, ii) anticipated and unanticipated or iii) insurable and uninsurable income shocks. In practice, consumption volatility is found to be lower than income volatility but little if any research documents their correlation across time and countries. Dogra and Gorbachev (2014) find that both move together across different population groups in the United States.

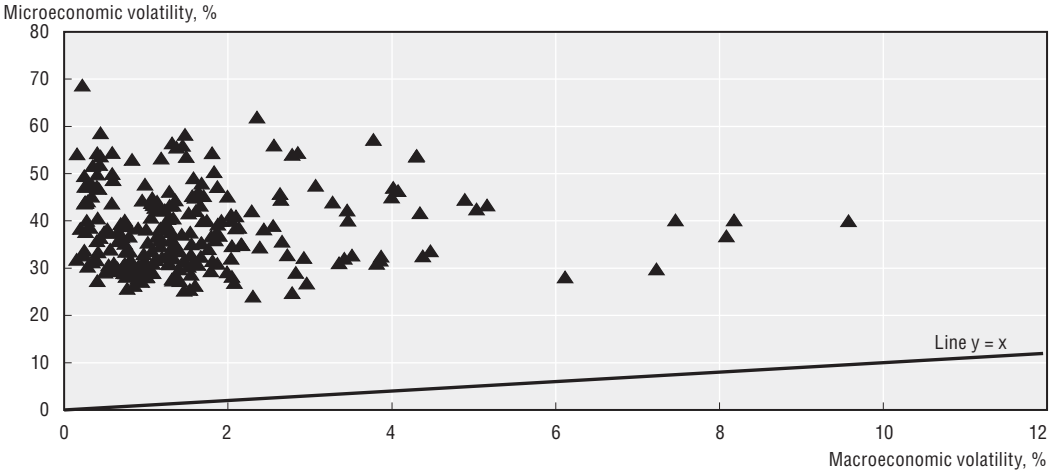
Workers' perceptions of unforeseeable labour-market events are central to many personal economic decisions. Both pleasant surprises, like getting a promotion, or a raise; and disappointments, such as job loss, health shocks, etc. are central to many personal economic decisions, as these risks are hard to insure. Hence, understanding the nature of earnings or income risk is by itself important. Feigenbaum and Li (2015) document that unpredictable income changes massively increased in the United States over 1971-2007. Moreover, Jappelli and Pistaferri (2010) show that if financial market arrangements and liquidity constraints are binding, even changes in income that are predictable can have significant effects on consumption.

level (Figure 1). By far most of micro-level volatility comes from macro-level sources (Caballero et al., 1997). However, complex correlation patterns across individuals mean that there is no clear mapping from macro to micro-level volatility. Indeed, the data underpinning this study show no correlation between micro- and macro-level volatility (Figure 1).

The volatility of household-level disposable income growth takes large values because many households experience large changes in their incomes. In a typical year over the 1994-2010 period, one-third of households living in OECD countries saw their disposable income change by more than one-third. This strong income variability at the micro level reflects the multiplicity of events that can generate large changes in earnings such as when one household member becomes unemployed, takes up a job, goes on unpaid parental leave, restarts work afterwards, goes part-time, retrains or stops working temporarily when the household moves to a different location.

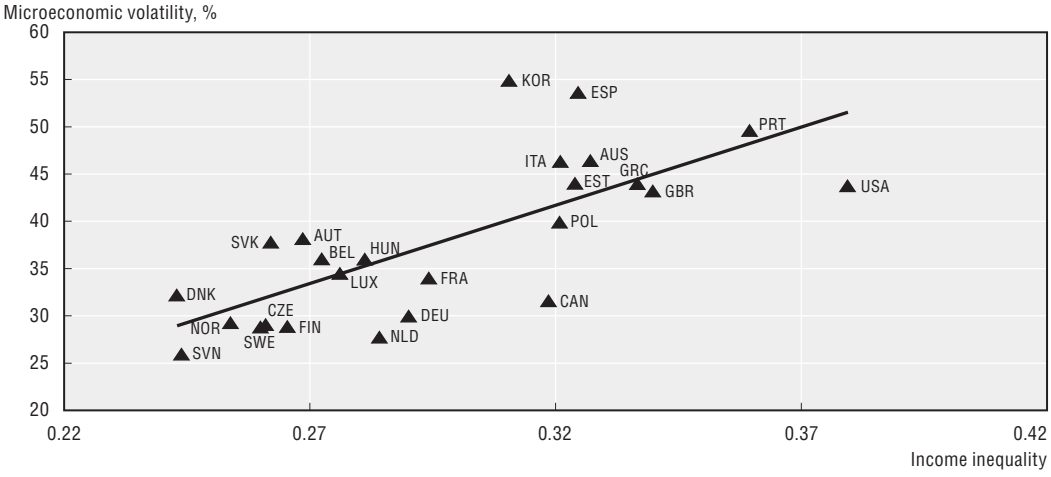
Income inequality across people and volatility for each person both reduce household welfare. The reason is that the additional utility from one extra unit of income decreases with the level of income. On the one hand, countries that have low income inequality tend to have experienced low microeconomic income volatility (Figure 2). This link may partly be due to policies such as taxes and transfers, which reduce both inequality and volatility. Furthermore, more compressed earnings distributions reduce the extent to which income can rise or fall in the face of individual shocks or opportunities. On the other hand, greater microeconomic volatility, if it reflects greater mobility of workers, might also exert an equalising effect on earnings cumulated over 10 or 20 years (Chapter 4 in OECD, 2015).

Figure 1. **Macroeconomic volatility is much lower than microeconomic volatility**



Note: Each observation represents a country at a specific year for the period 1994-2010. Microeconomic volatility is measured by the cross-sectional standard deviation of disposable income growth across households in a given country. See Box 2 in Section 4.1 for a presentation of micro-level volatility measures. Macroeconomic volatility is calculated as the 3-year rolling-window standard deviation of real disposable income growth measured in the national accounts.
Source: CNEF, SILC and ECHP for household income at the individual level and *OECD National Accounts* for aggregate disposable income.

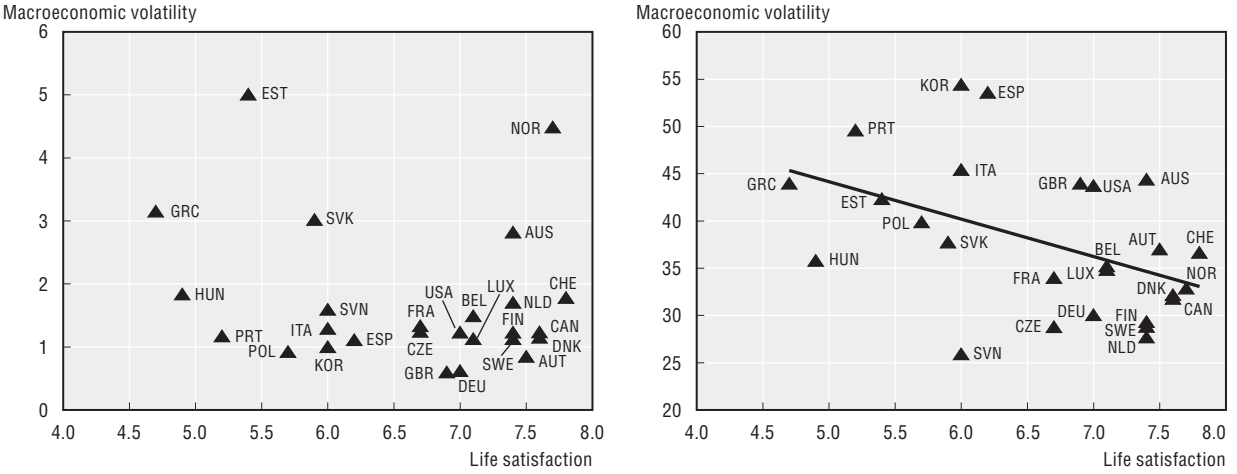
Figure 2. **Microeconomic volatility and income inequality are positively related**



Note: Microeconomic volatility (in %) is the cross-sectional standard deviation of disposable income growth across households in each country. Figures represent averages for the period 2005-10. See Box 2 in Section 4.1 for a presentation of volatility measures and Section A.2 in Appendix A, for further details and a discussion of the distribution of income changes. Income inequality is measured by the Gini index of household disposable income. The Gini coefficient ranges from 0 (perfect equality) to 1 (one individual receives all of the income and the others none).
Source: CNEF, SILC and OECD Income distribution dataset.

Data about well-being suggest that household-level volatility matters in practice. The OECD gathers survey-based indicators of well-being (OECD, 2013). Figure 3 suggests that disposable income volatility at the household level is indeed negatively correlated with self-reported life satisfaction (right panel), while macroeconomic volatility of disposable income growth is not (left panel).

Figure 3. **Life satisfaction and micro-level volatility are negatively correlated**



Note: Microeconomic volatility is measured by the average of the cross-sectional standard deviation of disposable income growth across households at the country level between 2005 and 2010. See Box 2 in Section 4.1 for a detailed description of volatility measures. Macroeconomic volatility refers to the 3-year rolling window of the standard deviation of real disposable income growth as measured by the national accounts at the aggregate level.
Source: *OECD Better Life Index*, *OECD National Accounts* and Household income data from CNEF and SILC.

3. What role do economic policies play?

This section proposes a simple framework to assess how economic policies and labour market institutions shape the relationship between growth and volatility at the micro level. This framework does so by following the channels through which changes in economic conditions affect consumption growth and volatility (Box 2).

The framework only lays out the marginal impacts of output volatility on earnings, consumption and welfare and takes all other determinants as exogenous. This simplicity comes at the cost of potential biases. Individual welfare, for instance, is also driven by leisure, health and environmental factors that may themselves be affected by the economic policies and institutions investigated. These effects lie outside the scope of the present analysis.

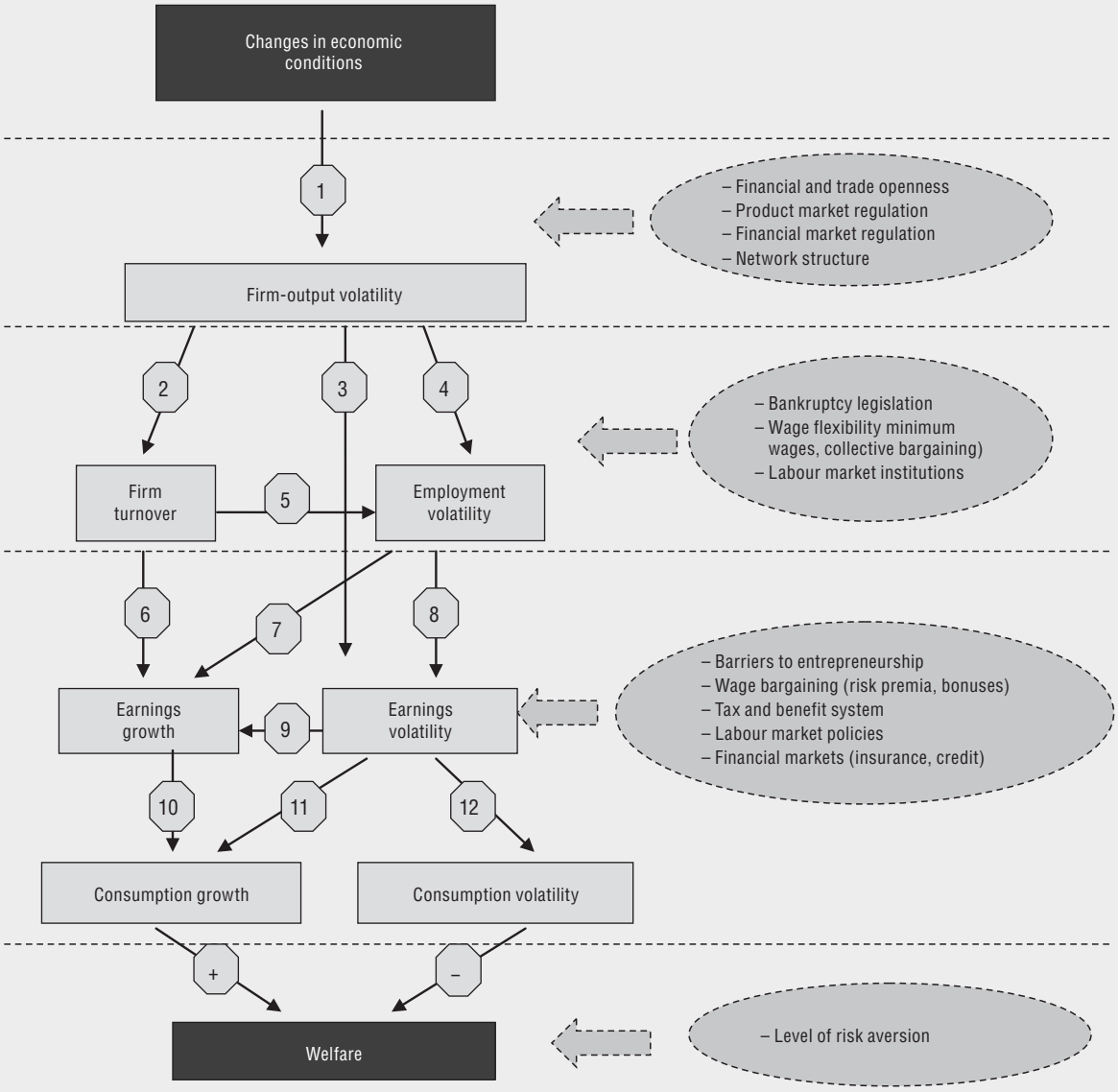
3.1. The likelihood and extent of changes in economic conditions

Changes in economic conditions are not necessarily related to macroeconomic shocks; they can occur at the level of households, firms, sectors, countries or the global economy. Institutional features and policies can shape the likelihood of experiencing exogenous or endogenous changes.

At the country level, financial development and the size of the financial sector may come at the cost of greater vulnerability. Indeed, financial deregulation induces greater risk-taking in the financial sector which often creates negative externalities on other sectors through more volatile credit growth and a higher probability of financial turmoil and credit crunches (Korinek and Kreamer, 2013; Sutherland et al., 2012). Similarly, Brunnermeier and Sannikov (2014) show that a large and innovative financial sector can lead to the paradoxical situation where instruments meant to better manage risks and diversify idiosyncratic risk may actually increase systemic risks and volatility.

At the firm level, product market deregulation and other innovation-enhancing policies such as R&D subsidies are likely to prompt productivity changes (Comin and Mulani, 2009;

Box 2. **Transmission of volatility and related policies**



1. Changes in economic conditions inside and outside firms affect the production process and profitability.
2. Change in production and profits encourages firms to enter or forces some to exit the market.
3. Firms adjust wages in response to the change in production (intensive margin).
4. Firms adjust employment in response to the change in production and profits (extensive margin).
5. Firm entry (exit) creates (destroys) jobs.
6. Firm turnover permits creative destruction and reallocation (boosting productivity and earnings) but can also destroy physical and human capital (reducing productivity and earnings).
7. Employment volatility can enable social mobility and reallocation but may also imply hysteresis effects.
8. Employment and hours fluctuations translate into earnings fluctuations.
9. Precautionary savings raise potential growth (long run), risk premium for uncertain earnings (short run).

Box 2. **Transmission of volatility and related policies** *(cont.)*

10. Earnings directly affect consumption via the inter-temporal budget constraint. The tax and benefit system also has a direct impact.
11. Precautionary savings lower consumption growth (or level) in the short run.
12. Income smoothing (taxes and transfers) and consumption smoothing (partial insurance, credit, endowment), other sources of income (capital, family, housing) may smooth or exacerbate fluctuations.

Aghion and Griffith, 2008). Trade openness exposes firms to external sources of risk (Vannoorenberghe, 2012).

The extent to which a change in economic conditions raises firm-level output volatility depends, *inter alia*, on its nature (demand vs. supply, transitory vs. permanent, positive vs. negative, macro vs. micro), its size and characteristics of the firm. For instance, demand shocks are likely to modify output, while cost-push shocks, depending on the wage and price elasticity of demand, may partly be absorbed by adjustments in wages and prices. The size and expected duration of the change in economic conditions also matter. Small transitory demand changes may be smoothed by inventory changes. Better inventory management has indeed been identified as one of the main microeconomic drivers of the decline in aggregate output volatility prior to the Great Recession (Davis and Kahn, 2008). Moreover, greater financial development in principle helps individual firms to smooth transitory shocks, but aggregate financial over-extension can also increase macroeconomic volatility (Sutherland et al., 2012).

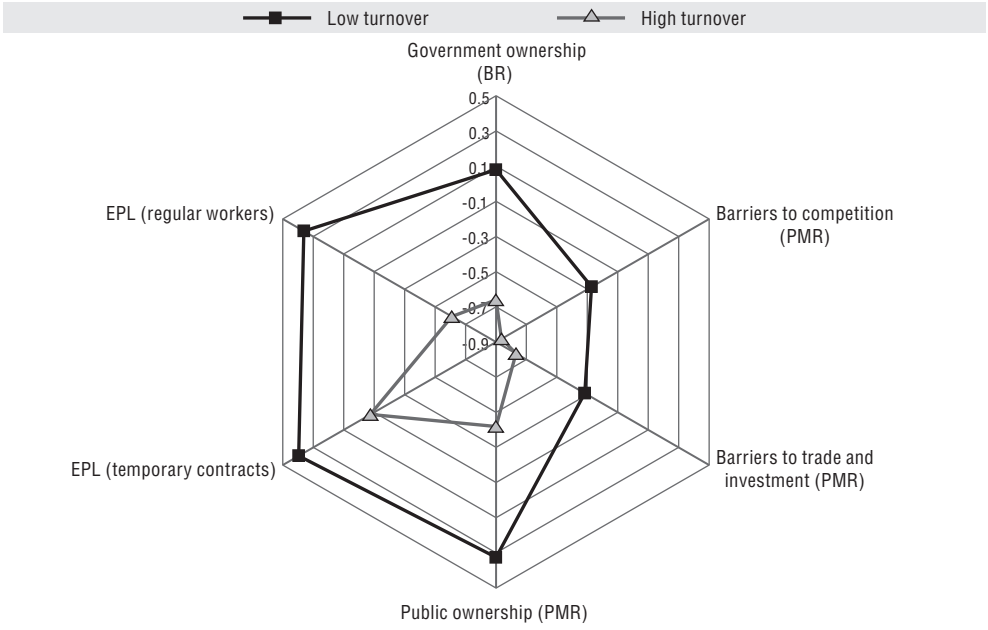
The transmission of volatility throughout the economy also depends on the structure of firm and customer networks (Acemoglu et al., 2012). Carvalho and Gabaix (2013) show how output changes in large interconnected firms can propagate through the network and affect other firms, and thus volatility. On the other hand, Kelly et al. (2013) illustrate that big firms with a well-diversified network of customers are less affected by idiosyncratic demand changes. Trade openness, by increasing export exposure, permits greater international diversification (Buch et al., 2009).

3.2. Firm turnover

Once a change in economic conditions affects firm production processes, several adjustments can occur. The change can prompt some firms to exit the market while encouraging others to enter it. While high firm turnover can be interpreted as a sign of instability, it may also reflect adaptability in reallocating resources from non-viable to high-growth firms, known as creative destruction. Endogenous growth models pioneered by Aghion and Howitt (1992) illustrate how creative destruction can raise an economy's growth potential.

Policies and institutions are an integral part of the environment within which firms operate and they can help them to cope with volatility and uncertainty. Figure 4 indicates that regulatory constraints seem to influence firm entry and exit rates (hereafter referred to as firm turnover rates). Greater public ownership is associated with lower firm turnover rates. Finally, barriers to competition and barriers to trade and investment are also associated with lower firm turnover as they protect incumbent firms and also lead to lower risk-taking.

Figure 4. **Regulatory settings differ between countries with high and low firm turnover**



Note: Countries have been separated in two groups depending on their turnover rate. Low turnover-rate countries are DEU, DNK, FRA, LUX, NOR and SVN and high turnover-rate countries are FIN, GBR, IRL, ITA and NLD. The indicators are standardised to have OECD-wide zero mean and a standard deviation of one. Zero indicates the average across the OECD area, which can differ from the average across the 11 countries covered, for which data about firm turnover are available. Government ownership of banks is taken from de Serres et al., 2006. EPL stands for employment protection legislation, taken from OECD databases. Barriers to competition, barriers to trade and investment and public ownership are taken from the OECD databases of product market regulation (PMR).
Source: Gross firm turnover rates for 11 European countries between 2003 and 2007 from Bartelsman et al. (2013).

Stringent employment protection lowers firm turnover and is negatively associated with the size of high-risk innovative sectors, as high firing costs reduce the expected value of risky innovations and induce firms to stick with less productive but better known technologies (Bartelsman et al., 2013). In addition, the related high exit costs lower the productivity threshold below which firms exit the market, which not only increases the dispersion of productivity across firms but also lowers average productivity. Similarly, Poschke (2009) shows that too-stringent employment protection impedes labour reallocation, discourages entry of firms but also delays exit of unproductive firms and thereby lowers growth.

Finally, high barriers to firm entry and stringent bankruptcy legislation reduce the market share of more productive firms in an industry,[2] especially in high-turnover sectors (Andrews and Cingano, 2012). In addition, anti-competitive regulation and low financial development are negatively associated with average productivity.

3.3. Employment volatility

Output volatility can also affect labour compensation or employment. Employment volatility can involve changes in hours worked or hiring or firing. Economic policies ranging from bankruptcy law to employment protection, wage setting and short-time working schemes do not only shape the volatility of firm output and turnover, but they also affect worker reallocation or changes in hours or wages.

Higher labour reallocation tends to be associated with higher employment volatility. While reallocation can reflect separations that lead to unemployment, a more dynamic labour market may also provide better access to jobs (Petrongolo and Pissarides, 2008). However, not all workers benefit from the dynamism of the labour market in the same way. Displaced workers are likely to experience difficulties in finding a new job and suffer long-lasting wage losses, in particular those dismissed during recessions (von Wachter and Davis, 2011).

There is a lot of heterogeneity in job and worker flows across OECD countries. This suggests that country-specific policies and institutions may play an important role in determining the level of job and worker reallocation (OECD, 2010).

High firm turnover goes hand-in-hand with high job turnover (Bartelsman et al., 2013). In addition, surviving young firms typically exhibit high rates of employment growth. This link suggests that barriers to entrepreneurship and, more generally, barriers to product market competition influence labour reallocation.

More stringent employment protection legislation (EPL) generally decreases labour reallocation by decreasing firm's incentives for job creation and destruction. Overall, empirical studies find that stringent EPL reduces worker reallocation and, through this channel, holds back productivity growth (Martin and Scarpetta, 2012). Bassanini and Garnero (2013), using industry-level data, suggest that more restrictive dismissal regulations reduce the rate of job-to-job transitions within industries, while they have no effect on transitions towards unemployment or transitions across industries.

Public spending on active and passive labour market policies also affects persistence after adverse shocks to employment. Unemployment benefits increase the reservation wage, which can weaken job-search intensity. The disincentive effect of job-search could be partially offset by benefit conditionality and active labour market policies (ALMPs), which can ease re-employment of workers by training them during unemployment. ALMPs, combined with more generous unemployment benefits, can also lead to better, more productive, job matches.

The wage bargaining process also affects labour reallocation. Previous research suggests that structural unemployment is generally lower in countries with either highly coordinated/centralised wage bargaining or uncoordinated/decentralised wage-setting institutions compared with intermediate bargaining arrangements. Generally, in countries with highly centralised or coordinated wage setting, it is possible to internalise the detrimental employment effects of excessive wage pressures which may allow the economy to adjust more quickly to shocks (Bassanini and Duval, 2006). However, if shocks are heterogeneous across the economy and persistent, adjustment may become more difficult relative to a fully decentralised system.

3.4. Labour earnings fluctuations

Besides firm entry or exit, firms may also adjust the wage bill, by hiring or firing workers, adjusting hours worked or hourly wages to cope with a change in the economic conditions. For the United States, Comin et al. (2009) find that the volatility of firm sales growth and the volatility of incumbent workers' wage growth are significantly and positively correlated, and that the strength of this association has been growing since the 1980s.

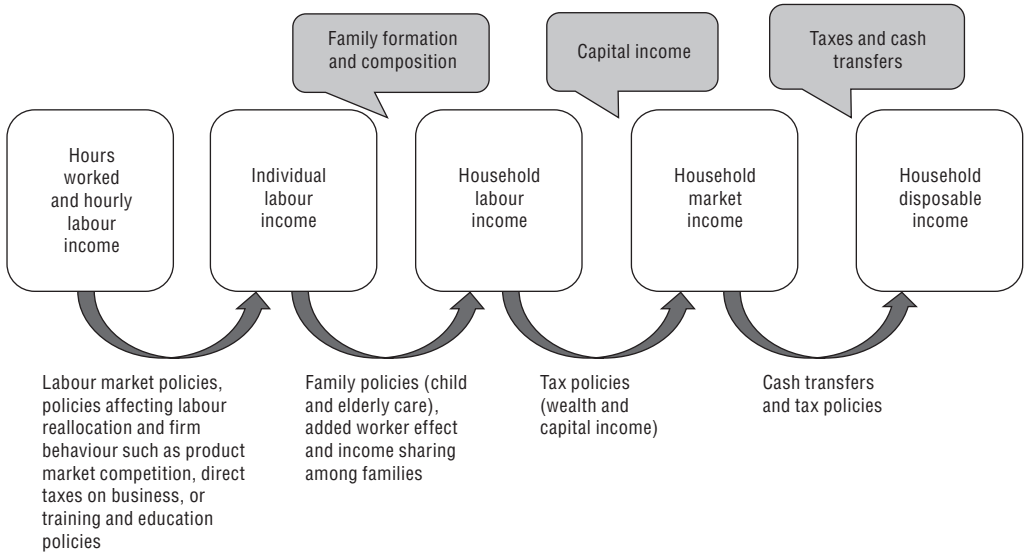
Firms can adjust the hourly wage paid to their employees or their working time. While there is wide agreement on the existence of downward nominal wage rigidity (Nickell and Quintini, 2003; Holden, 2004), empirical evidence shows that a fair number of job stayers

experience wage reductions during recessions. Elsby et al. (2013) find that the share of workers that undergo nominal wage declines generally lies between 10% and 20% in the United States and the United Kingdom, and culminated at around 25% during the Great Recession. Nevertheless, nominal wage declines remain limited in many other countries, thus impeding real wage adjustment in times of low inflation and leading to higher structural unemployment and lower growth (Fehr and Goette, 2005).

On the other hand, part-time jobs and short-time work schemes have gained traction in recent years, potentially amplifying fluctuations in hours worked while stabilising employment. At the macroeconomic level, Ohanian and Raffo (2011) show that volatility in hours per worker contributes considerably to labour input fluctuations in the main euro-area countries and Japan, while volatility of labour input is largely determined by employment fluctuations in English-speaking countries. This is consistent with the view that different labour market institutions, notably differences in hiring and firing costs and work-sharing arrangements, may significantly affect how firms adjust labour input along the extensive and intensive margins.

Figure 5 illustrates how different institutional settings and economic policies are likely to affect the transmission of labour earnings volatility to household disposable income. Fluctuations in labour income, which involve changes in hours, employment status or hourly earnings affect household disposable income after a number of steps involving household structure, capital income, taxes and transfers. This paper looks at the impact of policies on employment and labour earnings volatility and studies how labour earnings volatility fuels disposable income volatility, while investigating the role of taxes and transfers. This sequential approach allows identifying the main policy drivers of volatility at each income level, as well as their build-up along the chain.

Figure 5. **From labour earnings to disposable income**



4. Data and measures

This section presents the data, reviews various volatility measures and introduces the econometric specifications. The framework presented in Section 3 suggests focusing the analysis on: i) job reallocation; ii) individual earnings volatility; and iii) disposable income volatility. Two main types of data sources are used: labour force surveys and household panels.

4.1. *Labour force surveys*

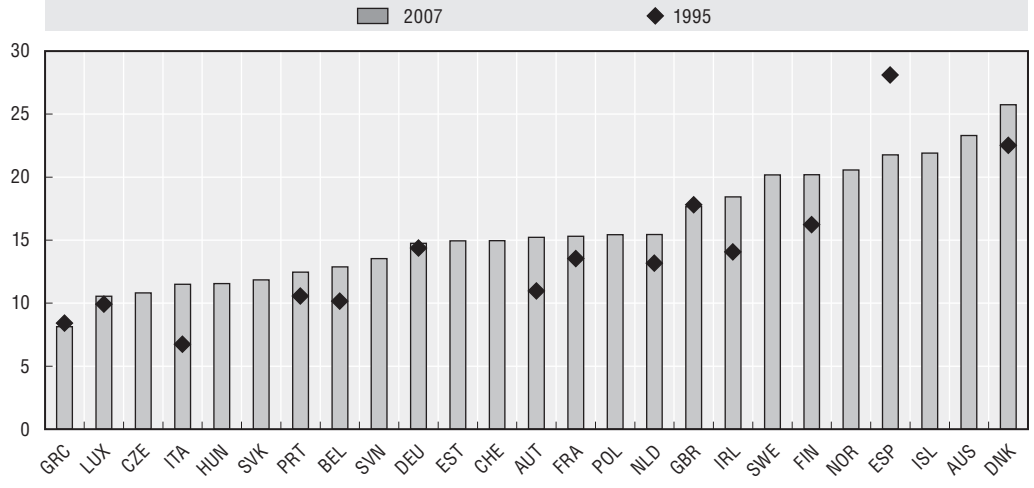
Worker reallocation comprises two distinct types of labour reallocation: *churning*, that is, worker flows without creation or destruction of jobs; and *job reallocation* defined as creation and destruction of jobs. Both types are likely to influence productivity by stimulating the accumulation of human capital or reflecting flexibility at the firm level to accommodate innovation and creative destruction. On the other hand, job flexibility and employment volatility entail uncertainty and increased instability for individual workers. A dynamic labour market provides workers with better job opportunities. However, not all workers benefit. Dismissed workers can have problems to find a job and if they find one, they may not have the same level of income and working conditions as in the previous job. The trade-off between these two dimensions of welfare will be addressed in Section 6.

The present paper uses Labour Force Survey (LFS) data to measure the intensity of worker flows as a measure for worker reallocation. Hiring rates are defined as the proportion of workers with tenure of less than one year, while separations are simply the difference between hirings and employment changes for a given year. These data underestimate hirings and separations, as they ignore changes that occur within a year. This caveat is particularly important for temporary workers, many of whom may change jobs several times a year. These rates are available for 26 countries and cover horizons between 1993 and 2010. Akin to Bassanini (2010), worker reallocation is defined as worker hiring (H) and separation (S) rates in excess of net employment growth (E):

$$x = 0.5 * \left(H + S - |\Delta E|\right)$$

Figure 6 shows that worker reallocation rates are very different across OECD countries. The English-speaking and Nordic countries have reallocation rates well above those observed in other European countries with the exception of Spain. Except for the latter country, reallocation rates have generally increased between 1995 and 2007 for countries where data are available in both years.

Figure 6. **Annual worker reallocation rates vary considerably across countries**



Note: Worker reallocation is defined as hirings plus separations minus the absolute value of employment growth divided by two.
Source: OECD Labour Force Surveys and OECD calculations.

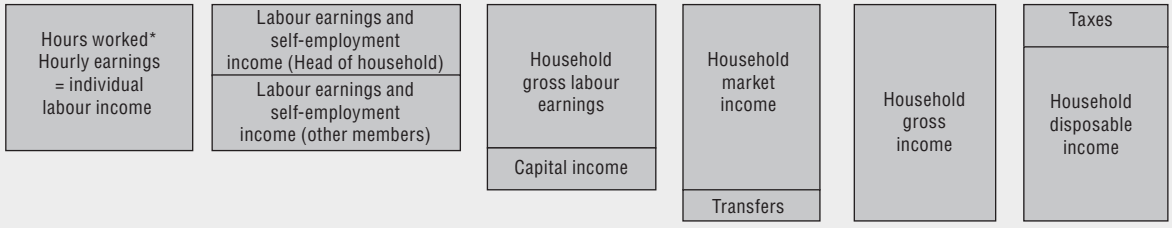
4.2. Household panel data

Earnings and disposable income data are based on household surveys. This study combines several surveys to increase coverage both across countries and over time. Appendix A summarises the data availability of the harmonised household surveys across OECD countries (Figure A.1 in Appendix A). The data set represents a fairly large panel of individual earnings and household disposable income growth data across 26 OECD countries from 1994 through 2010. Box 3 reviews the three main volatility estimators that are usually used to measure volatility in micro-panels (Garda and Ziemann, 2014).

Box 3. **Measures of income volatility in micro-panels**

Microeconomic volatility of households and individuals can be assessed by different measures. Household consumption growth volatility is the measure most closely related to welfare (Section 2). Due to the lack of harmonised cross-county data for individual household consumption, personal earnings or household disposable income are used instead. Figure 7 illustrates how different components of income sum up to household disposable income.

Figure 7. **The link between earnings and income variables**



Several micro-panels covering household income for a wide range of OECD countries are available:

- The European Community Household Panel (ECHP) covering 15 European countries from 1992 to 2000.
- The European Union Statistics on Income and Living Conditions (EU-SILC) covering 23 European countries from 2002 to 2010.
- The Cross-National Equivalent File (CNEF) covering Canada, Germany, Korea, the United Kingdom, the United States and Switzerland from 1968 to 2008.

Joining the three databases yields a large panel of individual earnings and household disposable income data across 27 OECD countries. The ECHP and EU-SILC panels rely on national surveys that follow a common framework, ensuring cross-country comparability. The CNEF dataset harmonises national panels. The present study assembled the ECHP, EU-SILC and CNEF datasets while making sure to select variables in the different panels to make sure that they measure the same, or very close, concepts.

One major difficulty when using these panels in the context of analysing volatility is the rotation structure of these panels and attrition. Indeed, the coverage of the panel decreases substantially if one requires several consecutive observations per individual or household in order to obtain a stream of growth rates for which the standard deviation as a measure of volatility can be calculated (see Figure A.2 in Appendix A). Against this backdrop, several estimators have been proposed in the literature. At the individual or household level, three estimators are commonly used, all of which require longitudinal data on earnings for individuals and based on year-to-year changes. At the country level, these measures are (see also Garda and Ziemann, 2014):

- *Rolling-window measure*: earnings volatility is calculated for each individual as the standard deviation of year-to-year earnings growth over several consecutive periods (here, three years). An overall measure of earnings volatility for a country or sub-group (for example, a sector) is then calculated as the average of the individuals' standard deviations.

Box 3. **Measures of income volatility in micro-panels** *(cont.)*

- *Incidence of large changes*: an individual is defined as having volatile earnings if she experiences a large increase or decrease (here, of at least 20%) in earnings from one year to the next. The country measure of earnings volatility can then be calculated as the proportion of individuals in a particular country with volatile earnings.
- *Cross-sectional measure*: earnings volatility is measured as the cross-sectional standard deviation of year-to-year earnings changes. The idea is that higher earnings volatility should appear as a higher dispersion of year-to-year changes.

By imposing more or less structure on the volatility measure, the three estimators reflect different trade-offs between model and estimation risk. The large-incidence measure assumes homogenous average growth rates within and across countries and time which minimizes the estimation risk at the cost of high model risk. On the contrary, the rolling-window measure imposes no structure on the classical standard deviation estimator at the cost of high estimation risk as only very few estimators per window and individual are available. The cross-sectional measure sits somewhere in-between as it takes into account that countries grow at different growth rates and that growth varies over time (average growth rates per year and country need to be estimated).

The various volatility measures exhibit very tight correlation (Table 1).

Table 1. **Correlation of different volatility measures**

	Rolling window	Incidence 20% changes
	Disposable income	
Incidence 20% changes	0.84***	–
Cross-sectional	0.90***	0.79***
	Labour income	
Incidence 20% changes	0.74***	–
Cross-sectional	0.76***	0.90***

Note: Three asterisks (***) denote statistical significance at the 1% level.
Source: Income and earnings growth data from 1994 through 2010 based on harmonised national household surveys (CNEF, EU-SILC, ECHP).

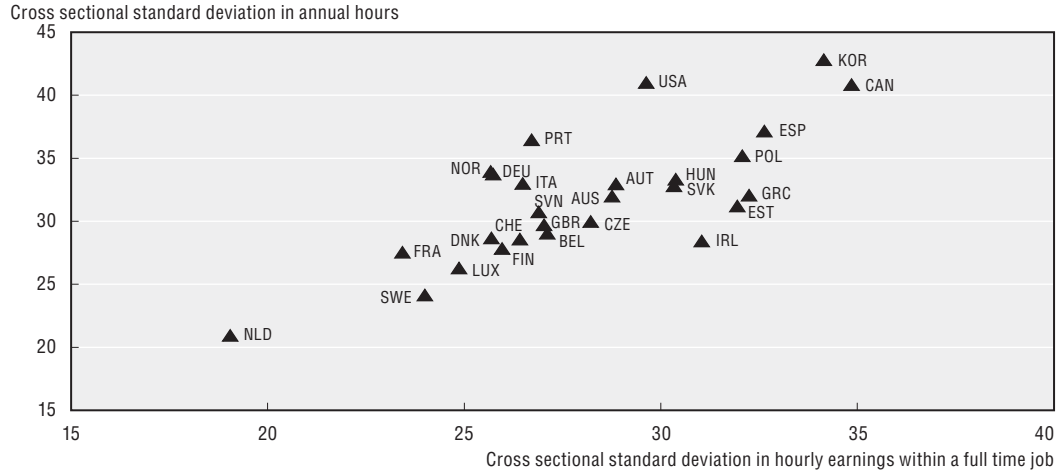
Percentage changes in income from one year to the next are calculated as arc-percentages, in line with the literature on micro-level volatility. The arc-percentage change in earnings is equal to the change in earnings from one year to the next divided by average earnings over the two-year period. This choice avoids infinite increases and ensures a symmetric treatment of increases from nothing to something (+200%) and the reverse (-200%).

Nominal income changes are adjusted for inflation using annual consumer price inflation data from the *OECD Main Economic Indicators* database.

All the measures take into account workers, male or female, aged between 25 and 59 years old, and exclude students, the disabled and retired people. Household measures (mainly disposable income) relate only to households with a head aged between 25 and 59 years old, excluding students, the disabled and retired people. Only households with constant household size are considered. The study excludes people aged 60-64 to reduce the impact of retiring on measured income volatility. Employment rates substantially rose for this age category in the last two decades, but the incidence of retirement decisions still remained very large in this group in the period.

Changes in individual labour income[3] can either reflect changes in hours worked or hourly earnings (Figure 8). To disentangle these two sources of volatility, individual earnings are decomposed into annual hours worked and hourly earnings.

Figure 8. **Cross-country differences in annual hours worked and hourly earnings volatility**



Note: All values refer to country averages. To reflect different coverage across time (see Appendix A), observed volatilities are corrected for year-fixed effects.
Source: Calculations based on EU-SILC, ECHP and CNEF household surveys.

Employment volatility is defined throughout this study as the volatility of annual hours worked. Regrettably, household surveys only provide information at annual frequency for this measure. Accordingly, it is not possible to disentangle changes in working time from changes due to transitions from employment to unemployment and *vice versa*. Employment volatility is defined as the absolute change of annual hours worked divided by 2 000.[4] For instance, a number of 10% corresponds to a change of 200 hours irrespective of the initial level of hours worked. Indeed, absolute changes seem to be more appropriate than relative changes to measure fluctuations in annual hours worked.

The volatility measure for hourly earnings includes only full-time workers to quantify changes in hourly earnings in a way that is robust to errors in the measurement of hours worked.[5] The measure of volatility in hourly earnings excludes arc percentage changes of more than 100% in absolute terms (multiplication or division by three from one year to the next). In contrast, the measure of volatility in hours worked keeps large changes, as they can have a strong influence on welfare, particularly as they often reflect unemployment spells or shifts to part-time jobs. Nominal earnings changes are adjusted for inflation using annual consumer price inflation data from the *OECD Main Economic Indicators Database*.

5. The links between economic policies and microeconomic volatility

This section discusses the links between microeconomic volatility and economic policies and institutions according to the framework presented in Section 3. The volatility measures presented in Section 4 serve as dependent variables, while a set of policy indicators is used as explanatory variables (Appendix B). Each of the volatility measures addresses a specific module of the framework (Box 2), which helps to disentangle the different transmission channels of microeconomic volatility.

The baseline specification is a standard reduced-form model of institutional determinants of microeconomic volatility at the country level:

$$\sigma_{ct} = \alpha + \sum_{i=1}^{I} \varphi_i P_{ct}^{i} + \delta_c + \delta_t + \varepsilon_{ct} \qquad [1]$$

where σ_{ct} is one of the three volatility measures for changes in annual hours worked or hourly earnings (Box 3) or worker reallocation (Section 3.1) in country *c* at time *t*, P^{i}_{ct} the policy indicator *i* in country *c* at time *t*.[6] Finally, δ_c and δ_t denote country and time-fixed effects, respectively.

A second specification is estimated on the micro data at the level of either households or individuals. Estimating directly at the level of people or households allows taking into account the effect of their characteristics. Garda and Ziemann (2014) have shown that employment and earnings growth volatility are significantly correlated with age, education and the level of income. In addition, this micro-level specification allows for interactions of these characteristics with policies to investigate the marginal impacts of policies on certain groups of workers. The specification is:

$$\sigma_{nct} = \alpha + \sum_{j=1}^{J}\gamma_j C^{j}_{nt} + \sum_{j=1}^{J}\sum_{i=1}^{I}\left(\varphi_i + \phi_{ij}C^{j}_{nt}\right)P^{i}_{ct} + \delta_c + \delta_t + \varepsilon_{nct} \qquad [2]$$

where C^{j}_{nt} represents characteristic *j* such as age, education or level of income of individual *n* at time *t*. Volatility σ_{nct} refers to the incidence of 20% changes of annual hours worked or to rolling-window volatility, each observed at the household level. Cross-sectional standard deviations cannot be used in this specification, because cross-sectional volatility is defined at the country level and this specification requires a micro-level dependent variable (see Box 3). Some of the policy indicators are likely to interact non-linearly with the volatility indicators. Accordingly, the equations include quadratic terms of the policy indicators. This allows for linear, increasing, declining, hump-shaped and U-shaped relationships between volatility and policies.

5.1. *Labour income volatility*

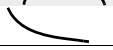
The regression analysis will distinguish between two different sources of labour income volatility: employment volatility and hourly earnings volatility. Three dependent variables will be used: i) employment volatility assessed through worker reallocation (see Section 4.1 for the definition); ii) volatility of changes in annual hours worked and; iii) the volatility of hourly earnings growth on a full-time job (see Box 3). The first part of the results refers to the country-level specification [1] and uses country-year estimates of micro-level volatility. The second part refers to the micro-level specification [2] and uses individual characteristics included in the household surveys.

5.1.1. *Country-level specification*

Table 2 depicts the estimated relationships derived from panel regressions between policies and different components of earnings volatility. The table shows the main results using the measure of cross-sectional standard deviation for annual hours worked and hourly earnings. However, results are robust to the measure chosen. Appendix C presents the results in greater detail using the three measures.

Hump-shaped relationships suggests that the link between the volatility and the policy indicator is positive for low values of the policy indicator and negative for high values, reflecting typically a positive value for the linear coefficient and a negative value for the squared term coefficient. One example for such a relationship is employment protection legislation for regular workers (see Table C1 in Appendix C). Focusing on links established at the 5% level indicates that the results are particularly strong for the volatility

Table 2. **Link between policies and labour income volatility**

	Worker reallocation	Volatility of annual hours worked	Volatility of hourly earnings
Employment protection for regular workers	 *	 ***	 *
Centralisation of wage bargaining		 ***	 ***
Level of unemployment benefits		 *	 **
Active labour market policies	 **		
Product market regulation		 **	
Credit intermediation	 ***	 ***	 ***

Note: The shapes indicate the estimated relationship between policy estimators (rows) and volatility estimates for different aggregates of labour income volatility (columns). Volatility of annual hours worked and hourly earnings are measured with cross-sectional standard deviation. Empty cells signify that the estimated coefficients are not significant at the 10% level (see Tables C1 and C2 in Appendix C for detailed regression coefficients, significance levels and results using the three measures of volatility). Asterisks show confidence levels for the linear and squared term: *** stands for 99%, ** for 95% and * for 90%. If significance differs between the linear and squared terms, the lower level is shown.
Source: OECD calculations using CNEF, ECHP and EU-SILC and OECD statistics.

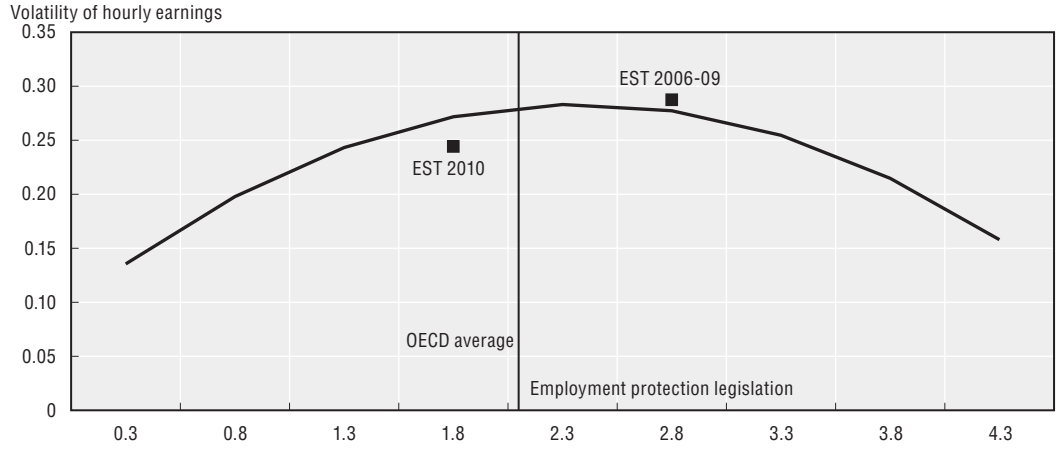
of annual hours worked. Statistical significance is not as strong (10% only) for worker reallocation and earnings volatility.

The analysis shows a hump-shaped link between employment protection legislation for regular workers (EPL) and all indicators of labour market related microeconomic volatility (Table 2).[7] This finding suggests that the improvement in labour allocation, greater economic dynamism and stronger potential growth associated with easing tight EPL, documented in OECD (2006), initially comes at the cost of greater economic volatility for individuals. It corroborates earlier OECD work showing that relaxing EPL increases worker reallocation (OECD, 2010; Bassanini et al., 2010) and extends the result to the volatility of hours worked and hourly earnings. The present finding complements earlier results by documenting that, when EPL for regular workers is further relaxed, worker reallocation and the volatilities of hours worked and hourly earnings all tend to decline. This second effect underscores the benefits of fluid labour markets: compared with tight or moderately restrictive policy settings, more deregulated labour markets bring larger growth benefits together with lower microeconomic volatility.

The estimates suggest that in economies with stringent levels of employment protection[8] such as the Czech Republic, Germany, Greece, Italy, Portugal, Slovenia and Sweden, a gradual deregulation could raise labour income volatility by increasing both employment and labour earnings volatility. One particular example of a reform which overcame the reform trap is the case of Estonia in 2009 (Figure 9).[9] Estonia relaxed its EPL in 2009, which reduced the EPL indicator from highly regulated (above the critical value) to medium regulated (below the critical value based on the coefficient of the quadratic term). The associated decrease in hourly earnings volatility was a bit higher than suggested by the estimates, but the estimation suggests that a weaker reform could have led to higher volatility. However, one caveat is that only one year of data is available after the reform.

Although the evidence is weak, stronger unemployment insurance seems to be associated with higher volatility of both hours worked and hourly labour earnings. Unemployment benefits, here represented by gross replacement rates due to data limitations for net replacement rates, can increase the reservation wages preventing the unemployed from reintegrating the labour market causing higher changes in annual hours worked. This result is in line with previous empirical evidence (OECD, 2010) indicating that higher levels of unemployment benefits amplify the adverse labour market impacts of

Figure 9. **Hourly earnings volatility decreased after Estonia greatly reduced employment protection**



Note: The curve shows the estimated relationship between the volatility of hourly earnings and EPL, based on the estimates in Table C2 in Appendix C. Volatility of hourly earnings is measured using the cross-sectional standard deviation. Rectangles are data for Estonia pre-reform (average 2006-09) and post-reform (2010). The vertical line shows the OECD average for the EPL indicator for 2010.
Source: OECD calculations using CNEF, ECHP and EU-SILC and OECD statistics,

economic downturns by increasing the persistence of unemployment. The positive link between unemployment benefit levels and microeconomic volatility may also reflect that strong unemployment insurance promotes risk-taking and workers' mobility which may eventually reduce work-life income inequality by exerting an equalising effect over the long run (OECD, 2015).

Centralisation of wage bargaining is found to have a hump-shaped relationship with the two components of labour earnings volatility: annual hours worked and hourly earnings. Intermediate values for centralisation of wage bargaining favour high volatility of annual hours worked and hourly earnings. By contrast, completely decentralised or fully centralised wage bargaining systems exhibit low volatility of working time or hourly earnings. This association may reflect benefits from internalising negative externalities in centralised systems (Bassanini and Duval, 2006), and benefits from flexible and tailored negotiations at the plant level in decentralised systems (OECD, 2012). In contrast to labour and product market regulations, there is little evidence that one particular wage bargaining system is more conducive to economic growth than another (OECD, 2004).

Spending on active labour market programmes seems to reduce worker reallocation. However, this result is not robust across specifications. ALMPs are expected to increase the probability of re-employment of workers by increasing hirings. At the same time, by training workers during unemployment and improving the matching process, ALMPs are expected to decrease separations. The total impact on worker reallocation seems to favour the decrease in separations and hence worker reallocation. This net effect suggests that ALMPs seem effective at improving the quality of labour-market matches, thereby reducing unnecessary worker reallocation. ALMPs are measured by the ratio of spending to GDP, smoothed to abstract from cyclical fluctuations. An alternative measure would be the amount of ALMP spending per person unemployed, converted in one currency through purchasing power parities; however, this measure would by construction tend to magnify ALMP spending in countries with higher real GDP per capita.

Policies not directly relating to the labour market also appear to influence labour earnings volatility (Table 2). Easing product market regulations (PMR) to instil greater competition is associated with an initial increase in the volatility of hours worked when starting from a stringent stance. However, the relationship then changes, with hours worked becoming more stable when product-market regulations are further relaxed to make settings very pro-competitive.

The present study found no significant interactions between product-market and labour-market reforms. Prior literature indicates that product-market reforms have different effects on employment depending on the tightness of employment protection (Fiori et al., 2012; Griffith et al., 2007). However, interactions between EPL and ALMP, EPL and PMR or EPL and GRR showed no significant results when assessing effects on microeconomic volatility.

Credit deepening is initially associated with lower volatility (Table 2), presumably because it enables firm-level smoothing, which in turn drives down labour-market volatility. Testing directly for such firm-level smoothing could be a valuable extension of the current finding. At high levels of credit intermediation (more than 90% of GDP), however, the link flattens, suggesting that the smoothing effects of greater credit availability saturate.

5.1.2. *Micro-level specification*

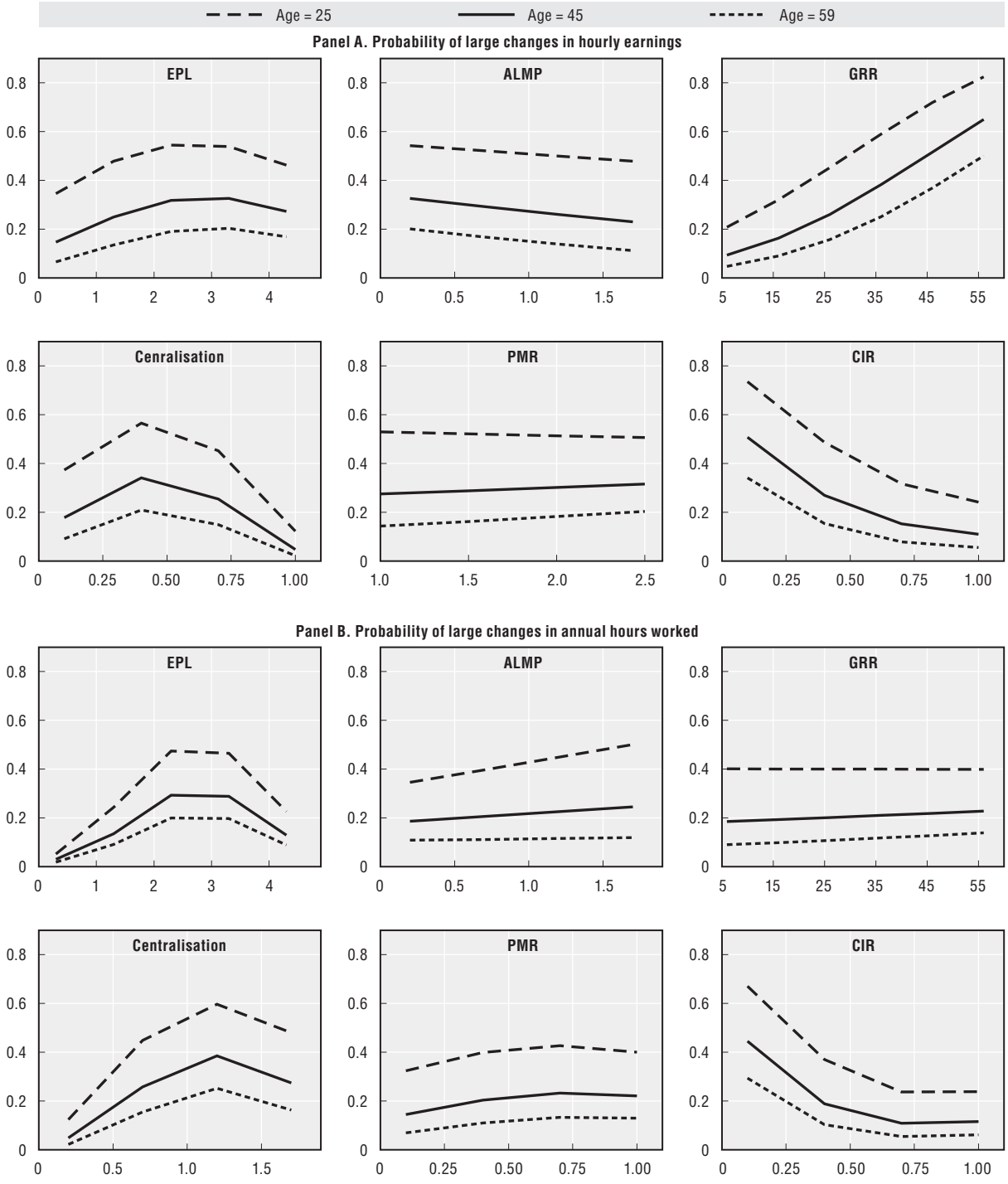
The use of household panels permits controlling for age, education and the income level of individuals, all of which have been found to influence earnings volatility (Garda and Ziemann, 2014). Accordingly, specification [2] is used to capture direct and indirect impacts of individual characteristics. The results indicate that young, male, low-income workers suffer from the highest volatility of annual hours worked and hourly earnings.

The results from the micro-panel regressions confirm the results obtained at the country level. Employment protection and the centralisation of wage bargaining yield a hump-shaped relationship with the volatility of hours worked and hourly earnings. The credit intermediation ratio affects the volatility negatively and with a decreasing slope. Product market regulation has a hump-shaped impact on the volatility of annual hours worked and no impact on that of hourly earnings.

Young workers generally experience a higher volatility of working time and hourly earnings than others (Figure 10). More generally, economic policies affect different age groups quite differently. Younger workers are also more affected by labour market institutions as the slope and shape of the relationship with EPL and ALMPs are more pronounced for the volatility of annual hours worked (lower panel in Figure 10). This is in line with the fact that young workers have a higher propensity to change jobs and are therefore more affected by labour-market frictions. Product market regulation and the credit intermediation ratio have also a differential impact by age, being stronger for younger workers. Figure 10 also shows that unemployment benefit replacement rates have greater impact on the volatility of hourly wages than of hours worked, in line with the hypothesis that more generous unemployment benefits facilitate risk-taking in the labour market.

Educational attainment, defined as not completing, completing or going beyond upper-secondary schooling, has little impact on microeconomic volatility (Figure 11). Similarly, the effects of economic policies on microeconomic volatility do not differ across broad educational groups. Income levels also matter for volatility and how policies influence it.[10] Low-income workers experience the greatest volatility in hourly earnings. Economic policies have different effects on employment volatility depending on workers' income levels (Figure 12). As expected, ALMPs have their greatest effects on working time

Figure 10. **Impact of structural policies on labour income volatility by age group**

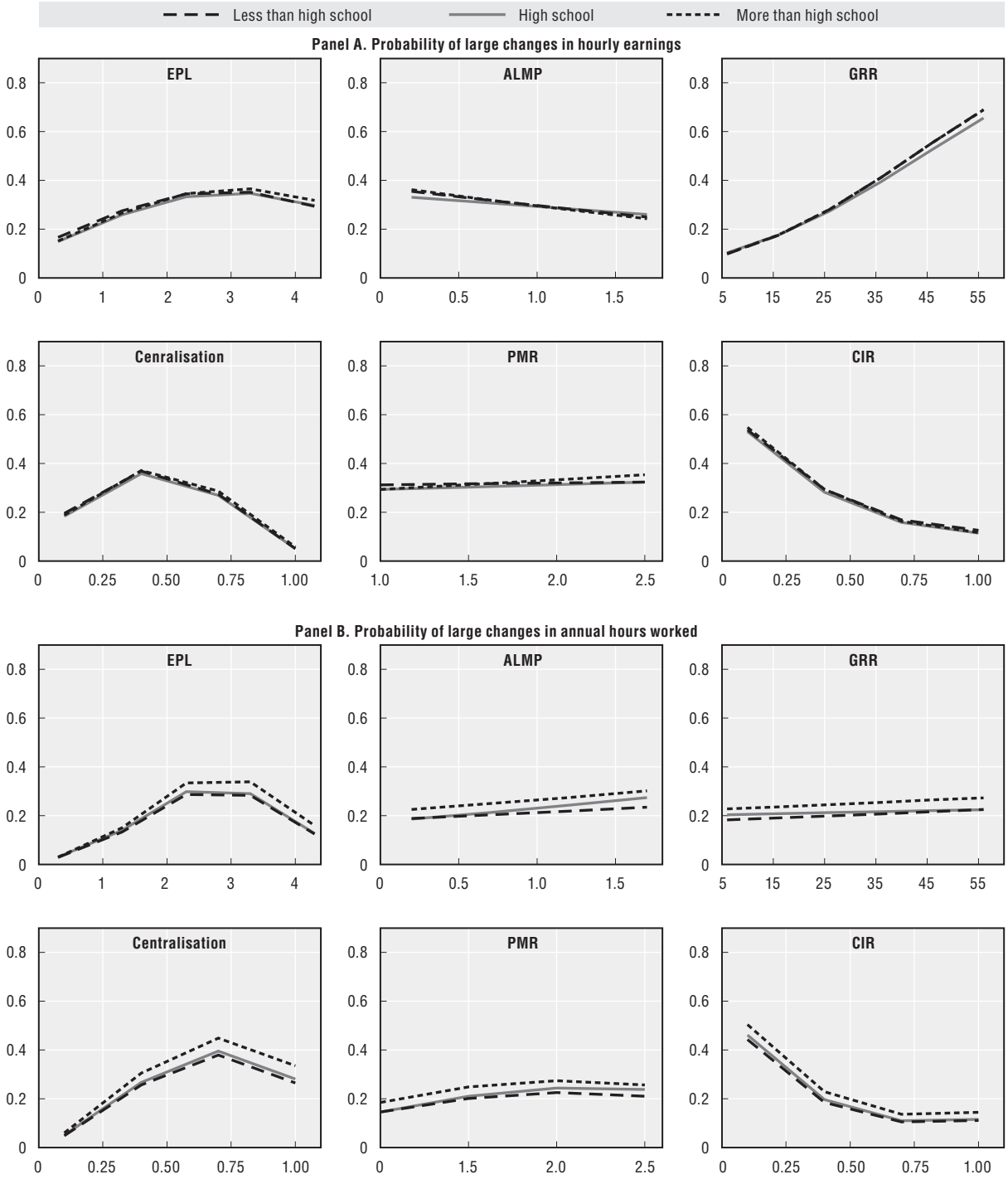


Note: The graphs plot the predicted margins derived from panel regression coefficients. Refer to Table C3 in Appendix C for detailed coefficient estimates.

Source: Calculations based on CNEF, ECHP and EU-SILC.

and hourly earnings for low-income workers. Deregulating product markets increases the volatility of hourly earnings for low-income workers but not for others. Conversely, more generous unemployment benefit systems generally seem to result in higher volatility of

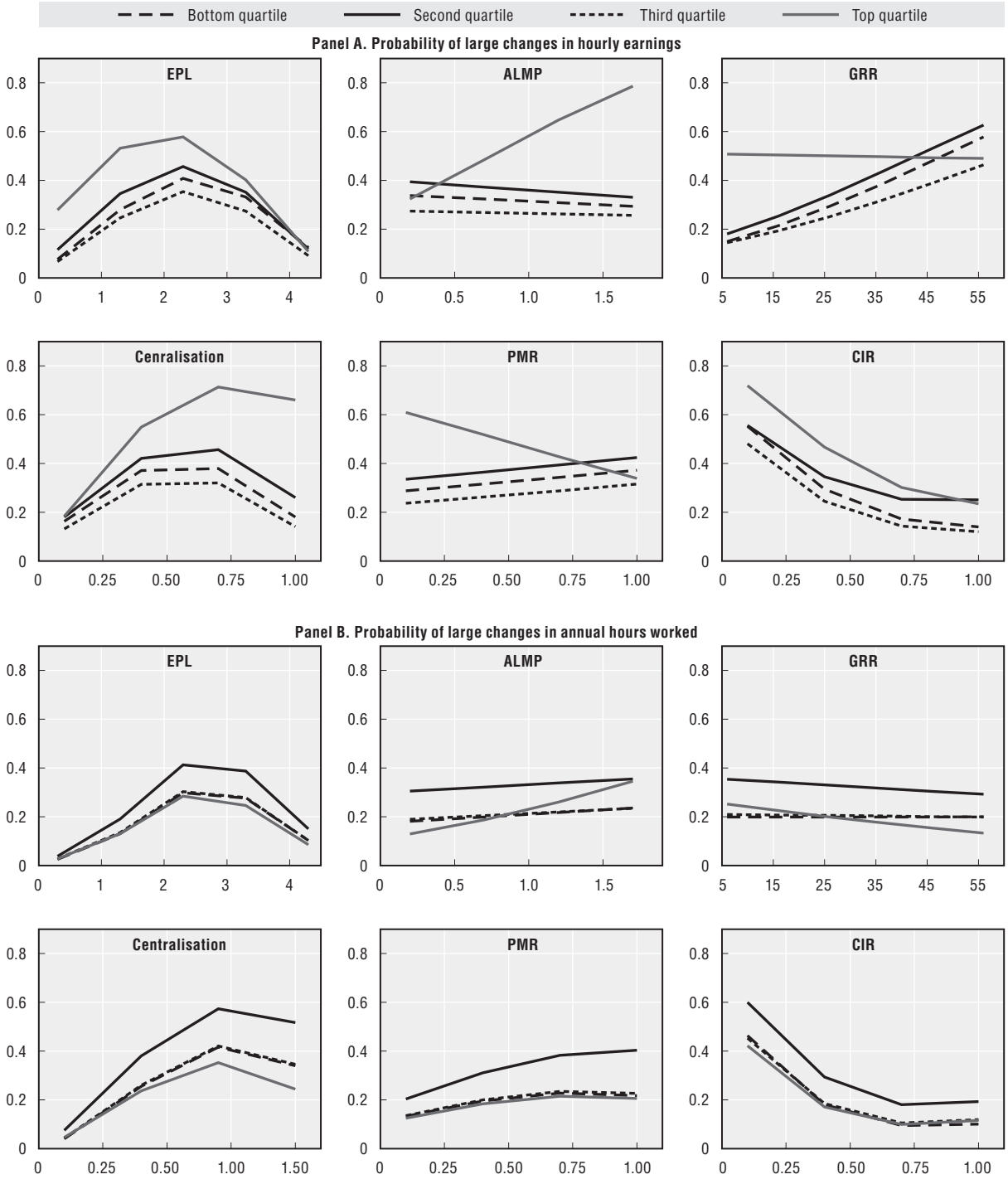
Figure 11. **Impact of structural policies on labour income volatility by level of education**



Note: The graphs plot the predicted margins derived from panel regression coefficients. Refer to Table C3 in Appendix C for detailed coefficient estimates.
Source: Calculations based on CNEF, ECHP and EU-SILC; OECD.

hourly earnings except for the lowest incomes. This hints at the presence of dual or segmented labour markets as low-income workers are more likely to occupy temporary or atypical jobs characterised by lower bargaining power than permanent contract workers.[11]

Figure 12. **Impact of structural policies on labour income volatility by level of income**



Note: The graphs plot the predicted margins derived from panel regression coefficients. Refer to Table C3 in Appendix C for detailed coefficient estimates.
Source: Calculations based on CNEF, ECHP and EU-SILC.

5.1.3. *Investigating causality through sector-level analysis*

One caveat of the preceding panel-regression analysis is that the observed correlations do not necessarily reflect causal links between the policy indicators and volatility measures.

The framework presented in Section 2 helps to alleviate concerns about spurious correlations or reverse causality as it lays out the channels through which the specific policies are expected to affect income volatility. A way to push the identification mechanism one step further is to exploit sector-level data in the CNEF and ECHP datasets.[12] This sub-section aims at estimating the impact of policies on employment and labour income volatility using a difference-in-difference strategy on industry-level data (Box 4).

Box 4. **Using industry data to investigate the effect of policies across countries**

The empirical strategy is based on an approach pioneered by Rajan and Zingales (1998). It reflects the idea that the influence of a particular economic policy is greater in industries in which the policy is more likely to affect the firm's behaviour, the so called "policy-binding industries". To identify the "policy-binding" sectors, a so-called benchmark indicator needs to be identified. This benchmark should be defined in the economy where the policy is the least stringent, with the assumption that it proxies for the technological and market-driven firm behaviour across industries in the absence of policy-induced costs.

For example, in their seminal paper Rajan and Zingales (1998) use the dependence on external finance in the United States across sectors as a benchmark variable to study the impact of financial development on economic growth across countries. The idea is that sectors that are more dependent on external finance (the policy-binding industries) should be the ones benefitting the most from financial development, and thus enjoy higher growth.

This strategy is a difference-in-difference estimation and has the advantage that it controls for policies or institutions that influence the volatility in the same way in all industries. More precisely, all factors and policies that can be assumed to have, on average, the same effect on volatility in policy-binding industries as in other industries can be controlled for by country dummies. The general specification is as follows:

$$\sigma_{cj} = \alpha + \varphi B_j P_c + \beta X_{cj} + \delta_c + \delta_j + \varepsilon_{cj}$$

where P_c is the policy indicator in country c, B_j is the benchmark in industry j, X_{cj} are additional country-sector characteristics and δ_c and δ_j represent country and industry fixed effects, respectively, which are included to capture additional confounding factors. The parameter of interest is φ. The greater this parameter is, the greater the relative effect of the policy under analysis in binding industries will be with respect to non-binding industries. The sign of φ also provides an indication of the direction of the average effect of the policy, subject to the identifying assumption that in non-binding industries this effect is either of the same sign and smaller or zero. In line with the strategy in Section 3, quadratic terms of the policies are introduced (as long as these were significant in the previous analysis) to address possible non-linearities in the relationships.

This equation is estimated for two different policies using only one at a time: employment protection legislation for regular workers (EPL) and product market regulation (PMR). The policy benchmarks identified in the present study are:[1]

- Worker reallocation for EPL: Employment protection is more likely to be binding in industries that have a high propensity of hirings and separations as EPL taxes the labour adjustment margin of firms. Accordingly, similar to Bassanini et al. (2010), worker reallocation in US industries is used as a benchmark to identify the effect of EPL on labour income volatility across industries.

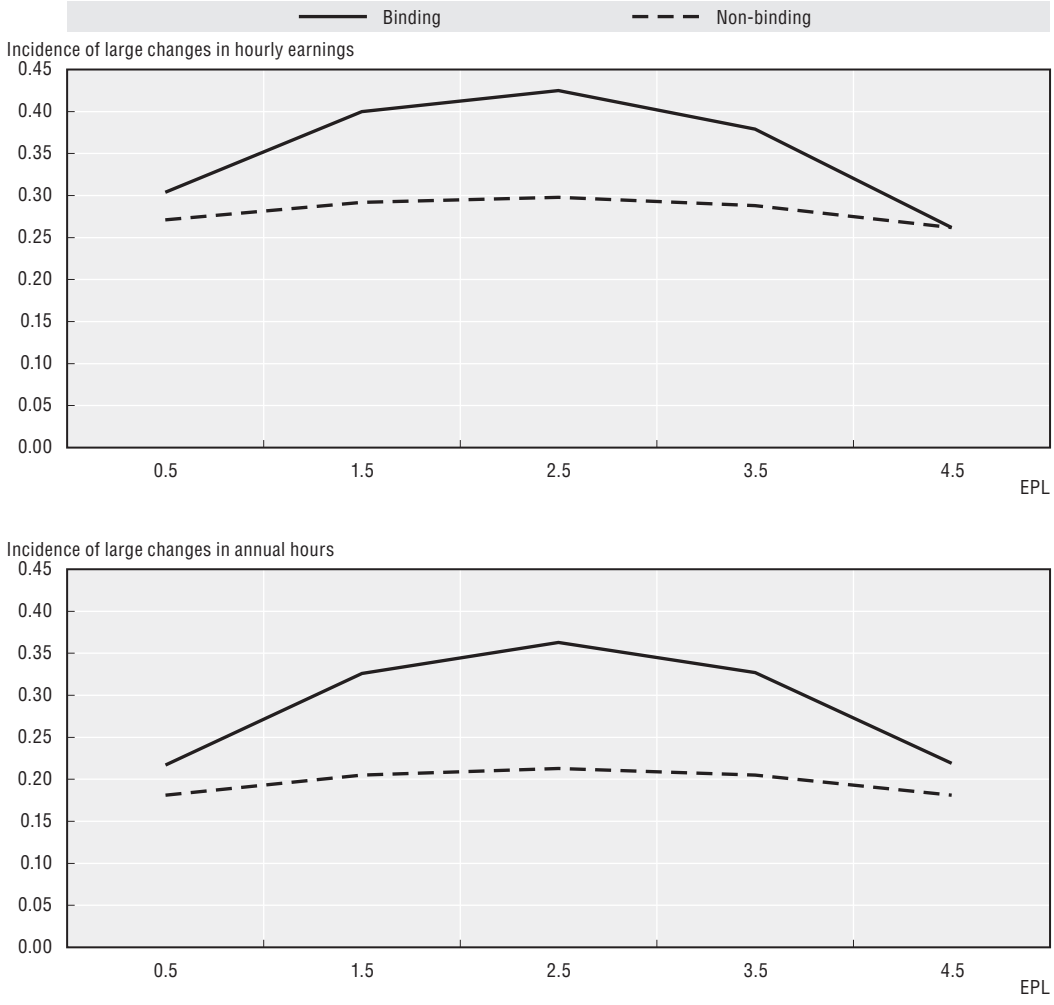
Box 4. **Using industry data to investigate the effect of policies across countries** *(cont.)*

- Firm entry and exit rates for PMR: Klapper, Laeven and Rajan (2006) provide "natural" entry and exit rates for US sectors. The higher the "natural" rate of entry and exit, the higher the costs of complying with bureaucratic requirements and the higher the potential restrictive impact of stringent product market regulation.

1. Dependence on external finance in US industries has also been identified as a benchmark for credit intermediation ratio. However, problems arose when matching databases at the sector level resulted in the loss of many industries and countries and, hence, not enough data points to have reliable estimates.

The results shown in Figure 13 confirm the hump-shaped relationship between the level of employment protection legislation for regular workers and labour income volatility (measured by the incidence of large changes in hourly earnings and annual hours worked).

Figure 13. **Earnings volatility and EPL in binding and non-binding industries**

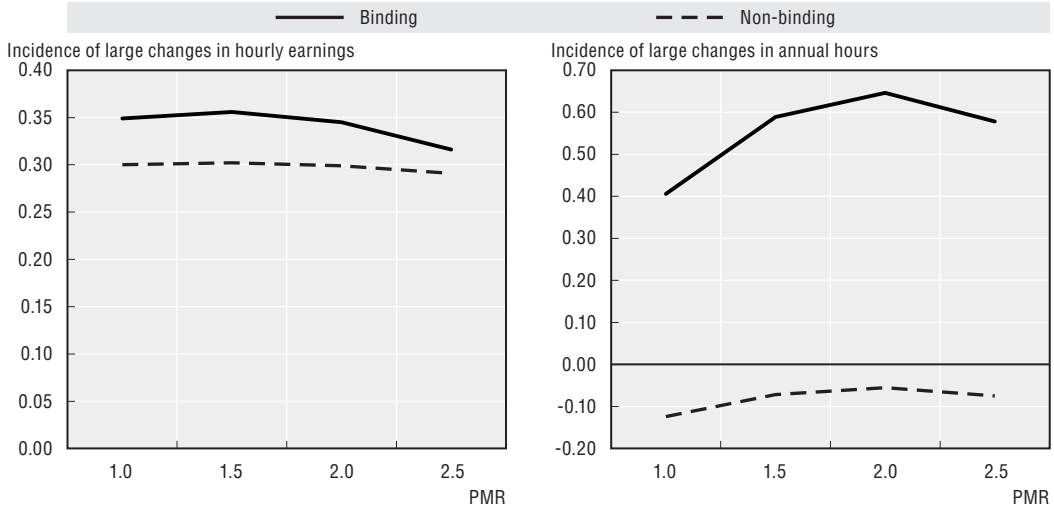


Note: The graphs plot the incidence of large changes derived from the specification in Box 4. See Table C6 in Appendix C for detailed regression results. The data span from 1994 to 2000. Policy-binding industries are defined using the benchmark, which is the worker reallocation rate in US industries.
Source: Based on CNEF and ECHP for sector-level volatility measures and Bassanini et al. (2010) for benchmark worker-reallocation rates from US industries.

EPL has a larger impact on labour income volatility in binding sectors, that is in sectors with higher rates of worker reallocation. On the other hand, labour income volatility in non-binding sectors is much less affected by EPL. The finding that the hump-shaped relationship originates from EPL-binding sectors points to a causal link.

Figure 14 also confirms the results from the previous sub-section for PMR. Product market regulation has a hump-shaped effect on annual hours worked volatility while there is no effect on hourly earnings. Figure 14 shows that PMR has a larger impact on hours worked volatility in binding sectors, that is, in sectors with a higher natural rate of firm entry, while it is not significant in non-binding sectors.

Figure 14. **Earnings volatility and PMR in binding and non-binding industries**



Note: The graphs plot the incidence of large changes derived from the specification in Box 4. See Table C6 in Appendix C for detailed regression results. The data span from 1994 to 2000. Policy-binding industries are defined using the benchmark, which is the firm entry rate in US industries.
Source: Based on CNEF and ECHP for sector-level volatility measures and Klapper et al. (2006) for benchmark firm rates for US industries.

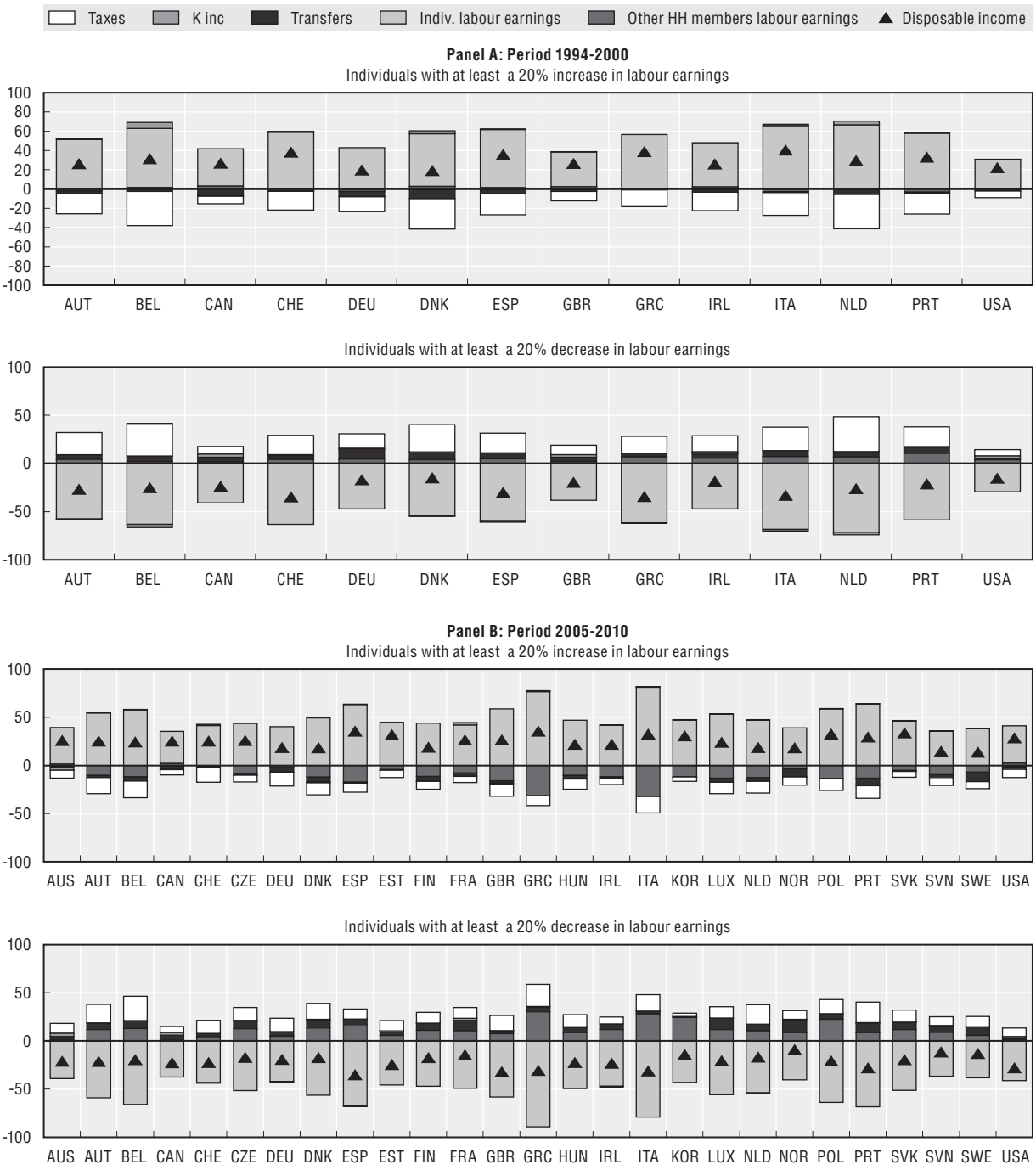
5.2. Disposable income volatility

A decomposition of disposable income into its components highlights cross-country heterogeneity in the way changes in individual earnings pass through to household income. Figure 15 shows how an increase or decrease in individual gross labour earnings of 20% or more affects household disposable income in selected OECD countries. Panel A is for the period 1994-2000 and panel B for the period 2005-10.

In all countries, disposable income is partially shielded from the full impact of large changes in individual earnings. Cash social transfers and taxes dampen the impact of swings in earnings on household disposable income. Taxes yielded a larger attenuation effect than transfers during the period 1994-2000 in all countries. In contrast, during 2005-10, transfers became more important for attenuating the large decline in individual labour income in Norway, Luxemburg, France and Canada.

Transfers play a significant but generally more limited role than taxes. This finding could raise a policy trade-off with inequality (discussed in Section 6.3), since cash transfers are more effective in reducing inequality in most OECD countries than taxes (Hoeller et al.,

Figure 15. **Contributions to changes in household disposable income**



Note: Percentage changes in income components are calculated as the arc percentage change, i.e. the difference in income between two years, divided by the average income of the two years. The period of coverage is 1994-2000 for panel A (with the exceptions of Austria 1995-2000; Switzerland 1999-2000; Finland 1996-2000; and USA 1994-96); for panel B it is 2005-10 (with the exceptions of Australia, Switzerland, Germany, Ireland 2005-08; Slovak Republic and Sweden 2005-09; France and Greece 2007-09; Italy 2007-10, and Korea 2005-07). The estimates shown are for households headed by individuals aged between 25 and 59 years, and exclude students, disabled and retired people. Only households with constant household size are considered.
Source: Calculations based on CNEF, ECHP, EU-SILC.

2014). This contrast reflects that progressive taxation responds strongly to income changes, while cash transfers are primarily determined by income levels (or in some cases not connected to income).

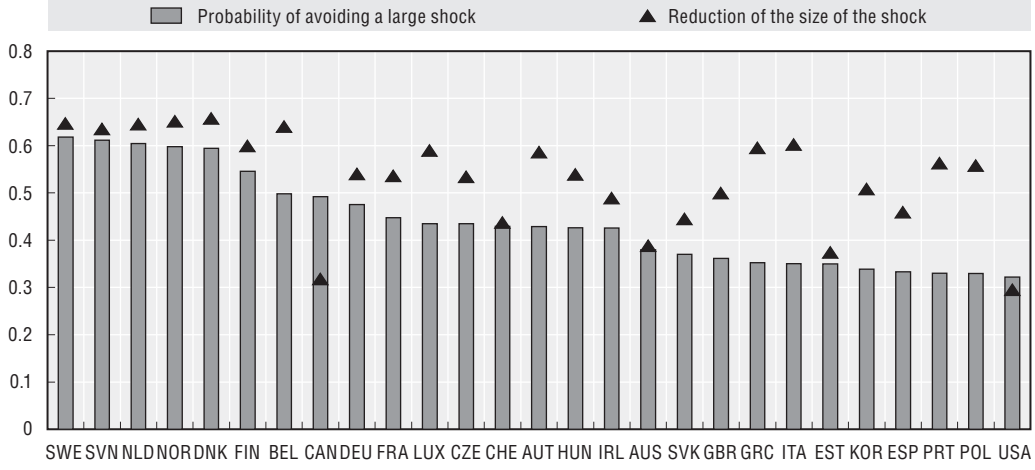
The income of other household members also plays an important role in smoothing disposable income, especially in Italy, Korea and Slovenia over the period 2005-10. On the other hand, capital income plays little role in attenuating or amplifying shocks to labour earnings. As discussed earlier, even if capital income variations are more pronounced than those of labour and disposable income, its weight in disposable income is very small.

The main factors that attenuate the transmission of large declines in labour income into household disposable income (Figure 15, bottom panel) vary across country groups:

- Changes in the labour income of other households' members appear to be the most important smoothing instrument in southern European countries. They offset more than 25% of the reduction in the income of the household head. Taxes were also an important buffer, as they provided an offset of 15%, while that provided by transfers was only 5%. Hence, for these countries, the family acts as a more important income-smoothing device than the tax and transfer system.
- In the Nordic countries, other household members, labour income, taxes and transfers play a similar role in smoothing this reduction, each contributing about 10%.

Further, the attenuation effect varies considerably across countries. For the Nordic countries and the Netherlands, in 60% of the cases a large shock to disposable income can be avoided after having experienced a large earnings shock (bars in Figure 16). This translates into an attenuation of the size of the shock passed to disposable income of more than 60% (see the triangles in Figure 16).

Figure 16. **Attenuation of earnings shocks**



Note: Attenuation is measured as the probability of avoiding a large change in disposable income, which is defined as the proportion of households not experiencing large changes in disposable income conditional on a large change (more than 20%) in individual earnings. The measure shows how large changes in individual labour earnings of the household head are attenuated when looking at household disposable income. Numbers refer to averages over the period 2005-10.
Source: Based on CNEF, ECHP and EU-SILC and OECD calculations.

On the other hand, the probability of avoiding a large shock in disposable income after experiencing a large shock to labour earnings reaches only 35% in most Southern (Spain,

Greece and Italy) and Eastern European (Estonia, Slovakia, and Poland) countries as well as in Korea, and most English-speaking countries (Australia, Canada, the United Kingdom and the United States).

Taxes and transfers reduce disposable income volatility. The size of the impact depends on the size, mix and progressivity of each component of the tax and cash transfer system. A progressive income tax and benefit system reduces volatility because it reduces tax obligations and increases cash transfers, more than one for one when market income falls.

The attenuation impact of the tax system can be considered along three dimensions: i) the size effect, measured by total taxes over GDP; ii) the tax mix, since some taxes could have a greater effect on volatility than others, measured by the share of the tax under consideration (personal income, consumption, property, and social contributions) in total tax receipts; and iii) personal income tax progressivity.

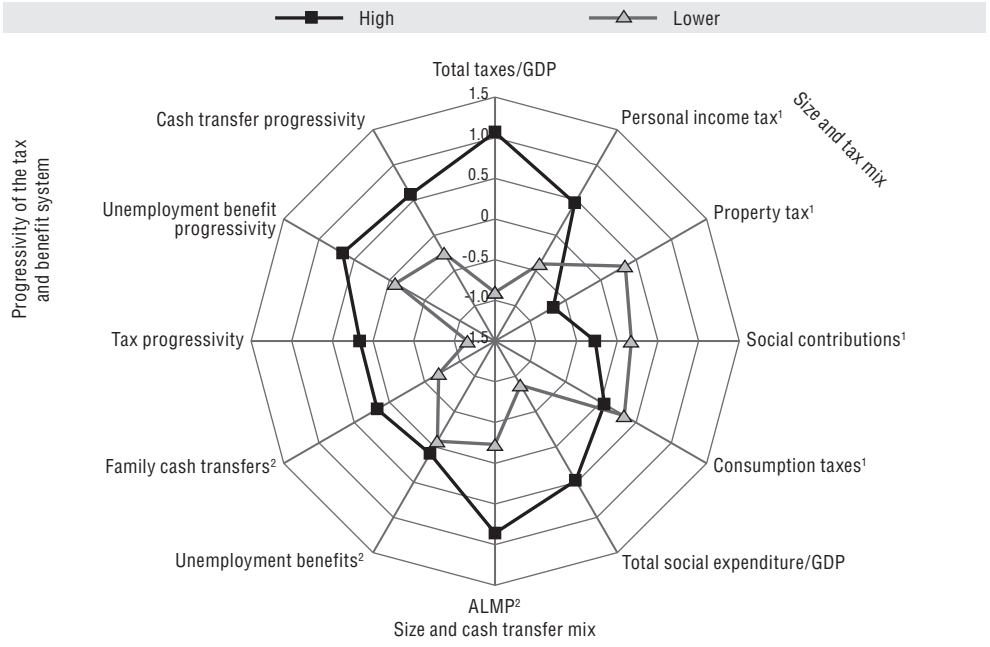
Furthermore, the ability to smooth the impact of swings in income also depends on the different dimensions of the cash transfer system. As before: i) the size effect is measured by the ratio of transfers to GDP; ii) the cash transfer mix is measured by the share of the specific cash transfer (unemployment benefits, family benefits and active labour market programmes) in total cash transfers; and iii) the progressivity of unemployment benefits and other cash transfers.

Figure 17 shows standardised policy indicators for the top and bottom quintiles of the probability of avoiding large disposable income shocks.[13] Attenuation is high in the Nordic countries and the Netherlands and low in Korea, Poland, Estonia, Spain, Portugal and the United States. An indicator above zero means the variable is above the OECD average, while below zero means below the average. For example, consumption taxes do not differ between low and high-attenuation countries since the indicator has a value of zero, i.e. is at the average. Instead, an indicator with a value of one means that it is one standard deviation above the average.

Results indicate that high attenuation is related to higher cash transfers as a percentage of GDP. With respect to the mix of cash transfers, higher family benefits, unemployment benefits and spending on active labour market policies are associated with a better ability to smooth disposable income shocks from labour earnings shocks. The progressivity of the benefit system is also related to the attenuation capability. Highly progressive cash transfer schemes are better able to offset the effect of changes in labour earnings on disposable income.

Higher total taxes are also associated with a stronger attenuation of disposable income shocks. However, the mix of taxes is also important. Countries where the personal income tax is more important are better able to shield disposable income from labour earnings shocks, since they play a crucial role for income and spending decisions of liquidity-constrained households. Instead, higher shares of property taxes and social contributions taxes are associated with lower attenuation. Consumption taxes, which tend to be regressive, do not play an important role. Finally, the role of taxes in the attenuation of disposable income emanates from the progressivity of the income tax. More progressive income tax systems attenuate disposable income shocks more.

Figure 17. **Tax-and-benefit systems differ between high and low-attenuation countries**



1. As a proportion of total tax revenues.
2. As a proportion of total cash transfers.

Note: Numbers are averages over the period 2005-10. The indicators are standardised to have zero mean and a standard deviation of one across OECD countries for which data are available. A standardised indicator above zero means the variable is above the OECD average. For example, consumption taxes on average do not differ between low- and high-attenuation countries since the indicator has a value of zero. In a polar opposite example, the tax-GDP ratio is one standard deviation above the average in high-attenuation countries and almost one standard deviation below in low-attenuation countries. Attenuation of a disposable income shock is defined as the probability of not experiencing large changes in disposable income conditional on a large change (more than 20%) in individual labour earnings. High and low refer to the top and bottom 20th percentile of the probability of avoiding large disposable income shocks. The personal income tax (PIT) progressivity is measured as the percentage increase in net income when gross wage earnings increase by one currency unit, i.e. the elasticity of after-tax income with respect to pre-tax gross wage income. Progressivity of unemployment benefits is defined as the difference in the net replacement rate for low and high earners, defined as having earnings equal to 67 and 150% of the average wage, respectively. The larger the difference, the more progressive are unemployment benefits. The progressivity of cash transfers is taken from Hoeller et al. (2014), measured by the Kakwani index. A progressive index means that the cash transfers as a share of individual income are higher at the lower end of the income distribution. Total social expenditure and total taxes are measured as percentages of GDP.

Source: OECD calculations using CNEF, ECHP, EU-SILC and various OECD databases.

6. Reconciling microeconomic volatility and economic growth

6.1. Trade-offs and complementarities between growth and microeconomic volatility

The results presented above shed light on how structural reforms generally recommended by the OECD influence the microeconomic volatility of disposable income. Some reforms can enhance welfare by boosting growth and lowering volatility at the same time. This is, for instance, the case for comprehensive reforms that lower product-market regulation and employment protection legislation for permanent contracts from the strictest to the least strict setting.

Other reforms generally recommended to boost growth potential can raise a trade-off with microeconomic volatility of disposable income. This category includes reforms that aim at boosting long-term growth potential by cutting transfers and reducing progressive income taxes. The above characterisation of high versus low-attenuation countries

underscored that transfers typically contribute to stabilising disposable income in the face of shocks while consumption taxes, which are not progressive, do not contribute much to stabilisation.

Other approaches that may involve trade-offs between long-term growth and microeconomic volatility are marginal reforms to product market regulation and employment protection in countries where policy settings in these areas are strict. The non-linear effects identified above indicate that such gradual adjustments from very to moderately tight policy settings are likely to increase microeconomic volatility, although they can also be expected to boost growth. In this regard, countries with strict policy settings can be considered as lying in a reform trap, where a marginal reform risks posing more difficult trade-offs than deeper changes.

6.2. Getting closer to a growth-volatility frontier?

Under standard assumptions, households exhibit preferences for high consumption growth and low volatility (Box 5). As the preceding analysis has shown, some growth-enhancing structural reforms, such as relaxing too-strict employment protection legislation for regular workers are also likely to increase the volatility of earnings and hence consumption. Consequently, such reforms may, at least in the short run, confront households with trade-offs between consumption growth and volatility, with the optimal choice of the policy stance depending on the individual degrees of risk aversion.

Box 5. **Household welfare and the efficient consumption frontier**

Individual consumers maximize lifetime utility of consumption C subject to the inter-temporal budget constraint depending on wealth W, income Y and the interest rate r:

$$\text{Max } E_t V_t = \text{Max } E_t \left\{ \sum_{s=0}^{\infty} \beta^s U(C_{t+s}) \right\}$$

$$s.t. : W_{t+1} = (1+r) W_t + Y_t - C_t$$

Using the recursive form of the value function V and the envelope theorem, the first-order conditions lead to the well-known Euler equation that describes the optimal consumption paths. For instance, denoting β the discount factor, assuming power utility with relative risk aversion γ, and a constant deterministic risk-free rate r, the Euler equation is:

$$\beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \right\} (1+r) = 1$$

Denoting g_t the growth rate of consumption between t and $t+1$, the following second-order Taylor-expansion is useful:

$$\left(\frac{C_{t+1}}{C^t} \right)^{-\gamma} = (1+g_t)^{-\gamma} \approx 1 - \gamma g_t + \gamma(\gamma+1)\frac{g_t^2}{2}.$$

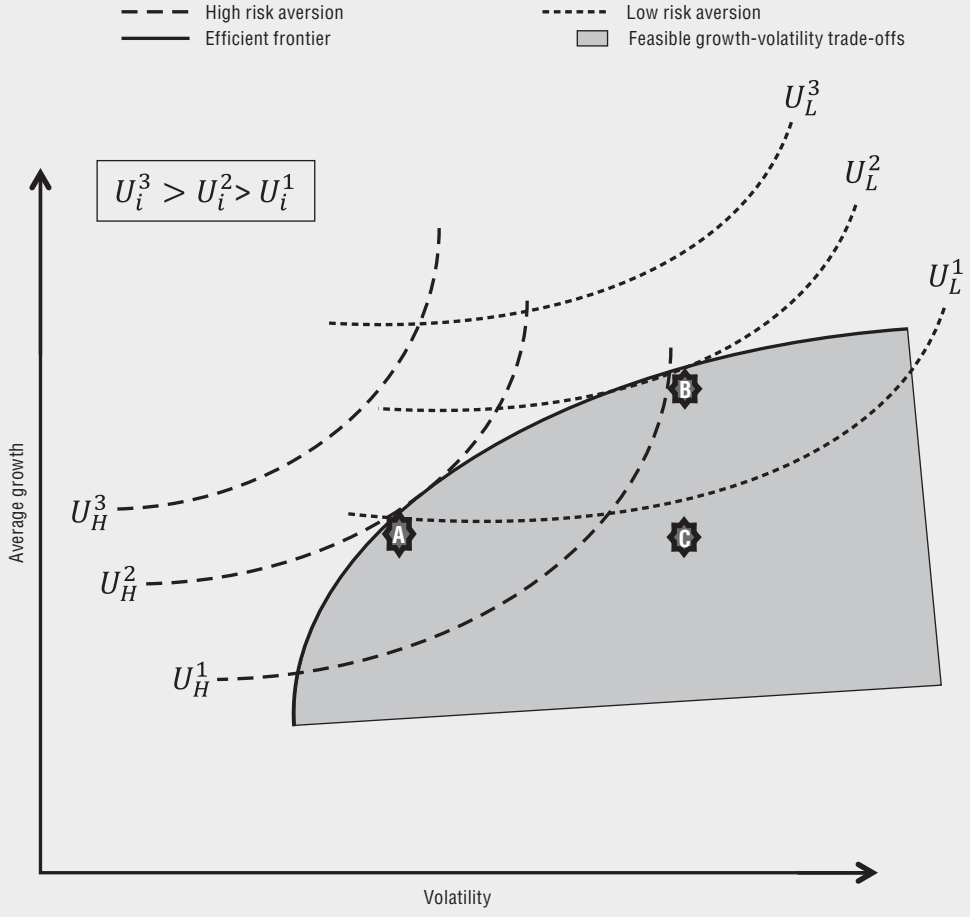
When g is small, the variance of the growth rate can be approximated by $\sigma^2 = E(g^2) - E(g)E(g) \approx E(g^2)$. The Euler equation for welfare maximization can thus be rewritten as the following quadratic relationship between expected consumption growth μ=E(g) and its volatility σ^2:

$$\mu \approx c + \frac{1}{2}(\gamma+1)\sigma^2$$

Box 5. **Household welfare and the efficient consumption frontier** *(cont.)*

with c a function of r, γ and β. This relationship can be illustrated by indifference curves (Figure 18). Starting from a given level of consumption, different pairs of expected consumption growth and volatility can yield the same level of expected utility. In order to do so, higher volatility has to be compensated by higher expected consumption growth with the slope of the relationship depending on the level of risk aversion γ.

Figure 18. **Risk aversion and optimal consumption profiles**



The highest attainable level of consumption utility depends on the set of feasible consumption profiles characterised by average growth and volatility pairs. All consumption profiles on the efficient frontier are optimal in the sense that none of these profiles is simultaneously dominated in terms of both average growth and volatility by any other profile within the feasible set. The greater the level of risk aversion, the greater is the slope of the frontier at the optimal growth-volatility trade-off and hence, the lower are both growth and volatility. Country A is optimally located for highly risk-averse consumers with U_H indifference curves while country B would be located sub-optimally with the same indifference curves since it leads to a lower level of consumption utility. For consumers with a low level of risk aversion, indicated with U_L indifference curves, country A would lead to lower utility than in country B. Finally, country C is dominated by both country A

Box 5. **Household welfare and the efficient consumption frontier** *(cont.)*

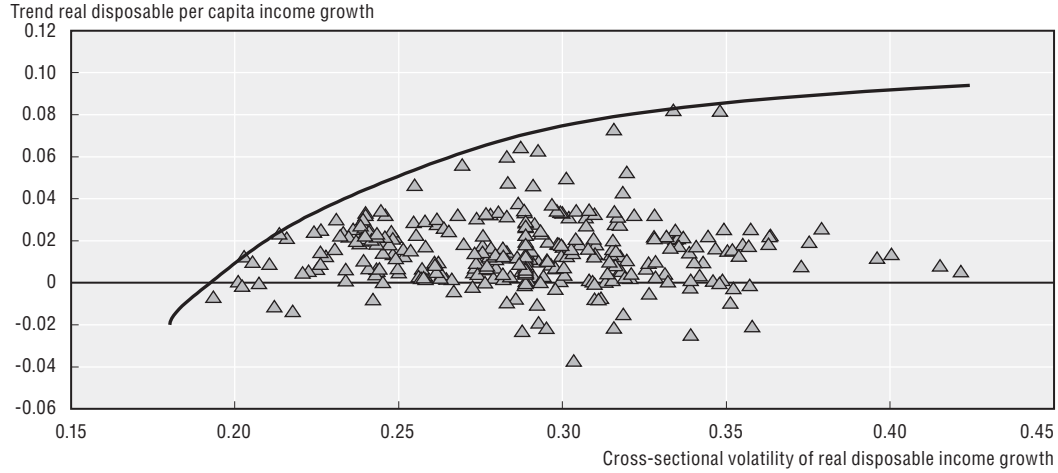
and B in terms of the growth-volatility trade-off and this, independent of the level of risk aversion of its households. Indeed, households in country C would prefer to be in the position of households in country A who benefit from the same level of growth with lower volatility and similarly, they would prefer to live in country B since for the same level of volatility they would enjoy higher growth. In a world with perfect labour mobility, all workers in country C would move to either A or B. They would choose A or B depending on how averse they are to risk.

Similar to a risk-return analysis for financial assets, one can illustrate this volatility-growth trade-off by plotting an efficient frontier. The underlying premise is that high volatility stemming from social mobility, creative destruction, and productivity-enhancing reallocation should be rewarded by higher per capita growth. Consequently, countries that are not near the efficient frontier are likely to suffer from deficient policy settings that either impede the transmission of volatility into growth or generate harmful excess volatility or do both.

The empirical analysis will focus on households. Welfare dynamics can be approximated by a linear combination of average consumption growth and individual consumption growth volatility (Box 5). Consumption growth efficiency would then be measured as the distance to the efficient frontier formed by country-year observations that exhibit optimal trade-offs between consumption growth and volatility. The optimal point on the frontier depends on the individual level of risk aversion. In the absence of comprehensive cross-country household data on consumption, this study approximates the consumption frontier by using disposable income (Figure 18).

Similar to Section 5, the panel of country-year observations can be used to assess the link between economic policies and the distance to the efficient frontier (Figure 19). The main, albeit tentative, result from this approach is that growth-enhancing reforms appear to generally reduce the distance to the growth-volatility frontier (Table 3). Higher spending

Figure 19. **Growth-volatility frontier**



Note: Real per capita disposable income growth is derived from trend disposable income from national accounts deflated by the consumer price index and divided by the number of inhabitants. Households' disposable income growth volatility is measured by the cross-sectional standard deviation of real disposable income growth taken from household surveys. Each triangle corresponds to a country and a year since 1990.

Table 3. **Distance to growth-volatility frontier and structural policies**

	Linear term coefficient	Squared term coefficient	Resulting link with distance to frontier
Employment protection	0.0165 (0.0138)	-0.0195*** (0.00386)	
Spending on ALMPs	-0.0171* (0.00899)	0.00869** (0.00387)	
Gross replacement rates	0.0273** (0.0116)	-0.00299 (0.00435)	
Centralisation of wage bargaining	0.0342** (0.0143)	-0.0112** (0.00475)	
Credit intermediation ratio	0.000461 (0.0119)	0.00526* (0.00295)	
Product market regulation	-0.00941 (0.00637)	0.00117 (0.000968)	not significant

Note: All policy indicators are standardised and centred. Estimation based on a sample of 173 observations across 21 countries. Time-fixed and country-fixed effects are included. The shapes in the last column indicate the estimated relationship between policy estimators (rows) and the distance to the frontier (columns). Asterisks reflect confidence levels: *** stands for 99%, ** for 95% and * for 90%.
Source: OECD calculations using CNEF, ECHP and EU-SILC and OECD statistics.

on active labour-market programmes and lower unemployment-benefit replacement rates are associated with higher growth for a given amount of microeconomic volatility. Although not very significant, the results suggest, that the growth benefits of reducing employment protection from stringent levels make these reforms less costly for welfare than the increase of volatility would suggest (see Section 5). Effects of reforms in product market regulation do not seem to be significant.

Increasing expenditure on active labour market policies is generally beneficial for welfare, although at very high levels (above 1 standard deviation from the average) reducing spending can be welfare-increasing. The results tentatively suggest that reducing gross replacement rates is associated with increasing welfare as the distance to the growth-volatility frontier diminishes, although this is at odds with the better job matches that stronger unemployment insurance can produce. The link between welfare and unemployment insurance could indeed be reversed in the long run as more generous benefits seem to increase mobility and reduce work life earnings volatility (OECD, 2015). More decentralised bargaining systems are associated with being closer to the frontier. Although the effects are not statistically significant, credit intermediation seems to have a non-monotonic association with the distance to the frontier: both too high and too low levels seem detrimental to welfare. Very low credit intermediation hampers the functioning of the economy while expansion in credit intermediation from high levels typically reduces growth.

In other words, countries that implement pro-growth policies seem to make better use of their level of volatility, in the sense of having growth that is close to the maximum level observed among countries with similar levels of volatility. This finding does not necessarily mean that structural reforms always improve welfare as the optimal growth-volatility trade-off depends on individual and collective preferences.

7. Concluding remarks

Recent OECD work has investigated the impact of policies on macroeconomic volatility, but from a welfare perspective, it is volatility at the household level that matters.

While microeconomic volatility can reflect growth-generating processes of creative destruction or more labour market dynamics boosting productivity growth, greater earnings volatility for individuals translates into risk, and for risk-averse individuals, higher volatility reduces welfare for a given rate of growth. This study documents how structural reforms influence household-level economic volatility.

This paper finds evidence suggesting that countries which severely restrict competition or tightly regulate employment find themselves in "marginal-reform traps", where marginal reforms from very to moderately tight settings boost growth but entail greater microeconomic volatility. However, reforms that relax restrictions to fully or near-fully deregulated settings can reduce earnings volatility. However, deep reforms along one dimension, such as firing restrictions, require significant adjustment in other institutions, such as active labour-market programmes, to help those that are affected to share in the benefits.

Household disposable income is more stable than individual labour earnings. The main sources of this attenuation vary across countries. Earnings from other family members is the most important smoothing instrument in southern European countries, while taxes and transfers are as important as income from other family members in reducing the impact of large changes in the labour earnings of the household head in the Nordic countries.

Finally, the study contributed to answering the question of whether structural reforms generally boost economic welfare. An exploratory methodology developed for the study suggests that growth-enhancing reforms generally seem to bring countries closer to the maximum level of growth that has been observed across countries for a given level of microeconomic volatility, the so-called "growth-volatility frontier". Further research that incorporates individual and collective preferences is necessary to shed more light on trade-offs between growth and volatility.

Notes

1. Regular workers are defined as workers who hold stable contracts, by contrast with temporary workers. A policy setting is defined to be lowly, moderately or very competitive depending on how the corresponding indicator in the country and year under consideration compares with values taken by the policy indicator across the sample. Relaxed, moderately tight and very tight settings are defined symmetrically.
2. This is called allocative efficiency, measured by "the extent to which the more productive firms in an industry have higher market share". It is defined as the difference between market-share-weighted productivity and average productivity within a sector.
3. Labour income includes self-employment income in all countries to ensure comparability (Figure 7). The reason is that the CNEF database does not allow disentangling dependent employees from self-employed, so that the contribution of the latter to the standard deviation cannot be isolated.
4. 2 000 corresponds to the approximate number of annual hours worked on a full-time job.
5. The full-time sample is obtained by restricting the sample to individuals working at least 1 800 hours in both years. The value of 1 800 hours was chosen to include all people who work very close to full time and to accommodate countries where full-time work involves a bit fewer than 2 000 hours.
6. Appendix B gives a flavour of how the policy indicators vary across countries and over time.
7. Results using EPL for fixed term contracts show the same hump-shaped relationship as with EPL for regular workers but are not significant and hence not presented here.
8. These are countries with EPL above the estimated critical value, which is slightly above the OECD average.
9. Estonia introduced comprehensive changes to EPL for permanent workers, reducing the notice period and the amount of severance payments pertaining to regular contracts, which took effect in July 2009.

10. For each year, income quartiles are constructed based on the average income over the years that enter the volatility measure (i.e. t and t-1 for large changes and t, t-1, t-2 and t-3 for 3-year rolling window volatility). The dataset used to calculate the volatility of annual hours worked also includes workers who are under- or unemployed while the panel for hourly earnings is restricted to full-time workers. As a result, the first income quartile in part reflects unemployment or under-employed workers while the second quartile mainly comprises low-income workers.

11. This is reminiscent of the insider-outsider model (Lindbeck and Snower, 1986).

12. This approach has been implemented for a panel of nine countries (AUT, BEL, CAN, DEU, DNK, FRA, GBR, IRL, PRT) based on ECHP and CNEF data for the period 1994-2000 and 13 sectors. The longitudinal data in SILC does not include sector information.

13. Results plotted in Figure 17 remain broadly similar when using a different measure of shock attenuation (i.e. the triangles shown in Figure 16 instead of the bars in the same figure).

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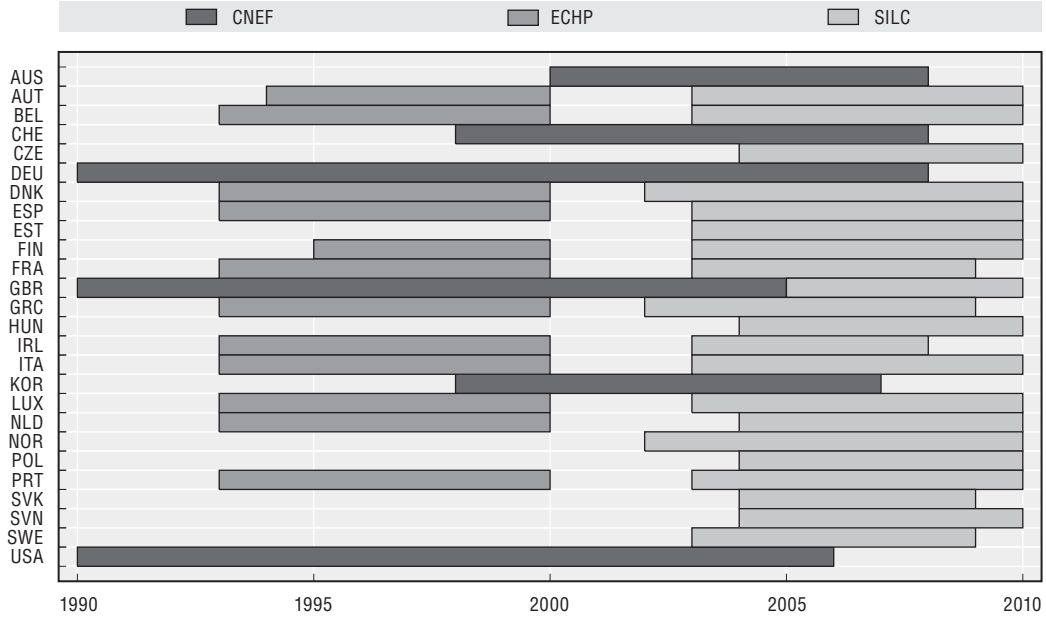
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APPENDIX A

Household panels

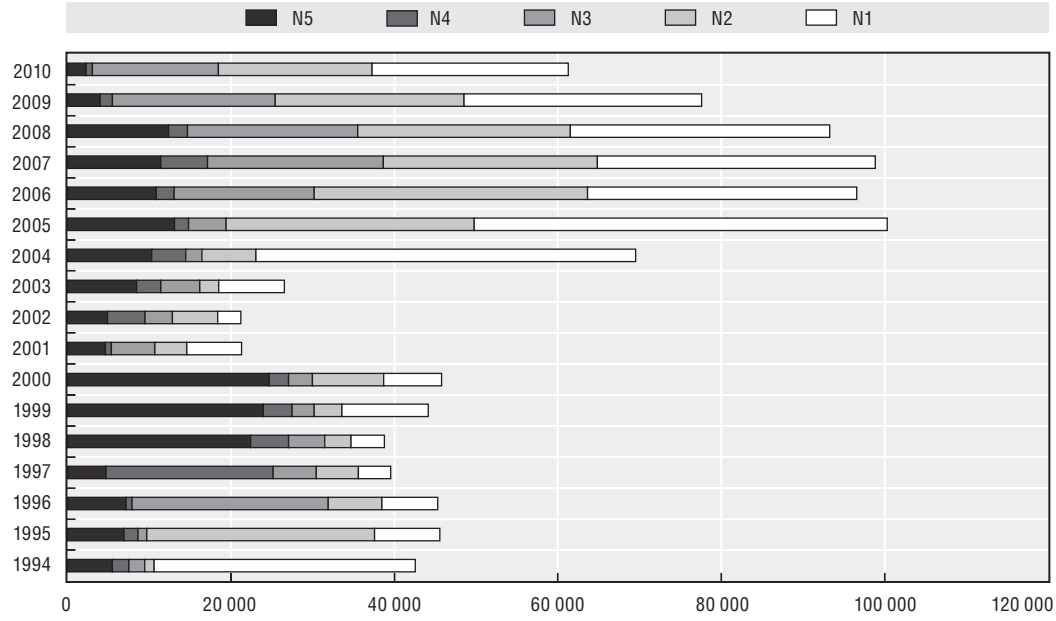
A.1. Availability of household surveys

Figure A.1. **Coverage of micro-panels by survey and country**



Note: Based on the availability of household disposable income data according to CNEF, ECHP and EU-SILC. Note that since 1996 the US survey is bi-annual. The Canadian files, CNEF-SLID available from 1994-2010, are only available to work remotely, and results are available at an aggregated-weighted level, and hence only used in cross-country regressions.

Figure A.2. **Number of observations by survey length per household**



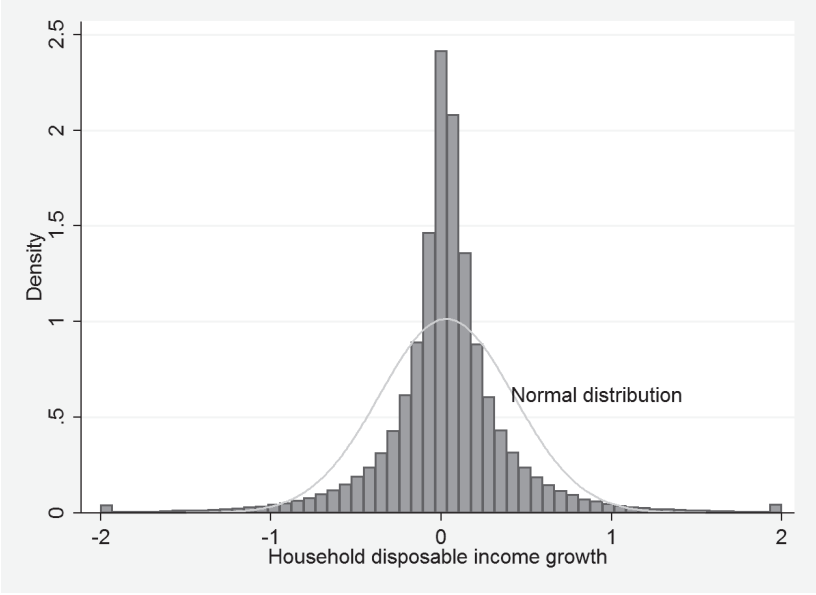
Note: Nx refers to the number of observations with at least x consecutive growth rates of household disposable income for the specific year.

A.2. Disposable income volatility measurement issues

Household measures (mainly disposable income) relate only to households with a head aged between 25 and 59 years, excluding students as well as disabled and retired people. Only households with constant household size are considered. US academic studies that do not apply this restriction obtain higher measures of volatility than the present report. For instance, Zeliak et al. (2010) evaluate the volatility of after-tax household income at 50% against 43% in the present study (in the United States in 2005). Pooling together the household-level data for all OECD countries, the distribution of household disposable income growth exhibits a cross-sectional standard deviation of 38% across OECD countries in the period 2005-10 (Figure A.3). Changes in household disposable income growth are dispersed very differently from a normal curve of the same variance: no or very small changes are much more likely, moderate changes less likely, and large changes much more likely (Figure A.3). The kurtosis of changes in household disposable income growth is 9.5 against 3 for a normal distribution. In a similar vein, Guvenen et al. (2015) find a kurtosis of 18 for annual individual labour earnings changes in the United States.

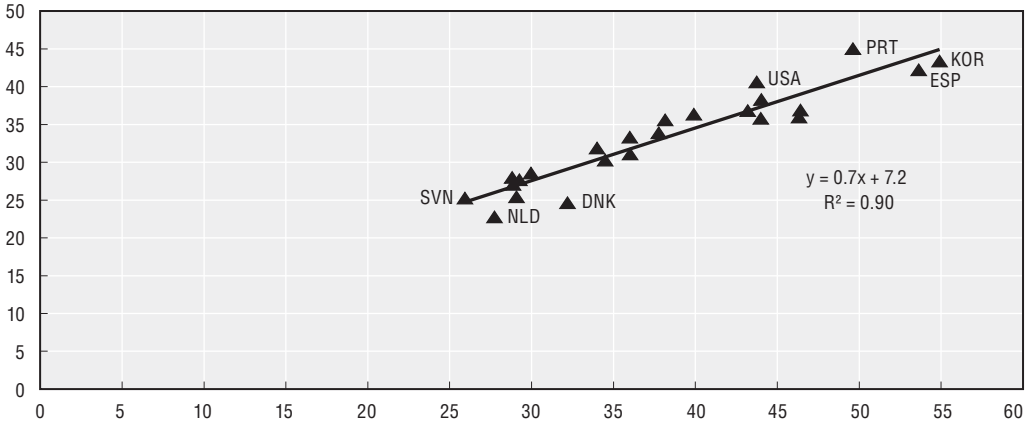
A measure of household disposable income volatility excluding very large changes, for example, above 1.5 or below -1.5 is highly correlated with the main measure, which retains the very large changes (Figure A.4). Excluding very large changes would reduce the average cross-sectional standard deviation to 33%. However, from a welfare perspective, there is little basis for excluding very large changes in household disposable income when estimating its household-level volatility. More than 60% of the very large changes in household disposable income are due to swings in household head labour earnings, mainly because of employment-unemployment transitions. Hence, these very large changes are not considered as outliers but reflect episodes of income volatility that are particularly relevant for welfare. Consequently, the volatility measures used in the study retain very large changes (with one exception relating to hourly earnings, see below).

Figure A.3. **Distribution of household disposable income growth**



Note: Pooled household-level data for the period 2005-10.
Source: Calculations based on household panels (CNEF and EU-SILC).

Figure A.4. **Household disposable income volatility excluding very large changes is highly correlated with the measure that keeps these observations**



Source: Calculations based on household panels (CNEF and EU-SILC).

APPENDIX B

Policy indicators

Table B1. **Policy indicators**

	EPL Employment Protection Legislation for regular workers	PMR Product Market Regulation	GRR Gross Replacement Rates	CENT Centralisation of wage bargaining	CIR Credit Intermediation Ratio	ALMP Spending on Active Labour Market Policies (% GDP)
AUS	1.2 (1.4)	1.4 (1.7)	28.0 (-)	0.4 (0.5)	0.5 (0.4)	0.2 (0.2)
AUT	2.4 (2.8)	1.4 (2.1)	32.0 (32.5)	0.9 (1.0)	0.4 (0.5)	0.6 (0.3)
BEL	1.8 (1.8)	1.6 (2.2)	41.0 (39.5)	0.5 (0.5)	0.3 (0.2)	1.1 (1.0)
CAN	0.9 (0.9)	1.5 (1.9)	13.5 (15.0)	0.3 (0.3)	0.4 (0.3)	0.2 (0.3)
CHE	1.6 (1.6)	1.5 (2.5)	32.0 (35.5)	0.3 (0.3)	0.6 (-)	0.5 (0.6)
CZE	3.1 (3.3)	1.5 (2.6)	6.0 (-)	0.2 (0.3)	0.2 (0.2)	0.1 (0.1)
DEU	2.9 (2.7)	1.3 (2.2)	20.5 (26.5)	0.5 (0.5)	0.5 (0.5)	0.5 (1.0)
DNK	2.1 (2.1)	1.3 (1.7)	53.0 (62.5)	0.4 (0.5)	0.6 (0.4)	1.2 (1.6)
ESP	2.4 (2.4)	1.6 (2.4)	35.0 (35.0)	0.4 (0.3)	0.4 (0.3)	0.7 (0.5)
EST	2.7 (-)	1.4 (-)	- (-)	- (-)	0.4 (0.2)	0.1 (-)
FIN	2.2 (2.3)	1.3 (1.9)	33.0 (34.0)	0.4 (0.4)	0.3 (0.2)	0.7 (1.0)
FRA	2.5 (2.3)	1.5 (2.3)	39.0 (37.0)	0.2 (0.2)	0.3 (0.2)	0.7 (1.0)
GBR	1.2 (1.0)	1.2 (1.3)	15.5 (17.5)	0.1 (0.1)	0.7 (0.4)	0.0 (0.1)
GRC	2.8 (2.8)	2.2 (2.7)	14.0 (16.5)	0.3 (0.3)	0.4 (0.2)	0.2 (0.2)
HUN	2.0 (2.0)	1.4 (2.6)	13.5 (-)	0.2 (0.2)	0.2 (0.2)	0.3 (0.3)
IRL	1.3 (1.4)	1.4 (1.9)	40.5 (29.0)	0.5 (0.5)	1.1 (-)	0.6 (0.9)
ITA	2.8 (2.8)	1.5 (2.3)	36.0 (26.0)	0.3 (0.4)	0.3 (0.2)	0.4 (0.5)
KOR	2.4 (2.4)	1.9 (2.5)	9.0 (-)	- (-)	0.4 (-)	0.3 (-)
LUX	2.2 (-)	- (-)	27.0 (-)	0.3 (0.3)	1.5 (-)	0.4 (0.2)
NLD	2.9 (2.8)	1.0 (1.8)	35.0 (52.0)	0.6 (0.6)	1.0 (0.6)	0.8 (1.0)
NOR	2.3 (2.3)	1.5 (1.9)	47.0 (40.0)	0.5 (0.5)	0.4 (0.4)	0.5 (0.7)
POL	2.2 (2.2)	- (-)	10.5 (-)	0.3 (0.2)	0.2 (0.1)	0.5 (0.4)
PRT	4.4 (4.6)	1.7 (2.6)	45.0 (40.0)	0.3 (0.3)	0.3 (0.2)	0.5 (0.4)
SVK	2.2 (2.5)	1.6 (-)	- (-)	0.5 (0.5)	0.2 (0.1)	0.2 (0.3)
SVN	2.7 (-)	2.0 (-)	- (-)	0.5 (0.4)	0.4 (-)	0.2 (-)
SWE	2.6 (2.7)	1.6 (1.9)	37.5 (25.5)	0.5 (0.5)	0.3 (0.2)	0.8 (1.9)
USA	0.3 (0.3)	1.1 (1.5)	19.0 (14.0)	0.2 (0.2)	0.4 (0.3)	0.1 (0.1)

Note: Policy indicators are shown in 2008 (1998 between brackets). EPL is the OECD indicator of strictness of employment protection for regular contracts (ranging from 0 to 6 from weakest to strongest). The present study uses Version 1 of this indicator. PMR stands for the OECD Indicator of Product Market Regulation (ranging from 0 to 6). GRR is the gross replacement rate which compares unemployment benefits with earlier wages; it is taken from the *OECD Benefits and Wages* database. CENT is an index of centralisation in wage bargaining; it ranges from 0 to 1 and comes from the ICTWSS database. The credit intermediation ratio, CIR, denotes the share of loans (by banks and other financial intermediaries) in the total liabilities of other sectors of the economy, including non-financial corporations, the general government (S13), and households and NPISHs from Annual National Accounts, Table 720 - Financial Balance Sheets. ALMP stands for government spending on active labour market programmes (10-70) as a percentage of GDP, smoothed using a Hodrick Prescott filter of 6.25.
Source: OECD databases and ICTWSS.

APPENDIX C

Panel regression results

Table C1. **Labour reallocation and policies**

		Annual hours worked			
	Worker reallocation	20% changes	Large declines	Cross sectional	3-year rolling window
Employment protection (EPL)	5.929*	0.583***	0.266***	0.697***	0.553*
	(3.182)	(0.117)	(0.0665)	(0.140)	(0.305)
EPL^2	-1.285*	-0.0965***	-0.0431***	-0.132***	-0.131**
	(0.618)	(0.0192)	(0.0110)	(0.0283)	(0.0489)
Active labour market programmes (ALMP)	-2.922**	0.0425	0.0213	-0.0275	-0.119
	(1.098)	(0.0467)	(0.0196)	(0.0532)	(0.112)
Gross replacement rates (GRR)	0.00531	0.00388**	0.00169*	0.00355	-0.00765
	(0.0476)	(0.00171)	(0.000850)	(0.00218)	(0.00652)
Centralisation of wage bargaining (Cent)	-5.307	1.709***	1.006***	1.899***	2.461
	(8.708)	(0.396)	(0.220)	(0.426)	(1.512)
Cent^2		-1.414***	-0.922***	-1.340***	-1.241
		(0.262)	(0.138)	(0.248)	(1.310)
Credit intermediation ratio (CIR)	-30.62***	-1.000***	-0.400***	-0.932***	-1.599***
	(4.756)	(0.190)	(0.0984)	(0.159)	(0.285)
CIR^2	16.73***	0.560***	0.221***	0.526***	1.115***
	(2.163)	(0.110)	(0.0583)	(0.0877)	(0.259)
Product Market Regulation (PMR)	-4.574	0.458***	0.204**	0.594***	1.169*
	(7.599)	(0.131)	(0.0799)	(0.137)	(0.584)
PMR^2	2.130	-0.108***	-0.0475**	-0.131***	-0.285*
	(1.877)	(0.0310)	(0.0211)	(0.0326)	(0.152)
Output gap	0.0827	0.000768	-0.00115	-0.000419	-0.00115
	(0.0721)	(0.00148)	(0.00110)	(0.00229)	(0.00743)
Constant	24.00**	-1.232***	-0.619***	-1.445***	-1.475***
	(9.725)	(0.265)	(0.128)	(0.292)	(0.421)
Observations	144	154	154	154	40
Number of countries	18	20	20	20	9
Adjusted R-squared	0.556	0.451	0.351	0.306	0.705

Note: Standard OLS regressions including country and time-fixed effects. Robust standard errors are adjusted by clustering at the country level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The data span from 1994 to 2010. See Table C5.
Source: Based on CNEF, ECHP and EU-SILC.

Table C2. **Hourly earnings volatility and policies**

Hourly earnings	20% changes	Large declines	Cross sectional	3-year rolling window
EPL	0.384**	0.291***	0.162*	0.772***
	(0.160)	(0.0828)	(0.0779)	(0.232)
EPL^2	-0.0762**	-0.0580***	-0.0341**	-0.142***
	(0.0357)	(0.0183)	(0.0154)	(0.0365)
ALMP	-0.00485	-0.0185	-0.0496	-0.0472
	(0.0514)	(0.0376)	(0.0338)	(0.0519)
GRR	0.00981**	0.00538**	0.00584**	-0.00233
	(0.00367)	(0.00236)	(0.00216)	(0.00275)
Cent	2.406***	1.919***	1.058***	3.183***
	(0.589)	(0.586)	(0.203)	(0.963)
Cent^2	-2.335***	-1.699***	-1.012***	-2.992***
	(0.429)	(0.497)	(0.162)	(1.027)
CIR	-0.941***	-0.285	-0.469***	0.0545
	(0.250)	(0.238)	(0.121)	(0.246)
CIR^2	0.504***	0.248	0.244***	-0.156
	(0.174)	(0.180)	(0.0601)	(0.201)
PMR	0.105**	0.0504	0.0398	-0.0248
	(0.0463)	(0.0401)	(0.0269)	(0.0552)
Output gap	0.00336	0.000536	0.000541	0.00569
	(0.00338)	(0.00293)	(0.00147)	(0.00339)
Constant	-0.854**	-0.804***	-0.223	-1.135***
	(0.318)	(0.277)	(0.168)	(0.327)
Observations	154	154	154	40
Number of countries	20	20	20	20
Adjusted R2	0.260	0.176	0.279	0.610

Note: Standard OLS regressions including country and time-fixed effects. Robust standard errors are adjusted by clustering at the country level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The data span from 1994 to 2010. See Table C5.
Source: Based on CNEF, ECHP and EU-SILC.

Table C3. **Annual hours worked, policies and individual characteristics**

		Large changes			Rolling window		
EPL		2.282***	2.283***	2.609***	1.383***	1.416***	1.425***
EPL^2		-0.411***	-0.415***	-0.494***	-0.258***	-0.266***	-0.264***
	High school	-0.0113			-0.00499		
	More than high school	0.0392***			0.0104*		
Interaction with	Age		5.56e-04			3.94e-04*	
	2nd quartile			0.0735*			-0.0317
	3rd quartile			0.0605*			-0.0228
	4th quartile			0.0730**			-0.0173
ALMP		0.114	0.468***	0.534***	0.00886	0.0744**	0.0447
	High school	0.0945***			0.0228**		
	More than high school	0.0509			0.0110		
Interaction with	Age		-0.00723***			-0.00117***	
	2nd quartile			-0.438***		4.19e-05***	
	3rd quartile			-0.425***			-0.0756*
	4th quartile			-0.400***			-0.0528
GRR		0.00337	-0.00411	-0.00923			-0.0491
	High school	-0.00173*			-0.000881	-0.00306*	-0.00386*
	More than high school	-0.000219			-0.000808***		
Interaction with	Age		0.00016***		-0.000238		
	2nd quartile			0.00575			0.000375
	3rd quartile			0.00858***			0.00120
	4th quartile			0.00958***			0.00191*
Cent		6.074***	6.190***	5.855***	2.510***	2.806***	2.624***
Cent^2		-4.303***	-4.278***	-4.160**	-1.427**	-1.544***	-1.591***
	High school	0.0247			0.0104		
	More than high school	0.103			0.00273		
Interaction with	Age		-0.00248			-0.00342***	
	2nd quartile			0.638***			0.0380
	3rd quartile			0.430***			-0.0145
	4th quartile			0.431**			-0.00557
CIR		-3.936***	-4.190***	-4.028***	-1.222***	-1.340***	-1.230***
CIR^2		2.386***	2.389***	2.554***	0.858***	0.842***	0.869***
	High School	-0.0308			-0.0141		
	More than high school	0.0157			-0.0207		
Interaction with	Age		0.00590***			0.00217**	
	2nd quartile			-0.137			-0.010
	3rd quartile			-0.0577			-0.0277
	4th quartile			-0.207			-0.0701
PMR		1.176**	1.063**	1.282**	0.296*	0.216*	0.300*
PMR^2		-0.286**	-0.285**	-0.301**	-0.0415	-0.0248	-0.0555
	High School	0.0647*			-0.00978		
	More than high school	-0.00853			-0.0114		
Interaction with	Age		0.00316***			0.000343	
	2nd quartile			0.181			0.0653
	3rd quartile			0.0130			0.0171
	4th quartile			-3.19e-05			0.0126

Table C3. **Annual hours worked, policies and individual characteristics** *(cont.)*

	Large changes			Rolling window		
Output gap	-0.000133	0.000387	-0.00195	-0.00845***	-0.00847***	-0.0067***
Age	-0.0303***	-0.0378***	-0.0303***	-0.0106***	-0.0121***	-0.0104***
Age^2	0.0002***	0.0002***	0.0002***	0.00001***	0.00001***	0.00001***
Male	0.145***	0.145***	0.147***	0.0239***	0.0238***	0.0242***
High school	-0.0507	0.0431***	0.0389***	0.0437**	0.00544	0.00405
More than high school	0.0163	0.163***	0.163***	0.0334	0.0320***	0.0303***
Full time	0.00582	0.00563	0.0110	0.0245*	0.0244*	0.0257*
2nd quartile	0.445***	0.445***	-0.0636	0.0687***	0.0689***	0.0733
3rd quartile	0.0642**	0.0642**	-0.197	-0.00425	-0.00403	0.0427
4th quartile	0.0456	0.0463	-0.216	-0.00778	-0.00753	0.0190
If couple	-0.0324**	-0.0368***	-0.0301**	-0.00544	-0.00594	-0.00513
Constant	-3.994***	-3.773***	-4.232***	-1.635***	-1.593***	-1.630***
Observations	807 381	807 381	807 381	84 592	84 592	84 592

Note: Estimations using the incidence of 20% changes come from probit regressions, and using the rolling window standard OLS. All regressions include country and time-fixed effects. Robust standard errors are adjusted by clustering at the country-time level. Only the coefficients are shown in the table. *** p < 0.01, ** p < 0.05, * p < 0.1. The data span from 1994 to 2010. See Table C5.
Source: Based on CNEF, ECHP and SILC.

Table C4. **Volatility of hourly earnings, policies and individual characteristics**

		Large changes			Rolling window		
EPL		0.548	0.477	1.269***	0.905**	0.827**	0.974***
EPL^2		-0.0946	-0.0967	-0.317***	-0.167***	-0.158***	-0.181***
	High school	0.0220*			0.00201		
	More than high school	0.0355**			0.0123		
Interaction with	Age		0.00199***			0.000598***	
	2nd quartile			0.194***			0.00576
	3rd quartile			0.238***			0.0269
	4th quartile			0.273***			0.0362
ALMP		-0.205*	-0.00244	0.968***	-0.0598	0.0333	-0.230**
	High school	0.0635**			0.0439***		
	More than high school	-0.0300			0.0280		
Interaction with	Age		-0.00445***			-0.00156**	
	2nd quartile			-1.085***			0.0994
	3rd quartile			-1.004***			0.207*
	4th quartile			-1.051***			0.200*
GRR		0.0424***	0.0429***	-0.00101	-0.00186	-0.00380	0.00153
	High school	-0.0033***			-0.00108		
	More than high school	-0.000425			-0.000255		
Interaction with	Age		-4.33e-05			4.06e-05	
	2nd quartile			0.0282***			-0.00275
	3rd quartile			0.0221***			-0.00435
	4th quartile			0.0280***			-0.00314
Cent		4.246***	3.997**	5.708***	3.316*	3.147*	3.920**
Cent^2		-4.722**	-4.694**	-3.688*	-3.072	-2.868	-3.223
	High school	0.0464			0.0448		
	More than high school	0.104			-0.00491		
Interaction with	Age		0.00528*			-0.00111	
	2nd quartile			-1.333***			-0.426*
	3rd quartile			-1.596***			-0.668***
	4th quartile			-1.573***			-0.667***

Table C4. **Volatility of hourly earnings, policies and individual characteristics** *(cont.)*

		Large changes			Rolling window		
CIR		-2.907***	-3.159***	-3.450***	0.0374	-0.102	-0.118
CIR^2		1.321***	1.299***	1.553***	-0.0529	-0.0423	-0.109
	High school	-0.0473			-0.0774**		
	More than high school	-0.0883			-0.0768		
Interaction with	Age		0.00519*			0.000981	
	2nd quartile			0.792**			0.266
	3rd quartile			0.427			0.197
	4th quartile			0.326			0.127
PMR		0.0246	-0.193	-0.509*	-0.0483	-0.0953	0.0762
	High school	0.0345			-0.00310		
	More than high school	0.0917			-0.0126		
Interaction with	Age		0.00608***			0.000930	
	2nd quartile			0.669***			-0.0782
	3rd quartile			0.668***			-0.145
	4th quartile			0.667***			-0.150
Output gap		0.00694	0.00627	-0.00704	0.00350	0.00314	0.00441
Age		-0.0310***	-0.0454***	-0.0300***	-0.0059**	-0.00988***	-0.00616**
Age^2		0.000300***	0.000307***	0.000289***	5.81e-05**	6.92e-05**	6.01e-05**
Male		0.145***	0.144***	0.150***	0.0363***	0.0359***	0.0365***
High school		-0.0843	-0.0284***	-0.0306***	0.00645	-0.00256	-0.00501
More than high school		-0.200***	-0.00301	0.00470	0.0231	0.0139**	0.0111*
2nd quartile		-0.0674	-0.0667	-1.708***	-0.315***	-0.313***	-0.131
3rd quartile		-0.348***	-0.347***	-1.746***	-0.414***	-0.412***	-0.0863
4th quartile		-0.189***	-0.187***	-1.778***	-0.406***	-0.404***	-0.0950
If couple		0.0225***	0.0181**	0.0235***	0.00509	0.00454	0.00564
Constant		-1.329	-0.783	-0.658	-0.684	-0.412	-1.058
Observations		379 035	379 035	379 035	48 659	48 659	48 659
Max likelihood		-228 707	-228 680	-227 745	0.064	0.064	0.070

Note: Estimations using the incidence of 20% changes come from probit regressions, and using the rolling window standard OLS. All regressions include country and time-fixed effects. Robust standard errors are adjusted by clustering at the country-time level. Only the coefficients are shown in the table. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The data span from 1994 to 2010. See Table C5.
Source: Based on CNEF, ECHP and SILC.

Table C5. **Country coverage in the macro and micro level regressions**



Note: This table shows the effective coverage of country-year in the panel regressions, i.e. after combining survey data (Figure A.1.) and policy indicators.
Source: Based on CNEF, ECHP and SILC.

Table C6. **Earnings volatility and economic policies by sectors**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Annual hours		Hourly earnings		Annual hours		Hourly earnings	
VARIABLES	Incidence of large changes	Rolling window	Incidence of large changes	Rolling window	Incidence of large changes	Rolling window	Incidence of large changes	Rolling window
USrealloc *EPL	0.185**	0.108	0.169*	0.282***				
	(0.0864)	(0.0717)	(0.0905)	(0.105)				
USrealloc *EPL^2	-0.0402**	-0.0255*	-0.0394**	-0.0470**				
	(0.0156)	(0.0129)	(0.0163)	(0.0190)				
USentry *PMR					0.101*	0.0826*	0.0107	-0.133**
					(0.0540)	(0.0423)	(0.0538)	(0.0615)
USentry *PMR^2					-0.0256*	-0.0220*	-0.00369	0.0376**
					(0.0144)	(0.0113)	(0.0143)	(0.0164)
Constant	0.195***	0.166***	0.250***	0.107**	-0.174	-0.128	0.262	0.640***
	(0.0419)	(0.0348)	(0.0439)	(0.0511)	(0.183)	(0.143)	(0.182)	(0.208)
Observations	117	117	117	117	135	135	135	135
Number of countries	9	9	9	9	9	9	9	9
Adjusted R-squared	0.655	0.553	0.650	0.609	0.612	0.547	0.614	0.588

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The data span from 1994 to 2000. USrealloc is defined as the worker reallocation rate in US industries. US entry is defined as the firm entry rate in US industries. Country and industry dummies, and dummies for the proportion of male workers and the proportion of workers older than 45 years are included. See Box 4 for details on the identification methodology.
Source: Annual hours worked and hourly earnings derived from household surveys (CNEF and ECHP), worker reallocation rates are from Bassanini (2010), and firm entry rates from Klapper et al. (2006).

OECD Journal: Economic Studies
Volume 2015
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Can pro-growth policies lift all boats? An analysis based on household disposable income

by
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In a majority of OECD countries, GDP growth over the past three decades has been associated with growing income disparities. To shed some lights on the potential sources of trade-offs between growth and equity, this paper investigates the long-run impact of structural reforms on GDP per capita and household income distribution. Pro-growth reforms can be distinguished according to whether they are found to generate an increase or a reduction in household disposable income inequality. Those that contribute to reduce inequality include the reduction in regulatory barriers to competition, trade and FDI, as well as the stepping-up in job search assistance and training programmes. Conversely, a tightening of unemployment benefits for the long-term unemployed is found to lift mean household income but to lower income among poorer households, thus raising inequality. Several other reforms have no significant impact on income distribution.

JEL Classification: 047, D37, E61

Keywords: Growth, inequality, pro-growth policies

* The authors are members of the Economics Department of the OECD. They would like to thank Boris Cournède, Oliver Denk, Mark Pearson, Stefano Scarpetta, Jean-Luc Schneider, Paul Schreyer, Jan Strasky, Federico Cingano, Céline Thévenot, Florence Jaumotte and participants to the Working Party No. 1 of the Economic Policy Committee for useful comments and suggestions. They also thank Agnès Cavaciuti for statistical assistance and Caroline Abettan for editorial assistance. This work should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the authors.

1. Introduction

Pro-growth structural reforms are regularly assessed on the basis of their effectiveness in boosting material living standards through their ability to lift employment and productivity. GDP per capita has been the variable traditionally used to measure of living standards (OECD, 2013a). Yet, the limitations of GDP per capita in measuring people's wellbeing – even from a narrow material living standard perspective – are well-known (Stiglitz et al., 2009, OECD, 2011a, OECD, 2010, Boarini et al., 2006). For instance, median household income – an income measure which better reflects the actual material living standards of a "typical" household – has evolved quite differently from GDP per capita in a number of countries.

The purpose of this paper is to provide new empirical evidence on the effects of structural policies on households' incomes across the distribution, with the aim of identifying policy tradeoffs and complementarities between efficiency and equity.[1, 2] It is a follow-up on an earlier paper that provided a new assessment of how households' income fared compared with GDP and of the evolution of inequality and poverty across OECD countries over the last 15 years (Causa et al., 2014).[3]

The previous paper confirmed that focusing on output alone provides an inaccurate picture of people's actual material living standards as it showed for instance that growth in GDP per capita outpaced growth in mean household income in most OECD countries during the last two decades. It also emphasised the need to go beyond single measures of inequality and argued in favor of looking at the structure and location of inequalities, such as within each half of the income distribution. Putting more focus on the lower-half of the distribution, it documented a relatively widespread tendency for bottom incomes to lose ground relative to median incomes, and, as a result, an increase in relative poverty in the majority of OECD countries.

The current paper builds on these findings and complements previous OECD analysis in the area of structural policies and inequality, in particular OECD (2012)[4] and OECD (2011b). It goes beyond earlier studies in two main respects:

- The paper relies on a recently-developed analytical framework that encompasses average income and the income distribution within a simple unified measure – income standards. The latter summarizes the level of income by placing progressively more weight on different portions of the distribution. Taking average income as the benchmark point, the analysis focuses on the lower-half of the income distribution, i.e. moving progressively from median to bottom incomes. This is consistent with a Rawlsian approach to social welfare, which puts relatively stronger weight on the lower end of the distribution.
- The paper analyses the joint effects of structural policies on GDP per capita and household incomes, on average and across the distribution. It investigates the extent to which structural policies have differential long-run impacts on GDP per capita and household incomes at different points of the distribution. This is aimed at identifying potential policy trade-offs and synergies between economic efficiency, household material living

standards and inequality. Relying on this assessment, different countries may implement different policy reforms, depending on various factors such as societal preferences and aversion to inequality, but also short-term budgetary and or political constraints.

The paper is structured as follows. Section 2 defines and illustrates incomes standards as encompassing measures covering household incomes on average and across the distribution. Section 3 lays out the starting point of the analysis: it assesses the extent to which GDP per capita trickles down to household incomes on average and across the distribution; it attempts to identify the potential drivers of the widespread growing shortfall of household incomes *vis-à-vis* GDP. Section 4 starts by briefly discussing the potential channels of transmission from GDP per capita-enhancing policies to average incomes and their distribution. It then presents the empirical approach pursued in the paper to address this issue. On the basis of this framework, Section 5 delivers new empirical evidence on the joint impact of structural reforms on GDP per capita and household disposable incomes, on average and across the distribution. As a result, the paper delivers evidence on the impact of structural policies on inequality in disposable incomes.

The analysis covers a large span of institutional settings that have been found to boost GDP per capita, either directly or through various channels (i.e. labour utilisation and labour productivity). It focuses on the area of tax policies, labour market and product market policies. Non-policy factors such as up skilling, globalisation and technological change are also covered, albeit more succinctly.[5] Section 6 wraps up the empirical findings by classifying policy reforms on the basis of their joint effects on GDP per capita and household disposable incomes across the distribution.

2. A unified framework for assessing households' material living standards on average and across the distribution

2.1. Basic concepts and data limitations

The central income concept used throughout the analysis is that of household disposable income, as this is the best proxy of households' economic resources defined by internationally agreed standards and computable across the income distribution.[6] Household disposable income broadly builds on the following pillars:

- *Income concept*: Disposable income encompasses all income sources, hence it includes net transfers from government (cash transfers net of direct taxes paid by households) in addition to market income, which covers both labour income (wages, salaries and self-employment income) and income derived from capital.
- *Unit of observation:* Income is measured at the household as opposed to individual level and takes into account economies of scale in consumption within households.[7]
- *Scope of the reference population:* Income is measured for total population (as covered in survey-based data) as opposed to sub-groups such as, in particular, the working or working-age population.

In the rest of this paper, *income* will refer to *disposable* income unless otherwise specified.

The empirical analysis relies on the *OECD Income Distribution Database*, where an attempt is made to achieve the best possible comparability across countries and over time (Box 1). For each country and each year, the database covers mean disposable income by deciles (i.e. the population is sliced in ten equally sized groups ranked by income), allowing direct computation of income standards (see Box 2). Despite the high quality of the data,

Box 1. **The *OECD Income Distribution Database***

In order to benchmark and monitor countries' performance in the field of income inequality and poverty, the OECD has developed over the last 20 years a statistical database of a number of standardised indicators. These indicators are based on the central concept of "equivalised household disposable income", i.e. the total income received by the household less the current taxes and transfers they pay, adjusted for household size with an equivalence scale.

The method of data collection used for the *OECD Income Distribution Database* aims to maximise international comparability as well as inter-temporal consistency of data. This is achieved by a common set of protocols and statistical conventions (e.g. on income concepts and components) to derive estimates. The information obtained by the OECD through a network of national data providers is more up-to-date relative to that available through many other statistical sources, but reflects the long time-lags that characterise data collection in this field in most OECD countries. Country estimates are provided to the OECD in the form of semi-aggregated tabulations, and are based on national sources that are deemed to be most representative for each country. One disadvantage of this approach is that it does not allow accessing the original micro-data, which constrains the subsequent analysis that can be performed.

The data collection is undertaken via a standardized questionnaire. Selected data from this questionnaire are available at *www.oecd.org/els/soc/inequality-database.htm*.

The data cover OECD countries and span the period from mid-80s until end 2000s. Currently, the data are not available on a yearly basis and time coverage varies widely across countries, ranging from e.g. 5 points for Australia to 17 points for Canada. Due to the increasing importance of income inequality and poverty issues in policy discussion, the database is in the process of being annually updated. The OECD aims to extend its database to Brazil, China, India, Indonesia, Russia and South Africa.

especially from a cross-country comparative perspective, some caveats need being borne in mind, which qualify the boundaries of the analysis:

- The data do not build on a longitudinal panel structure, which makes it impossible to measure inequality in a dynamic perspective and therefore to study intra and inter-generational income mobility. As a consequence, this paper focuses on inequality from a static perspective.
- As most household surveys, the data used here measure income on a cash basis and therefore do not include several non-cash components such as in-kind public transfers and income for owner-occupied housing.[8] Capital income does not include capital gains. These income components are generally not evenly distributed across the income distribution. For example, in-kind public services represent a higher share of disposable incomes at the bottom of the distribution.[9, 10] The absence of in-kind public services implies that the current paper may overestimate the level of inequality in countries where such transfers represent a relatively important income component at the low end of the distribution – hence a major redistribution tool. Income from capital gains represents a higher share of disposable income at the top of the distribution and more generally in its upper-half. One associated risk is thus that of underestimating the level of inequality in countries where capital gains represent a relatively important income component for households in the upper-end of the distribution.

- As most household surveys, the data used here underestimate top incomes, reflecting a number of well-known factors such as non-response rates increasing with income levels or confidentiality issues. Assessing top incomes would need to rely on tax return data, as has been done in OECD (2011b and 2014) for 17 OECD countries – based on pioneering work by Piketty and co-authors.[11] While top incomes are not the focus of this study, an associated risk is to underestimate levels and, even more, increases in inequality. Available evidence would suggest that in practice this risk could have tangible (though not measurable) consequences in the case of the United States.
- Real incomes are derived from the implicit assumption that all consumers across the income distribution face the same price for their consumption basket because price indices differentiated by population groups are not available for most countries.[12] This is a potential caveat, as different people buy different bundles of goods (e.g. poor people spend more on food and less on leisure) and they may buy their goods and services in different types of stores (which sell "similar" products at very different prices). Again it is not clear though if and to what extent this risk would impact cross-country comparisons.
- Indirect taxes are not included in the measure of taxes paid by households. Their impact may tentatively be reflected in cross-country-time series differences in consumption prices faced by households. Still, as implied by the above-discussed limitation, such inference would only be valid for the average household. As a result, the data do not allow for addressing the distributional implications of e.g. consumption taxes.

2.2. Household incomes across the distribution: The average and distribution-sensitive income standards

Headline household-based income standards indicators are constructed based on the general mean approach developed by Foster and Szekely (2008) following Atkinson's framework for measuring inequality (Box 2). Income standards are known as functions that summarise the income distribution by a single "representative" level of income, which can then be used in comparison of material living standards across countries and over time. Widely-used income standards reflect the general affluence of the distribution – the case of the average – or the affluence of some parts of the distribution – the case e.g. of the average income in the lowest quintile. Compared with those, the family of income standards defined in this paper, based on the general mean approach, do not restrict attention to income below an arbitrary cut-off point while ignoring incomes across the line. On the contrary, they allow placing progressively less weight on incomes higher up or down the distribution, such as from top to average incomes, from average to median incomes, from median to bottom incomes (Box 2).

Box 2. **General means as income standards**

General means are grounded in Atkinson's (1970) framework for inequality and welfare analysis and belong to the family of "equally distributed equivalent income" functions. The equally distributed equivalent level of income is the level of income per head, which if equally distributed, would give the same level of social welfare as the present distribution. Formally, general means are defined as follows:

$$\mu_\alpha = \left[(x_1^{\alpha} + \ldots + x_n^{\alpha})/n\right]^{\frac{1}{\alpha}} \text{ for all } \alpha \neq 0 \text{ and } \mu_\alpha = \left[(x_1 \ldots x_n)\right]^{\frac{1}{n}} \text{ for all } \alpha = 0,$$

where the vector $x = (x_1, \ldots x_n)$ describes the income distribution, $x_i > 0$ is the income of the i-th person and n is the population size. Clearly, the general mean reduces to the standard mean or equivalently the average when $\alpha = 1$. The case where $\alpha = 0$ is called the geometric mean whereas $\alpha = -1$ is known as the harmonic mean.

Box 2. **General means as income standards** *(cont.)*

For a fixed distribution x, the value of the general mean $\mu\,\alpha(x)$ is increasing in the parameter α, with the value approaching the maximum income of x as α rises to ∞ and tending to the minimum income as α falls to $-\infty$. The income standard $\mu\alpha(x)$ places greater weight on higher incomes and less weight on lower incomes as the parameter rises. Hence α can be interpreted as (an inverse) measure of the level of inequality aversion. The parameter value $\alpha = 1$ (corresponding to the average) provides a natural dividing line between the "bottom sensitive" income standards (with $\alpha < 1$) that emphasise lower incomes and take values below the average, and "top sensitive" income standards (with $\alpha > 1$) that emphasise higher incomes and take values above the average. The geometric mean ($\alpha = 0$) is generally empirically close to the median.

Inspection of income standard as defined by general means allows for a broad assessment of inequality across countries and over time. Because these functions can be linked to the Lorenz criterion underlying inequality measurement, this assessment will be consistent with that implied by most widely used summary inequality measures such as the Gini coefficient* – and can be intuitively explained as follows: i) comparing income distributions across two countries (A and B) at a given point in time, if country A and country B feature the same level of average income but all bottom sensitive income standards are lower and all top sensitive income standards are higher in country A, then this implies higher inequality in A compared with B, consistent with Gini-based inequality ranking; ii) comparing income distributions in a single country over a given period: weaker growth in all bottom sensitive income standards and stronger growth in all top sensitive income standards compared with the average implies an increase in inequality over this period, consistent with Gini-based inequality assessment.

Income standards as defined by general means feature a number of analytical properties making them an attractive alternative to widely-used income standards such as median incomes or mean incomes in the bottom of the distribution. General means are the only income standards that satisfy simultaneously linear normalisation (requiring that when all incomes are identical, the income standard is simply the common income level), replication invariance (requiring that the income standard is measured on a per capita basis), homogeneity (requiring that if all incomes are doubled, the income standard must double as well), continuity (requiring that the income standard does not abruptly change as incomes are altered) and subgroup consistency (requiring that if the income of two distributions in two populations subgroups change in such a way that the income standard rises in one and is unchanged in the other, then the overall standard must rise). It has to be noted for instance that the mean income of the bottom fifth, the income standard employed in many studies including Dollar and Kraay (2001), does not satisfy sub-group consistency. As a result of these properties, this approach has been recently fully extended as a general tool being now systematically used by the World Bank for tracking inequality and poverty (Foster et al., 2013).

While the baseline specification is estimated for the full-range of bottom to top-sensitive income standards, as governed by the parameter α, the range of income standards considered is narrowed for policy analysis. Reflecting the initial focus of this paper – on bottom income households and the poor, the policy analysis is performed for average income and a selected range of bottom-sensitive income standards. From a welfare and policy perspective, these reflect increasing levels of inequality aversion, from no inequality aversion ($\alpha = 1$) to strong inequality aversion – while the first case is consistent with utilitarian welfare principles, the last case comes close to Rawlsian welfare principles ($\alpha = -8$):

1. Null emphasis on the income distribution: the standard mean ($\alpha = 1$, average income) provides the benchmark point.
2. Weak emphasis on the bottom of the distribution: the geometric mean ($\alpha = 0$, median income) is empirically generally close to the median.
3. Moderate emphasis on the bottom of the distribution: this case ($\alpha = -3$, income of the lower-middle class) is covered mainly to ensure continuity between the median and the low-end of the distribution. This intermediate case can be interpreted as covering incomes in the "lower-middle class", defined as households with incomes above the poverty threshold but below the median income.

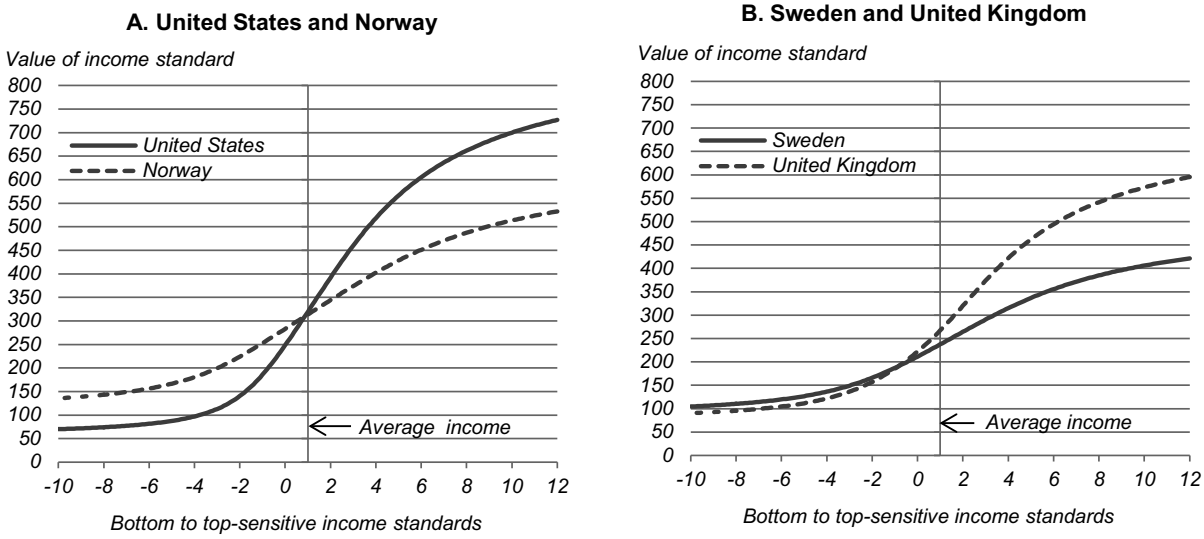
Box 2. **General means as income standards** *(cont.)*

4. Strong emphasis on the bottom of the distribution: this case (α = -8, income of the poor) is empirically generally close to the mean income of the poor, where the latter are defined in relative terms with a threshold set between 50 and 60% of median income.

* The Gini coefficient is defined as the area between the Lorenz curve (which plots cumulative shares of the population, from the poorest to the richest, against the cumulative share of income that they receive) and the 45° line, taken as a ratio of the whole triangle.

Income standards as defined above can be used to evaluate and compare income distributions across countries and over time. First, inspection of income standard curves delivers a broad assessment of inequality rankings across countries, which will be consistent with that implied by most widely used summary inequality measures such as the Gini coefficient. This evaluation is illustrated in Figure 1 for selected pairs of OECD countries, in each case exhibiting similar levels of average household incomes in 2010 (i.e. the income standard curves cross at μ_1). Panel A compares the United States with Norway: for a common level of average income, all bottom-sensitive income standards ($\alpha < 1$) are lower for the United States than for Norway, whereas all top-sensitive income standards ($\alpha > 1$) are higher, clearly indicating the lower level of income inequalities in the latter country compared with the former.

Figure 1. **Household incomes across the distribution: Selected OECD countries**



Note: As explained in the text, household incomes across the distribution are measured by the full range of income standards, i.e. from top to bottom-sensitive income standards. Income data refer to 2010 and are divided by a factor of 200 and expressed in USD, constant prices and constant PPPs (OECD base year 2005) with Purchasing Power Parities for private consumption of households. The figures read as follows: Panel A compares the United States with Norway; for a common level of average income all bottom-sensitive income standards ($\alpha < 1$) are lower for the United States than for Norway, whereas all top-sensitive income standards ($\alpha > 1$) are higher, indicating the lower level of income inequalities in the latter country compared with the former. See text for details.
Source: OECD Income Distribution Database.

In addition, inspection of income standard curves allows assessing in a snapshot the "location" and profile of inequality within countries at any given point in time. For example, contrasting with the previous case showing strong distributional differences for top and bottom-sensitive income standards, a comparison between Sweden and the United Kingdom

points to strong distributional differences for top-sensitive income standards only (Figure 1, Panel B). This indicates that the higher level of income inequalities in the United Kingdom compared with Sweden is mostly driven by higher inequality within the upper half of the distribution.

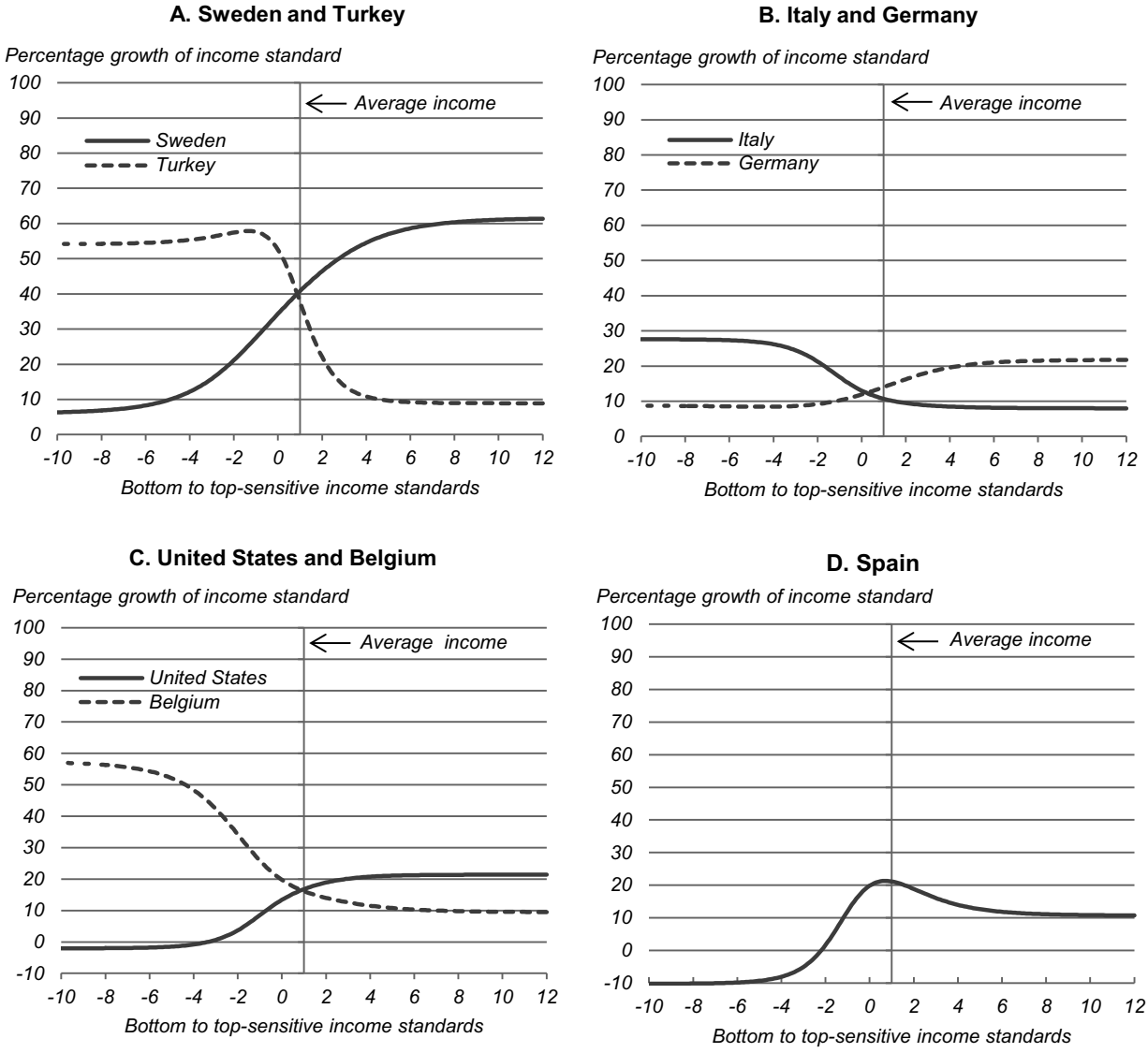
The comparison between growth in bottom to top-sensitive income standards and growth in mean incomes provides a broad assessment of inequality developments. In addition, as is the case with level-based analysis, this assessment will be consistent with that implied by most widely used summary inequality measures such as the Gini coefficient. This evaluation is illustrated in Figure 2 (Panels A to C) for selected pairs of OECD countries, in each case exhibiting similar growth of average household income over the period going from the mid-90s to end-2000s (i.e. the income standard curves cross at μ_1). Panel A compares Sweden to Turkey: in Turkey all bottom-sensitive income standards grew much faster than the average, whereas top-sensitive income standards grew more slowly, implying a marked decline in inequality. In Sweden, the opposite occurred, implying a sharp increase in inequality. A similar picture emerges from the comparison between Germany, where inequality increased, and Italy, where it decreased (Figure 2, Panel B). But the flatness of these countries' income standard curves relative to that of Sweden and Turkey indicates smaller changes in income dispersion.

Growth in income standards allows not only for assessing the broad evolution of inequality but also associated profiles, i.e. the sources and patterns of changing inequality within each country. For example, the contrasting developments in inequality between Sweden and Turkey and between Italy and Germany were driven by growth differences in both the upper and lower halves of the income distribution, that is, for both top and bottom sensitive income standards compared with the average. In the case of Belgium and the United States (Figure 2, Panel C), the broad divergence in inequality – a decline in the former country and a rise in the latter – was mainly driven by differential developments within the lower-half of the income distribution. The data would suggest for instance that the rise in inequality in the United States between the mid-1990s and end-2000s resulted from a marked growth shortfall of bottom compared to middle incomes amid similar growth dynamics within the upper-half of the income distribution – however this should be qualified due to the risk that the data used here may underestimate the increase in upper-income inequalities in the United States.[13]

Finally, Spain provides a good illustration of contrasting inequality developments in the two halves of the distribution (Figure 2, Panel D): it experienced lower growth in top-sensitive income standards compared with the middle of the distribution, implying contracting inequalities in the upper-half of the income distribution, but at the same time slower (in fact negative) growth in bottom-sensitive income standards compared with the middle of the distribution, implying increasing inequalities in the middle and lower-half of the income distribution.[14] According to the Gini coefficient, income inequality declined over that period in Spain, suggesting that summary inequality measures on their own provide a partial view of inequality developments.

To summarise, income standards deliver, within a single curve, a comprehensive assessment of countries' income distribution and provide a powerful complement to standard inequality analysis derived from single measures such as the Gini coefficient or income shares. For instance, designing appropriate policies to reduce the level or curb the rise in inequality can be helped by previous identification of the profile of inequality at one

Figure 2. **Growth in household incomes across the distribution between the mid-1990s and late 2000s: Selected OECD countries**



Note: As explained in the text, household incomes across the distribution are measured by the full range of income standards, i.e. from top to bottom-sensitive income standards. The data show cumulative growth rates and refer to the period 1995-2009. Income data are expressed in USD, constant prices and constant PPPs (OECD base year 2005) with Purchasing Power Parities for private consumption of households. The figures read as follows. Panel A compares Sweden to Turkey: for a common growth in average income, in Turkey all bottom-sensitive income standards grew much faster than the average, whereas top-sensitive income standards grew more slowly, implying a decline in inequality. In Sweden, the opposite occurred, implying an increase in inequality. Panel D illustrates contrasting inequality developments in the two halves of the distribution: Spain experienced lower growth in top-sensitive income standards compared with the middle of the distribution, implying contracting inequalities in the upper-half of the income distribution, but at the same time slower growth in bottom-sensitive income standards compared with the middle of the distribution, implying increasing inequalities in the middle and lower-half of the income distribution. See text for details.
Source: OECD Income Distribution Database.

point in time or with reference to the past. Whether inequality increases occurred across the whole distribution of income (such as in Sweden) or within a narrower part of the distribution (such as in the United States and even more so in Spain) would bear differential policy implications such as e.g. increasing top marginal tax rates *versus* introducing tax credits for low incomes.

3. From GDP per capita to household disposable incomes across the distribution

3.1. A first look at the data

Looking beyond GDP per capita to household incomes requires establishing the link between these two measures. In principle, domestic production should for the most part "trickle down" to domestic households, which implies that, absent measurement and methodological considerations and controlling for shifts in terms of trade, the elasticity of average household disposable income to GDP per capita should be close to one in the long run. Associated distributional patterns depend on the differential effects of GDP per capita growth across income groups. The question is then whether economic growth "lifts all boats", including incomes at the lower end of the distribution. It has been mainly studied in the field of poverty, such as e.g. by Dollar and Kraay (2001, 2013), Timmer (1997) and Ravallion and Chen (1997). If the benefits of growth are shared across the economic strata, this increases the attractiveness of purely growth-oriented policies. On the other hand, if economic growth typically leaves the poorer groups behind, there may be trade-offs between growth and inequality and pro-growth policies may have to be tempered by distributional considerations.

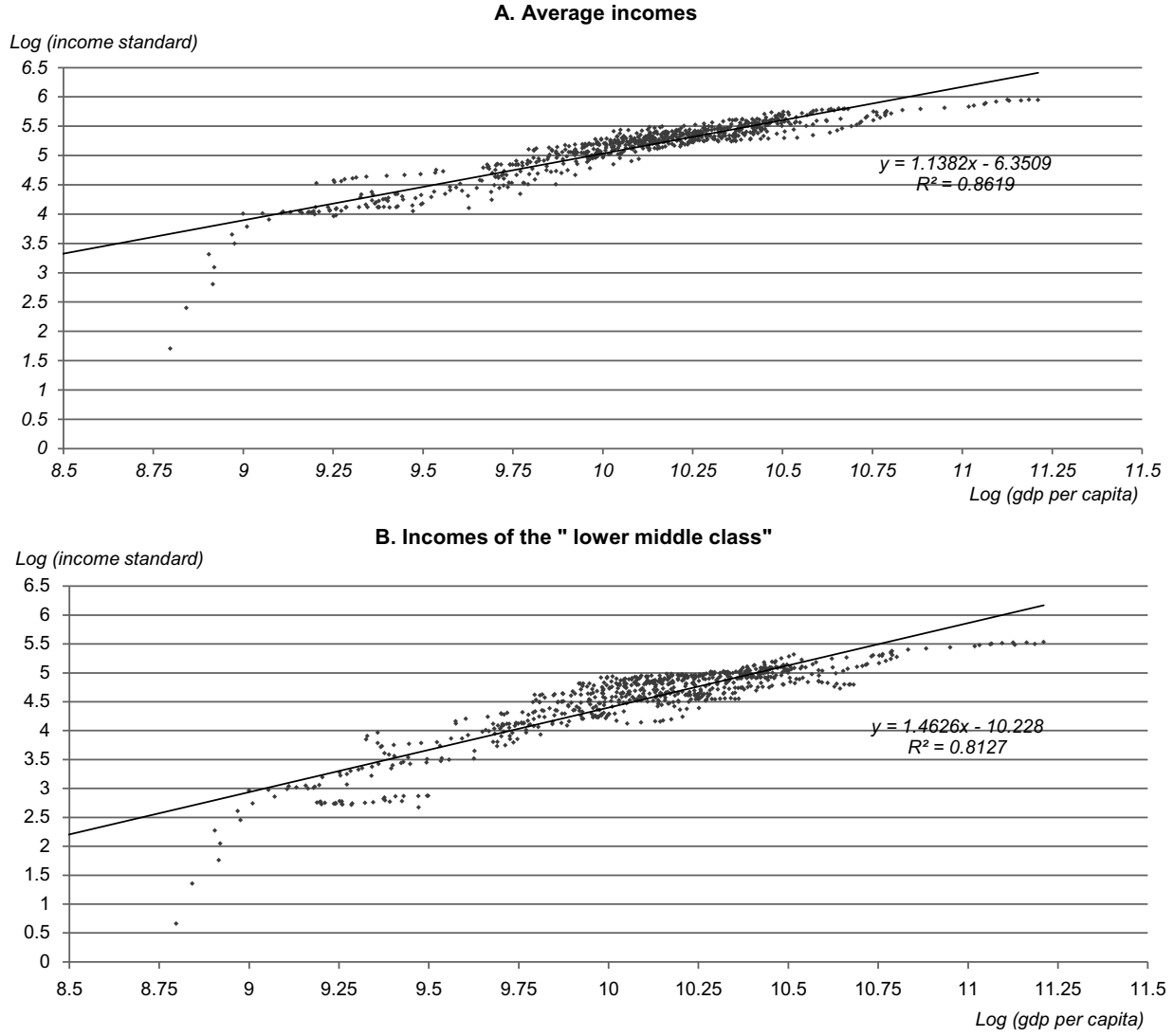
A preliminary look at the data would suggest that across OECD countries between the mid-1980s and the late 2000s, GDP per capita fully trickled down to domestic households (Figure 3)[15] Panel A shows a positive linear relationship between GDP per capita and average household income, with a slope close to unity, which indicates that on average household incomes have risen in similar proportions to GDP per capita. In addition, the data would suggest that the benefits of growth over the last fifteen years have been shared equitably since low incomes – represented here by incomes of the "lower-middle class" (see definition in Box 3) – have risen by somewhat more than GDP per capita (Panel B). At the same time, the relationship between these measures seems to exhibit dispersion and nonlinearities – especially at low GDP per capita levels. This calls for a multivariate analysis of the association between GDP per capita and household incomes across the distribution, as done in the next section.

3.2. GDP per capita elasticities of household disposable incomes: baseline results

The baseline model builds on the joint estimation of GDP per capita and household income equations (Box 3). The GDP per capita specification is based on the augmented-Solow model (Mankiw, Romer and Weil, 1992), where in addition to population growth, the set of long-run determinants of GDP include proxies for investment in human and physical capital, as well as labour-augmenting efficiency. The household income specification is based on the assumption that in the long run the level of income is mainly driven by the level of GDP per capita. In addition to the level of GDP per capita, the baseline household disposable income specification includes a proxy for terms-of-trade fluctuations and country-fixed effects. Empirical evidence suggests that the contribution of terms-of-trade fluctuations to the gap between real GDP per capita and average household disposable income can be large, especially in commodity-exporting countries.[16] The baseline estimation is produced across the full range of top to bottom-sensitive household incomes standards and covers average income as the benchmark case.

The baseline elasticities presented in Figure 4 indicate that on average across OECD countries and over the period examined (mid-1980s to the late 2000s), gains in real

Figure 3. **GDP per capita and household incomes across OECD countries**



Note: Each dot represents the income standard and GDP per capita levels of a given OECD country in a given year between 1985 and the late-2000s. As explained in the text, household incomes across the distribution are measured by selected income standards. Panel B illustrates the income standard for a moderate emphasis on the bottom of the distribution (α = -3). See text for details. Income data are expressed in USD, constant prices and constant PPPs (OECD base year 2005) with Purchasing Power Parities for private consumption of households. GDP is expressed in USD, constant prices and constant PPPs (OECD base year 2005) with Purchasing Power Parities for the GDP deflator.
Source: OECD Income Distribution Database.

household disposable income have not matched gains in GDP per capita. And growth has been unequal, as the gap between GDP per capita and household incomes has been wider at the lower end of the income distribution. This is indicated by the profile of the elasticity across the income distribution, which falls from 0.8 for high income to 0.75 around the average and 0.6 for low-income households. This finding is in line with the broad conclusions from previous empirical studies on inequality and in particular OECD (2011b), which documents widespread increases in inequality in OECD countries between the mid-1980s and the late 2000s.

While one would expect GDP per capita and average household disposable income to move in parallel – at least over a sufficiently long period – a number of factors could explain

Box 3. **The baseline model: structural econometric modelling of GDP and household incomes across the distribution**

The baseline specification takes the following form:

$$\Delta \ln(GDPt) = \beta_0 - \beta_1 \ln(GDP_{t-1}) + \beta_2 \ln(s_t) + \beta_3 \ln(h_t) - \beta_4 n_t + \beta_5 t + \delta_1 \Delta \ln(s_t) + \delta_2 \Delta \ln(h_t) + \delta_3 \Delta \ln(n_t) + \varepsilon$$

$$\Delta \ln(\mu_\alpha (x_t)) = \eta_{0,\alpha} + \eta_{1,\alpha} \ln(TT_t) + \eta_{2,\alpha} \Delta \ln(GDP_t) + \eta_{3,\alpha} \ln(GDP_t) - \eta_{4,\alpha} \mu_\alpha (x_{t-1}) + u$$

with $\text{cov}(\varepsilon, \mu) \neq 0$ and where:

- $\Delta \ln(GDPt)$ is the variation in GDP per capita between year t and year t-1
- $\Delta \mu\alpha\,(xt)$ is the variation in income standards between year t and year t-1 for a given value of α, i.e. the parameter driving the emphasis on different parts of the income distribution. The baseline specification covers the entire income distribution as measured by top to bottom-sensitive income standards. Household income equations are therefore estimated for a continuous range of αs.
- s is the investment rate defined as the share of investment in productive capital over GDP
- h is the stock of human capital, measured as mean years of schooling
- n is the growth rate of the working age population
- TT measures terms of trade effects (i.e. changes in export relative to import prices). Terms of trade effects are accounted for in consumer price deflators but not in GDP deflators. This variable is included as a control for one of the known and measurable sources of discrepancies between developments in GDP per capita and in household disposable incomes. See Causa et al. (2014) for recent evidence.
- ε et u are error terms, assumed to be correlated across the two equations

These equations are estimated jointly by SURE procedures. The GDP per capita and household income equations include country fixed-effects. The GDP per capita equation systematically includes a time trend and country specific time-trends. The baseline analysis is presented under two variants defined by a differential treatment of time in the household income equations: i) the household incomes equations are first estimated without and then ii) with time trends and country specific time-trends.

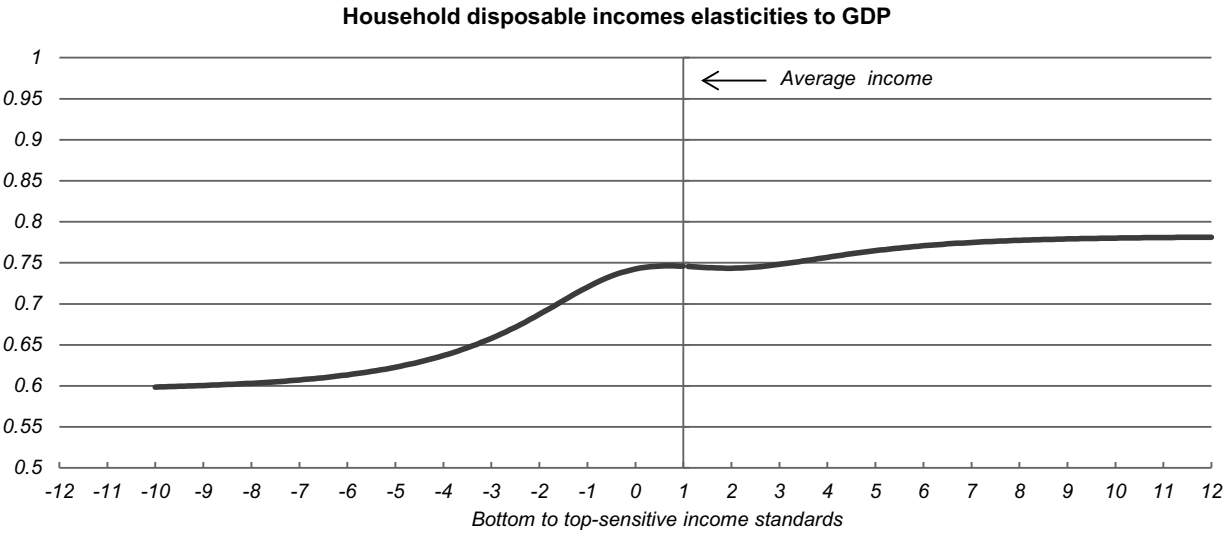
In the baseline setting, the parameters of interest are $\eta_{3,\alpha}/\eta_{4,\alpha}$ and measure the household disposable incomes elasticity to GDP per capita for: i) average household income ($\alpha = 1$) and ii) household incomes at different points of the distribution, as measured by top to bottom-sensitive income standards ($\alpha \neq 1$). The comparison of GDP per capita elasticities across α allows for assessing the distributional effects of GDP per capita growth.

The baseline estimations cover all OECD countries over the period from mid-1980s to late 2000s.

the relatively low elasticity obtained over the sample examined. First, some of the aforementioned measurement limitations associated with household income survey data of the kind used for this study can potentially account for part of the discrepancy:

- *The underestimation of top incomes*. Severe under-representation of top-income household in surveys could account in part the low elasticity even at the level of average household, if this group has benefited from a growing share of total income, as has been documented in several countries (Atkinson et al., 2011, OECD, 2011b). In fact, it is now consensually established that household surveys tend to be representative of the 99% of the income distribution but fail to capture the top 1%. In addition, such underreporting pattern has been growing over time (Burkhauser et al., 2012).

Figure 4. **From GDP per capita to household disposable incomes across the distribution, baseline elasticities**



Note: Elasticities estimated from the joint estimation of GDP and household income equations, without time trend (but with country fixed effects). It is assumed that GDP per capita drives long-run levels of household incomes across the distribution. Market income refers to disposable income before taxes and transfers for the working-age population. See text for details.

- *Non-compliance across the distribution*. The issue of top incomes underestimation is in fact more general and can pervade to the whole distribution. Not everyone who is asked to participate in a survey agrees to do so, and failure to respond is known to be different for households with different characteristics (Groves and Cooper, 1998). In developed countries, the probability of response is negatively related to almost all measures of socioeconomic status. This implies that income from household surveys tends to grow less rapidly than income measured from National Accounts, leading to a downward bias on the elasticity. As this relationship has strengthened over time, it implies a growing divergence between National Accounts and households' surveys figures (Deaton, 2005).
- *The exclusion of capital gains as a source of income*. Again, insofar as the share of profits distributed in the form of capital gains has been rising during the period examined, this would result in measured household income growing less rapidly than GDP per capita.

Second, aside from measurement problems, the low elasticity reported above may also reflect incomes transfers across the main economic sectors, which may have persisted long enough to have created a wedge between GDP per capita and household disposable incomes over a period of 25 years. More specifically, this gap would suggest a rise in income transfers from households to the public sector and the corporate sector.[17] A growing share of GDP going to the public sector could explain the lower elasticity at the bottom of the distribution if it has been associated with a partial reversal of redistribution policies, that is, lower (cash) public transfers and more broadly a decline in the progressivity of tax and benefits systems.[18]

- A growing share of GDP going to the corporate sector could be another potential driver of the rising gap between GDP per capita and household disposable incomes. This outcome could be related to the trend decline in the labour share of income and the concomitant rise in corporate saving. Such developments have been documented for a large number of countries over the last decades and attributed to various factors: in particular the

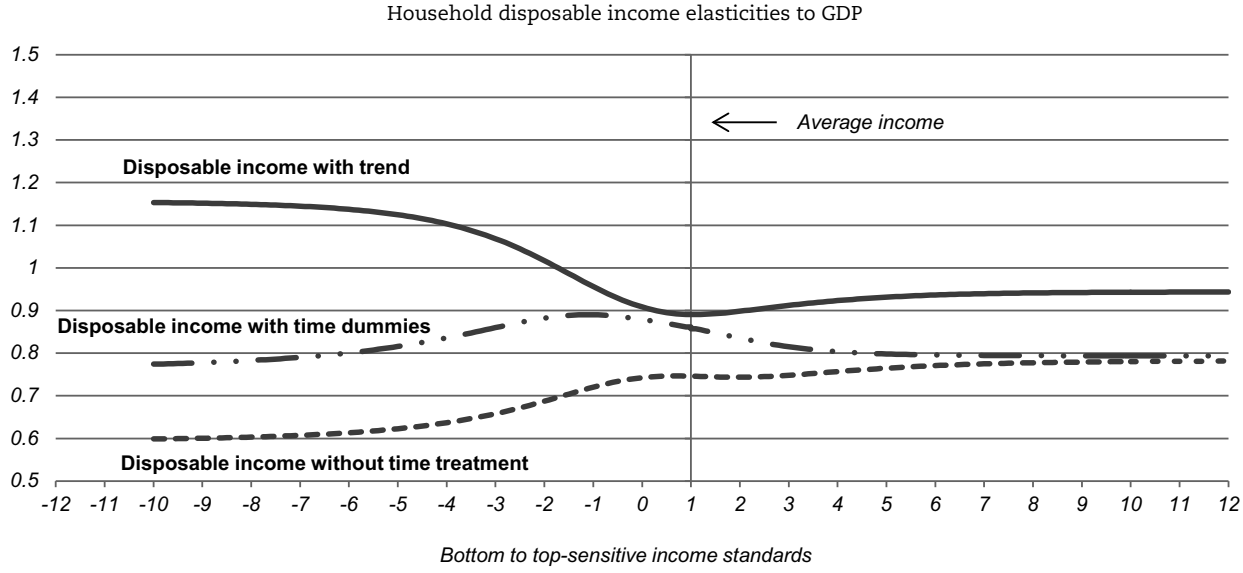
steady decline in the relative price of investment, which has lowered the cost of capital relative to labour (Karabarbounis and Neiman, 2012).[19] The decline in the labour share of income implies that the share of corporate profits – measured residually in the national accounts – has been rising over time. In principle, corporate income should be ultimately fully redistributed to households through interest, dividends, or re-invested profits (and hence capital gains). However, the substantial trend rise in corporate saving implies that a growing share of corporate profits is neither distributed in the form of dividends nor necessarily quickly re-invested to expand productive capacity. Together these phenomena may have contributed to the gap between household disposable income and GDP per capita through different mechanisms: Even under the assumption that all profits ultimately trickle down to households via shareholdings, the time required for profits to translate into higher measured household income may have lengthened considerably since the mid-1980s as a result of these developments.

- An increase in the portion of profits that is distributed through capital gains (re-invested profits, share buy-backs, etc.) means that a growing share of household income is under-reported for the reason mentioned above.
- The trend rise in the profit share of GDP per capita would imply that associated income transfers from the corporate to the household sector have increased for shareholders– generally households in the upper-end of the income distribution. This would help explain the lower elasticity of household income to GDP per capita at the bottom compared with the top of the distribution.

Assessing the relative contribution of these factors to the growing gap between GDP and household incomes is beyond the scope of this paper. However, to tentatively disentangle measurement-based explanations from cross-transfer-based explanations, an empirical strategy is to replace household average income as reported in surveys by household average income as reported in the National Accounts (NA). If transfers across sectors are the main reason for the failure of household income to match GDP gains on average, then using the N.A. measure of income should yield a similar picture, hence a similarly low elasticity. This is not the case: the elasticity of NA-based household average income to GDP turns out to be much closer to one (0.89), even though it remains statistically different from one. This suggests that the low elasticity of average household income to GDP that is obtained with survey-based data would rather reflect measurement gaps related to under-reporting. Explanations based on the growing share of corporate and public sector incomes at the expense of the household sector would have only played a limited role, at least on average across the sample of OECD countries. Some of these factors – e.g. the weaker redistributive role of the public sector and the trend rise in the profit share – may still account for the much lower elasticity at the bottom end of the distribution relative to the upper end.

- Against these findings and in order to assess whether such measurement issues would have grown over time, as suggested above, two sets of controls are alternatively introduced in the baseline: (country-specific) time trends and time dummies. Estimating the baseline elasticities with these controls included in the household income equations yields a different assessment on the long-run association between GDP per capita and household incomes across the distribution (Figure 5).[20] In the case of (country-specific) time trends, the elasticity of average household disposable incomes to GDP per capita is estimated to be close to one. It is thus very close to the elasticity obtained with the N.A.-

Figure 5. **From GDP per capita to household disposable incomes across the distribution, baseline elasticities with and without time treatment**



Note: Elasticities estimated from the joint estimation of GDP and household income equations. It is assumed that GDP per capita drives long-run levels of household incomes across the distribution. See text for details.

based measure of household income without time treatment. This finding would confirm that survey-based income measurement issues and underestimation have been growing over time. The elasticity estimated with time trends is significantly higher at the lower-end of the distribution than at the average and upper-end of the distribution, suggesting that GDP growth would have been associated with lower rather than higher inequalities.

- The introduction of (country-specific) time dummies generates an intermediate outcome. As in the case of time trends, the estimated elasticity around the average is also closer to one and controls to the one obtained with the N.A.-based measure of household income without time treatment – again confirming the growing role of measurement issues in survey data. However, the results with time dummies indicate less variation in estimated elasticities across the distribution. In this case, GDP growth would have been more neutral with respect to inequalities.

The sensitivity of the estimated elasticities to the introduction of time controls, in association with the comparison with (NA-based) household average income elasticities, suggests that time controls can capture the growing measurement gap between macro and micro household income data. The policy analysis in this paper therefore systematically relies on (country-specific) time trends in both the GDP and household income equations. The risk, however, is that such controls also capture economic factors – including policy changes – which have been a source of growing inequalities. This is particularly the case for policies associated with skill-biased technological change (SBTC): empirically, SBTC has been usually proxied by time trends and found to be a significant driver of higher wage dispersion (Braconier and Ruiz-Valenzuela, 2014; OECD, 2011b, Katz and Murphy, 1994; Acemoglu and Autor, 2012). This implies that the empirical results in this paper could fail to identify some policy effects on household incomes, i.e. those that are channelled via SBTC.

4. From GDP-enhancing policies to household disposable incomes across the distribution

4.1. Previous studies and interpretational guidance

4.1.1. The growth perspective

Empirical evidence on the impact of structural policies on GDP per capita is rich and covers potentially multiple channels. The majority of growth-oriented empirical studies on structural reforms have focused on the two main proximate determinants of GDP per capita – labour productivity and employment – or on a number of intermediate drivers, which include investment in physical capital, trade, R&D and multifactor productivity. This approach allows for a better modelling and understanding of the channels through which policies and institutions affect growth. This is also facilitated by the possibility to use disaggregated data, at the individual, firm, or industry level.[21]

A more limited set of studies have directly estimated the growth effects of policies by augmenting traditional (Solow-type) growth equations with policy variables.[22] These studies have generally relied on a so-called conditional convergence framework, under which investment in various forms of capital as well as policies and institutions are assumed to have a permanent impact on cross-country differences in GDP per capita levels, but policies generally do not have permanent effects on growth. The evidence on the effects of policies on GDP per capita via this type of specification is rather limited, at least in comparison with that on the effects of policies through intermediate drivers. In fact, studies based on the augmented Solow growth equation have typically focused on a narrow set of policies, in most cases product market regulation and the tax structure.

4.1.2. The inequality perspective

Empirical evidence of the growth effects of structural reforms does not provide direct interpretational guidance on the likely effects of reforms on household incomes across the distribution and hence on income inequality. Among growth-oriented studies, however, those that have focused on labour market outcomes allow for more direct inference of potential household income effects as well as on income inequality.[23] By lifting employment levels, structural policies can boost incomes and *via* this channel reduce inequality among the working-age population.

As an additional benchmark point, a large and growing empirical literature directly investigates the effects of structural policies on inequality. Most studies focus on labour earnings inequality, i.e. inequality among the population in employment, or, most often due to data limitations, on a subcomponent of it, i.e. wage inequality among full-time employees.[24] This highlights a second channel by which structural policies can impact income inequality, i.e. by affecting the dispersion of labour earnings among those employed.

Depending on the policy under consideration, the employment and wage dispersion channels may have either reinforcing or offsetting effects on inequality – and the latter case is quite frequent. Reflecting this concern, recent inequality studies have attempted to assess these *overall* labour income inequality of structural policies by combining analyses of both the earnings inequality and employment effect.[25, 26] Even so, the scope of these studies remains narrow insofar as it pertains to *one* source of income, labour income, and one population group, the working-age population.

Finally, some structural policies influence household disposable income and inequality in disposable income mechanically. This is by definition the case of tax and transfer policies

that directly act on the level of household incomes and differentially so across the distribution. Tax and transfer policies also induce behavioural and macroeconomic reactions and, via this channel, in turn affect both growth and the distribution of market income. As a result, associated reforms often raise a trade-off between equity and efficiency, as discussed in e.g. Joumard et al. (2012), Koske et al. (2012) and OECD (2012). Micro-simulation models usually assess the impact of redistribution-oriented policy reforms on household disposable incomes across the income distribution – and thus provide an additional complementary benchmark from the perspective of this paper.[27]

Compared with growth-oriented studies, there tends to be lower consensus among inequality-oriented studies regarding the effects of structural reforms. To a large extent, this reflects methodological and measurement differences, which reduce comparability across studies. In this context, the following differences are worth emphasising between the current and recent studies, such as OECD (2011b) and Koske et al. (2012):

- The use of income standards as encompassing measures of the income distribution as opposed to standard inequality measures such as income shares or the Gini coefficient.
- The joint estimation of the growth and inequality effects from structural reforms as opposed to e.g. reduced-form equations of the inequality effects from reforms.
- The focus is on a broad income concept, i.e. disposable income, covering total population as opposed to e.g. income for the working population, wages for full-time employees, or earnings for the working-age population. This means that estimated policy effects should be interpreted as "overall" or net, that is, ideally encompassing various channels, and in particular the labour market and redistribution channels as well as aggregating over various population groups.

4.2. Methodology and modelling assumptions

The baseline model is augmented with structural policies as common determining factors of GDP per capita and household incomes across the distribution (Box 4). The analysis

Box 4. **The impact of structural policies on GDP per capita and household incomes across the distribution: econometric approach**

This baseline specification presented in Box 4 is augmented with (lagged) structural policy variables as common determining factors of GDP per capita and household incomes across the distribution:

$$\Delta \ln(GDP_t) = \beta_0 - \beta_1 GDP_{t-1} + \beta_2 \ln(s_t) + \beta_3 \ln(h_t) - \beta_4 n_t + \beta_5 t + \delta_1 \Delta \ln(s_t) + \delta_2 \Delta \ln(h_t) + \delta_3 \Delta \ln(n_t) + \gamma \ln(Z_{t-1}) + \varepsilon$$

$$\Delta \mu_\alpha (x_t) = \eta_{0,\alpha} + \eta_{1,\alpha} \ln(TT_t) + \eta_{2,\alpha} \Delta \ln(GDP_t) + \eta_{3,\alpha} \ln(GDP_t) - \eta_{4,\alpha} \mu_\alpha (x_{t-1}) + \varphi_\alpha \ln(Z_{t-1}) + u$$

Where Z_{t-1} is the policy variable (or the set of policy variables), introduced in lagged form.[1]

The GDP per capita and household income equations include country fixed-effects, time trends and country-specific time trends.[2]

In the policy setting, the parameters of interest measure the joint estimated effects of structural policies on long-term levels of GDP per capita, household incomes across the distribution and – as a result – income inequality: i) the parameter γ/β_1 captures the impact of policy Z on the long-term level of GDP per capita; ii) for any given α, the parameter $(\eta_{3,\alpha}/\eta_{4,\alpha}) * (\gamma/\beta_1)$ captures the *indirect* impact of policy Z on the long-term level of household income at a given point of the distribution, as channeled via that of policy Z on GDP per

Box 4. **The impact of structural policies on GDP per capita and household incomes across the distribution: econometric approach** *(cont.)*

capita; iii) for any given α, the parameter $\varphi_\alpha / \eta_{4,\alpha}$ captures the *direct* (or additional) impact of policy Z on the long-term level of household income at a given point of the distribution, beyond its impact via that of policy Z on GDP per capita; iv) for any given α, the parameters $(\eta_{3,\alpha}/\eta_{4,\omega})^{*}(\gamma/\beta_1)+\varphi_\alpha/\eta_{4,\alpha}$ can be used to derive the *total (or net)* effect of structural policies on household income at given point of the distribution i.e. the above-defined *indirect* and *direct* (or *additional*) effects; v) finally, the comparison of *total* policy effects across α allows assessing the impact of structural policies on income inequality (see text) – in cases where the policy has a statistically significant differentiated impact across the distribution.

As developed before, while the baseline specification is estimated for the full-range of bottom to top-sensitive income standards, as governed by the parameter α, the range of income standards is narrowed for policy analysis. The policy analysis is performed for average income and a selected range of bottom-sensitive income standards. In practice and with reference to the definition of income standards in Box 2, the analysis is produced for parameter values $\alpha = 1$, $\alpha = 0$, $\alpha = -3$, and $\alpha = -8$.

The policy estimates generally cover OECD countries over the period from mid-1980s to late 2000s. The sample is in some cases reduced due to data availability. In particular, ICT investment data are not available for Turkey, Portugal, Poland, Norway and Mexico.

1. Policy variables are not introduced additionally in delta (a standard practice in a full error correction model) due to the low variance for most of the policy series considered.
2. The identification of significant policy effects is only marginally impacted by the inclusion of trends. Estimation results with time dummies or without any time treatment are available upon request.

focuses on long-run equilibrium effects, in line with the growth literature on structural reforms. Because it is assumed that household disposable incomes are ultimately driven by GDP per capita, the total effects of structural policies on household incomes decompose as follows: i) reform effects on GDP per capita which trickle down to household incomes, referred to as *indirect* effects and ii) reform effects on household incomes over and above those channelled via GDP – referred to as direct (or *additional*) effects. By construction, indirect household income effects follow reform effects on GDP per capita while direct household income effects can contrast reform effects on GDP per capita. As a result, these two components can either reinforce or offset each other. In the latter case, and depending on their respective strength, total household-income reform effects can run contrary to GDP per capita effects[28] – the implication would be that associated reforms introduce a wedge between GDP and household incomes. Against this background, the summary tables presented in this section systematically report: i) the effects of structural policies on GDP per capita; ii) the *total* (or *net*) effects of structural policies on household incomes, combining direct and indirect effects; iii) the *direct* (or *additional*) effects of structural policies on household incomes.

The pair-wise comparison of total policy effects between average income and different bottom-sensitive income standards such as the median, the lower middle class and the poor provides indication of reform effects on income inequality. For example, if a given policy reform has a positive income effect which is stronger for poor households compared with the average, this implies that this policy reform is associated with a reduction in income inequality. The focus on bottom-sensitive income standards implies that this paper emphasises the impact of structural reforms on household incomes in the lower-half of the distribution.

5. The impact of structural policies on GDP per capita and household incomes across the distribution: Empirical results[29]

The impact of structural reforms on long-term levels of household disposable incomes across the income distribution and, as a result, on income inequality, is established jointly with a broad reassessment of the impact of structural reforms on long-term GDP per capita. The analysis focuses on policies and institutions that in the past have been found to boost output growth either directly, or, for most of them, indirectly, that is via, labour productivity (e.g. multi-factor productivity, both at the aggregate level and at the industry-level) and labour utilisation (e.g. participation and unemployment, both at the aggregate level and for population sub-groups). It covers the broad areas of tax policies, labour market and welfare policies and product market regulation (Box 5). It then examines the influence of up-skilling. The role of non-policy factors such as technical change along with globalisation is only covered succinctly in the last part.

Box 5. **Policy variables**

The analysis covers the following policy areas and associated indicators:

- The tax structure: The share of various taxes (such as e.g. personal income taxes, corporate income taxes, taxes on goods and services and taxes on property) in total tax revenues.
- Labour taxation: Statutory average and marginal tax wedges (comprising income taxes plus employee and employer social security contributions less children-related cash benefits).
- Unemployment benefits systems: Various measures of gross benefit replacement rates, corresponding to different durations of unemployment spells, different family situations and different pre-unemployment earnings levels.
- Job protection: The summary OECD index of employment protection legislation.
- Minimum wages: The ratio of the statutory minimum wage relative to the median wage.
- Active labour market policies (ALMPs): Spending per unemployed over GDP per capita adjusted for the economic cycle,[1] considering the following categories: i) public employment services (PES) and administration and, ii) training and employment incentives.
- Product market regulation: The OECD's summary index of product market regulation in seven non-manufacturing industries.
- Education: Mean years of schooling; attainment rate of the population (15-64 years old) by level of education (below upper secondary, upper secondary and post-secondary non-tertiary and tertiary).

Based on the preferred specifications presented in Chapter 2 in OECD (2011),[2] this paper considers the following set of globalisation indicators:

- Trade integration: Import penetration and export intensity.
- Financial integration: Inward and Outward FDI stock as a share of GDP.
- Technology: Investment in ICT as a share of overall investment.

1. This variable is sourced in Bouis et al. (2012) and defined by the authors as follows: the amount of spending (by category) per unemployed over GDP per capita is adjusted for the economic cycle by considering the residuals of a country-specific regression of the variable on the unemployment gap (defined as the difference between the NAIRU and current unemployment).
2. Namely Table 2.1, column 4 and Table 2.5, column 3 of OECD (2011), the only difference being that in the present paper trade integration is not measured by overall trade exposure but disaggregated in its two sub-components.

The quantitative implications associated with the policy estimates are tentatively illustrated with simulations based on past reform experiences, where the size of the simulated reform in one area is based on the changes in the related policy indicators, measured on average across OECD countries and over the period 1995-2005. For this purpose, only changes in the policy variables that have gone in the direction consistent with growth-enhancing reforms have been considered in the calculation of the average size. In all cases (except the cyclically-adjusted measure of spending on ALMPs) a "reform" corresponds to a decline in the policy variable.

5.1. *Labour market and welfare policies*

Labour market policy reforms are often designed to boost aggregate employment through behavioural effects such as labour supply incentives, and via this channel, output growth. At the same time, these policies also affect income inequality through their impact on the earnings distribution. For some reforms, these two impacts on inequality may be offsetting each other.[30] For example, recent evidence suggests that reducing unemployment benefits and lowering statutory minimum relative to median wages are associated with both higher wage dispersion and higher employment rates (among low-skilled workers), which may result in a very small net change on inequality among the working-age population, while the impact on overall inequality is uncertain.[31] For other reforms, however, wage and employment effects may reinforce each other, resulting in both stronger growth and less inequality. This could be the case of policy reforms aimed at easing the strictness of job protection on regular contracts as a way to tackle labour market duality (i.e. the existence of separate segments where comparable workers enjoy differential wage conditions and job protection).[32] Preliminary findings are reported in Table 1.

5.1.1. *Job protection*

The effect of job protection on GDP per capita is found to be negative but the estimate falls just short of statistical significance at standard confidence levels.[33] Earlier studies, based on disaggregated data, have provided fairly strong evidence that easing job protection legislation raises multifactor productivity by enhancing workers' reallocation across firms and industries even though associated economy-wide effects are relatively small and may take time to materialise (see Bassanini et al., 2009).[34]

The empirical estimates also fail to identify any effects of job protection on average household income. By contrast, the findings reported in Table 1 point to a negative impact on household incomes of the lower middle class and, even more, the poor, pointing to disequalising effects of strict protection. This finding is consistent with "insider-outsider" mechanisms and institutional settings associated with labour market duality.[35, 36] Under such regimes, insiders, generally prime-aged medium-skilled males, enjoy employment security and bargaining power while outsiders, generally youth or the low-skilled, are more likely to be priced out of the labour market and overrepresented under atypical contracts with low pay and low security.

Although the results are too fragile to support strong conclusions, they indicate potential policy synergies as they imply that reforms aimed at easing hiring and firing procedures could serve both efficiency and equity objectives. As mentioned above, the potential gains from easing job protection are tentatively illustrated by simulating the impact of a change in policy parameters corresponding to the reduction observed between

Table 1. **The effects of labour market and welfare policies on GDP per capita and household disposable incomes across the distribution**

	Employment protection legislation			Unemployment benefit replacement rate, summary measure of generosity			Unemployment benefit replacement rate, long-term unemployment		
	GDP per capita	Total effect	*Direct effect*	GDP per capita	Total effect	*Direct effect*	GDP per capita	Total effect	*Direct effect*
Average income	ns			- *	- *	- *	- **	- *	
Bottom-sensitive income standards									
Median income					(- <) **	(- <) **		(- =)	
Income of the lower middle class					(- <) **	(- <) **		(+ >) *	+ *
Income of the poor					(- <) **	(- <) **		(+ >) *	(+ >) **
	Minimum relative to median wage			Active labour market policies, spending on public employment services and administration			Active labour market policies, spending on training and employment incentives		
	GDP per capita	Total effect	*Direct effect*	GDP per capita	Total effect	*Direct effect*	GDP per capita	Total effect	*Direct effect*
Average income	ns	+ ***	+ ***		+ **	+ ***	ns	ns	ns
Bottom-sensitive income standards									
Median income		(+ =) *	(+ =) *		(+ =) **	(+ =) ***		ns	ns
Income of the lower middle class		ns	ns		(+ =) *	(+ =) **		ns	ns
Income of the poor		ns	ns		(+ >) *	(+ >) *		ns	ns

Note: The entries of this table come from the estimation of the simultaneous effects of policies on long-term levels of GDP and household incomes across the distribution. Since GDP per capita is a determinant of household incomes across the distribution, the total effects of policies on the latter decompose as follows: i) indirect effects, i.e. channelled via reform-driven GDP effects and ii) direct (or additional) effects, i.e. over and above GDP effects. The tables systematically report: i) the effects of structural policies on GDP per capita, which, by construction imply equivalent indirect effects on household incomes; ii) the total (or net) effects of structural policies on household incomes, combining direct and indirect effects; iii) the direct (or additional) effects of structural policies on household incomes. The policy indicators are entered in lagged levels in both the GDP and the household income equations. See text for details on the definition of policy variables, specification and econometric technique. The entries can be read as follows. + denotes a positive policy impact while - denotes a negative one. The table also provides a (statistical) comparison of estimated policy effects on household income standards at different points of the distribution, respectively the median, the lower-middle class and the poor, with policy effects on average household income. Hence, the cases >, < and = denote, respectively, a positive impact of the reform which is, for a given income group, statistically higher, lower, or equal than that on average income. For example, in the case of the unemployment benefit replacement rate (summary measure of generosity), household income effects are negative for all income groups and they are higher in absolute value for median income, incomes of the lower middle class and incomes of the poor, in each case compared with average income. The symbols (*, **, ***) denote, respectively, statistical significance at the 10, 5 and 1% level.

1995 and 2005, on average across OECD reforming countries. This illustrative scenario is based on a modest change (in practice the magnitude of the decline corresponds to the current difference in stringency of regulation between Australia and Denmark).[37] Still, taken at face value, the estimates would imply that such reform could raise long-term level of household disposable incomes of the lower middle class by 0.7 and the poor by 1%.

5.1.2. *Unemployment benefits*

The results reported in Table 1 provide evidence of a negative link between unemployment benefit levels and GDP per capita, suggesting that reductions in benefit generosity have tended to boost output. This finding holds at the level of average household income. But, distributional effects are found to depend on whether the reform affects all unemployed workers or is targeted to the long-term unemployed:

- Untargeted reductions in replacement rates are found to raise household incomes by more than GDP per capita, with an impact that is not much different across the distribution. The decomposition of total household income effects suggests that indirect reform effects via

GDP per capita are reinforced by additional effects, over and above those via GDP per capita. These results would tend to suggest that in the long-run, employment gains[38] more than offset the income losses from reduced transfers to unemployed workers, with little impact on inequality.

- Reductions in replacement rates targeted to the long-term unemployed (i.e. benefits for jobseekers in the fourth and fifth year of unemployment, which include additional social assistance transfers when those are available) are found to increase disposable incomes for the median household but to reduce disposable incomes for the lower-middle class and, even more, poor households – unambiguously pointing to higher inequality.

The differential distributional implications associated with the two measures of benefit generosity could tentatively reflect that targeting unemployment benefit reforms to the long-term unemployed may deliver relatively less employment gains because the long-term unemployed have usually lower chances to find a job relative to the recently unemployed, reflecting compositional effects as well as skills erosion.

Average findings across the OECD may not hold at all levels of benefit generosity – reducing unemployment benefits would neither be equitable nor efficient in countries where those benefits are relatively low. Bearing this caveat in mind, reform effects are tentatively illustrated by simulating the GDP per capita and household income effects associated with two illustrative reform scenarios defined on the basis of past reform experiences across the OECD. Those reform scenarios correspond to untargeted (i.e. across the board) benefit cuts of 5 percentage points and to targeted (i.e. to the long-term unemployed) benefit cuts of 8 percentage points. In the first case, the estimates imply that the reform could raise long-run GDP per capita by 1.6% and incomes in the lower half of the distribution by between 2 and 2.4%. In the second case, however, while median income could rise by around 1.7%, incomes of the poor could on the contrary decline by 4.8%. These are quite strong effects, even taking into consideration the magnitude of the simulated change, which is based on the large historical reductions to long-term benefits, as observed on average across OECD countries between 1995 and 2005. The strong effect points to a possible over-estimation of the size of the elasticity in the regression analysis.

5.1.3. *Active labour market policies*

Reforms of unemployment benefit systems are often formulated in combination with recommendations to strengthen active labour market policies (ALMPs) so as to enhance the efficiency of job-search support, activation and training programmes for the unemployed. However the macro effects of ALMPs are difficult to identify empirically,[39] because available expenditure-based measures fail to properly capture policy design or effectiveness and are very sensitive to the economic cycle. For the empirical analysis, the latter problem is partly addressed by removing the cyclical component from the policy indicator (Box 6). Even so, the estimates fail to identify a significant effect on GDP per capita. On the other hand, there is evidence of significant positive effects on average household incomes. This finding holds for household incomes down the distribution and associated income gains are found to be larger for the poor, pointing to equalising effects. This tentatively indicates that stepping-up job-search support and programmes for the unemployed can increase jobseekers' employment chances and wages once in employment and, via this channel, reduce income inequality.

These results indicate potential policy synergies between the efficiency and equity objectives. The estimates imply that increases on spending on public employment services and administration equivalent to those measured on average across OECD countries over the period 1995-2005 – broadly corresponding to the current spending gap of Portugal relative to Sweden – would raise long-run levels of median income by 0.5% and income of the poor by 0.6%.

5.1.4. *Minimum wages*

The empirical analysis also fails to find significant evidence of an impact of the ratio of minimum-to-median wages on GDP per capita.[40] However, the results indicate that reductions in minimum wages tend to lower household mean and median disposable incomes, though not necessarily the poor. This finding is *a priori* surprising insofar as minimum wages are designed to support incomes of the most vulnerable workers. However, it may reflect a higher proportion of jobless households at the bottom end of the distribution, which are not directly affected by cuts in minimum wages. In fact, lower minimum wages may raise the job prospects of low-skill individuals, improving at the margin the income of these households. In contrast, cuts in minimum wages may have more detrimental income effects on workers whose earnings are closer to the median wage. Minimum wage reductions could also generate broader wage moderation effects spreading up the income distribution.[41] This would be consistent with the finding of positive and statistically significant effect of minimum wages on mean and median incomes.

Taken at face value, the estimates would imply that minimum wage reductions in the same order of magnitude of those that took place on average across OECD countries over the period 1995-2005 (i.e. in practice a decline of around 5 percentage points in the ratio of minimum to median wages) could lower long-run median disposable incomes by 0.6%. This indicates relatively weak transmission from policy reform to household incomes.

5.2. *Tax policy*

Many tax policies raise well-known trade-offs with respect to growth and equity objectives.[42] Economic theory and empirical evidence suggests that the tax structure influences macroeconomic efficiency and in particular that direct taxes have relatively more distortionary effects by reducing incentives to work and invest. One of the highest ranked growth-friendly tax reforms,[43] shifting the tax burden away from income taxes to consumption and property taxes, may in principle have adverse effects on inequality through various channels. For instance, reform-driven positive employment effects can be counterbalanced by increased income dispersion resulting from lower tax progressivity. Also, empirical evidence derived from the joint analysis of micro-level consumption and income data suggests that consumption taxes can be regressive, at least in the short-run.[44] There is ambiguity with respect to the distributional effects of property taxes. On the one hand, depending on how they are designed, recurrent taxes on immovable property can be regressive with respect to disposable incomes; on the other, inheritance and capital gains tax clearly reduce wealth inequality.[45]

The empirical framework used in this paper, based on a long-run relationship between household incomes and GDP per capita allows for capturing these longer-term effects of changes in tax policies on the two income measures. However, the analysis deserves a

cautious interpretation considering that both the level and structure of taxation are also likely to have also a direct and more mechanical influence linked to measurement on the wedge between GDP per capita and household disposable incomes:

Disposable income is by definition measured net of taxes and transfers. Hence, from a purely static and accounting perspective, changes in taxation that lead to a temporary transfer of income from households to the government (or vice versa) will likely have an impact on measured household disposable income at a given point in time.

Many forms of taxation are not taken into account in the measurement of real household disposable incomes. This is the case in particular of taxes paid on the consumption of goods and services. In principle, their effects on real disposable income may be captured through changes in consumer prices but this is valid only for the average income and even in this case changes in prices can reflect factors other than taxes.[46] As a result, changes in the structure of taxation are likely to have a first-round, accounting effect on household disposable income even if the reform keeps the overall level of taxation unchanged.

Bearing these caveats in mind, there is no evidence that shifting the tax burden away from income taxes to consumption and property taxes raises trade-offs between the objectives of achieving higher efficiency, household material living standards and equity (Table 2):

- In line with previous studies, raising tax revenues by relying relatively more on direct (i.e. personal and corporate income) taxes is found to depress GDP per capita. It is also found to have a negative effect on average household income as well as on lower incomes, without any significant differences on the magnitude of the impact across the distribution. However, the negative effect of direct taxes is estimated to be of a lower magnitude in the case of household incomes compared with GDP per capita. The decomposition of direct taxes between the personal and corporate tax components indicates that their combined negative impact is driven by the personal income tax component.
- Consistent with the former result and previous studies, raising tax revenues by relying relatively more on consumption and property taxes is found to boost GDP per capita. However, no significant effect on average household income is found. The estimated neutral real household income effects from consumption and property taxes holds for median income and income of the lower-middle class, but there is some evidence of positive effects on income of the poor, possibly reflecting lower tax wedges and unemployment.

The potential adverse impact of labour taxation on income can also be assessed by looking at the effect of marginal labour tax wedges faced by a representative average wage worker, for each OECD country and each year.[47] Holding average labour tax wedges and tax revenues constant, higher marginal tax wedges are found to be associated with lower GDP per capita and average household disposable income. The similar magnitude of the estimated effect across the different income levels precludes drawing any inequality implications.[48] The findings of a negative effect from high marginal taxes on income are in line with theory and empirical evidence, which point to a relatively high responsiveness of labour force participation or hours worked to net labour income among specific workforce groups such as the low-skilled and women but also top wage-earners.[49] Since the policy indicators used in the analysis include employers' social security contributions, the estimates could also reflect labour demand effects.

Table 2. **The effects of tax policy on GDP per capita and household disposable incomes across the distribution**[1]

	Share of direct taxes						Share of personal income tax					
	GDP per capita		Total effect		*Direct effect*		GDP per capita		Total effect		*Direct effect*	
Average income	-	***	-	**	+	***	-	***	-	***		
Bottom-sensitive income standards												
Median income			(- <)	**	(+ <)	***			(- =)	***		
Income of the lower middle class			(- =)	***					(- =)	***		
Income of the poor			(- =)	***					(- =)	***		

	Share of corporate income tax						Share of consumption and property taxes					
	GDP per capita		Total effect		*Direct effect*		GDP per capita		Total effect		*Direct effect*	
Average income	ns		+	**	+	**	+	***			-	***
Bottom-sensitive income standards												
Median income			(+ >)	*	(+ >)	**					(- <)	***
Income of the lower middle class											(- <)	***
Income of the poor									+	*		

	Share of consumption tax						Share of property tax					
	GDP per capita		Total effect		*Direct effect*		GDP per capita		Total effect		*Direct effect*	
Average income	+	***	+	*	-	***	+	**	+	**		
Bottom-sensitive income standards												
Median income			(+ =)	*	(- >)	**			(+ =)	**		
Income of the lower middle class			(+ =)	**					(+ =)	**		
Income of the poor			(+ =)	**					(+ =)	**		

	Labour tax wedge, marginal[2]					
	GDP per capita		Total effect		*Direct effect*	
Average income	-	**	-	**		
Bottom-sensitive income standards						
Median income						
Income of the lower middle class			(- =)	**		
Income of the poor			(- =)	**		

1. All the regressions control for tax revenue as a share of GDP.
2. This regression controls for the average tax wedge. See text for definitions of average and marginal tax wedges.

Note: The entries of this table come from the estimation of the simultaneous effects of policies on long-term levels of GDP and household incomes across the distribution. Since GDP per capita is a determinant of household incomes across the distribution, the total effects of policies on the latter decompose as follows: i) indirect effects, i.e. channelled via reform-driven GDP effects and ii) direct (or additional) effects, i.e. over and above GDP effects. The tables systematically report: i) the effects of structural policies on GDP per capita, which, by construction imply equivalent indirect effects on household incomes; ii) the total (or net) effects of structural policies on household incomes, combining direct and indirect effects; iii) the direct (or additional) effects of structural policies on household incomes. The policy indicators are entered in lagged levels in both the GDP and the household income equations. See text for details on the definition of policy variables, specification and econometric technique. The entries can be read as follows. + denotes a positive policy impact while - denotes a negative one. The table also provides a (statistical) comparison of estimated policy effects on household income standards at different points of the distribution, respectively, the median, the lower-middle class and the poor, with policy effects on average household income. Hence, the cases >, < and = denote, respectively, a positive impact of the reform which is, for a given income group, statistically higher, lower, or equal than that on average income. For example, in the case of direct taxes, household income effects are negative for all income groups and they are higher in absolute value for median income, while they are statistically equivalent for incomes of the lower middle class and incomes of the poor, in each case compared with average income. The symbols (*, **, ***) denote, respectively, statistical significance at the 10, 5 and 1% level.

5.3. *Product market regulation*

Previous analysis has found that relaxing anti-competitive product market regulation can bring productivity and employment gains in the long run, therefore spurring economic growth (Bourlès et al., 2010; Conway et al., 2006). However, the impact on income inequality is uncertain and empirical evidence generally inconclusive (OECD, 2013a; Guadalupe, 2007; Koske et al., 2012). This is because employment gains[50] may be at least partly offset by higher wage dispersion, as more intense product market competition tends to reduce the bargaining power of workers. The analysis relies on the OECD's summary index of product market regulation in seven non-manufacturing industries, covering energy, telecom and transport sectors.[51]

As shown in Table 3, no statistically significant impact of product market regulation on long-run GDP per capita could be identified. This runs against priors and previous evidence and aside from data limitations, could reflect the difficulty to identify the effects of regulation at the aggregate level – as opposed to e.g. the disaggregated industry-level.[52] By contrast, there is evidence of negative effects from stringent product market regulation on average household disposable income. Such negative effects hold across the income distribution – and increasingly so for households at its low-end, pointing to dis-equalising effects. This suggests that reducing overall regulatory barriers to product market competition would tend to boost household incomes and reduce income inequality. The finding of strong direct effects for household incomes could reflect that positive employment effects can more than compensate potential increases in wage dispersion.

Table 3. **The effects of product market regulation on GDP per capita and household disposable incomes across the distribution**

	Product market regulation				
	GDP	Total effect		Direct effect	
Average income	ns	-	*	-	*
Bottom-sensitive income standards					
Median income		(- <)	***	(- <)	***
Income of the lower middle class		(- <)		(- <)	***
Income of the poor		(- <)		(- <)	***

Note: The entries of this table come from the estimation of the simultaneous effects of policies on long-term levels of GDP and household incomes across the distribution. Since GDP per capita is a determinant of household incomes across the distribution, the total effects of policies on the latter decompose as follows: i) indirect effects, i.e. channelled via reform-driven GDP effects and ii) direct (or additional) effects, i.e. over and above GDP effects. The tables systematically report: i) the effects of structural policies on GDP per capita, which, by construction imply equivalent indirect effects on household incomes; ii) the total (or net) effects of structural policies on household incomes, combining direct and indirect effects; iii) the direct (or additional) effects of structural policies on household incomes. The policy indicators are entered in lagged levels in both the GDP and the household income equations. See text for details on the definition of policy variables, specification and econometric technique. The entries can be read as follows. + denotes a positive policy impact while - denotes a negative one. The table also provides a (statistical) comparison of estimated policy effects on household income standards at different points of the distribution, respectively, the median, the lower-middle class and the poor, with policy effects on average household income. Hence, the cases >, < and = denote, respectively, a positive impact of the reform which is, for a given income group, statistically higher, lower, or equal than that on average income. For example, in the case of product market regulation, household income effects are negative for all income groups and they are higher in absolute value for median income, incomes of the lower middle class and incomes of the poor, in each case compared with average income. The symbols (*, **, ***) denote, respectively, statistical significance at the 10, 5 and 1% level.

These results indicate potential policy synergies as they imply that product market reforms could serve both efficiency and equity objectives. Simulating the household incomes gains from an illustrative reform scenario defined as the average decline in

regulation observed between 1995 and 2005 across OECD countries delivers strong household income gains, reflecting both high estimated coefficients but also large and widespread reforms in the area of energy and networks sectors over the period (i.e. a decline of around 2 standard deviations of the current cross-country index, broadly equivalent to the stringency of regulation prevailing currently in Ireland compared with Austria). Taken at face value, this scenario would raise long-run levels of average income by 3%, median income by 4% and income of the poor by 8%, implying a catch-up of the latter *vis-à-vis* the former income groups and as a result lower inequality.

5.4. *Up-skilling, technological progress and globalisation*

The effects of the trend rise in skills are examined, as education is one of the main drivers of long-term material living standards and inequality. Reflecting the lack of data on educational policies though, policy conclusions can only be drawn on the basis of educational outcome variables. The analysis then provides some limited extension on the joint effects of up-skilling, globalisation, and technological change on material living standards and inequality, based on the findings of previous OECD work (Chapter 2 of OECD, 2011b). Because this paper emphasises the role of structural policies on growth and inequality and associated trade-offs and complementarities, non-policy factors such as broad globalisation forces and technology-driven trends are not given prominence. While globalisation is likely to interact with structural policies as joint determining factors of material living standards and inequality, analysing these interaction effects is beyond the scope of the present paper.[53]

Table 4. **The effects of up-skilling on GDP per capita and household disposable incomes across the distribution**

	Mean years of schooling			Attainment in below upper secondary education			Attainment in upper secondary non tertiary education			Attainment in tertiary education		
	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*
Average income	+ ***	+ ***		ns			+ ***	+ **		ns		
Bottom-sensitive income standards												
Median income		(+ =) ***						(+ =) **				- **
Income of the lower middle class		(+ =) ***						(+ =) *	- ***			(- <) *
Income of the poor		(+ =) ***						(+ =) *	(- <) ***			(- <) *

Note: The entries of this table come from the estimation of the simultaneous effects of policies on long-term levels of GDP and household incomes across the distribution. Since GDP per capita is a determinant of household incomes across the distribution, the total effects of policies on the latter decompose as follows: i) indirect effects, i.e. channelled via reform-driven GDP effects and ii) direct (or additional) effects, i.e. over and above GDP effects. The tables systematically report: i) the effects of structural policies on GDP per capita, which, by construction imply equivalent indirect effects on household incomes; ii) the total (or net) effects of structural policies on household incomes, combining direct and indirect effects; iii) the direct (or additional) effects of structural policies on household incomes. The policy indicators are entered in lagged levels in both the GDP and the household income equations. See text for details on the definition of policy variables, specification and econometric technique. The entries can be read as follows. + denotes a positive policy impact while – denotes a negative one. The table also provides a (statistical) comparison of estimated policy effects on household income standards at different points of the distribution, respectively, the median, the lower-middle class and the poor, with policy effects on average household income. Hence, the cases >, < and = denote, respectively, a positive impact of the reform which is, for a given income group, statistically higher, lower, or equal than that on average income. For example, in the case of mean years of schooling, total household income effects are positive for all income groups and they are of equal size for median income, incomes of the lower middle class and incomes of the poor, in each case compared with average income. The symbols (*, **, ***) denote, respectively, statistical significance at the 10, 5 and 1% level.

5.4.1. *Up-skilling*

While the positive link between human capital, employment and GDP per capita is well established, the relationship between education and income inequality is notoriously ambiguous. Upgrading of the educational composition of the workforce can have two separate effects (Knight and Sabot, 1983): i) a composition effect, whereby a rise in the share of highly-educated (high-wage) workers raises earnings inequality up to a certain point, but will then lower it as fewer low-education (low-wage) workers remain; and ii) a rate-of-return effect, whereby a rise in the share of highly-educated workers reduces the returns to education; as a result of these contrasting forces, the combined effect on inequality is unclear *a priori*. In addition, the effects of human capital on household disposable incomes could differ from those on market incomes, reflecting the interplay between employment and wage effects, but also the potential interaction between raising levels of education and the demand for redistribution.

The household income equation is simply augmented with education, where the latter is measured by mean years of schooling (Table 4). As expected, up-skilling is found to boost long-term levels of GDP per capita and average household income. Total household incomes effects are also positive across the distribution, and with the same order of estimated magnitude – which suggests the absence of distributional implications. The decomposition of total household income effects indicates that beyond positive effects channelled via GDP, there are no additional benefits from education at the household level. These findings can tentatively be qualified by replacing means years of schooling with attainment rates by education levels, leading to the following broad conclusions:

- Attainment in upper-secondary non-tertiary education boosts long-term GDP per capita. Total household incomes effects are also positive, both on average and across the distribution and, as for mean years of schooling, associated estimates do not allow for inferring distributional effects.
- The effect of attainment in tertiary education on long-term GDP per capita and household incomes do not reach statistical significance.

These findings imply that rising education did not boost household incomes as much as GDP per capita. They could reflect decreasing returns to education at the OECD-wide level, due to the relatively high development stage of the average OECD country – available schooling indicators probably no longer adequately measure population skills and the quality of education. Even though the analysis could not rely on policy indicators but only on performance indicators, these results would still indirectly suggest that reforms aimed at encouraging educational up skilling while promoting equity in access to education can serve both growth and equity objectives.

5.4.2. *Technological progress and globalisation*

Economic globalisation involves increased exposure to international trade and financial movements, increased mobility of production factors (i.e. workers and capital) and increased fragmentation of the production process. There is some consensus, in both developed and – though less so – developing countries, that globalisation is a growth-enhancing force, but there is no consensus, and mixed empirical evidence, about its distributional implications. The effects of globalisation on overall income inequality have mainly focused on the earnings dispersion channel as opposed to the employment channel. Available evidence would seem to suggest that globalisation-induced inequality effects are mainly driven by the

wage dispersion channel, in particular arising from changes in the skill and industry composition of labour demand.[54]

From a developed country perspective, concerns that globalisation would increase inequality reflect a variety of channels such as: i) increased wage dispersion resulting from import competition from low-wage developing countries, ii) growing outward investment reflecting the rapid development of international production sharing (from home companies to their foreign affiliates) distorting the wage distribution of home countries by shifting relative demand within industries – the so-called "outsourcing hypothesis",[55] and iii) an interplay between globalisation and technological change – whereby increased trade and international capital flows would boost scientific activities hence increase wage differentials via mechanisms such as skill-biased technological change.[56] To the extent that skill-biased technological change shifts demand of labour towards higher skills and especially when this increase in demand is not matched by a sufficient increase in the supply of skilled workers, technical progress may increase wage inequality. The implications of this hypothesis for inequality have found empirical support for many OECD countries.[57] Going further, recent evidence strongly suggests that skill-biased trade specialisation is associated with higher wage inequality, even accounting for technological change.[58]

However, increased international exposure can also reduce inequality through various channels such as i) price reductions in goods that are disproportionately consumed by low-income households; ii) lower wage differentials resulting from increased demand for unskilled labour due to inward foreign investment in low-skill sectors in particular services (i.e. hotels and retail distribution) and; iii) employment creation resulting from e.g. greenfield investment or innovation- induced increase in consumption.

To shed light on these effects, the analysis is selectively extended to cover some broad areas which have been found to influence inequality in previous OECD work (Chapter 2 of OECD, 2011b) – and accordingly this is done by controlling for concomitant structural shifts affecting the composition of OECD economies, e.g. in terms of the sectoral (agriculture, industry and services) and female shares of employment. Main results are presented in Table 5.

Stronger export intensity is found to boost long-run GDP per capita and average household disposable income. Such effects hold across the distribution of household income, with stronger estimated gains for the poor – implying reduced inequality. The decomposition of total household income effects suggests that indirect GDP per capita-driven gains are compounded by additional and reinforcing direct gains accruing to the lower-middle class and, even more so, the poor. The income-equalising effects of export intensity are broadly consistent with previous empirical literature (e.g. Jaumotte et al., 2008 and Koske et al., 2012).[59] Higher import penetration is found to depress long-run GDP per capita – but with estimates being only weakly significant – while no statistically significant effects could be uncovered on household disposable incomes. Overall, these findings signal synergies across policy objectives, i.e. that reforms aimed at encouraging exports among domestic firms could boost efficiency and equity.

The analysis delivers mixed findings on the impact of international financial integration:[60]

- The influence of inward FDI is qualitatively close to that of export intensity – a likely reflection of the interplay between trade and FDI and the resulting difficulty to properly identify their isolated effects: there is evidence of positive effects on GDP per capita and

Table 5. **The effects of up-skilling, technological progress and globalisation on GDP per capita and household disposable incomes across the distribution**[1]

	Export intensity			Import penetration			FDI inflow			FDI outflow			ICT investment share			Mean years of schooling		
	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*	GDP	Total effect	*Direct effect*
Average income	+ **	+ ***		- *			+ ***	+ ***		ns			+ ***	+ ***		+ ***	+ ***	
Bottom-sensitive income standards																		
Median income		(+ =) ***						(+ =) ***				- **		(+ =) ***			(+ =) ***	
Income of the lower middle class		(+ =) *	+ **					(+ >) ***	+ *		- *	(- <) **		(+ =) ***			(+ =) ***	
Income of the poor		(+ >) **	(+ >) **					(+ >) ***	(+ =) *		(- =) *	(- <) ***		(+ =) ***			(+ =) ***	

1. The specification controls for sectoral (agriculture, industry and services) and female shares of employment.

Note: The entries of this table come from the estimation of the simultaneous effects of policies on long-term levels of GDP and household incomes across the distribution. Since GDP per capita is a determinant of household incomes across the distribution, the total effects of policies on the latter decompose as follows: i) indirect effects, i.e. channelled via reform-driven GDP effects and ii) direct (or additional) effects, i.e. over and above GDP effects. The tables systematically report: i) the effects of structural policies on GDP per capita, which, by construction imply equivalent indirect effects on household incomes; ii) the total (or net) effects of structural policies on household incomes, combining direct and indirect effects; iii) the direct (or additional) effects of structural policies on household incomes. The policy indicators are entered in lagged levels in both the GDP and the household income equations. See text for details on the definition of policy variables, specification and econometric technique. The entries can be read as follows. + denotes a positive policy impact while - denotes a negative one. The table also provides (statistical) comparison of estimated policy effects on household income standards at different points of the distribution, respectively the median, the lower-middle class and the poor, with policy effects on average household income. Hence, the cases >, < and = denote, respectively, a positive impact of the reform which is, for a given income group, statistically higher, lower, or equal than that on average income. For example, in the case of export intensity, total household income effects are positive for all income groups and they are of equal size for median income and incomes of the lower middle class compared with average income while they are higher for incomes of the poor compared with average income. The symbols (*, **, ***) denote, respectively, statistical significance at the 10, 5 and 1% level.

positive equalising (both indirect and direct) effects on household disposable incomes. This finding could reflect FDI-induced demand for unskilled labour and associated employment creation; and it would suggest that policy reforms aimed at easing barriers to entry for foreign firms could serve both the efficiency and equity objectives.

- The impact of outward FDI is significant on neither GDP per capita nor average household income. By contrast, there is some evidence of negative effects on household incomes of the lower-middle class and the poor. These effects are consistent with the outsourcing hypothesis but could more broadly signal that jobs created and wages distributed by multinational companies do not mostly accrue to domestic but to foreign households.

Technological progress, as measured by the share of investment in communication technology (ICT) in overall investment, is found to boost long-run GDP per capita and average household disposable incomes. Household income gains are channelled via GDP per capita only – there is no evidence of additional household income effects. Average household income gains hold across the distribution, and are of the same estimated order of magnitude. As a result, there is no evidence of inequality effects, contrary to priors. This could reflect methodological differences compared with empirical studies that highlighted a significant technology-driven dis-equalising impact because:[61] i) generally such an effect has been estimated on the basis of wage dispersion among employed individuals, and ii) generally such an effect has been estimated on the basis of technological progress proxied by linear time trends; the failure to identify a specific dis-equalising effect from ICT could in this context be due to the inclusion of time trends in the household equations.

6. Which growth-enhancing policies appear to "lift all boats"? A wrap up

The previous section has shed new light on the joint effects of structural policies on GDP per capita and on household disposable incomes, on average and across the distribution. A number of structural policies have been shown to boost long-term levels of GDP per capita and, via this channel, household disposable incomes. There is only scarce evidence that growth-enhancing structural policies raise inequality of disposable incomes in the long-term – in fact a limited number of them are found to potentially reduce it, tentatively pointing to synergies between the growth and equity objectives.

In order to illustrate and quantify policy findings, empirical results can be used with a view to tentatively compare reforms in terms of their respective effects on different objectives such as efficiency and equity (Table 6). This illustration is produced by taking the estimates at face value and as a result clearly implies a cautious interpretation. The exercise proceeds as follows:

- GDP per capita estimates are used to standardise policy reforms so that they all deliver a 1% long-term increase in GDP per capita. The table presents the required change in associated policy parameters.
- Household income estimates are used to simulate the effects of such standardised policy reforms on household disposable incomes; first on average and second across the distribution.
- When GDP per capita estimates deliver insignificant policy results, reforms are standardised so that they deliver a 1% long-term increase in average household income. Household income estimates are used to simulate the effects of such standardised policy reforms on incomes across the distribution.

Table 6. **Wrapping up: Policy reforms to lift GDP per capita and household incomes, on average and across the distribution**

Example of specific structural policy reform	Change in policy parameters to deliver a 1% long-term increase in GDP per capita	Effects on long-term GDP per capita (%)	Effects on long-term average household income (%)	Effects on long-term household incomes across the distribution (%)		
				The median	The lower-middle class	The poor
Relax hiring and firing procedures/Reduce labour market duality	Reduction in the employment protection legislation index approximately equivalent to the stringency of regulation prevailing currently in Finland compared with Estonia[1]	*1.0*[1]			1.4	1.9
Reduce the level or duration of unemployment benefits	Untargeted reductions in benefit replacement rates by 3 percentage points	*1.0*	1.3	1.5	1.5	1.5
Reduce the level of unemployment benefits for the long-term unemployed	Reductions in benefit replacement rates targeted to the long-term unemployed by 4 percentage points	*1.0*	0.8	0.8	-1.5	-2.4
Reform the tax structure by reducing the share of direct (corporate and income) taxes and increasing the share of property or indirect taxes	Reductions in the share of personal income taxes in tax revenue by 1.3 percentage points	*1.0*	0.5	0.5	0.5	0.5
Reduce marginal tax rates on labour	Reductions in average statutory marginal tax wedges on labour by 3.5 percentage points	*1.0*	1.3	1.3[1]	1.3	1.3
Encourage educational upskilling and equity in access to education	General increases in average years of schooling by 0.25 years	*1.0*	0.9	0.9	0.9	0.9
Reduce barriers to entry for foreign firms – FDI inflows	Increases in the stock of inward FDI as a share of GDP by 4 percentage points	*1.0*	1.0	1.0	1.3	1.3
Reduce barriers to exports/Encourage exports among domestic firms	Increases in export intensity by 3 percentage points	*1.0*	1.1	1.1	1.1	1.2
Encourage innovation and raise the effectiveness of R&D support	Increases in the share of ICT in overall investment by 4 percentage points	*1.0*	0.7	0.7	0.7	0.7

Example of specific structural policy reform	Change in policy parameters to deliver a 1% long-term increase in average household disposable income	Effects on long-term GDP per capita	Effects on long-term average household income	Effects on long-term household incomes across the distribution		
				The median	The lower-middle class	The poor
Step-up job-search support and activation programs for the unemployed	Increases in spending on administration and PES per unemployed on GDP per capita approximately equivalent to the current spending gap of Ireland relative to the Netherlands		*1.0*	1.0	1.0	1.3
Increase the minimum cost of labour	Increases in the ratio of minimum relative to median wage by 8.3 percentage points		*1.0*	1.0		
Relax product market regulation (by easing entry restrictions in non-manufacturing sectors, reducing barriers to firm entry)	Reduction in the summary index of product market regulation in energy and network industries approximately equivalent to the stringency of regulation prevailing currently in Spain compared with the United States		*1.0*	1.4	1.8	2.9

1. These simulations are produced because the corresponding coefficients are below but very close to statistical significance (at a level of confidence of 12% for the GDP per capita effect of employment protection and 13% for the median income effect of marginal tax wedges).

Note: The table only reports results for which estimated effects are statistically significant. Empty cells refer to estimates which are not statistically significant. See text for details.

This exercise delivers the following main insights:

- Long-term reform-driven average household income gains are generally very close to GDP per capita gains. This reflects the fact that GDP per capita is a key driver of average household disposable income and, in the long term, reform effects at the GDP per capita level trickle down at the household level.
- Many structural reforms have a stronger traction on household incomes – especially those at the low-end of the distribution – than on GDP per capita. This reflects the fact that reform effects channelled via GDP per capita and its subsequent effect on household incomes are often compounded by additional effects beyond and above those via GDP:
  - Reducing barriers to competition, job protection, unemployment benefits for all categories of jobseekers and labour taxation are found to lift incomes of the lower-middle class more than GDP per capita.
  - Shifting from income to property and consumption taxes, boosting ICT investment and tightening unemployment benefits for the long-term unemployed are found to lift incomes of the lower-middle class by less than GDP per capita – the latter reform is even found to reduce disposable incomes of the lower-middle class.
  - There is relatively rich evidence of long-term policy synergies between growth and equity objectives. Many structural reforms are found to deliver stronger income gains for households at the low end of the distribution compared with the average household and can thus be viewed as helping to narrow inequality in disposable incomes. Such is the case of reforming job protection to tackle labour market duality; reducing regulatory barriers to domestic competition as well as to trade and FDI; and stepping-up job-search support and activation programmes.
- Conversely, clear cases of long-term policy trade-offs between the growth and equity objectives are not easy to identify empirically. One notable exception is tightening unemployment benefits for the long-term unemployed as it is found to lift GDP per capita and average household incomes but to reduce disposable incomes at the lower-end of the distribution, an indication that it may raise inequality. Nevertheless, this result should be taken with care: as stressed earlier, the magnitude of the effect obtained from the regression analysis may well overestimate the true value of the underlying elasticity.
- Reducing minimum relative to median wages could also raise concerns as it is found to depress disposable incomes on average and for the median household, though not for households at the low-end of the distribution.
- The size of the illustrative reform scenarios to lift GDP per capita and household incomes by around 1% does not seem out of reach. In a number of cases, such as in the area of taxation, unemployment benefits and product markets, the policy changes are of lower magnitude compared with past experiences, as observed on average across OECD reforming countries between 1995 and 2005.[62]

7. Conclusions

This paper has provided new empirical evidence on the effects of structural policies on household disposable incomes across the distribution. More specifically, using a sample of OECD countries over the period 1985-2010, it has investigated the extent to which structural policies have differential long-run impacts on GDP per capita and household incomes at different points of the distribution. One purpose was to identify potential policy

trade-offs and synergies between economic efficiency, household material living standards and inequality. The main findings can be summarised as follows:

- On average across OECD countries and between the mid-1980s and the late 2000s, growth in GDP per capita has not fully trickled down to household incomes. In addition, growth has been unequal, as the gap between the growth rates of GDP per capita and household disposable incomes has been wider at the lower end of the income distribution. To a large extent, this trend shortfall reflects a number of statistical issues, in particular the under-reporting of top incomes and non-compliance to filling the household survey questionnaire across the distribution.
- Pro-growth reforms can be distinguished according to whether they are found to generate potential synergies with equity objectives or raise trade-offs.
  - Many structural reforms are found to deliver stronger income gains for households at the low end of the distribution compared with the average household and can thus be viewed as helping to narrow inequality in disposable incomes. Such is the case of reducing regulatory barriers to domestic competition, trade and FDI, stepping-up job-search support and activation programmes and tightening unemployment benefits for all categories of jobseekers.
  - Conversely, a tightening of unemployment benefits for the long-term unemployed is found to lift GDP per capita and average household incomes but also to reduce disposable incomes at the lower-end of the distribution, an indication that it may raise inequality.
  - Reducing minimum relative to median wages could also raise concerns as it is found to depress disposable incomes on average and for the median household, though not for households at the low-end of the distribution.
- Many reforms are found to raise median household income by more than GDP per capita: this is the case of reducing barriers to competition, easing job protection, tightening unemployment benefits for all categories of jobseekers and lowering labour taxation; conversely, shifting from income to property and consumption taxes, boosting ICT and tightening unemployment benefits for the long-term unemployed raise median household income by less than GDP per capita.

Notes

1. Throughout the paper, more equity is to be interpreted as less inequality in income distribution and does not imply any judgement about the intrinsic value of a more equal distribution.
2. In this paper, inequality is examined from a static perspective. While ultimately a comprehensive assessment would need covering inequality in life-cycle perspective as well as dynamic inequality, hence intra-generational mobility as well as inter-generational mobility, such analysis is beyond the scope of this study, not least reflecting major data limitations. For a relatively recent analysis of intergenerational social mobility in OECD countries, see Causa and Johansson (2009).
3. It also builds on earlier studies on the topic OECD (2008, 2010, 2011b, and 2012).
4. See Chapter 5 in "Reducing Income Inequality while Boosting Economic Growth: Can it be done?".
5. This topic has been at the core of numerous inequality studies, such as e.g. Braconier and Ruiz-Valenzuela, (2014), Johansson and Olaberria, (2014), Ostry et al. (2014) and Chapter 2 of OECD (2011b).
6. Ideally one would need to rely on the most comprehensive household adjusted disposable income, taking into account in-kind transfers such as education and health care but this measure is not available on a time-series basis and is difficult to use for international comparisons (see below on data limitations). See OECD (2011b) for an analysis on the redistributive impact of in-kind transfers.

7. As standard in inequality analysis, income measures are defined on an "equivalised" (or "per consumption unit") basis. The notion of "equivalisation" implies that the income attributed to each person in a household reflects income sharing within the household and adjusts for household needs. It is assumed that these needs increase with household size, but less than proportionally. A number of "scales" exist for such adjustment. In this analysis, total household income is divided by the square root of household size.
8. While almost two-thirds of OECD countries provide some estimates of non-cash income components such as imputed rents, the high heterogeneity in the methodology applied for deriving such figures makes them unsuited to cross-country comparisons. These items are therefore excluded from the OECD database.
9. See Table 8.1 in OECD (2011b).
10. The distributive patterns of imputed rents are likely to vary across countries, reflecting different estimation methods and institutional settings. See Törmälehto and Sauli (2010).
11. OECD (2011b and 2014) are based mostly on pre-tax income data compiled by Atkinson et al. (2011). There is evidence of the rise in top income shares in the three decades before the crisis for certain OECD countries, especially in the United States and also, though substantially less, in Canada and the United Kingdom. See more recent work by Piketty (2013).
12. See Causa et al. (2014) for a discussion of implications and country-specific efforts to address this issue.
13. As stated above, this results from the low coverage of top incomes in household surveys along with the large increases in their income shares over the last three decades compared with the rest of the OECD for which data are available.
14. This confirms findings from the earlier paper (Causa et al., 2014) in which a similar conclusion was drawn from a different, range-dependent, methodology (that is, the comparison between the evolution of the Gini coefficient to that of the ratios of bottom-to-middle and top-to-middle incomes).
15. In Figure 3, each dot represents the income standard and GDP per capita levels of a given OECD country in a given year.
16. See Causa et al., 2014.
17. Part of income may have gone also to the rest of the world, but since the sample includes nearly all OECD countries, it is likely that net income flows would largely balance overall. In addition the estimates control for those real income transfers, which are channelled via changes in terms of trade.
18. The finding of reduced tax and transfers progressivity is consistent with the analysis of OECD (2011b). However, this needs to be qualified. The income data used here do not cover public transfers in kind (e.g. education, health); the decline in cash transfers could in some cases have been compensated by an increase of in-kind transfers and the latter generally represent a higher income share at the lower-end of the distribution.
19. Using a model with a CES production function and capital market imperfections, the authors show that the decline in the relative price of capital goods can largely explain the observed decline in the labour share assuming an elasticity of substitution between capital and labour significantly larger than one. In the model, the strength of capital market imperfections determine the extent to which firms rely on their own saving to fund investment, leading to "excess" corporate savings.
20. The conclusions from the comparison between the two specifications are qualitatively unchanged whether the trends are assumed to be common or country-specific.
21. A far from exhaustive list of relevant OECD studies would include Bassanini and Duval (2006), De Serres and Murtin (2013), Bourles et al. (2010), Nicoletti and Scarpetta (2003, 2005), Jaumotte (2004), Bassanini et al. (2009), Bassanini and Garnero (2013), Arnold et al. (2011) and Causa (2009).
22. OECD studies include Bassanini et al. (2001), OECD (2003), Arnold (2008), Boulhol et al. (2008) and Bouis et al. (2012).
23. A high number of growth-oriented studies estimate the impact of structural policies on various dimensions of labour market performance such as e.g. employment, unemployment and participation in Bassanini and Duval (2006), De Serres and Murtin (2013) and Bouis et al. (2012), hours worked in Causa (2009) job flows in Bassanini and Marianna (2009) and Bassanini and Garnero (2013).
24. Most papers focus on wages among full-time employees, i.e. they exclude part-time workers and the self-employed, in general reflecting data limitations. See Chapter 2 of OECD (2011b) and also Koske et al. (2012).

25. See OECD (2011b) and Koske et al. (2012).

26. Fournier and Koske (2012) focus on the effects of structural policies on earnings dispersion by means of quantile regressions based on wages. Koske et al. (2012) rely on associated estimates and on separate studies on the employment effect of structural policies to deliver a qualitative assessment of the "total" effects of policy reforms on labour income inequality. Chapter 2 of OECD (2011b) also focuses on the effects of structural policies on earnings dispersion by looking at various earnings deciles ratios (d9/d1, d5/d1 and d9/d5). Chapter 3 of OECD (2011) relies on associated estimates and on a separate analysis of the employment effect of structural policies to deliver a qualitative assessment of the "total" effects of policy reforms on labour income inequality.

27. See *inter alia*, Bourguignon and Spadaro (2005), Immervol et al. (2007, 2009), Figari et al. (2012), and Jara (2013).

28. It is possible to find that a given policy reform boosts GDP per capita but reduces household disposable incomes. This would be the case when there is household income-level evidence of negative direct reform effects (above and beyond the positive indirect effects via GDP per capita) of larger estimated magnitude compared with indirect effects, implying negative total effects. For example, reducing unemployment benefits could, in a purely static and accounting perspective – all else being equal and absent behavioural effects – reduce household disposable incomes via reduced transfers but raise GDP per capita via reduced public spending.

29. Alternative specifications and sensitivity tests have been performed for the whole set of estimations presented in this section. Overall, the estimated effects are robust to changes in controls, country coverage. Detailed results of these tests are available upon request to the authors.

30. OECD (2013a), Chapter 2.

31. See OECD (2011b) and Koske et al. (2012).

32. See Koske et al. (2012).

33. The estimated parameter is very close to being significant though, at the 12% confidence level.

34. See also Andrews and Cingano, (2013) and Bassanini and Garnero (2013). In contrast, the reform effects on aggregate employment are rather ambiguous, as lower job protection tends to raise both unemployment inflows and outflows.

35. This result is in line with empirical evidence in Koske et al. (2012) based on decile ratios for full-time employees.

36. Unfortunately, it was not possible to identify separately the effect of regular as opposed to temporary contracts, perhaps reflecting the strong co-variation and weak time variability of the indicators.

37. This is not a novel finding and reflects political economy considerations – typically fierce political opposition (Boeri, 2010; Bouis et al., 2012).

38. For evidence on employment effects see e.g. Nunziata (2002), Bassanini and Duval (2006), de Serres and Murtin (2013) Nickel et al. (2005), OECD (2011b).

39. See Kluve (2010) for a survey on the effectiveness of ALMPs to improve labour market performance. Vanhoult (1997) provides some evidence on inequality-reducing effects from higher spending on ALMPs.

40. Only countries with statutory and universal minimum wages are included in this specification. Other countries also effectively set minimum wages through collective agreements in a number of other countries but these minima can vary substantially across sectors and according to a worker's age, experience and qualifications.

41. The positive effect of declines in minimum wages on wage dispersion is confirmed by a large number of empirical studies (di Nardo et al., 1996; Lee, 1999, Lemieux, 2006 for the US; Koeniger et al., 2007, and Checchi and Garcia-Penalosa, 2010, Koske et al. 2012, for panels of OECD countries). The literature is less conclusive regarding employment: while some studies such as Koske et al. (2012) cannot detect a link between minimum wages and overall employment, others find negative employment effects, at least for some workers such as the very low-skilled (see Neumark and Wascher, 2007 for a review).The few studies that looked at the combined effect (as measured by the Gini index for labour income inequality, see e.g. Checchi and Garcia-Penalosa, 2008) conclude that an increase in minimum wages from their current level would generally raise inequality. This issue however is far from being settled in the literature.

42. Koske et al. (2012), Cournède et al. (2013).

43. See Arnold et al. (2011) and Arnold (2008) for a ranking of tax instruments with respect to their relationship with economic growth.

44. See *inter alia*, Ruiz and Trannoy (2008), for a microsimulation study on the short-term (that is immediate) distributional effects of consumption taxes in France. The paper runs against the prior that consumption taxes are strongly regressive. Indeed, the main conclusion of the micro-based analysis is that that the design of indirect taxes can only marginally address the redistribution objective, reflecting the relatively homogeneity of consumption profiles across incomes deciles.

45. See Koske et al. (2012).

46. The unavailability of price indices by income groups denies the possibility of identifying distributional effects.

47. The analysis relies on statutory rates derived from OECD *Taxing Wages* models. Average tax wedges are defined as the difference between total labour compensation paid by the employer and the net take-home pay of employees, as a ratio of total labour compensation. The marginal tax wedge is defined as the difference between the change in total labour compensation paid by employers and the change in the net take-home pay of employees, as a result of an extra unit of national currency of labour income. The difference is expressed as a percentage of the change in total labour compensation. The data refer to a single individual without children at 100% of average earnings.

48. The median income estimate is lower than, but close to, statistical significance (at the 13% confidence level).

49. Empirical evidence on the detrimental effects of labour taxes on labour utilisation is abundant. See Causa (2009) for a short survey.

50. See Bassanini and Duval (2006); Griffith et al. (2007); Nicoletti and Scarpetta (2005); Fiori et al. (2007); Nicoletti et al. (2001).

51. This is the only policy index available on a time-series basis but is clearly quite narrow and as result not the best proxy for measuring the overall effects of anti-competitive product market regulation on either GDP per capita or household income. This implies that associated results are not always comparable to previous work, for instance those that used other indices of product market regulation and/or alternative identification strategies.

52. Sector-level analysis also allows for capturing the effect of product market regulation both directly and indirectly through the rate of catching-up towards the technological frontier in lagging industries (Bourlès et al., 2010).

53. See Braconier and Ruiz-Valenzuela (2014) and Johansson and Olaberria (2014) for recent evidence on the effects of globalisation and education on growth and inequality.

54. See OECD (2011b) for references.

55. Feenstra and Hanson (2003); Hijzen (2007).

56. Thoenig and Verdier (2003), Stojanovska and Cuyvers (2010), Bloom et al. (2008).

57. Autor et al. (2006), Goos et al. (2009) and OECD (2011b).

58. Johansson and Olaberria (2014).

59. In the latter case the paper measures overall trade as a share of GDP and does not disentangle imports and exports effects.

60. Financial integration is measured by *de facto* indicators, based on the following arguments: i) *de jure* legal restrictions on FDI transactions may not adequately reflect actual exposure of countries to international capital markets, and in particular does not distinguish between inward and outward financial transactions; ii) the OECD indicator of legal barriers to FDI is available for a few years only, making it impossible to use it in a time-series context. One important shortcoming associated with *de facto* measures is the higher risk of endogeneity bias compared with *de jure* measures, implying the need to interpret associated results with caution.

61. Braconier and Ruiz-Valenzuela (2014), Johansson and Olaberria (2014), OECD (2011b), Koske et al. (2012).

62. Such tentative scenarios are derived mechanically but are not inconsistent with country-specific reform experiences identified in Bouis et al. (2012) by means of a formal definition of "reform shocks".

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OECD Journal: Economic Studies
Volume 2015
© OECD 2015

Does the post-crisis weakness of global trade solely reflect weak demand?

by
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Global trade growth over the past few years has appeared extraordinarily weak, even in relation to weak global GDP growth. This paper shows that the apparent breakdown in the relationship between global trade and global GDP growth is largely explained by two factors: an inappropriate measurement of global GDP and extraordinary demand weakness in the euro area. As a measure of demand for traded goods, global GDP at market exchange rates is more appropriate than the conventional purchasing power parity-based measure. Moreover, extraordinary demand weakness in the euro area – which is a particularly trade intensive region – has had a substantial negative effect on intra-euro area trade flows, which are commonly counted towards global trade. When global GDP is measured at market exchange rates and intra-euro area flows are removed from the measure of global trade, econometric estimations suggest that over the past 15 years the long-term elasticity of global trade to GDP has been similar to that of the 1990s. Indeed, the overwhelming part of post-crisis trade weakness can be attributed to weak global demand rather than structural changes, according to the econometric estimations in this paper and supporting evidence on changes in global investment, international production fragmentation and protectionism.

JEL classification: F10, F17, C53

Keywords: Global trade, trade elasticity, forecasting

* The authors are members of the Economics Department of the OECD. They would like to thank Jens Arnold, Sebastian Barnes, Jérôme Brézillon, Thomas Chalaux, Jean-Marc Fournier, Catherine Mann, Mauro Pisu, Jean-Luc Schneider, David Turner, Charlotte Emlinger and Sébastien Miroudot for helpful comments and Inés Gómez-Palacio for assistance in preparing the document. The views expressed here are the authors' and do not necessarily reflect those of the OECD or its member countries.
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1. Introduction and summary

The anaemic recovery of global trade following the collapse of 2009 raises the question of whether recent trade weakness mainly reflects cyclical factors or signals a structural break in the process of globalisation that may have implications for long-run global GDP growth. While over the two decades that preceded the crisis global trade grew on average at more than twice the rate of purchasing power parity (PPP) based global GDP, global trade growth over the period 2008-14 was slightly below this conventional measure of global GDP growth. In other words, the long-term elasticity of global trade to GDP appears to have declined from around 2 in the two decades preceding the crisis to around 1 thereafter.

Empirical studies suggest that the collapse of world trade during the global crisis of 2008-09 mainly reflected a sharp decline in import-intensive components of demand such as investment and durable goods consumption, implying that the reversal of cyclical composition effects would lead to a rebound of global trade growth.[1] However, the fact that there may be less scope for further trade liberalisation than over past decades – especially in large emerging market economies – and less scope for further declines in international trade costs suggests that recent weakness in global trade may in part also reflect longer-term structural changes (Krugman, 2013).[2]

The main conclusion of this paper is that most of the post-crisis weakness of global trade can be attributed to weak global demand rather than structural changes. This conclusion is based on a number of empirical findings:

- The decline in the long-term elasticity of global trade to GDP coincides with the onset of the global crisis of 2008-09, suggesting that the decline may at least partly reflect demand developments rather than longer-term structural developments.
- Post-crisis global demand growth has been weaker than suggested by conventional measures of global GDP growth based on purchasing power parities (PPPs) which overestimate growth of demand for traded goods by unduly putting more weight on emerging market economies than measures of global GDP growth at market exchange rates.
- Weak euro area demand explains a large part of the post-crisis weakness of global trade relative to global GDP, especially over 2010-12, as trade among highly trade-intensive euro area countries has been hit particularly hard.
- Once global GDP is calculated at market exchange rates and intra-euro area trade is removed from the measure of global trade, there is only a limited decline in the long-run elasticity of global trade to GDP over the past 15 years.
- The limited decline in the long-run global trade elasticity over the past 15 years entirely reflects post-crisis developments, with the post-crisis decline in the ratio of global trade to global GDP growth – the apparent global trade elasticity – being similar to that following past global downturns.
- A model that includes only growth rates of global trade and GDP allows for the empirical regularity of a pro-cyclical apparent global trade elasticity and tracks post-crisis trade

developments fairly accurately without assuming any structural change in the trade-GDP relation, suggesting that about 85% of the post-crisis trade weakness is explained by global demand weakness.

- The pro-cyclicality of the apparent global trade elasticity partly reflects the pro-cyclicality of global investment intensity; as global investment has remained subdued in the wake of the crisis, global GDP has become less import-intensive.
- The pro-cyclicality of the apparent global trade elasticity is also related to the empirical regularity that the pace of international production fragmentation increases with global GDP growth; the apparent slowdown in international production fragmentation during the crisis therefore reflects at least partly cyclical demand developments rather than a structural break.
- Despite the limited over-predictions of the model in growth rates for the years 2012-13 and possibly 2014 – which are, however, well within the model's error margin – the most likely scenario for global trade growth in the medium term is thus a rate of about twice that of global GDP growth at market exchange rates as cyclical effects fade.
- Based on the current projections of global GDP growth of 3.3% at market exchange rates (3.9% at PPPs) for 2016 in *OECD Economic Outlook* (November 2014), the model in growth rates developed in this paper predicts a recovery of global trade growth to about 7%.

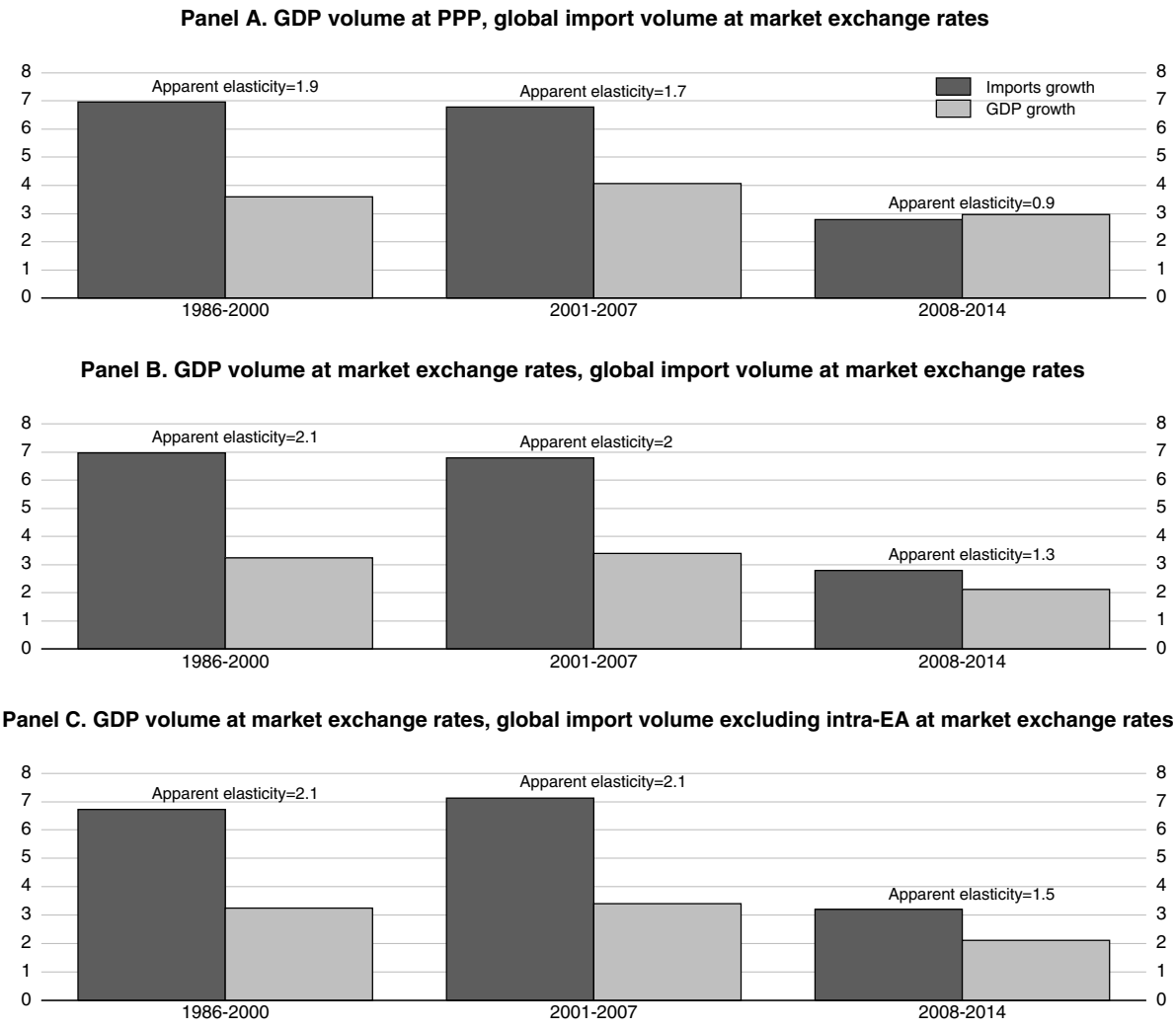
The remainder of the paper is structured as follows. Section 2 describes post-crisis trade developments, emphasising that global GDP measured in PPP terms overestimates demand addressed at exports. It further shows that most of the deviation of global trade intensity from its pre-crisis trend appears to be driven by trade weakness in the euro area. Section 3 assesses whether there is evidence for a structural decline in the long-term global trade elasticity preceding the global crisis of 2008-09, with the results suggesting that the long-term global trade elasticity has been stable over the period 1986-2007. The decline thereafter appears to be largely driven by cyclical effects rather than longer-term structural developments, as suggested by the accurate in-sample fit of a model in growth rates that explains global trade growth exclusively by cyclical GDP developments without assuming a change in the long-term trade-to-GDP relation. A brief discussion of trends in investment, international production fragmentation and protectionism further supports the hypothesis that the post-crisis slowdown in global trade growth mainly reflects global demand developments rather than structural change. Section 4 briefly discusses the implications of the empirical results for the OECD forecasting process and the future evolution of global trade.

2. Global trade and global GDP over the past three decades: Descriptive evidence

The apparent long-term elasticity of global trade measured at market exchange rates to GDP at purchasing power parities (the ratio of growth rates) remained at around 2 up until the global crisis of 2008-09 and started to decline only thereafter, suggesting that there is little empirical support for the view that there has been a gradual decline over the past 15 years (Figure 1, Panel A). As observed by Constantinescu et al. (2015) and various contributions to Hoekman (2015) the apparent long-term elasticity of global trade to GDP declined from around 2 in the 1990s around to below 1½ thereafter, but the decline reflects an abrupt change around the onset of the global crisis rather than gradual developments over the past 15 years, suggesting that it may, at least partly, reflect cyclical developments.

Figure 1. **The apparent elasticity of global trade declined in the wake of the crisis**

Average annual growth rate, in %



Note: The apparent elasticity of global trade to GDP is computed as the average annual growth rate of global import volumes to the average annual growth rate of global GDP volumes. Global import volume and GDP volume at market exchange rates are measured in 2010 USD and cover all countries in the world. Values for 2014 are partly based on projections in *OECD Economic Outlook* (November 2014).
Source: OECD Economic Outlook 96 Database; and OECD calculations.

The decline in the apparent global trade-to-GDP elasticity is less pronounced when both global trade and GDP are measured at market exchange rates instead of measuring global trade at market exchange rates and global GDP at purchasing power parities as done by Davies (2013) or Constantinescu et al., 2015 (Figure 1, Panel A and B).[3] Global trade volumes are conventionally measured at market exchange rates, reflecting the presumption that arbitrage should limit price differences across countries. It therefore seems natural to measure global demand for tradable goods at market exchange rates rather than PPPs; while a country with a low relative price of non-tradable goods may have the same real income as a country with a high relative price of non-tradable goods even at a lower GDP at market exchange rates, it will nonetheless contribute less to global demand for tradable goods. For instance, a country experiencing a large currency depreciation may experience only a marginal decline in GDP measured at purchasing

power parities as the relative price of non-tradable goods to tradable goods declines, but reflecting the decline in GDP at market exchange rates its purchasing power for tradable goods would nonetheless decline substantially. Mis-measurement of global demand for tradable goods when using global GDP at purchasing power parities can introduce a substantial downward bias into estimates of the global trade elasticity, which becomes especially pronounced when the growth differential between low-income and high-income countries increases or when global GDP growth declines, as was the case in the wake of the global crisis of 2008-09 (Box 1).[4]

Box 1. **Which is the appropriate measure of global GDP in the context of global trade analysis?**

This box shows that measuring global trade volumes at market exchange rates while measuring global GDP at PPPs introduces a bias into estimates of global trade elasticities.

For illustrative purposes, consider a global economy consisting of two countries with equal and constant import intensities (defined as ratios of national import volumes to national GDP volumes in constant national currency). A logical requirement is that in this economy the global trade elasticity be 1 irrespective of real growth differentials across countries; equal import intensities imply that the composition of GDP growth is irrelevant for global trade growth while constant import intensities imply that import volumes grow at the same rate as GDP volumes.

Formally, the global trade elasticity is defined as:

$$\sigma^{W} \equiv \frac{w_M^1 \cdot g_M^1 + w_M^2 \cdot g_M^2}{w_Y^1 \cdot g_Y^1 + w_Y^2 \cdot g_Y^2},$$

where superscripts denote countries 1 and 2, g_M and g_Y are growth rates of imports and GDP, and w_M and w_Y are shares in global imports and GDP. Note that irrespective of the currency of aggregation the assumption of constant import intensities implies that import volumes grow at the same rate as GDP volumes, i.e. $g_M = g_Y$.

If imports and GDP are aggregated in the same currency – for instance, in US dollars at market exchange rates as in this paper – the assumption of equal import intensities across countries implies that country shares in global imports and global GDP are identical, i.e. $w_M^i = w_Y^i$. In this case, the global trade elasticity indeed collapses to 1:

$$\sigma^{W} = \frac{w_Y^1 \cdot g_Y^1 + w_Y^2 \cdot g_Y^2}{w_Y^1 \cdot g_Y^1 + w_Y^2 \cdot g_Y^2} = 1.$$

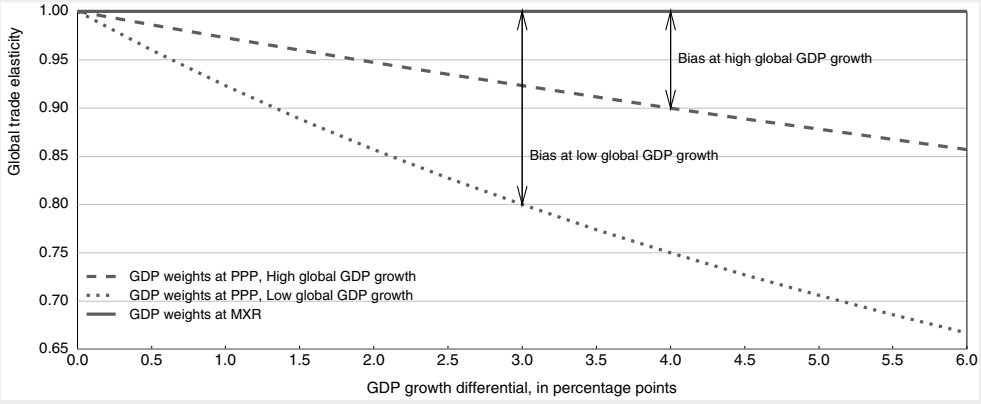
By contrast, if imports are aggregated at market exchange rates and GDP is aggregated at PPPs, the assumption of equal import intensities across countries no longer implies that country shares in global imports and global GDP are identical; depending on the direction of the purchasing power correction a country's weight in global GDP at PPPs may be larger or smaller than its weight in global imports at market exchange rates:

$$\sigma^{W} = \frac{w_M^1 g_Y^1 + w_M^2 g_Y^2}{w_Y^1 g_Y^1 + w_Y^2 g_Y^2}.$$

Assuming that the purchasing power correction reduces country 1's share in global GDP, i.e. $w_Y^1 < w_M^1$ and $w_Y^2 > w_M^2$, and that GDP growth in country 2 is higher than in country 1 (country 1 can be thought of as an advanced economy and country 2 as an emerging market economy), it follows immediately that the bias i) is negative, ii) increases in absolute terms with the growth differential between the two countries and iii) increases in absolute terms as global GDP growth declines (Figure 2).*

Box 1. **Which is the appropriate measure of global GDP in the context of global trade analysis?** *(cont.)*

Figure 2. **The global trade elasticity is biased when GDP is aggregated at purchasing power parities**



Note: GDP growth differential denotes the difference in GDP growth between country 2 and country 1. The chart assumes equal trade weights; equal GDP weights at market exchange rates (MXR); and GDP weights of 1/3 for country 1 and 2/3 for country 2 at PPPs. High global GDP growth assumes global GDP growth (at market exchange rates) of 6% while low global GDP growth assumes a rate of 2%.
Source: OECD calculations.

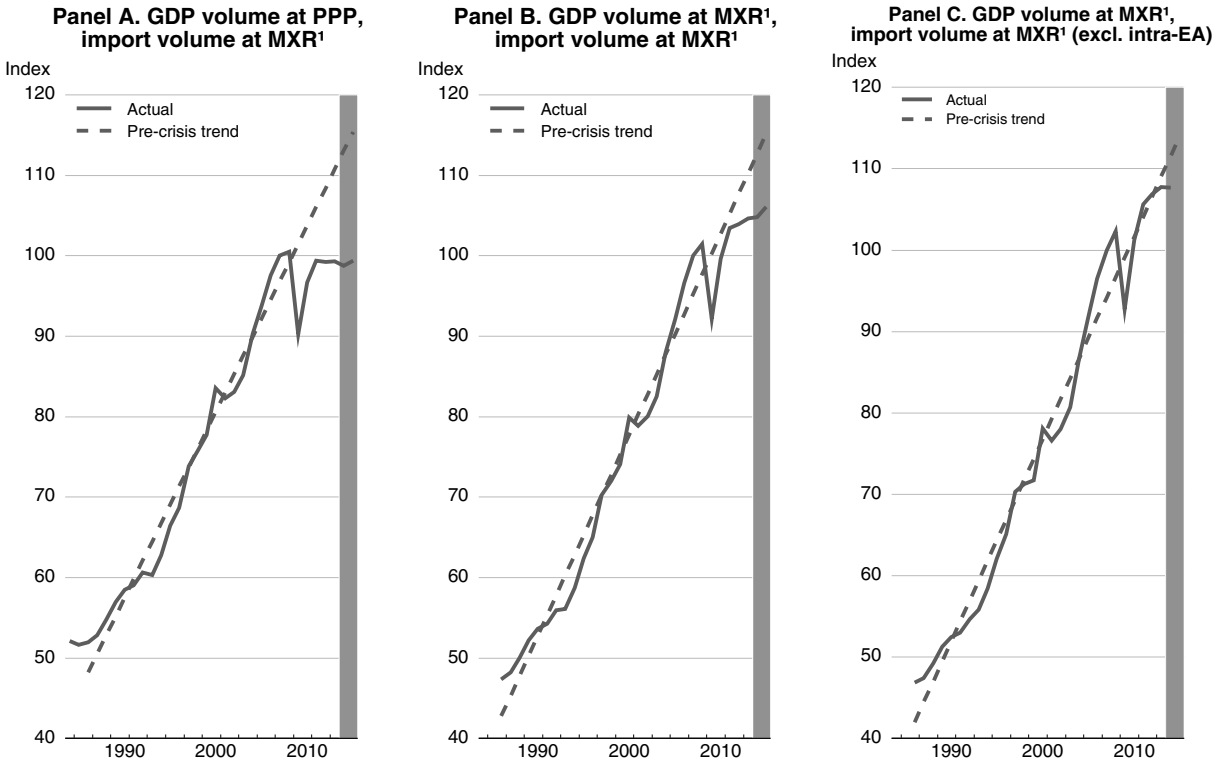
* It should be noted that the global trade elasticity is not sensitive to the precise currency in which trade and GDP are aggregated so long as both are aggregated in the same currency; for instance, aggregating both trade and GDP at purchasing power parities or aggregating both trade and GDP at current rather than constant exchange rates (as in this paper) yields similar apparent elasticities (see Annex Figure D.1).

The post-crisis decline in the apparent global trade-to-GDP elasticity is partly driven by the post-crisis weakness of intra-euro area trade (Figure 1, Panel C). If intra-euro area trade – which was hit particularly hard by demand weakness in the euro area – is excluded from the measure of global trade, the post-crisis global trade elasticity remains around 1.5 (Figure 1, Panel C).[5] By statistical convention intra-euro area trade – which accounts for around 10% of global trade and is similar to intra-national trade along several dimensions as it is not subject to tariffs or currency risk while transport costs among geographically proximate countries are low – is included in the measure of global trade. Consequently, a shock to euro area demand may have a disproportional effect on global trade as it reduces both intra-euro area imports among highly integrated member countries and imports from outside the euro. By contrast, a shock to US demand reduces both inter-state imports and imports from outside the United States, but only the reduction in extra-US imports is accounted for in the conventional measure of global trade.[6] To some extent, the deviation of global trade intensity from its pre-crisis trend therefore appears to reflect a statistical convention – which may reverse once demand in euro area countries picks up – rather than a structural development.

Developments in global trade intensity – here defined as the ratio of global trade volume to global GDP volume – further support the view that the global trade-to-GDP relation was fairly stable over 1986-2007 and that intra-euro area trade contributed significantly to the post-crisis weakness of global trade (Figure 3). Over 2001-07 global trade

Figure 3. **Global trade intensity has deviated from its pre-crisis trend**

Ratio of global import volume to global GDP volume, index 2007 = 100



Note: The trend line represents the pre-crisis trend 1986-2007. Values for 2014 are partly based on projections in *OECD Economic Outlook* (November 2014).

1. Market exchange rates at 2010 USD.

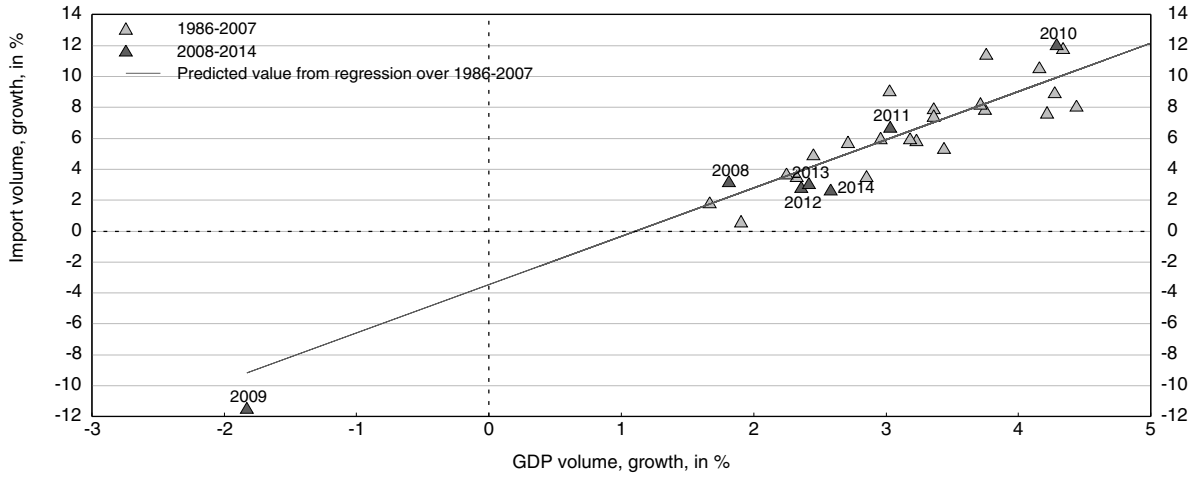
Source: OECD Economic Outlook 96 Database; and OECD calculations.

intensity was close to its pre-crisis trend over the period 1986-2007, but it started to deviate abruptly in 2009, especially when global GDP is measured at PPP rather than market exchange rates (Figure 3, Panels A and B). When intra-euro area trade flows are removed from the measure of global trade, however, global trade intensity is only marginally below its pre-crisis trend (Figure 3, Panel C).[7]

Annual growth rates of global trade (including intra-euro area trade) in the wake of the crisis are well explained by annual growth rates of global GDP, leaving little room for structural explanations of global trade weakness (Figure 4). Even for the years 2011-14 – which are conventionally viewed as highlighting a structural break in the trade-GDP relationship (Constantinescu et al., 2015; Davies, 2013) – annual global trade growth is close to the predicted values from the linear regression of trade on GDP growth over the pre-crisis period (1986-2007). A noteworthy feature of the linear trend line in Figure 4 is that it is consistent with a decline in the apparent elasticity of global trade to GDP without assuming a change in the long-term trade-to-GDP relation; at the average GDP growth rate over 1986-2007 of 3.3% the linear trend line predicts trade growth of 6.7%, implying an apparent elasticity of 2.1, while at the average GDP growth rate over 2008-14 of 2.1%, the equation predicts trade growth of 3.1%, implying an apparent elasticity of 1.5.[8] The pro-cyclicality of the apparent global trade elasticity appears to be – at least partly – related to the pro-cyclicality of global investment intensity (Box 2). Other possible explanations include the larger pro-cyclicality of the goods sector, which constitutes the bulk of trade,

Figure 4. **Post-crisis trade growth has been close to the rates predicted by GDP growth**

Global trade and GDP volumes at market exchange rates



Note: Values for 2014 are partly based on projections in *OECD Economic Outlook* (November 2014). Global import volume and GDP volume at market exchange rates are measured in 2010 USD.
Source: OECD Economic Outlook 96 Database and OECD calculations.

relative to the services sector, which constitutes the bulk of GDP, and the pro-cyclicality of international production fragmentation (Freund, 2009).

Summing up, the decline in the apparent elasticity of global trade to GDP does not appear to pre-date the global crisis of 2008-09, suggesting that the abrupt change thereafter may at least partly reflect demand developments. The decline in the apparent elasticity is partly related to the weakness of intra-euro area trade and post-crisis growth of global trade appears to be well explained by global GDP growth, further supporting the hypothesis that global trade weakness may at least partly reflect demand developments.

3. Can weak demand account for the weakness of post-crisis global trade growth?

Based on a more formal econometric analysis and the description of recent trends in investment, international production fragmentation and protectionism, this section further investigates whether post-crisis trade developments may reflect a structural break in the relation between global trade and GDP or whether demand developments alone are sufficient to explain post-crisis global trade weakness. A standard error correction model is estimated over different sub-periods to detect structural breaks in the long-run trade elasticity. This model suggests that the long-run relation between global trade and GDP was stable over 1986-2007, with a structural break around the year 2008. However, the error correction model constrains the apparent trade elasticity to be constant irrespective of medium-term GDP growth, which is inconsistent with the stylised fact that the apparent elasticity declines in the wake of global downturns. Consequently, the error correction model attributes a decline in the apparent elasticity to a structural break in the long-run trade elasticity. It is shown that a less restrictive model, that does not constrain the long-term elasticity to be constant, can account for the post-crisis decline in the apparent elasticity and accurately tracks post-crisis trade developments without any structural change in the trade-GDP relation. Details on the different methods to assess the stability of the trade-GDP relation are described in Box 2.

Box 2. **Measuring the structural relation between global trade and GDP**

This box shows that over short sample periods the apparent long-term elasticity of global trade to GDP may fluctuate even though the structural relation between global trade and GDP is stable.

The ratio of global trade growth to global GDP growth over short sample periods is directly observable and is denoted as the **apparent global trade elasticity** in this paper. Fluctuations in the apparent elasticity may reflect either changes in the long-term structural relation between global trade and GDP or cyclical effects related to the expenditure composition of global GDP as highlighted, for instance, by Bussière et al. (2013).

The **structural long-term global trade elasticity** is not directly observable in real time, but under the assumption that a stable long-term structural relation between global trade and GDP exists over sufficiently long sample periods it can be estimated as the coefficient β in the (logarithmic) level equation:

$$\ln(trade_t) = \alpha^{LT} + \beta^{LT} \cdot \ln(gdp_t) + \varepsilon_t$$

or as the coefficient $-\delta/\gamma$ in the error correction equation:

$$\Delta \ln(trade_t) = \alpha^{ECM} + \beta^{ST} \cdot \Delta \ln(gdp_t) + \gamma \ln(trade_{t-1}) + \delta \ln(gdp_{t-1}) + \varepsilon_t .$$

It should be noted that over short sample periods both methods yield unreliable estimates of the underlying long-term structural long-term global trade elasticity. The coefficient β in the level equation typically declines in the wake of global downturns, suggesting that over short sample periods the estimated β depends on the global business cycle. Over short sample periods, the $-\delta/\gamma$ coefficient in the error correction equation is highly unstable (see Annex Figure B.1), as the error correction model fails to distinguish between the short-term dynamics and the long-term structural relation between global trade and GDP.

The **short-term global trade elasticity** measures the percentage point change in global trade growth for every percentage point change in global GDP growth and can be estimated as the coefficient β^{ST} in the equation in first differences:

$$\Delta \ln(trade_t) = \alpha^{ST} + \beta^{ST} \cdot \Delta \ln(gdp_t) + \varepsilon_t .$$

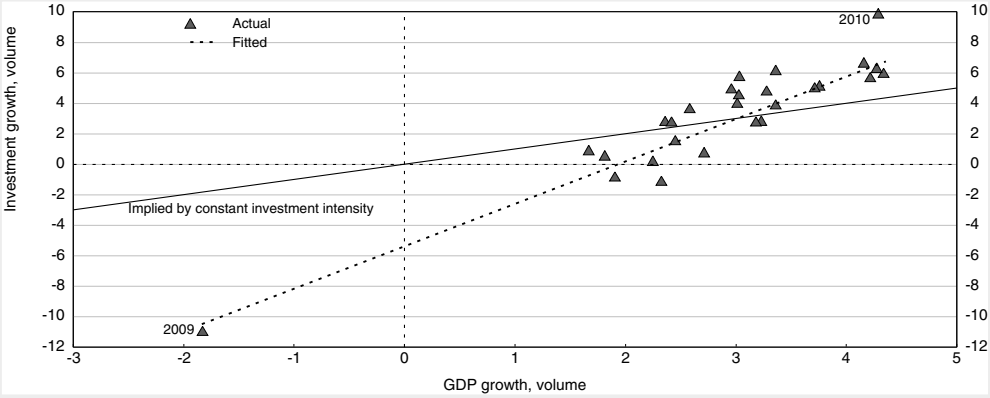
The equation in first differences does not constrain the apparent long-term global trade elasticity to be constant even at a stable structural relation between global trade and GDP; at stable coefficients α^{ST} and β^{ST} the elasticity is defined as $\sigma \equiv \Delta \ln(trade_t) / \Delta \ln(gdp_t) = \beta^{ST} + \alpha^{ST} / \Delta \ln(gdp_t)$. Given an estimated intercept term α^{ST} over the period 1986-2014 of around -3.5 and a short-term elasticity of around 3, the equation in first differences implies that over sample periods of 5-6 years the apparent long-term global trade elasticity increases with GDP growth.[1]

The negative intercept α^{ST} and the implied pro-cyclicality of the apparent trade elasticity over short sample periods in the model in first differences is consistent with the pro-cyclicality of global investment intensity; at above-average global GDP growth, global investment intensity tends to increase while it tends to decrease at below-average global GDP growth (Figure 5). In fact, the estimated relation between global GDP growth and global investment growth implies that at 0 global GDP growth global investment growth is negative, suggesting that predicted negative global trade growth at 0 global GDP growth may be related to the predicted decline in global investment.

The model in first differences that assumes the short-term global trade elasticity to be constant but that does not constrain the long-term elasticity can replicate the stylised fact that the apparent elasticity declines during periods of low global GDP growth – which may reflect a level shift in potential global GDP – without assuming a structural change in the

Box 2. **Measuring the structural relation between global trade and GDP** *(cont.)*

Figure 5. **Global investment intensity is pro-cyclical**



Source: OECD Economic Outlook 96 Database and OECD calculations.

underlying model parameters. By contrast, the error correction model that constrains the long-term elasticity to be constant can account for the persistent low apparent trade elasticity in the wake of the crisis only by assuming a structural decline in the long-term global trade elasticity.[2]

The model in first differences implies that the apparent global trade elasticity returns to its pre-crisis average only if GDP growth returns to its pre-crisis average. Over the short sample 2008-14, the model is consistent with a lower apparent global trade elasticity as average post-crisis GDP growth has been lower than global GDP growth over 1986-2007. However, the model in first differences implies that the apparent global trade elasticity returns to its pre-crisis average of around 2 if global GDP growth returns to its pre-crisis average, which is the baseline projection of all major international organisations.[3]

1. Over sample periods of five years, global GDP growth at market exchange rates has ranged from 2% to 4%.
2. The error correction model assuming no structural change in model parameters implies that the apparent global trade elasticity returns to its pre-crisis average irrespective of global GDP growth.
3. *OECD Economic Outlook* (November 2014) projects 3.3% global GDP growth at market exchange rates for 2016; the *World Bank Global Economic Prospects* (January 2015) projects 3.3%; and the *IMF World Economic Outlook* (October 2014) projects 3.4%. Global GDP growth at market exchange rates over the period 1986-2007 was 3.3%.

3.1. Econometric evidence on the stability of the global trade elasticity

A standard error correction model framework is used to estimate the long-term elasticity of global trade to GDP over different time periods (Irwin, 2002; Constantinescu et al., 2015). This framework assumes that a stable cointegration relation between global trade and GDP exists within sub-periods, but that this relation may change across time periods as exogenous factors such as trends in trade liberalisation, transport costs or international production fragmentation change. Following the notation of Constantinescu et al. (2015) to facilitate direct comparison of estimation results, the estimated equation takes the form:

$$\Delta \ln m_t = \alpha + \beta \Delta \ln y_t + \gamma \ln m_{t-1} + \delta \ln y_{t-1} + \varepsilon_t \quad [1]$$

where Δ denotes first differences, m_t denotes global import volume and y_t global GDP volume at time t, α is the regression intercept and ε_t is the error term. The short-run elasticity

of global trade to GDP is β while the speed of adjustment to the long-run equilibrium is $-\gamma$. The long-run elasticity of global trade to GDP is given by $-\delta/\gamma$.

Estimation of model [1] based on a PPP-based measure of global GDP would imply that the long-term global trade elasticity has declined to around 1.3 around the year 2000 (Table 1, Model 1), which would be consistent with the conventional view that the long-term trade-GDP relation changed around the turn of the century (Constantinescu et al., 2015).[9] According to this view, the years 1986-2000 would appear as a period of exceptionally high trade growth, with an estimated long-term global trade elasticity of 2.3, while the decline to around 1.3 at the turn of the century would indicate the return to the pre-1986 norm.

Table 1. **Estimation results for model [1] based on annual data**

Long-run elasticity[1, 2]

Model	Definition of long-run elasticity	1970-85	1986-2000	2001-14
(1)	Global import volume at 2010 USD to global GDP volume at PPP	1.3***	2.3***	1.3***
(2)	Global import volume at 2010 USD to global GDP volume at 2010 USD	1.3***	2.4***	1.8***
(3)	Global import volume ex. intra-EA imports at 2010 USD to global GDP volume at 2010 USD	1.3***	2.3***	2.0***

1. Based on the estimation of the following equation:

$$dln(imports)_t = \alpha_1 + \beta_1 * dln(gdp)_t * DV_1 + \gamma_1 * \ln(imports)_{t-1} * DV_1 + \delta_1 * \ln(gdp)_{t-1} * DV_1 + \alpha_2 + \beta_2 * dln(gdp)_t * DV_2 + \gamma_2 * \ln(imports)_{t-1} * DV_2 + \delta_2 * \ln(gdp)_{t-1} * DV_2 + \alpha_3 + \beta_3 * dln(gdp)_t * DV_3 + \gamma_3 * \ln(imports)_{t-1} * DV_3 + \delta_3 * \ln(gdp)_{t-1} * DV_3 + \varepsilon_t,$$

where gdp is global GDP volume; imports is global imports of goods and services; DV_1, DV_2 and DV_3 are dummy variables for the periods 1970-85, 1986-2000 and 2001-14, respectively, and ε_t is the error term.

2. The long-term elasticities for the sub-periods 1970-85, 1986-2000 and 2001-14 are given by $-\delta_1 / \gamma_1$, $-\delta_2 / \gamma_2$ and $-\delta_3 / \gamma_3$, respectively. Statistical significance is established using a non-linear Wald test. *** indicates a significance level of 1%.

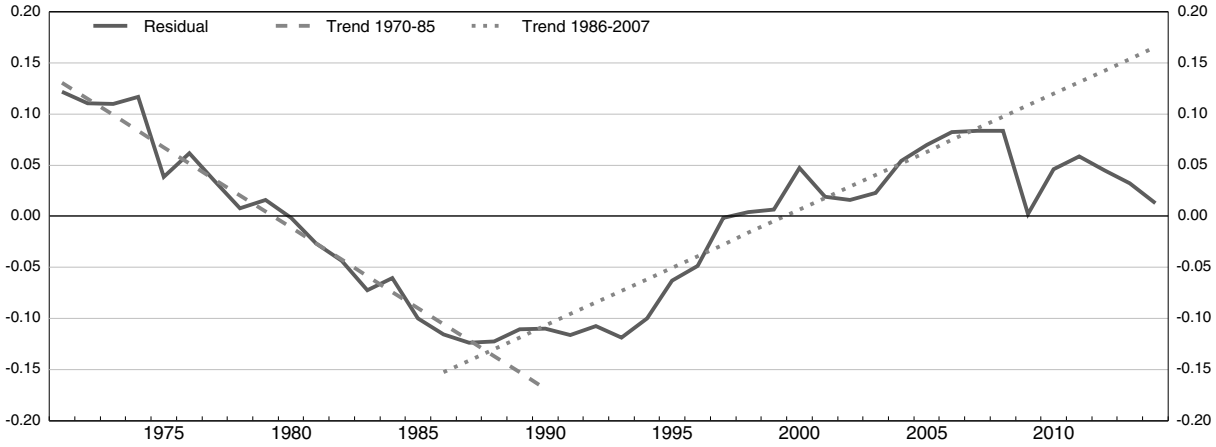
Source: *OECD Economic Outlook 96 Database* and OECD calculations.

Based on global GDP at market exchange rates – which is a more accurate gauge of global demand for traded goods than global GDP at PPPs – the estimated long-term trade elasticity has remained around 2 over the past 15 years (Table 1, Model 2). While the estimates suggest a significant decline at the turn of the century, the estimated long-term elasticity has remained well above the pre-1986 norm.[10] Moreover, the estimated long-term elasticity has declined only marginally from 2.3 to around 2 once intra-euro area flows are excluded from the measure of global trade (Table 1, Model 3). Given that estimates of long-run elasticities obtained over short samples such as 2001-14 may be affected by cyclical factors and that removing intra-euro area flows only removes part of the cyclical effects of the global crisis, these results cast considerable doubt on the hypothesis that the long-run trade elasticity declined around the year 2000.

The limited decline in the long-term elasticity of global trade to GDP (measured at market exchange rates in the remainder of the paper) over 2001-14 appears to be driven by post-2007 developments rather than structural changes preceding the crisis (Figure 6). The residual of the long-term cointegrating relation between global trade and GDP underlying the error correction model [1] – estimated over the period 1970-2014 using GDP – is trending down over 1970-85 and trending up over 1986-2007. The break in the long-run elasticity of global trade to GDP around the late 1980s partly reflects the acceleration in the process of globalisation, especially trade liberalisation in a number of large emerging market

Figure 6. **The break in the cointegrating relation between trade and GDP coincides with the global crisis**

Residual of the long-term equation underlying model [1] estimated over 1970-2014



Note: Residual based on the estimation over 1970-2014 of the long-term equation implicitly underlying the error correction in model [1]: $ln(imports)_t = \alpha + \beta * ln(gdp)_t + \varepsilon_t$. Global import volume and GDP volume at market exchange rates are measured in 2010 USD.
Source: OECD Economic Outlook 96 Database and OECD calculations.

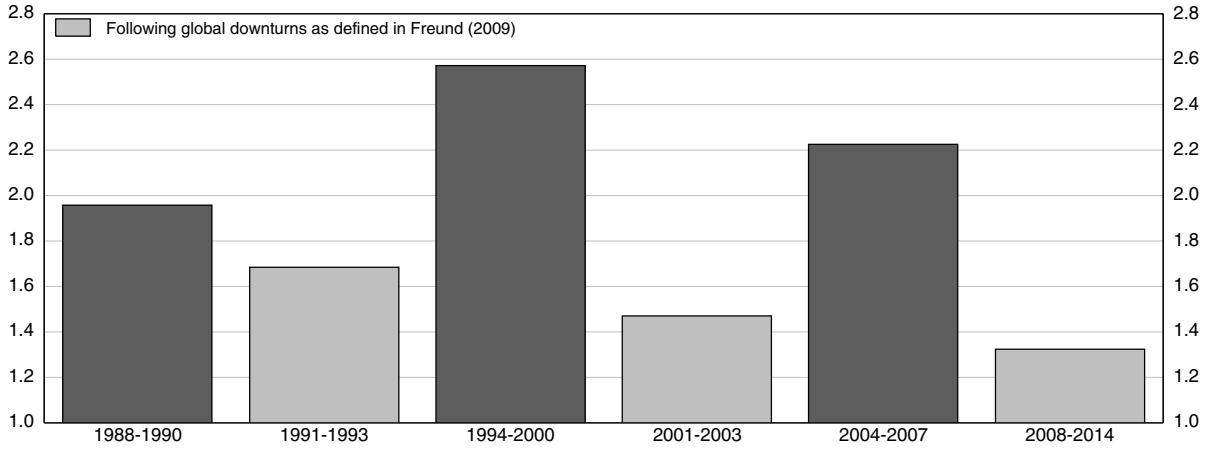
economies, such as China, India and the former Soviet economies, as well as the implementation or deepening of major regional trade agreements such as the North American Free Trade Agreement or the Single European Market, which triggered the international fragmentation of production chains. Instead of producing predominantly in a single country, multinational firms increasingly fragmented the production chain across several countries to take advantage of cost differences, implying that value added increasingly crossed borders several times before being shipped to the final consumer. The post-2008 deviation of the residuals from the pre-crisis trend reflects the decline in the apparent global trade elasticity in the wake of the crisis, but in the context of the severity and the length of the crisis the limited number of post-crisis observations suggests caution in interpreting this as a structural break.[11]

While it is tempting to interpret the decline in the apparent elasticity and the break in the long-term residuals around the crisis as reflecting a structural slowdown in the process of globalisation, the fact that this decline coincides with the onset of the global crisis suggests that it may at least partly be driven by demand developments.[12] In the very long-term there is no reason for the global trade elasticity to remain above 1 as the potential for further transport cost reductions and trade liberalisation declines (Krugman, 2013).[13] However, it appears unlikely that the transition from a long-term elasticity of well above 2 to around 1 would occur as abruptly as suggested by Figures 1 and 4.

Even at a stable long-run elasticity of global trade to GDP, over short sample periods the ratio of global trade growth to global GDP growth – the apparent elasticity – can vary for cyclical reasons (Figure 7). Econometric tests typically suggest a stable long-term relation between global trade and GDP from the late 1980s to 2007 (as represented by a stable δ/γ in model [1]), but in the wake of global downturns identified by the statistical filtering method of Freund (2009) the apparent elasticity was typically well below the stable long-term elasticity. Against the background of the severity of the global crisis of 2008-09, the decline in the apparent elasticity over 2009-14 does not appear as particularly striking.

Figure 7. **The ratio of global trade to GDP growth typically declines following global downturns**

Volumes, market exchange rates



Note: Global import volume and GDP volume at market exchange rates are measured in 2010 USD. Values for 2014 are partly based on projections in *OECD Economic Outlook* (November 2014).
Source: OECD Economic Outlook 96 Database and OECD calculations.

A model that includes only growth rates of global trade and GDP tracks post-crisis trade developments fairly accurately without assuming any structural break in the parameters over the period 1986-2014, suggesting that the overwhelming part of the post-crisis weakness in global trade can be explained by global demand developments. By constraining the long-term global trade elasticity to be constant even at persistently low GDP growth, the error correction model [1] can account for the post-crisis decline in the apparent elasticity only by assuming a structural break in the long-term elasticity. By contrast, the model in growth rates can account for the stylised fact that the global trade elasticity declines in the wake of global downturns without assuming any structural break in the trade-GDP relation (see Box 2). While a simple linear regression of global trade growth on global GDP growth tracks global trade growth fairly accurately (see Figure 4 in the previous section) the inclusion of lagged values of global trade and GDP further raises the fit of the equation. The remainder of the paper therefore focuses on the following model in growth rates:

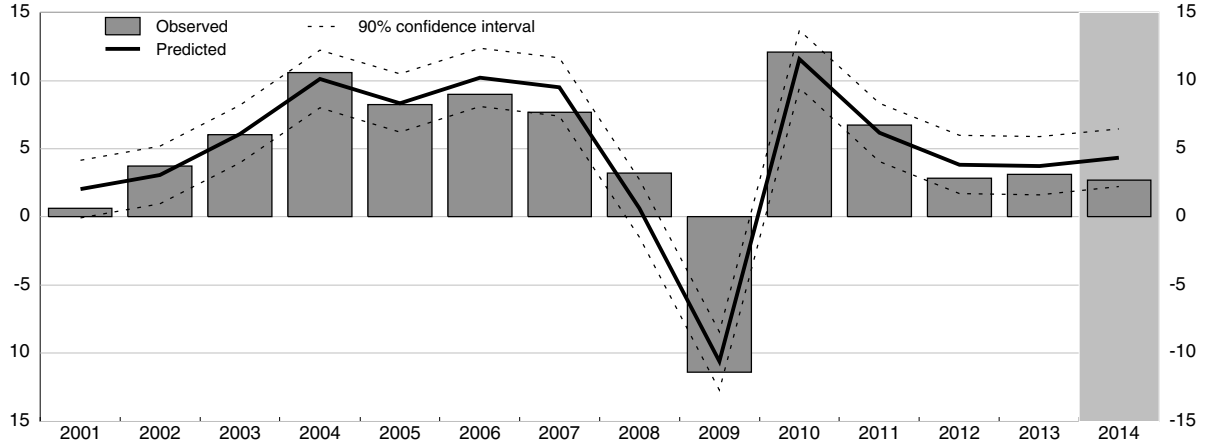
$$\Delta \ln m_t = \alpha + \beta_1 \Delta \ln m_{t-1} + \beta_2 \Delta \ln y_t + \beta_3 \Delta \ln y_{t-1} + \varepsilon_t, \quad [2]$$

where Δ denotes first differences, m_t denotes global import volume and y_t global GDP volume at time t, α is the regression intercept and ε_t is the error term. Formal tests suggest that the parameters of this model are stable over the estimation period 1986-2014 (Annex Table C.1).[14] Moreover, the in-sample fit is accurate even for the post-crisis period (Figure 8) and model [2] explains about 85% of the post-crisis decline in global trade growth.[15]

For the years 2012-13 and possibly 2014, the model in growth rates slightly over-predicts global trade growth but the error is well within the model's error margin and likely to reflect a number of special factors rather than major structural developments. The over-prediction for 2012 and 2013, for instance, partly reflects the extraordinary demand weakness of the highly trade-intensive euro area, for which imports declined by 1% in 2012 and grew by only around 1% in 2013. Projected trade weakness for 2014 appears to mainly reflect developments in non-OECD Asia, including China, rather than euro area developments. A structural explanation for recent trade weakness can therefore not fully be ruled out.

Figure 8. **In-sample fit of the model in growth rates without structural break**

Estimated over 1986-2014, import volume growth, in %



Note: The predicted value of global import volume growth is based on the estimation of model [2] over the period 1986-2014. Values for 2014 are partly based on projections in *OECD Economic Outlook* (November 2014). Global import volume and GDP volume at market exchange rates are measured in 2010 USD.

Source: OECD Economic Outlook 96 Database and OECD calculations.

However, it would be premature to conclude from a single year of unexpectedly low trade growth that there is a structural break in the long-term trade-GDP relation.[16]

Estimations based on quarterly data confirm the results based on annual data in the sense that the estimated long-term global trade elasticity over the period 2001-14 is around 2 (Annex Table B.1) and that the limited decline with respect to the 1990s reflects post-crisis developments (Annex Table B.2). Although higher-frequency data allow a more precise estimation of the dynamics of the trade-GDP relation, quarterly data cannot resolve the fundamental issue that, over periods of seven years, estimates of the long-term elasticity are highly unstable and can be perturbed by cyclical effects.[17] Testing the long-run relation between trade and GDP with 30 quarterly observations is conceptually no different from testing it with seven yearly observations (Hakkio and Rush, 1991). Rather than using quarterly data to estimate the long-term elasticity over short sample periods, this paper therefore applies standard econometric methods to test for the existence of a stable cointegration relation between global trade and GDP over the period 1986-2014. These tests suggest that the cointegration relation was broadly stable over 1986-2008, implying that quarterly data also reject the hypothesis that the decline in the global trade elasticity pre-dated the crisis.

Summing up, the econometric analysis suggests that the most likely scenario for global trade growth over the next two to three years is a rate of about twice that of global GDP growth at market exchange rates as cyclical effects fade and GDP growth picks up as to around its pre-crisis average, as projected by all major international organisations. While the limited number of post-crisis observations precludes a definitive rejection of the hypothesis that structural changes in the global trade-GDP relation may have contributed to recent trade weakness, the econometric analysis rejects the hypothesis that the limited decline in the long-term global trade elasticity reflects structural developments pre-dating the crisis of 2008-09 (Constantinescu et al., 2015). Based on a model in growth rates that does not constrain the elasticity of global trade to GDP to be constant, post-crisis trade developments are well explained by GDP developments alone, suggesting that the decline in the apparent global trade elasticity after 2008 mainly reflects cyclical factors rather than a structural break in the process of globalisation.

3.2. Descriptive evidence on investment, production fragmentation and protectionism

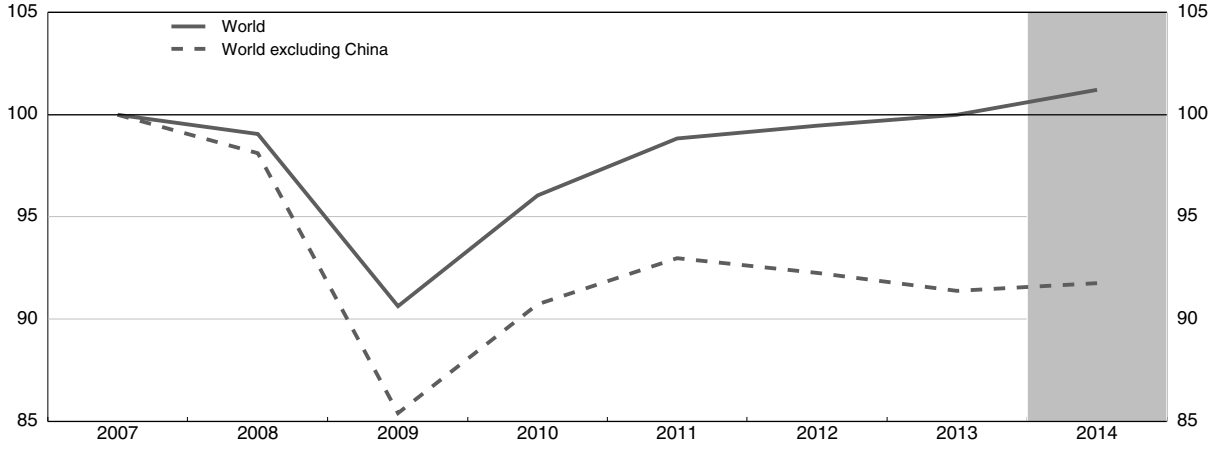
This sub-section assesses the plausibility of the main result from the econometric analysis by using descriptive statistics on recent developments in global investment, international production fragmentation and protectionism. It is first analysed whether in the wake of the crisis the composition of global demand shifted away from import-intensive investment, a development that may at least partly reverse as the global recovery strengthens over the next years. It is further analysed whether post-crisis developments in international production fragmentation signal a structural break or whether the slowdown is consistent with typical cyclical developments and whether there is any evidence for changes in trade protection.

3.2.1. Investment

Global investment has been weak in the wake of the crisis, suggesting that the shift in the composition of global GDP towards less import-intensive components such as government consumption or private non-durables consumption has contributed to the post-crisis weakness of global trade. The apparent rebound of global investment intensity in the wake of the crisis has largely been driven by developments in China, for which the post-crisis investment boom largely reflects infrastructure investment (OECD, 2013) whose import content is low (Figure 9). For the remaining countries investment has been exceptionally weak in the wake of the crisis, further supporting the notion that trade may rebound strongly if investment intensity, especially in OECD countries, rebounds.

Figure 9. **The ratio of global investment volume to GDP volume has been weak in the wake of the crisis**

Index (2007 = 100)



Note: Global investment and GDP volumes measured at market exchange rates. The value for 2014 is partly based on projections in *OECD Economic Outlook* (November 2014).
Source: *OECD Economic Outlook 96 Database* and OECD calculations.

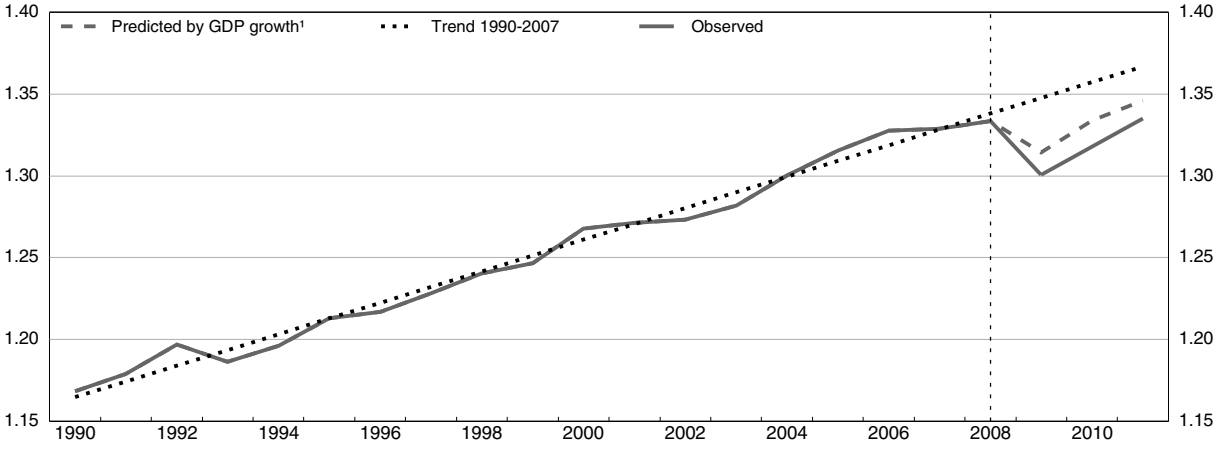
3.2.2. International production fragmentation

There is no evidence for a slowdown in international production fragmentation – the process of slicing up the production process into stages located in different countries – in the run-up to the global crisis and the decline for 2009 is broadly consistent with global GDP developments, suggesting that there is thus far no evidence for a structural break. A common measure of international production fragmentation is the ratio of gross exports to

value added exports, which can be interpreted as the average number of border crossings for each unit of imported final good (Fally, 2012). This measure started to increase along a linear trend in the late 1980s up to 2008, thereby raising gross exports and the global trade elasticity. It started to deviate from trend only at the onset of the global crisis (Figure 10). Regression analysis suggests that international production fragmentation is pro-cyclical in the sense that international production fragmentation accelerates when global GDP growth is high and decelerates during global downturns. The pro-cyclicality may reflect the fact that during global recessions the composition of global trade shifts toward products with shorter value chains (Ferrantino and Taglioni, 2014) or the fact that multinational companies postpone investment projects related to international outsourcing. Based on the estimated semi-elasticity of international production fragmentation to global GDP, post-crisis developments in international production fragmentation are largely explained by GDP developments, with international production fragmentation declining in 2009 and rebounding over 2010-11 (Figure 10).

Figure 10. **The decline in international production fragmentation in 2009 is consistent with GDP developments**

Ratio of gross exports to value-added exports



1. Predicted value for 2009 and 2011 based on the estimation over 1990-2008 of $\Delta GVAX_t = \alpha + \beta * \Delta ln(gdp)_t + \varepsilon_t$, where GVAX is the ratio of gross to value-added exports.

Note: Between OECD-WTO reference years (1995, 2000, 2005, 2008 and 2009) the gross exports to value added exports ratio is interpolated using the inverse of the VAX ratio in Johnson and Noguera (2012). The OECD-WTO reference year 2011 is based on preliminary data.
Source: OECD-WTO Trade in Value Added (TiVA); Johnson and Noguera (2012).

3.2.3. Protectionism

Increases in protectionism appear to have played at best a marginal role in the slowdown of global trade following the crisis. While circumstantial evidence suggests an increase in the number of "murky" protectionist measures taken by G20 governments (Evenett, 2013) – including subsidies to domestic industries, anti-dumping actions or discriminatory regulation – WTO (2014) concludes that "the share of world trade affected by restrictive trade measures is not high" and that the rise in trade-restrictive measures has to be seen in the context of offsetting trade liberalising measures, especially in lower-income G20 countries. For instance, the share of world trade covered by trade-restrictive measures introduced by G20 countries in 2012 was similar to the share covered by trade-liberalising measures (around 1% of world trade).[18]

4. Implications for projecting trade when GDP projections are known

Models linking global trade and GDP are routinely used in the OECD Economics Department to assess the consistency of the global trade and GDP projections. The results reported in this paper imply that in the near term consistency checks should be conducted based on the relation between global trade growth and GDP growth since around the late 1980s, as the relation has been fairly stable thereafter with no evidence for a structural break in the equation in growth rates (model [2]) in the wake of the global crisis of 2008-09.[19] Based on the estimation of model [2] over 1986-2013 that has tracked global trade growth fairly accurately over 1990-2013, the most recent global GDP projections for 2016 of 3.3% at market exchange rates (3.9% at PPPs) in *OECD Economic Outlook* (November 2014) imply that global trade growth should pick up to around 7%.

Notes

1. Based on an extensive review of empirical studies Bems et al. (2013) suggest that 65-80% of the trade collapse of 2009 can be attributed to declines in expenditure and shifts in its composition, with the remaining fall in global trade attributable to inventory adjustments and credit shocks. By contrast, tariff increases and antidumping duties contributed at most 0.4 percentage points to the 24% decrease in merchandise trade in 2009.
2. Anecdotal evidence suggests that the global crisis triggered an increase in the number of "murky" protectionist measures by G20 countries (Evenett, 2013).
3. Although Constantinescu et al. (2015) does not explicitly disclose the precise measure of global GDP used in their study, the similarity of their estimation results with those based on global GDP at PPPs reported in Table 1 suggests that Constantinescu et al. (2015) is based on the PPP measure. Given that the long-term component of global trade growth in Constantinescu et al. (2015, Figure 6) is obtained by multiplying the assumed long-term elasticity of 1.3 with global GDP growth, the fact that the long-term component is close to 0 for 2009 while global GDP growth at market exchange rates was around -2% also appears to suggest that Constantinescu et al. (2015) is based on global GDP at PPPs.
4. The growth differential between G7 countries and the BRICS countries increased from around 4½ percentage points over the period 1986-2007 to 5½ percentage points over the period 2008-14 while global growth slowed by around 1 percentage point (from 3.3% to 2.1% at market exchange rates).
5. See Annex A for details on the construction of intra-euro area import volumes and Figure A.2 for post-crisis growth in intra-euro area import volumes.
6. The share in global GDP of the United States is slightly higher than that of the euro area (23% versus 18% in 2010), but the share in global trade is only around half that of the euro area (12.5% versus 24% in 2010). Assuming similar import elasticities – which is consistent with the results in Bussière et al. (2013) and Morin and Schwellnus (2014) – the effect on global imports of a similar decline in demand across the two zones would be about twice as large for the euro area as for the United States.
7. Note that the negative effect of intra-euro area trade on the global trade intensity reflects both weak euro area demand and a decline in the apparent elasticity of intra-euro area trade to euro area GDP, with intra-euro area trade intensity well below its pre-crisis trend (Figure A.3).
8. The regression of global trade growth on global GDP growth $\Delta \ln(imports_t) = \alpha + \beta \Delta \ln(gdp_t) + \varepsilon_t$ corresponds to a short-run model that does not restrict the long-term elasticity of global trade to GDP. More specifically, if $\alpha \neq 0$ the long-term elasticity implied by this model $\Delta\ln(imports) / \Delta\ln(gdp) = \beta + \alpha / \Delta\ln(gdp)$ depends on long-term GDP growth. For the coefficients estimated over 1986-2007 ($\alpha = -3.5$ and $\beta = 3.1$), GDP growth of 3.3% (average 1986-2007) implies a long-term elasticity of 2.1 while GDP growth of 2.1% (average 2008-14) implies an elasticity of 1.5.
9. The detailed estimation results are reported in Table D.1.
10. It should be noted that the differences between sub-periods in Table 1 are statistically significant at the 5% level (see Table D.1).
11. Formal tests for structural breaks detect statistically significant changes in the long-term relation between global trade and GDP in the late 1980s and around the onset of the global crisis in 2008-09

but no change around the year 2000, suggesting that the break in the global trade elasticity did not pre-date the global crisis (Table D.2). The cointegration test of Gregory and Hansen (1996) allowing for a structural break in the cointegration relation yields 2007 as the break date for the sample period 1986-2014. Moreover, it suggests a broadly stable cointegration relation between global trade and GDP from the late-1980s to 2007. The Gregory and Hansen (1996) test narrowly fails to reject the null hypothesis of no cointegration when allowing for a break in 2007, but it is well known that formal tests of cointegration have low power in small samples (Hakkio and Rush, 1991). The error-correction based cointegration test of Banerjee et al. (1996) which has generally more power when cointegration exists, rejects the null hypothesis of no cointegration over the period 1986-2007.

12. Note that the residuals of the long-term equation and the statistical tests for structural breaks in the long-term cointegrating relation between global trade and GDP are based on the long-term equation in (logarithmic) levels which assumes a constant apparent global trade elasticity irrespective of global demand growth (see Box 2). The statistical tests therefore mechanically attribute a decline in the apparent global trade elasticity to a change in the structural long-term global trade elasticity.

13. Gruber et al. (2011) constrain the long-run global trade elasticity to 1 but allow for an exogenous globalisation trend meant to capture the effect of transport cost declines, trade liberalisation or the lengthening of global value chains on the global trade growth.

14. The parameter stability in the model in growth rates implies that predicted global trade grows at about twice the rate of global GDP once cyclical effects fade, i.e. at average GDP growth over the period 1986-2014 the short-term model implies an apparent global trade elasticity of about 2 (see Annex 3 for the properties of the model in growth rates and Table D.3 for detailed estimation results).

15. Global trade growth declined from 6.9% over 1986-2007 to 2.8% over 2008-14, with the model estimated over 1986-2007 explaining 3½ percentage points of the overall decline. This result is robust to using a simple linear regression of global trade growth on global GDP growth over 1986-2007 to predict global trade growth over 2008-14.

16. The possible over-prediction for 2014 is similar in size to the one for 2001 after which trade resumed growth similar to the rate predicted by the model in growth rates.

17. Rolling regressions over 7-year windows over 1986-2014 based on model [1] shows that the estimated long-term global trade elasticity is highly unstable (Figure B.1).

18. The share of world trade covered by trade-restrictive and trade-liberalising measures is a crude indicator for the trade effects of protection as trade effects depend on the type and the size of the measures and import demand elasticities.

19. In the medium term, it is likely that the apparent elasticity of global trade to GDP returns to a level well below 2 as trade liberalisation and declines in transport costs are likely to proceed at a slower pace than over the past two decades.

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ANNEX A

Details on global GDP volume at market exchange rates and intra-euro area trade

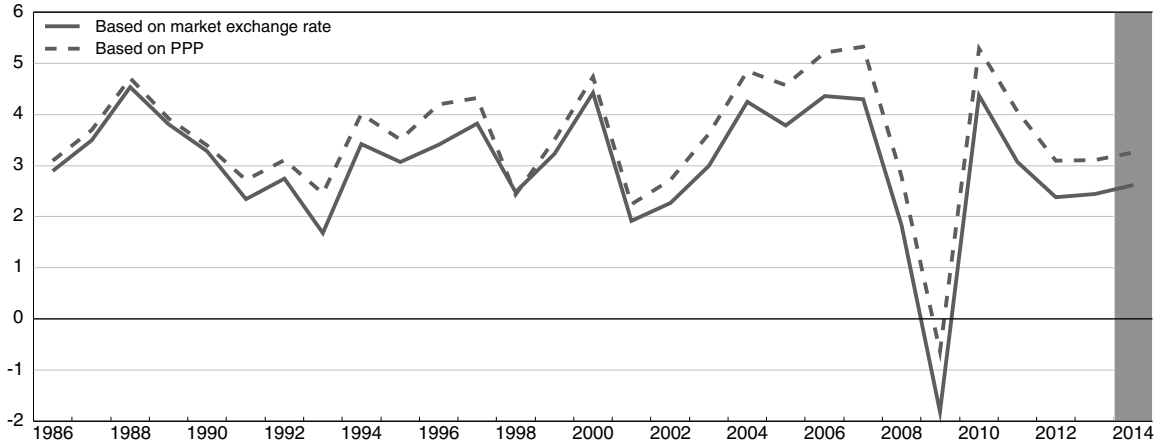
Global GDP growth at market exchange rates is computed as the weighted sum of country-specific real GDP growth rates for all countries in the world, where the weights are shares in global GDP at market exchange rates defined as follows:

$$w_{i,t} = \left(gdp_{i,t} * e_{i,2010}\right) \Big/ \sum_i \left(gdp_{i,t} * e_{i,2010}\right)$$

where $gdp_{i,t}$ denotes real GDP of country i at date t (in constant domestic currency for the base year 2010) and $e_{i,2010}$ the value of the bilateral exchange rate of country i with the US dollar in 2010.[1] Note that global import volumes are computed at market exchange rates using the same aggregation procedure. Post-crisis growth of global GDP at market exchange rates has been around 1 percentage point below the growth rate of the conventional measure of global GDP at PPPs which is directly available in the November 2014 *OECD Economic Outlook Database* (Figure A.1).

Figure A.1. **Real global GDP growth at PPPs and market exchange rates**

Percentage change



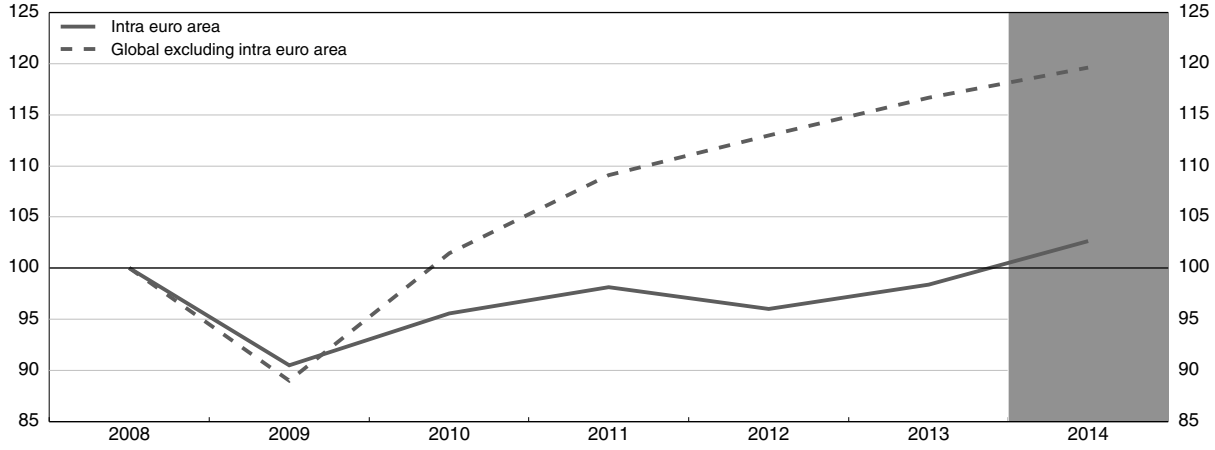
Note: The value for 2014 is partly based on projections in *OECD Economic Outlook* (November 2014).
Source: OECD Economic Outlook 96 Database and OECD calculations.

1. The level of global GDP volume at 2010 market exchange rates can be obtained by constructing an index of global GDP volume and applying it to nominal global GDP in US dollars in 2010.

Intra-euro area imports of goods and services are constructed using the share of intra-euro area imports reported by Eurostat (merchandise only) and multiplying it by the measure of total euro area import volumes (goods and services) in the *OECD Economic Outlook No. 96 Database*. Eurostat does not report intra-euro area imports before 1999 so that IMF Direction of Trade Statistics are used to compute the share of intra-euro area imports in total euro area imports before that date. Over the post-crisis period intra-euro area imports have been a significant drag on global import volume growth (Figure A.2). Moreover, the elasticity of intra-euro area trade to euro area GDP appears to have declined in the wake of the crisis, as illustrated by the deviation of the ratio of intra-euro area imports to euro GDP from its pre-crisis trend (Figure A.3).

Figure A.2. **Intra-euro area import volumes have been a drag on global import volumes**

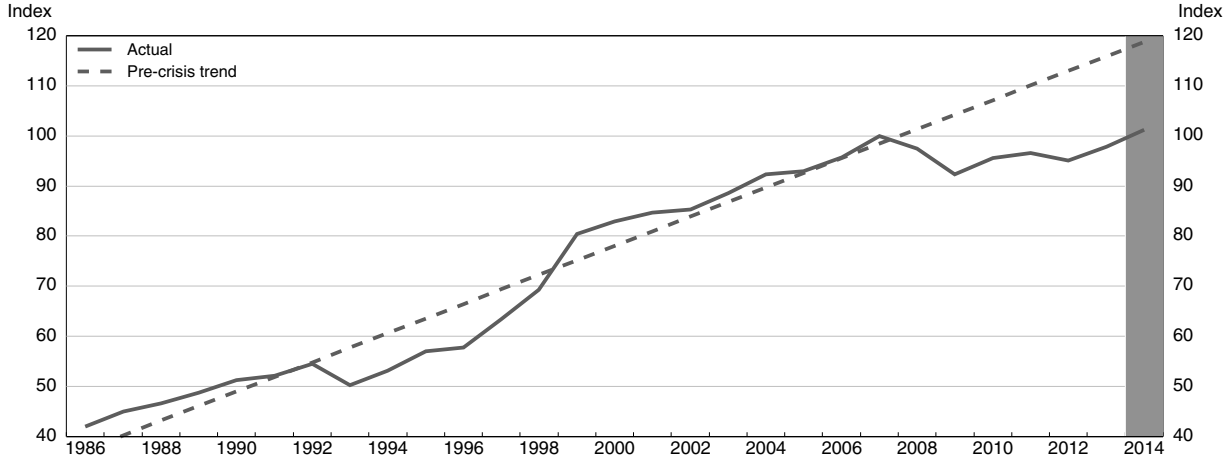
Index (2008 = 100)



Note: The value for 2014 is partly based on projections in *OECD Economic Outlook* (November 2014).
Source: Eurostat; *OECD Economic Outlook 96 Database*; and OECD calculations.

Figure A.3. **The ratio of intra-euro imports to euro area GDP has deviated from its pre-crisis trend**

Index (2007 = 100)



Note: The value for 2014 is partly based on projections in *OECD Economic Outlook* (November 2014).
Source: *OECD Economic Outlook 96 Database* and OECD calculations.

ANNEX B

Details on estimation results based on quarterly data

The estimation results for the sample periods 1986-2000 and 2001-14 based on quarterly data are similar to those based on annual data in the sense that there is a limited decline in the long-term global trade elasticity over the second sub-sample, with the long-term elasticity nonetheless remaining close to 2 (Table B.1).

Table B.1. **Estimation results for model [1] based on quarterly data**

Dependent variable	$\Delta\ln(imports)_t$	
	1986-2000	2001-14
constant (α)	-2.4	-1.4
	(1.8)	(1.2)
$\Delta\ln(gdp)_t$ (β)	2.0***	3.5***
	(0.4)	(0.2)
$\ln(imports)_{t-1}$ (γ)	-0.05	-0.05
	(0.04)	(0.04)
$\ln(gdp)_{t-1}$ (δ)	0.1	0.1
	(0.1)	(0.1)
Long-term elasticity ($-\delta/\gamma$)[1]	2.6***	1.9***
Statistical difference with previous period[2]		0.7
Adjusted R-squared	0.74	0.74
Sample size[3]	116	116

1. The long-term elasticities for the sub-periods 1986-2000 and 2001-14 are given by $-\delta_2/\gamma_2$ and $-\delta_3/\gamma_3$, respectively. Statistical significance is established using a non-linear Wald test.
2. F-statistic based on a nonlinear using a nonlinear Wald test.
3. To allow direct comparison with Constantinescu et al. (2015) the overall sample size is reported although the effective sample size for the identification of the relevant coefficients is equal to size of the sub-samples.

Note: Statistical significance based on unadjusted t-statistics at the 1, 5 and 10% level is denoted by ***, **, and *, respectively; standard errors in parentheses. Based on the estimation of the following equation:

$$dln(imports)_t = \alpha_2 + \beta_2 * dln(gdp)_t * DV_2 + \gamma_2 * \ln(imports)_{t-1} * DV_2 + \delta_2 * \ln(gdp)_{t-1} * DV_2 + \alpha_3 + \beta_3 * dln(gdp)_t * DV_3 + \gamma_3 * \ln(imports)_{t-1} * DV_3 + \delta_3 * \ln(gdp)_{t-1} * DV_3 + \varepsilon_t,$$

where gdp is global GDP volume; imports is global imports of goods and services; DV_2 and DV_3 are dummy variables for the periods 1986-2000 and 2001-14, respectively, and ε_t is the error term.

Source: *OECD Economic Outlook 96 Database* and OECD calculations.

The Gregory and Hansen (1996) cointegration test over the period 1986-2014 indicates 2008Q1 as a break date and broadly stable cointegration before, suggesting that the decline in the long-term global trade elasticity over the period 2001-14 compared with 1986-2000 is driven by post-2007 developments.

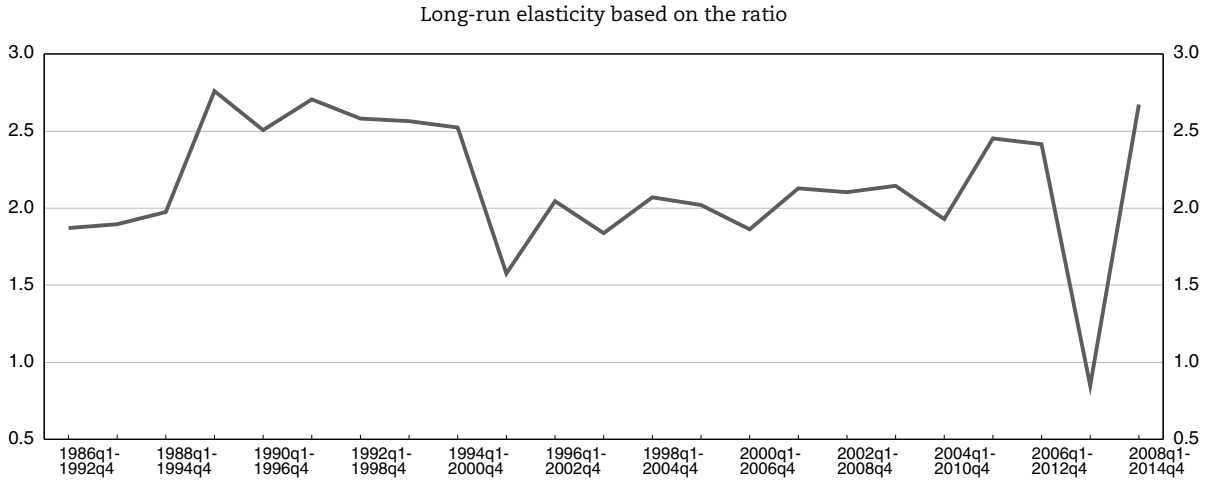
Table B.2. **Cointegration tests based on quarterly data**

	Null hypothesis	Test statistic	5% critical value	10% critical value	Break date
Gregory-Hansen[1] (1986-2014)	no cointegration	-4.5	-5.0	-4.7	2008Q1

1. Gregory-Hansen (1996) cointegration test allowing for a break (constant and slope) with 10% trimming.
Note: Tests based on the long-term equation using quarterly data: $ln(imports_t) = c + \beta * ln(gdp_t) + \varepsilon_t$.
Source: *OECD Economic Outlook 96 Database* and OECD calculations.

Estimating long-term relations over 6-7 year horizons would be misguided as higher-frequency data do not help to estimate the long-term relation between global trade and GDP. As noted by Hakkio and Rush (1991), the gain in degrees of freedom is more apparent than real as identifying a long-term property of the data with 30 quarterly observations is essentially equivalent to identifying it with 7 yearly observations. Moreover, estimates of the long-term elasticity over 7-year windows are highly unstable, implying that they are highly dependent on the chosen sample dates (Figure B.1).

Figure B.1. **Long-term elasticity estimated over 7-year windows using quarterly data**



Note: Based on model [1].
Source: *OECD Economic Outlook 96 Database* and OECD calculations.

ANNEX C

Properties of the model in growth rates

The model in growth rates in model [2] implies a non-constant apparent elasticity of global trade to GDP, with the apparent elasticity given by:

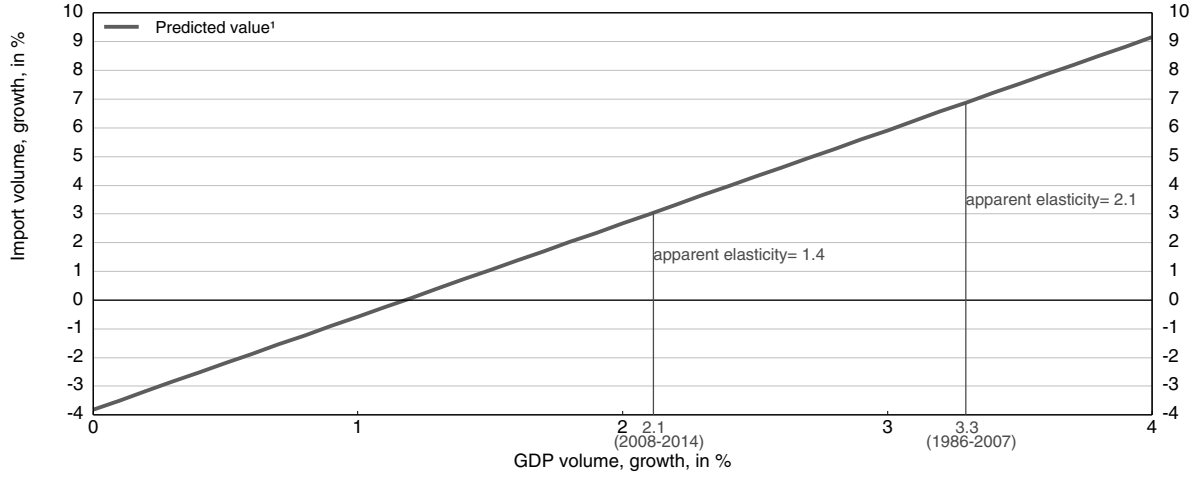
$$\frac{\Delta\ln(imports_t)}{\Delta\ln(gdp_t)} = \frac{\alpha}{(1-\beta_1)\cdot\Delta ln(gdp_t)} + \frac{\beta_2+\beta_3}{1-\beta_1}$$

At the parameter values estimated over the period 1986-2014 (Table D.3) and positive global GDP growth, the apparent global trade elasticity is pro-cyclical, which is consistent with the stylised fact that the apparent elasticity typically declines in the wake of global downturns (see Figure 7).

Reflecting the pro-cyclicality of the apparent global trade elasticity, the model in growth rates in model [2] does not require assuming a structural break in model parameters to replicate global trade developments in the wake of the crisis. As noted by Clements and Hendry (2002), forecasting performance of models in first differences are less sensitive than error correction models to persistent changes in means of stationary variables, such as the persistent decline in the mean of global GDP growth in the wake of the crisis. Even without assuming a structural break in the parameters estimated over the period 1986-2014, the short-term model thus predicts global trade growth of 3% at the average rate of global GDP growth of 2.1% over 2008-14 (apparent elasticity of 1.4) and global trade growth of around 7% at the average rate of global GDP growth of 3.3% over the period 1986-2007 (apparent elasticity of 2.1, Figure C.1).

The stability in the parameters of the model in growth rates in model [1], which is confirmed by formal tests of structural breaks (Table C.1), suggests that going forward global trade is likely to grow at twice the rate of global GDP as cyclical effects fade. At an average GDP growth rate of 3.3% as over 1986-2007, the model in growth rates is consistent with a long-term global trade elasticity of slightly above 2 (see Figure C.1).

Figure C.1. **Apparent elasticity implied by the model in growth rates in model [2]**



1. Based on model [2] assuming steady-state growth of trade and GDP volumes.
Note: Average growth rates are reported in red for the periods 1986-2007 and 2008-2014.
Source: OECD Economic Outlook 96 Database and OECD calculations.

Table C.1. **Tests for breaks in the parameters of the model in growth rates**

	Null hypothesis	Test statistic	5% critical value	10% critical value	Break date
Bai-Perron (1986-2014)	No break	5.1	14.0	12.1	-

Note: Tests based on model [2].
Source: OECD Economic Outlook 96 Database and OECD calculations.

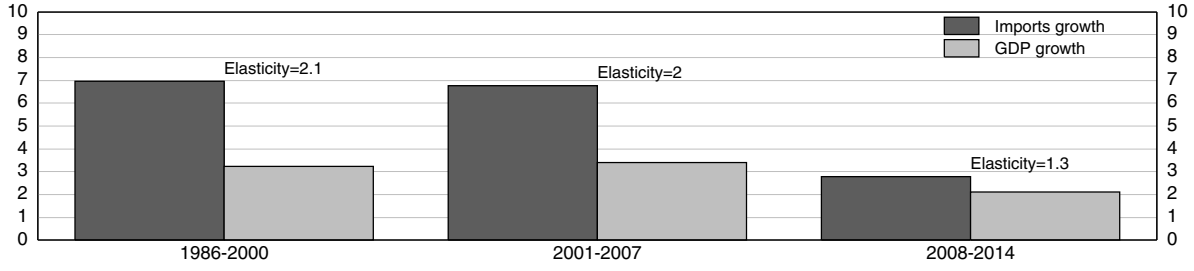
ANNEX D

Additional tables and figures

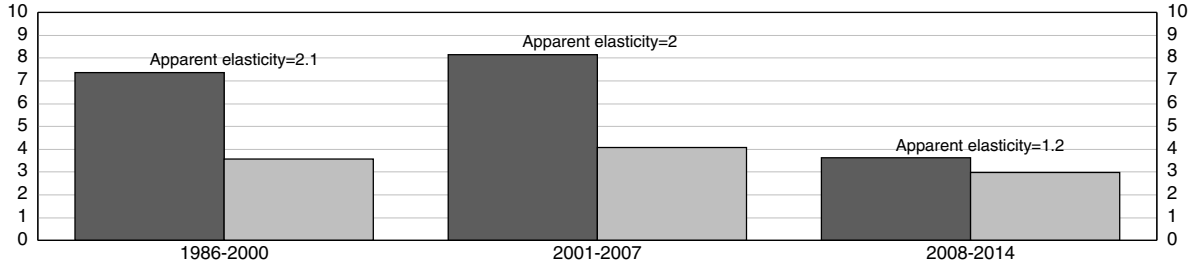
Figure D.1. **The apparent global trade elasticity using alternative aggregation methods**

Average annual growth rate, volume, in %

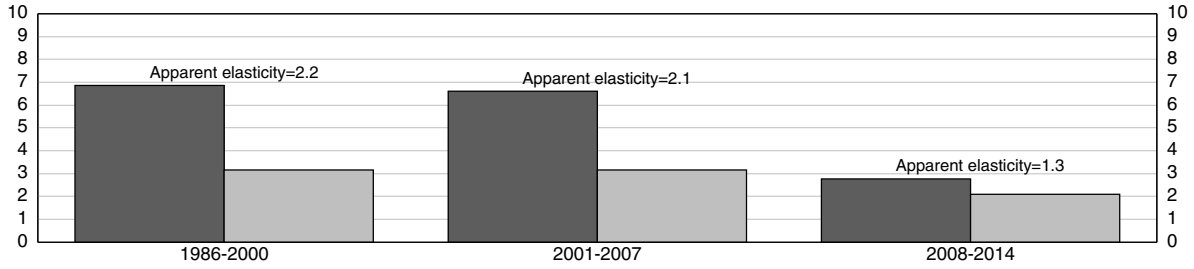
Panel A. GDP volume and global import volume at constant market exchange rates (2010 USD)



Panel B. GDP volume and global import volume at current PPP



Panel C. GDP volume and global import volume at current market exchange rates



Source: OECD Economic Outlook 96 Database and OECD calculations.

Table D.1. **Detailed estimation results for model [1] based on annual data**

Panel A: Global GDP volume at PPPs

Dependent variable	$\Delta\ln(\text{imports})_t$		
	1970-85	1986-2000	2001-14
constant (α)	-6.1**	-6.5	-2.9
	(2.4)	(5.7)	(2.2)
$\Delta\ln(\text{gdp})_t$ (β)	1.9***	3.1***	3.4***
	(0.3)	(0.6)	(0.3)
$\ln(\text{imports})_{t-1}$ (γ)	-0.6***	-0.2	-0.2*
	(0.2)	(0.2)	(0.1)
$\ln(\text{gdp})_{t-1}$ (δ)	0.7***	0.4	0.3*
	(0.2)	(0.4)	(0.2)
Long-term elasticity ($-\delta/\gamma$)[1]	1.3***	2.3***	1.3***
Statistical difference with previous period[2]		3.3*	2.9*
Adjusted R-squared	0.87	0.87	0.87
Sample size[3]	45	45	45

Panel B: Global GDP volume at market exchange rates

Dependent variable	$\Delta\ln(\text{imports})_t$		
	1970-85	1986-2000	2001-14
constant (α)	-7.0***	-11.8**	-5.9
	(2.5)	(5.7)	(5.2)
$\Delta\ln(\text{gdp})_t$ (β)	1.9***	3.3***	3.4***
	(0.3)	(0.6)	(0.3)
$\ln(\text{imports})_{t-1}$ (γ)	-0.6***	-0.3	-0.2
	(0.2)	(0.2)	(0.2)
$\ln(\text{gdp})_{t-1}$ (δ)	0.8***	0.6*	0.4
	(0.2)	(0.3)	(0.3)
Long-term elasticity ($-\delta/\gamma$)[1]	1.3***	2.4***	1.8***
Statistical difference with previous period[2]		20.9***	4.5**
Adjusted R-squared	0.89	0.89	0.89
Sample size[3]	45	45	45

Panel C: Global GDP volume at market exchange rates, excluding intra-EA imports

Dependent variable	$\Delta\ln(\text{imports})_t$		
	1970-85	1986-2000	2001-14
constant (α)	-11.1***	-16.9***	-9.9
	(3.6)	(5.7)	(7.5)
$\Delta\ln(gdp)_t$ (β)	1.6***	3.3***	3.5***
	(0.4)	(0.7)	(0.4)
$\ln(imports)_{t-1}$ (γ)	-0.9***	-0.4**	-0.3
	(0.3)	(0.2)	(0.2)
$\ln(gdp)_{t-1}$ (δ)	1.2***	0.9***	0.6
	(0.4)	(0.3)	(0.4)
Long-term elasticity ($-\delta/\gamma$)[1]	1.3***	2.3***	2.0***
Statistical difference with previous period[2]		20.9***	4.5**
Adjusted R-squared	0.85	0.85	0.85
Sample size[3]	45	45	45

1. The long-term elasticities for the sub-periods 1970-85, 1986-2000 and 2001-14 are given by $-\delta_1/\gamma_1$, $-\delta_2/\gamma_2$ and $-\delta_3/\gamma_3$, respectively. Statistical significance is established using a non-linear Wald test.
2. F-statistic based on a non-linear Wald test.
3. To allow direct comparison with Constantinescu et al. (2015) the overall sample size is reported although the effective sample size for the identification of the relevant coefficients is equal to size of the sub-samples.

Note: Statistical significance based on unadjusted t-statistics at the 1, 5 and 10% level is denoted by ***, **, and *, respectively; standard errors in parentheses. Based on the estimation of the following equation:

$$dln(imports)_t = \alpha_1 + \beta_1 * dln(gdp)_t * DV_1 + \gamma_1 * \ln(imports)_{t-1} * DV_1 + \boldsymbol{\delta_1} * \ln(gdp)_{t-1} * DV_1 + \alpha_2 + \beta_2 * dln(gdp)_t * DV_2 + \gamma_2 * \ln(imports)_{t-1} * DV_2 + \delta_2 * \ln(gdp)_{t-1} * DV_2 + \alpha_3 + \beta_3 * dln(gdp)_t * DV_3 + \gamma_3 * \ln(imports)_{t-1} * DV_3 + \delta_3 * \ln(gdp)_{t-1} * DV_3 + \varepsilon_t,$$

where gdp is global GDP volume; imports is global imports of goods and services; DV_1, DV_2 and DV_3 are dummy variables for the periods 1970-85, 1986-2000 and 2001-14, respectively; and ε_t is the error term.

Source: OECD Economic Outlook 96 Database and OECD calculations.

Table D.2. **Tests for breaks in the long-term import-to-GDP relation**

	Null hypothesis	Test statistic	5% critical value	10% critical value	Break date
Bai-Perron[1] (1970-2014)	0 break (vs 1)	233.9	12.3	10.4	1988
	1 break (vs 2)	50.3	13.8	12.2	2009
	2 breaks (vs 3)	14.1	14.7	13.2	1995
Gregory-Hansen[2] (1989-2014)	no cointegration	-4.4	-5.0	-4.7	2007
Banerjee et al.[3] (1986-2007)	no cointegration	-3.3	3.4	3.0	-

1. Bai-Perron (2003) test of multiple breaks (constant and slope) with 10% trimming.
2. Gregory-Hansen (1996) cointegration test allowing for a break (constant and slope) with 10% trimming.
3. Banerjee et al. (1996) cointegration test.

Note: Tests based on the long-term equation $ln(imports_t) = c + \beta * ln(gdp_t) + \varepsilon_t$.

Source: OECD Economic Outlook 96 Database and OECD calculations.

Table D.3. **Detailed estimation results for model [2] based on annual data**

1986-2014

Dependent variable	$\Delta\ln(\text{imports})_t$
constant (α)	-0.03**
	(0.01)
$\Delta\ln(\text{imports})_{t-1}$ (β_1)	0.3*
	(0.15)
$\Delta\ln(\text{gdp})_t$ (β_2)	3.6***
	(0.22)
$\Delta\ln(\text{gdp})_{t-1}$ (β_3)	-1.3**
	(0.55)
Adjusted R^2	0.90
Sample size	29

Note: Import and GDP volumes are measured at constant market exchange rates. Statistical significance at the 1, 5 and 10% level is denoted by ***, **, and *, respectively; standard errors in parentheses.

Source: OECD Economic Outlook 96 Database and OECD calculations.

OECD Journal: Economic Studies
Volume 2015
© OECD 2015

Incorporating anchored inflation expectations in the Phillips curve and in the derivation of OECD measures of the unemployment gap

by
Elena Rusticelli, David Turner *and* Maria Chiara Cavalleri*

Inflation has become much less sensitive to movements in unemployment in recent decades. A common explanation for this change is that inflation expectations have become better anchored as a consequence of credible inflation targeting by central banks. In order to evaluate this hypothesis, the paper compares two competing empirical specifications across all OECD economies, where competing specifications correspond to the "former" and "new" specification for deriving measures of the unemployment gap which underlie the OECD Economic Outlook *projections. The former OECD specification can be characterised as a traditional "backward-looking" Phillips curve, where current inflation is partly explained by an autoregressive distributed lag process of past inflation representing both inertia and inflation expectations formed on the basis of recent inflation outcomes. Conversely, the new approach adjusts this specification to incorporate the notion that inflation expectations are anchored around the central bank's inflation objective. The main finding of the paper is that the latter approach systematically out-performs the former for an overwhelming majority of OECD countries over a recent sample period. Relative to the backward-looking specification, the anchored expectations approach also tends to imply larger unemployment gaps for those countries for which actual unemployment has increased the most. Moreover, the anchored expectations Phillips curve reduces real-time revisions to the unemployment gap, although these still remain uncomfortably large, in the case of countries where there have been large changes in unemployment.*

JEL classification: C22, E24, E31, J64

Keywords: Anchored expectations, Phillips curve, equilibrium unemployment, real-time revisions

* The authors are members of the Macroeconomic Analysis Division of the OECD Economics Department.
They would particularly like to thank Jonathan Millar for his detailed comments and suggestions on the empirical work, which prompted investigations into the new approach described in this paper. In addition, the authors would like to thank Stéphane Lhuissier, Werner Roeger, Peter Hoeller and Douglas Sutherland for comments on the paper, the many country desk officers at the OECD who have commented on individual country results as well as Ines Gomez Palacio for assistance in preparing the document. The views expressed in this paper are those of the authors and do not necessarily represent those of the OECD or its member countries.
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Introduction and summary

The relationship between inflation and unemployment, which is at the heart of macroeconomics, has undergone a profound change over recent decades, with inflation becoming much less sensitive to movements in unemployment. In particular, much recent research has addressed the puzzle of the "missing deflation" (Stock, 2011) in the wake of the financial crisis. Understanding the nature of the relationship between inflation and unemployment is important for quantifying the degree of slack in the economy, with implications for the assessing monetary policy requirements and fiscal sustainability.

A common explanation for the increased insensitivity of inflation to demand conditions is that inflation expectations have become better anchored because of credible inflation targeting by central banks. In order to evaluate this hypothesis, the paper compares two competing empirical specifications across all OECD economies, where the competing specifications correspond to the "former" and "new" specification for deriving measures of the unemployment gap which underlie the *OECD Economic Outlook* projections. The former OECD specification can be characterised as a traditional "backward-looking" Phillips curve, where current inflation is partly explained by an autoregressive distributed lag process of past inflation representing both inertia and inflation expectations formed on the basis of recent inflation outcomes. Conversely, the new approach adjusts this specification to incorporate the notion that inflation expectations are anchored around the central bank's inflation objective.

The main finding of the paper, and its contribution to the existing literature, is that the anchored expectations specification out-performs the "backward-looking" specification for an overwhelming majority of OECD countries over a recent sample period. Particular emphasis is placed on the consistently higher statistical significance of the unemployment gap term in the anchored expectations specification, which implies that the corresponding unemployment gap is identified with greater confidence and precision. Conversely, the lack of statistical significance in the "backward-looking" specification implies that the corresponding derived measure of equilibrium unemployment is little more than a filter of actual unemployment. Relatedly, the anchored expectations Phillips curve reduces real-time revisions to the unemployment gap, although these still remain uncomfortably large in the case of countries, where there have been large changes in unemployment. The difference in specifications is not just of importance in terms of statistical fit, but also in terms of the differing implied economic relationship between inflation and unemployment. The anchored expectations specification implies larger unemployment gaps (or, equivalently, lower equilibrium unemployment rates) for those countries for which actual unemployment has increased the most in the aftermath of the financial crisis.

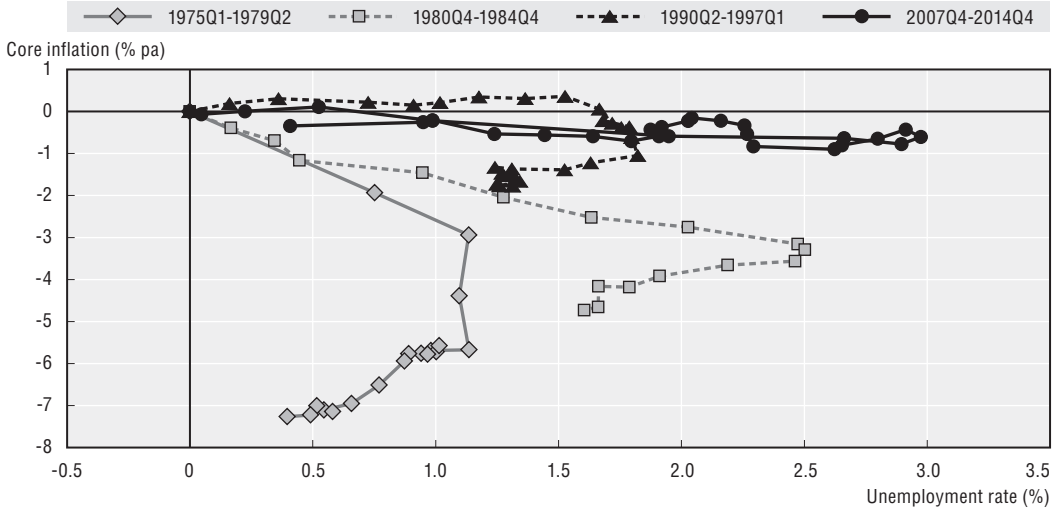
The next section briefly reviews the evidence that inflation has become less sensitive to movements in unemployment. Section 3 describes a general Phillips curve specification, while the traditional backward-looking Phillips curve specification, which was the basis of the former OECD method for deriving the unemployment gap, is defined in Section 4. Section 5 provides evidence that long-term inflation expectations have become better

anchored. Section 6 describes amendments to the Phillips curve specification to incorporate anchored inflation expectations, as well as statistical tests of its robustness. The differing economic interpretations of the two specifications are contrasted in Section 7, together with their implications for estimates of the unemployment gap. Finally, real-time revisions to the unemployment gap before, during and after the crisis are evaluated for a selection of countries for both competing specifications in Section 8.

2. Evidence of reduced inflation sensitivity to unemployment

Given the steep and prolonged increase in unemployment in the major OECD economies in the wake of the Great Recession, the fall in core inflation has been remarkably modest. This absence of a substantial fall in inflation was recently referred to by the IMF as "the dog that didn't bark" in an allusion to a Sherlock Holmes story (IMF, 2013). It can be illustrated by the contrasting relationship between inflation and unemployment over the Great Recession for the main OECD economies with the same relationship over major downturns in the 1970s, 1980s and early 1990s (Figure 1). For the major seven OECD economies the cumulative increase in the unemployment rate from 2007 to 2014 has been more than 12 percentage point years, which has been associated with a fall in core inflation of only 1/3 of a percentage point over the same period. The implied "sacrifice ratio" amounts to more than 30, whereas it would average only about 2½ when computed over major downturns in the 1970s, 1980s and early 1990s.[1]

Figure 1. **Inflation and unemployment in the 7 major OECD economies over major downturns**



Note: The figure shows the cumulative change in core inflation and the cumulative change in actual unemployment for the G7 countries observed each quarter from the beginning of a major cyclical downturn, in each case signalled by the start of a prolonged period of rising unemployment. The aggregate unemployment rate for the G7 economies is computed by weighting the unemployment rate in individual countries using labour force weights. Core inflation is a weighted average of annualised core CPI inflation for the major 7 OECD economies using GDP weights (measured at 2010 PPPs).
Source: OECD Main Economic Indicators database and OECD calculations.

3. A general Phillips curve specification

A general framework, which encompasses the competing models considered in this paper, is the familiar expectations-augmented Phillips curve, where inflation (π) is explained in terms of: expected inflation (π^e); demand represented by the unemployment

gap, which is the difference between actual unemployment (U) and equilibrium unemployment (U^*); and supply shock variables which have a temporary effect on inflation, such as real import price inflation, real oil price inflation and changes in indirect taxes:

$$\pi_t = \pi_t^e - \beta\left(U_t - U_t^*\right) + supply\,shocks + \varepsilon_t \quad [1]$$

Wherever possible, inflation is specified in terms of core CPI inflation (excluding food and energy) to purge the dependent variable from the direct impact of some of the main supply shocks. Inflation expectations are postulated to follow a general autoregressive process of the following form:

$$\pi_t^e = [1 - b(1)]\pi^T + b(L)\pi_{t-1}, \quad [2]$$

where b(L) is a lag polynomial and π^T is the inflation rate which is targeted by the central bank. Within this set-up, three cases can be distinguished:

- unanchored adaptive expectations which are based on recent historical experience and where time averaging imposes the long-term constraint that b(1) = 1 on the lag polynomial;
- expectations are fixed at the inflation target in the special case where b(L) = 0, so that $\pi^e = \pi^T$; and
- intermediate cases in which b(1) < 1, so that expectations are partially backward-looking, but still tend towards the target over time.

Equation [2] for inflation expectations can be reformulated as:

$$\pi_t^e = [1 - b(1)]\pi^T + b(1)\pi_{t-1} + \tilde{b}(L)\Delta\pi_{t-1}, \text{ where} \quad [3]$$

$$\tilde{b}(L) \equiv (1 - L)^{-1}[b(L) - b(1)], \quad [3a]$$

so that when [3] is substituted into the Phillips Curve [1], it gives the general formulation:

$$\Delta\pi_t = -\left[1 - b(1)\right]\left(\pi_{t-1} - \pi^T\right) + \tilde{b}(L)\Delta\pi_{t-1} - \beta\left(U_t - U_t^*\right) + supply\ shocks + \varepsilon_t \quad [4]$$

4. The backward-looking Phillips curve specification

The former OECD approach to estimating the Phillips curve and deriving the unemployment gap adopted a traditional backward-looking Phillips curve specification (Gianella et al., 2008; and more recently Guichard and Rusticelli, 2011), in which b(1) = 1 so that inflation and inflation expectations follow unit root processes, and [4] simplifies to:

$$\Delta\pi_t = \tilde{b}(L)\Delta\pi_{t-1} - \beta\left(U_t - U_t^*\right) + supply\ shocks + \varepsilon_t \quad [5]$$

Under this specification, but not the more general form of [4], the equilibrium unemployment rate corresponds to what is often referred to as the Non-Accelerating Inflation Rate of Unemployment (NAIRU). As the unemployment gap and the NAIRU are unobservable, the system is completed with two equations modelling the movement in the NAIRU as a random walk process and the unemployment gap as a second order autoregressive process (see Annex 1 for details).

A major problem with this backward-looking specification is that when estimated over a recent sample period beginning in 1998 (see Table A1.1 in Annex 1 for details), the coefficient on the unemployment gap (β) is not statistically significant for most OECD countries (Table 1). This so-called "flattening of the Phillips curve", where the coefficient on the unemployment gap (β) is small and insignificant, is another representation of the reduced sensitivity of inflation to unemployment previously illustrated in Figure 1, and calls into question the reliability and usefulness of the Phillips curve as an appropriate empirical framework to estimate the NAIRU.

Table 1. **Significance of the unemployment gap in the backward-looking specification**

Country	1970-2014	1998-2014	Country	1970-2014	1998-2014
Australia	***		Japan	***	
Austria	**	**	Korea	**	
Belgium	**		Latvia	**	*
Canada	***		Luxembourg	**	
Chile	***	*	Mexico	**	
Colombia	-	**	Netherlands	**	*
Czech Republic	**		New Zealand	**	
Denmark	***	*	Norway	**	
Estonia			Poland	*	*
Finland	**		Portugal	**	
France	***		Slovak Republic	***	***
Germany	***		Slovenia	**	*
Greece	*		Spain	**	
Hungary	**		Sweden	*	
Iceland	***	***	Switzerland	**	
Ireland	*		Turkey	**	
Israel	**	**	United Kingdom	***	
Italy	*		United States	**	

*, **, *** indicate that coefficients are greater than zero at the 10%, 5% and 1% statistical significance level, respectively, (i.e. the applied tests are "one-tailed").
Source: OECD calculations.

An attempt to strengthen the link between inflation and labour market dynamics considered the presence of hysteresis effects by allowing the NAIRU to change more rapidly in the presence of persistent changes in unemployment. The inclusion of long-term unemployment, chosen as a proxy of hysteresis risks and included in the state equation driving the NAIRU, helps to improve both the size and the significance of the coefficient on the unemployment gap in the estimated backward-looking Phillips curve for some countries (Rusticelli, 2014). However, this methodological modification does not perform well across all OECD countries, but only in the case of the European peripheral countries, where the rise in aggregate unemployment following the financial crisis was the largest. Moreover, the additional estimated parameters associated with the introduction of long-term unemployment makes the modelling framework less robust.

5. Evidence that long-term inflation expectations have become better anchored

Long-term inflation expectations have become better anchored as central banks have become more explicit about their inflation objectives, often adopting specific targets for inflation. There is a burgeoning literature documenting how estimated Phillips curves and/or the formation of inflation expectations are sensitive to the underlying monetary policy regime, and inflation targeting in particular:

- Benati (2008) shows that for countries under stable monetary regimes with clearly defined nominal anchors – Canada, New Zealand, Sweden and the United Kingdom under inflation targeting; euro area countries under European Monetary Union; and Sweden, the United States and the United Kingdom under the Gold Standard – inflation appears to be (nearly) purely forward-looking so that the inclusion of lagged inflation is not necessary in estimated Phillips curves.

- Gurkaynak et al. (2010) show that inflation expectations (derived from inflation-indexed bonds) have become more firmly anchored in the United Kingdom since the independence of the Bank of England in 1997, and also relative to inflation expectations in the United States, which they attribute to inflation targeting. These findings are further supported by evidence from Sweden, another inflation-targeting country.
- Davis (2012) shows that for the United States, long-run inflation expectations have become better anchored and so much less sensitive to inflation surprises than they were in the 1970s and 1980s, a finding which he attributes to the changed monetary policy of the Federal Reserve.
- Davis (2014) analysing survey data on inflation expectations across 36 developed and developing countries, finds that for those countries that adopted inflation targeting, the response of inflation expectations to any shock (to inflation, inflation expectations or oil prices) becomes much less significant and less persistent.

Moreover, the adoption of some form of inflation targeting has become increasingly widespread throughout the OECD (see Table 2). The Reserve Bank of New Zealand was the first OECD central bank to adopt a specific target for inflation in 1990, followed by the Bank of Canada in 1991. Since then, the central banks in almost all OECD countries have adopted some form of explicit objective for inflation. The European Central Bank has adopted an inflation objective of maintaining the area-wide inflation "below, but close to, 2%" in 1998. Although until recently there was not a specific inflation objective for the United States, the financial market reaction to FOMC statements suggested that the markets believed the Federal Reserve had an implicit long-run inflation objective of between 1 and 3.5%, with a mid-point close to Chairman Bernanke's suggestion of 2% as optimal long-run average inflation (Thornton, 2007; Bernanke 2004).

The attraction of long-term inflation expectations to a credible inflation objective is illustrated in Figure 2 for the major OECD economies, which shows that long-run inflation expectations have become much less correlated with lagged inflation since 1998 (Figure 2), a result which is confirmed by more formal tests presented in Annex 2.

6. The anchored expectations Phillips curve

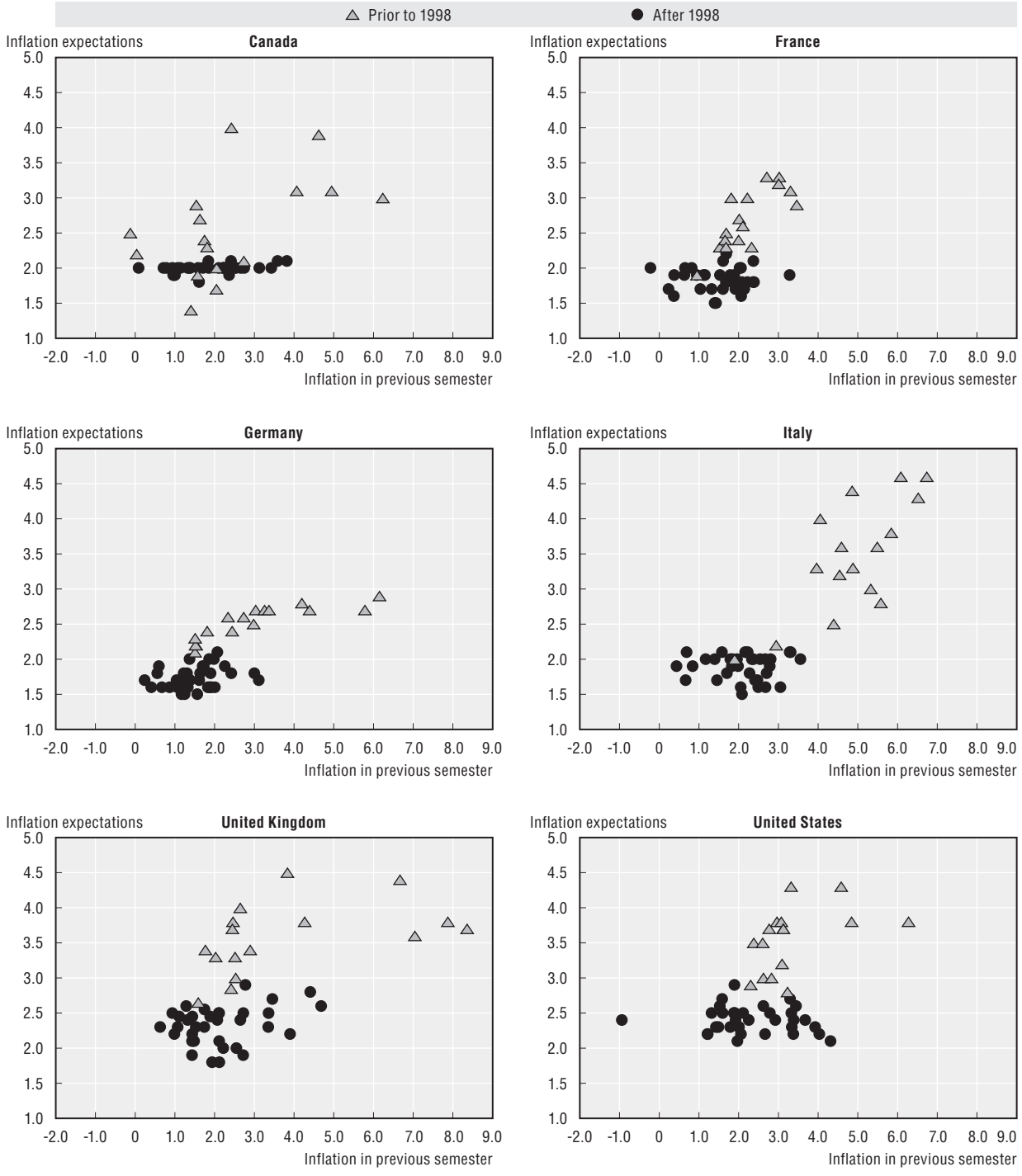
The new OECD modelling framework incorporates the notion of partially anchored inflation expectations, given by the general form of [4] with b(1) < 1, so that inflation and inflation expectations are stationary and will gravitate towards π^T. The economic interpretation of equilibrium unemployment (U*) in the more general form of [4] is, however, very different from the NAIRU concept in [5], because if the unemployment rate differs from U*, inflation can still be stable, as described further in Section 7 below.

To estimate equation [4], the term $\left(\pi_{t-1} - \pi^T\right)$ is replaced by a separate lagged inflation variable, with freely estimated coefficient θ, and an (initially) unrestricted intercept term (τ):

$$\Delta\pi_t = \tau - \theta\pi_{t-1} + \tilde{b}(L)\Delta\pi_{t-1} - \beta\left(U_t - U_t^*\right) + supply\ shocks + \varepsilon_t \qquad [6]$$

The implied level of stable inflation expectations, comparing [4] with [6] is then given by (τ/θ), and when there is an explicit central bank numerical objective for inflation the restriction that (τ/θ) is equal to this objective is imposed when consistent with the data (which is equivalent to testing that the restriction that the coefficients on the lagged inflation and numerical target variables have the same magnitude, but opposite sign).

Figure 2. **The influence of inflation targeting on inflation expectations**



Note: Inflation expectations are the 6 to 10 years ahead expected average CPI inflation rates from the *Survey of Professional Forecasters*, available per semester from 1990 to 2014. Inflation is the annualised CPI inflation rate. In accordance with the start of the sample estimation period chosen for this paper, the relationship pre- and post-1998 is distinguished.
Source: OECD calculations, *OECD Main Economic Indicators database* and *Survey of Professional Forecasters*.

Given the rationale underlying the new specification, the model can only be estimated over a sample period when inflation expectations can plausibly be considered to be anchored. Indeed, when this specification is estimated over a sample period beginning in the 1970s, 1980s or early 1990s the results are generally unsatisfactory, particularly in terms of the reduced significance of the unemployment gap term. One option, to only estimate the equation over sample periods in which a formal inflation target is in operation, is rejected because there are a number of countries for which this would imply a very short sample period over which it would be difficult to derive plausible parameter estimates.[2] Moreover, an over-arching objective of the exercise is to come up with an approach which could readily be adopted across most, if not all, OECD countries. Instead, the approach adopted is to begin the sample estimation period in 1998, and for those countries for which an inflation target was introduced more recently, the restriction that inflation expectations are anchored at the target is only tested for this more recent period. For euro area countries, a restriction of 2% inflation expectations is chosen for each individual country, even though the ECB's target is for area-wide inflation to be "below, but close to, 2% over the medium term". Details on the country-specific anchored expectations Phillips curve estimates are provided in Annex 1, Table A1.2.

An alternative approach of using survey measures of inflation expectations, either directly in [1] or in [2], is problematic for two reasons. Firstly, there is a lack of consistent series of inflation expectations for most OECD countries over the sample period considered. Secondly, survey measures of inflation are usually defined in terms of headline CPI inflation and therefore they would be inappropriate for a Phillips curve equation specified in terms of core inflation. There is also some evidence to suggest that the second-round inflation effects of oil price changes are now relatively small (Hooker, 2002), which in turn would suggest that wage bargaining may be more focused on an underlying or core measure of inflation and that survey measures of short-term headline inflation expectations may therefore be inappropriate in modelling the inflation process.

6.1. Robustness testing

The backward-looking Phillips curve specification [5] is a special case of the more general specification [4], implying no role for the lagged level of inflation or any separate influence for the inflation target. However, such restrictions on the general model are overwhelmingly rejected. The coefficient on lagged inflation is significantly different from zero for almost all countries and in 80% of cases is statistically significant at the 1% confidence level.[3] The restriction that the estimated constant (τ) and the coefficient on lagged inflation (θ) are consistent with expectations being anchored at the central bank's inflation target is accepted for all countries, with the only exceptions of Japan and Estonia (Table 2), both being countries where an explicit inflation target has only been introduced quite recently.[4]

While the backward-looking specification yields estimates of the unemployment gap coefficient (β) which are statistically significant at least at the 10% level for nearly all countries over a full sample (usually beginning in 1970), the coefficient is only significant in one-quarter of the cases over a shorter sample starting in 1998. Conversely, the unemployment gap is statistically significant in the anchored expectation Phillips curve for all countries (Table 3). Moreover, for those countries where both approaches lead to significant estimates of β, the fit of the anchored expectations Phillips curve is higher for all countries as indicated by the higher adjusted R^2.

Table 2. **The inflation target restriction, 1998-2014**

Country	Official target (%)[1]	Restriction tested and accepted (%)[2]	Country	Official target (%)[1]	Restriction tested and accepted (%)[2]
Australia	2-3	2.5	Latvia	2 since 2005	Not accepted
Canada	2 +/-1	2	Korea	2.5-3.5	3
Chile	3 +/-1	3	Mexico	3	3
Colombia	3 +/-1	3	Norway	2.5 since 2001	2.5 since 2001
Czech Republic	3-4 (2002-05); 3 (2006-09); 2 since 2010	Time-varying, according to target	New Zealand	0-2 (1998-2002); 1-3 since 2002	2 since 2002
Denmark	None	N/A	Poland	2.5	2 since 2004
Euro area[3]	< 2	2	Sweden	2	2
Hungary	3 +/-1	3	Switzerland	0-2	1
Iceland	2.5 +/-1.5	2.5	Turkey	From 35 to 5 between 2002-12; 5 since 2012	Time-varying, according to target
Israel	2 +/-1 since 2003	2 since 2003	United Kingdom	2	2
Japan	2 since 2013	Not accepted	United States	2 since 2012	2 since 2012

1. The official target is set on HICP inflation for euro area countries, core CPI inflation for Korea, and CPI inflation for all other countries.
2. The restriction imposed is that the intercept divided by the coefficient on lagged inflation (θ) is equal to the number in this column.
3. For the euro area, the official target is an area-wide HICP inflation close to, but below, 2%. To operationalise this as a country-specific target, a restriction of 2% was tested for each country individually from 1998, except for Latvia, Slovenia and the Slovak Republic for which the restriction was tested from 2005 and Estonia from 2011. This restriction is accepted for all countries with the exception of Estonia.

Source: OECD countries' central banks.

Table 3. **Significance of the unemployment gap across different Phillips curve specifications**

Sample estimation period 1998-2014

Country	Backward-looking	Anchored expectations	Country	Backward-looking	Anchored expectations
Australia		**	Japan		***
Austria	**	**	Korea		*
Belgium		**	Latvia	*	***
Canada		**	Luxembourg		**
Chile	*	***	Mexico		*
Colombia	**	***	Netherlands	*	**
Czech Republic		***	New Zealand		***
Denmark	*	*	Norway		**
Estonia		**	Poland	*	**
Finland		**	Portugal		***
France		*	Slovak Republic	***	**
Germany		**	Slovenia	*	***
Greece		***	Spain		***
Hungary		**	Sweden		***
Iceland	***	***	Switzerland		***
Ireland		***	Turkey		**
Israel	**	***	United Kingdom		**
Italy		**	United States		**

*, **, *** indicate that coefficients are greater than zero at the 10%, 5% and 1% statistical significance level, respectively, (i.e. the applied tests are "one-tailed").

Source: OECD calculations.

The higher the statistical significance of the unemployment gap term the greater the confidence one can have in the point estimate for the unemployment gap. This can be illustrated by varying the signal-to-noise ratio in the estimated state space model, which controls the smoothness of the equilibrium unemployment estimates and therefore

affecting the unemployment gap. If the unemployment gap in the original Phillips curve equation is highly statistically significant and a constraint on any alternative estimate of the gap is set in terms of a similar level of statistical significance, then the variation around these plausible alternative estimates of the unemployment gap is relatively small (see Annex 3 for details).

An alternative explanation for the reduced sensitivity of inflation to unemployment could be the presence of downward nominal wage rigidities at low levels of inflation, which implies asymmetries in the responsiveness of nominal wage growth and hence inflation to the unemployment gap (Daly et al., 2012; Yellen, 2012; Abritti and Fahr, 2013; OECD, 2014). A statistical test of asymmetry was performed by testing whether the coefficient β is statistically different when core inflation falls below 0.5%. The null hypothesis of this form of nonlinearity was rejected for more than 80% of the countries.

7. Comparing the two specifications

7.1. Differing economic interpretation of the unemployment gap

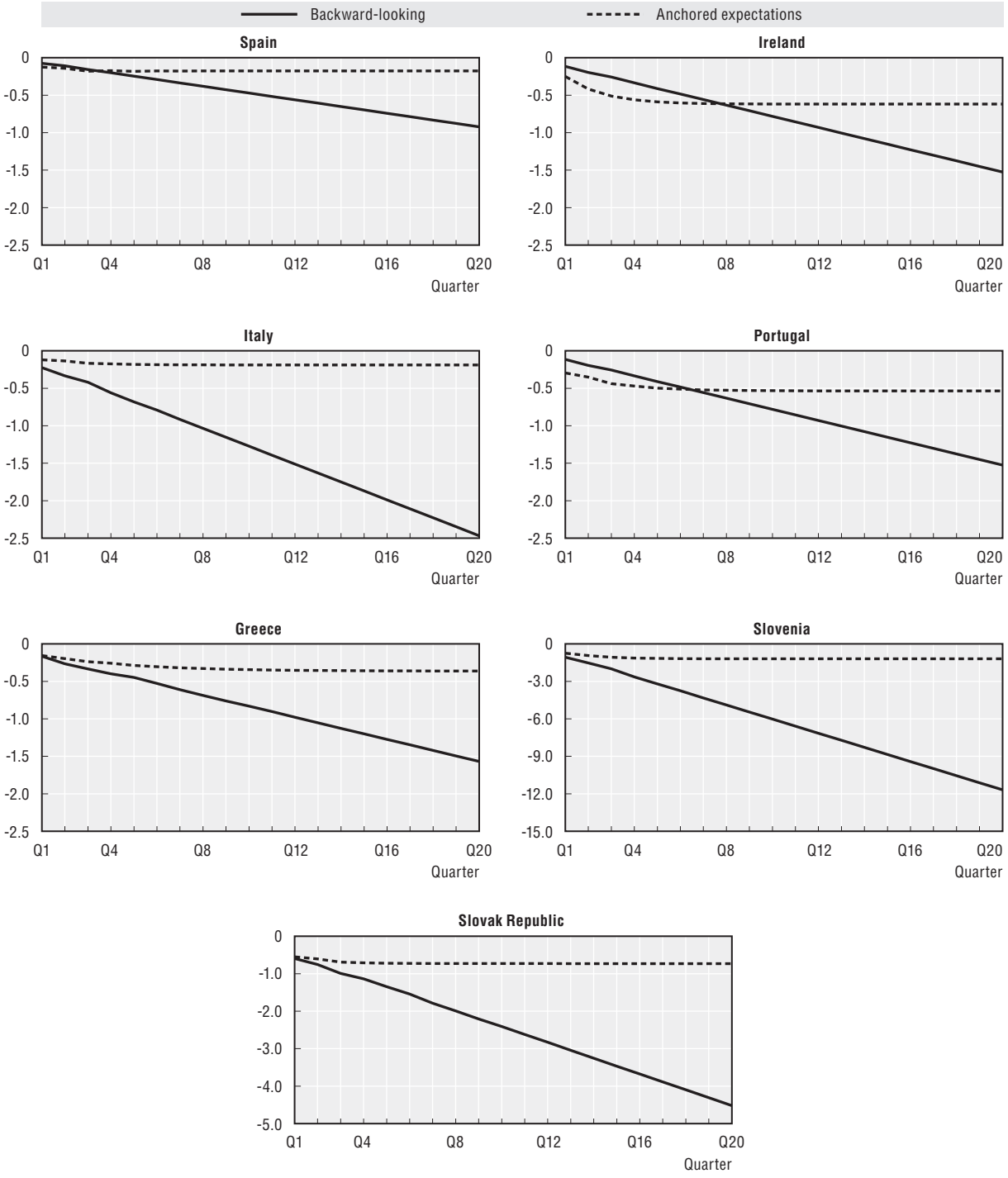
The unemployment gap, derived from the two alternative Phillips curve specifications has different macroeconomic implications for inflation dynamics. In the absence of any other shock, the backward-looking specification of the Phillips curve implies that inflation will only be stable when the unemployment gap is closed (i.e. when unemployment equals the NAIRU), and it will keep falling as long as unemployment exceeds the NAIRU. In other words, a stable positive unemployment gap generates a constant rate of disinflation. Conversely, the anchored expectations specification implies that, in the absence of any other shock, when the unemployment gap is closed inflation will stabilise at the level consistent with long-run inflation expectations which in most cases will be anchored at the central bank's inflation objective. As a consequence, a stable and positive unemployment gap generates an inflation rate which is stable, but at a lower level than the central banks inflation objective.

To demonstrate these very different properties of the two specifications, the impulse response functions of annual inflation to a 1 percentage point increase in the unemployment gap have been evaluated according to the parameter estimates for a group of countries for which unemployment has risen most over the crisis (Figure 3). A corollary of these different properties is that a situation which is characterised by the presence of low but relatively stable core inflation will lead to very different estimates of the unemployment gap in line with the two specifications; according to the backward-looking model the unemployment gap should be small, whereas based on the anchored expectations specification the gap could be large and relatively stable.

A different way of underlining both the importance of the statistical significance of the unemployment gap and the very different properties of the competing specifications is to examine scatter plots of the relationship between core inflation and the estimated unemployment gaps for the group of countries for which unemployment has recently increased most (Figure 4). In the backward-looking specification, the unemployment gap estimates should be correlated with the *change* in core inflation, while for the anchored expectations Phillips curve the gap should be correlated with the *level* of inflation (or more precisely the deviation of inflation from the central bank's objective). The two sets of unemployment gap estimates are obtained by applying the two different modelling frameworks and for this reason their size is different across the two Phillips curve specifications.

Figure 3. **The estimated effect of the unemployment gap on inflation**

Countries where unemployment increased the most during the crisis



Note: The impulse response of annual inflation to a 1 percentage point increase in the unemployment gap, for a group of countries for which unemployment has risen most over the crisis, evaluated according to the estimated parameters of the respective models.
Source: OECD calculations.

Figure 4. **Scatter plots of inflation and the unemployment gap**

Countries where unemployment increased the most during the crisis, 1998-2014

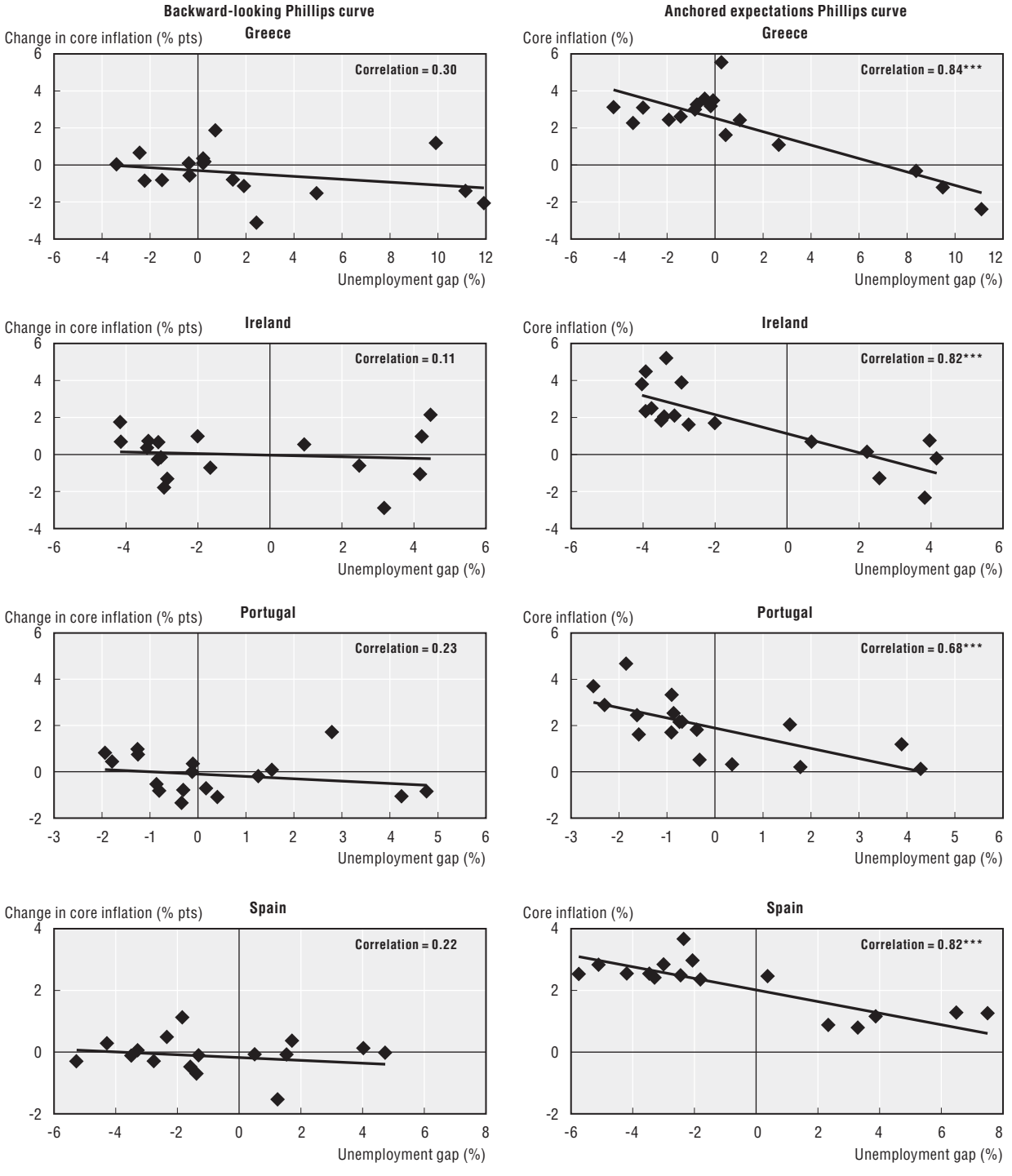
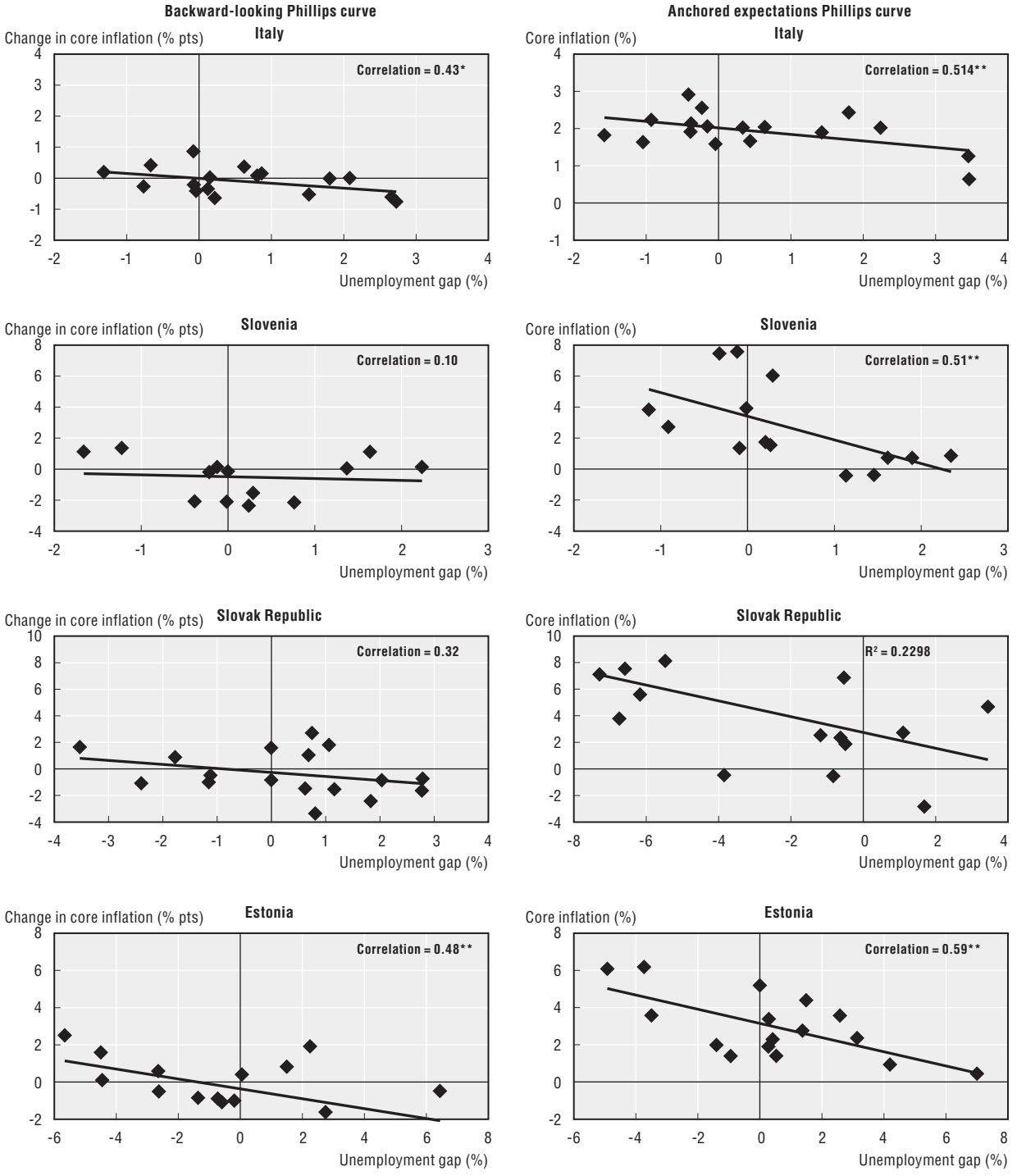


Figure 4. **Scatter plots of inflation and the unemployment gap** *(cont.)*

Countries where unemployment increased the most during the crisis, 1998-2014



*, **, *** indicate the Pearson's r index of correlation is statistical significant at 10%, 5% and 1%, respectively.

Note: Estimates of the unemployment gap are computed by taking the difference between actual unemployment and the estimate of the equilibrium unemployment rate from the backward-looking and anchored expectations Phillips curve model estimates, shown in the left-hand-side and right-hand-side columns, respectively. The vertical axis shows the change in annual core consumer price inflation corresponding to each estimate of the unemployment gap. The selected countries are those where the peak rise in the unemployment rate relative to the pre-crisis level was at least 5 percentage points.

Source: OECD Economic Outlook 96 Database, OECD calculations.

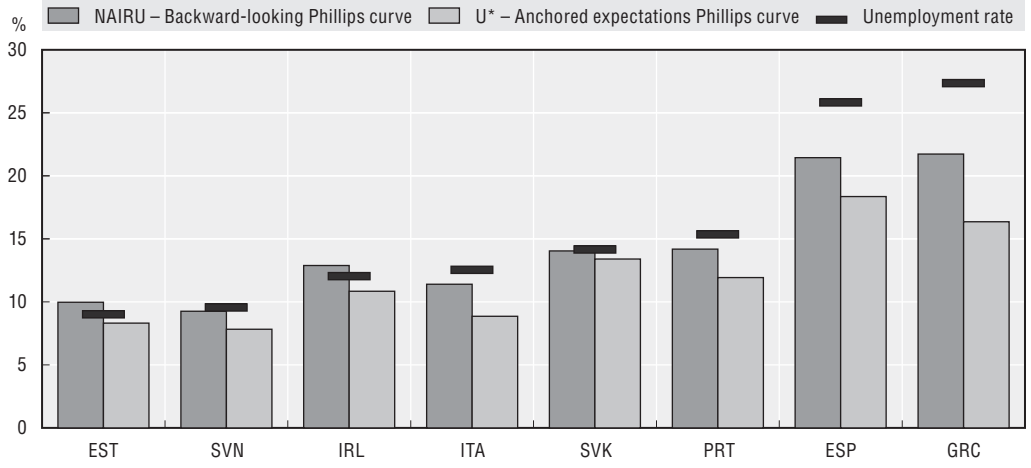
On the basis of these scatter plots, the relationship between core inflation and the unemployment gap is much tighter for the anchored expectations approach (the right-hand-side panels in Figure 4). Indeed, for most of the countries considered, the correlation between the unemployment gap estimates and core inflation is statistically significant only with the anchored expectations Phillips curve. The anchored expectations Phillips curve performs better than the backward-looking specification for all countries, the Slovak Republic being an exception. In the case of the Slovak Republic, the anchored expectations framework yields poorer estimates because core inflation was very high and relatively volatile before the recent introduction of the inflation target in 2005.

7.2. Differing estimates of the unemployment gap

The different properties of the alternative models also imply different estimates of equilibrium unemployment for some countries, particularly those for which unemployment has risen most steeply, and where typically inflation has fallen and tended to stabilise at a lower level. In these cases, the backward-looking model reconciles relatively stable inflation with a smaller unemployment gap, whereas the anchored expectations model will match a low level of inflation with a larger persistent unemployment gap. Thus, for the eight OECD countries where unemployment has risen the most since the crisis, the anchored expectations model implies current estimates of equilibrium unemployment which on average are nearly 2½ percentage points lower than the NAIRU derived from the backward-looking model (Figure 5).

Figure 5. **Equilibrium unemployment estimates for countries where unemployment increased most**

2013 Q4

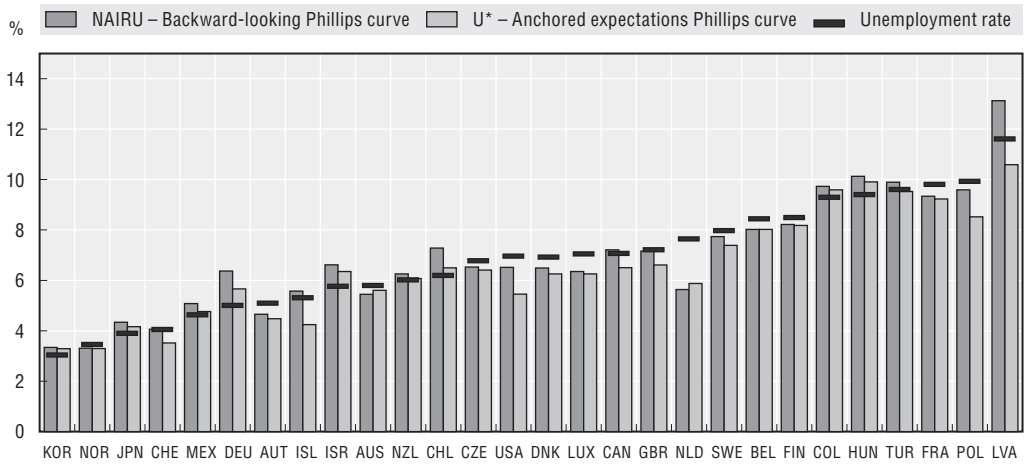


Note: Estimates of the unemployment gap for the group of OECD countries for which the peak rise in the unemployment rate relative to the pre-crisis level was at least 5 percentage points.
Source: OECD Economic Outlook 96 Database, OECD calculations.

For all other countries, for which unemployment has increased less steeply, the difference in current estimates of equilibrium unemployment is much smaller; the equilibrium unemployment estimate from the anchored expectations model is, on average, only 0.3 percentage points lower (Figure 6). In only two cases, Australia and the Netherlands, has the equilibrium unemployment estimate been revised upward with respect to the previous NAIRU estimate, by 0.2 percentage points on average.

Figure 6. **Equilibrium unemployment estimates in all other OECD countries**

2013 Q4



Source: OECD Economic Outlook 96 Database, OECD calculations.

8. Revisions to real-time estimates of equilibrium unemployment

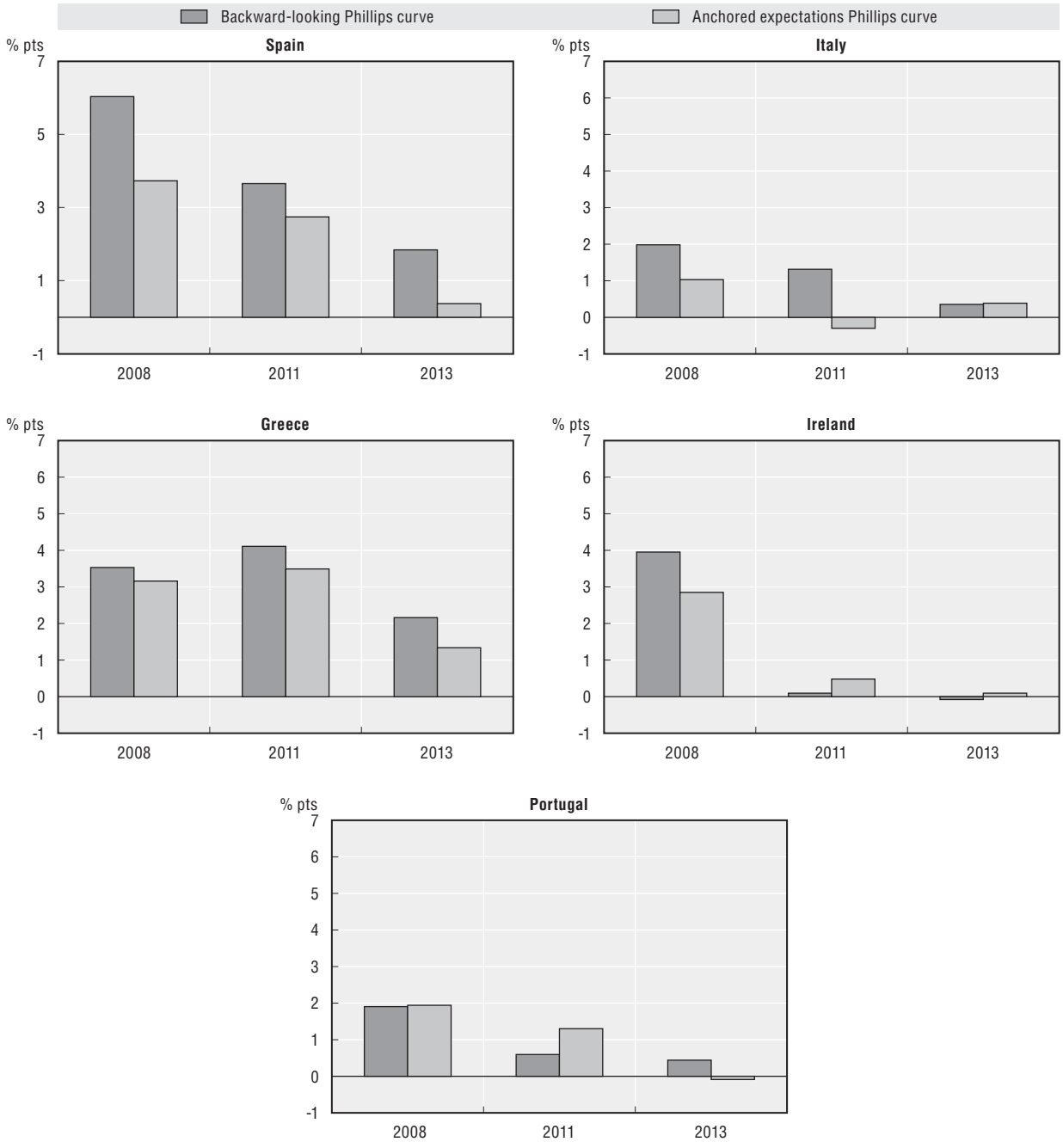
The robustness of the two alternative models is evaluated by comparing real-time and *ex post* estimates of equilibrium unemployment measures, hereafter referred to as NAIRU and U*. The set of countries considered includes those where unemployment has risen the most in the aftermath of the financial crisis. For these countries, revisions to real-time NAIRU estimates have been computed for 2008, 2011 and 2013, which correspond to the dates when the standard OECD estimation framework has been updated to re-estimate and publish new NAIRU series.[5] For the new anchored expectations approach, real-time estimates of U* have been generated by using datasets starting in 1998 and ending in 2008, 2011 and 2013 respectively.

For most countries and across all updates, the revisions are generally smaller for the equilibrium unemployment estimates obtained with the anchored expectations Phillips curve, indicating a general improvement in terms of stability of the estimates (Figure 7). For Spain and Greece, where actual unemployment rose the most, the size of the revisions is the largest, but revisions to U* are on average 1 percentage point lower than the revisions to the NAIRU estimates. Overall, the new estimation framework yields real-time revisions which are 1 percentage point smaller before the crisis in 2008, and 0.35 percentage point and 0.5 percentage point smaller in 2011 and 2013, respectively.

Still, even with the anchored expectations framework, revisions to the countries with the sharpest rise in unemployment remain uncomfortably large (up to 3 percentage points for Greece and Spain). A possible reason could be linked to the choice of the autoregressive process to model the unemployment gap in the transition equation of the state space. This law of motion, imposed on the unemployment gap, ensures that the unemployment rate converges to the equilibrium rate in the absence of shocks, but it might constrain the equilibrium unemployment estimate to follow too tightly developments in the unemployment rate. Experiments with different forms of transition equations (not shown here), where the autoregressive model for the unemployment gap is dropped, tend to result in smaller real-time revisions.

Figure 7. **Real-time revisions to equilibrium unemployment estimates across vintages**

Countries where unemployment increased the most during the crisis



Note: Annual revisions are computed as difference between *ex post* and real-time equilibrium unemployment estimates for both approaches. The sample starting point considered for all estimates is 1998Q1 for the anchored expectations Phillips curve, but much earlier for the backward-looking Phillips curve. The sample ending point corresponds to the revision time, i.e. 2008Q4, 2011Q4 and 2013Q4, for the real-time estimates and to 2014Q1 for the *ex post* estimates.
Source: OECD calculations.

Notes

1. The sacrifice ratio is here defined to be the cumulative percentage point increase in the unemployment rate (measured in percentage point years) associated with a fall in core inflation of 1 percentage point. The calculation of sacrifice ratios in this way does not allow for a clean comparison because other factors, such as supply shocks, may also impinge on the relationship between inflation and unemployment. Nevertheless, the magnitude of the difference is so large as to be indicative of a change in the underlying relationship between inflation and unemployment.
2. When the anchored expectations specification was estimated over a longer sample period, for a selection of counties where inflation targeting was adopted in the early 1990s (New Zealand, Canada, Sweden and Australia), the results were also generally less satisfactory. In particular, the statistical significance of the unemployment gap was in all cases reduced. This might indicate that for those countries which first adopted inflation targeting, especially following a period of much higher inflation, credibility took longer to be established.
3. The level term of inflation is not significant in the case of Colombia and Estonia, where the inflation rate has been particularly volatile over the estimation sample.
4. The implicit level of long-term inflation expectations, implied by the model, is equal to 1.7 for the United States prior to 2012, 1.8 for Denmark, 3.3 for Latvia and close to zero for Japan.
5. Slovenia, the Slovak Republic and Estonia were excluded because the NAIRU estimation approach adopted prior to 2011 was not a backward-looking Phillips curve but an HP filter applied to the unemployment rate.

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ANNEX 1

Details of model specifications and results

The backward-looking Phillips curve

The former OECD approach to estimating the unemployment gap is based on a backward-looking Phillips curve cast in a state-space framework (Gianella et al. (2008); Guichard and Rusticelli, 2011) and can be summarised as:

$$\Delta\pi_t = \beta\left(U_t - U_t^*\right) + \sum_{j=1}^{A}\alpha_j\Delta\pi_{t-j} + \sum_{j=1}^{L}\lambda_j\omega_j^m(\pi_{t-j}^m - \pi_{t-j}) + \sum_{j=1}^{G}\gamma_j\omega_j^{oil}(\pi_{t-j}^{oil} - \pi_{t-j}) + \sum_{j=1}^{D}\delta_j VAT_j + \varepsilon_t \quad [1.1]$$

$$U_t = U_t^* + U_t^{gap} \quad [1.2]$$

$$U_t^{gap} = \phi_1 U_{t-1}^{gap} + \phi_2 U_{t-2}^{gap} + \eta_t \quad [1.3]$$

$$U_t^* = U_{t-1}^* + \nu_t \quad [1.4]$$

The first equation represents the measurement equation of the state space model, i.e. the Phillips curve which relates changes in core consumer price inflation ($\Delta\pi_t$) to the unemployment gap (U_t^{gap}), lags of the change in inflation and control variables.[1] The control variables consist of three types of short-term supply shocks: real import price inflation weighted by import penetration (ω_j^m), real oil price inflation weighted by oil intensity of production (ω_j^{oil}) and indirect tax. The number of lags is determined on the basis of their statistical significance. The second equation is an identity and specifies actual unemployment U_t as the sum of a structural component, i.e. the NAIRU U_t^*, and a cyclical one, i.e. the unemployment gap U_t^{gap}. The third and fourth equations are the transition equations of the state space describing the law of motion of the two unobserved components of unemployment, where equation [1.3] specifies the unemployment gap as a stationary second-order autoregressive process (Jaeger and Parkinson, 1994; Laubach, 2001) and [1.4] specifies the NAIRU as a random walk process.[2]

The three error terms of the model $\varepsilon_t, \eta_t, \nu_t$ are all assumed to be i.i.d. normally distributed with mean zero and uncorrelated variances $\sigma_\varepsilon^2, \sigma_\eta^2, \sigma_\nu^2$, respectively. Following the approach of Staiger et al. (1997a, 1997b), Laubach (2001) and Llaudes (2005), these parameters are empirically selected on an individual country basis and fixed throughout the estimated state space model in order to preserve good distributive properties for the unobserved components. The estimation of the signal-to-noise ratio can lead to very flat NAIRUs due to the so-called pile-up problem (Stock, 1994): pure maximum likelihood estimation methods of the variance of non-stationary processes yield estimates which are downward biased towards zero when the true unknown parameter is small, as in case of the standard deviation of the innovation process in the random walk describing the NAIRU

model. More details on the initialisation procedure for the state parameters and the selection of the variances of the error terms can be found in Guichard and Rusticelli (2011). Detailed estimation results for the backward-looking specification are given in Table A1.1.

The anchored expectations Phillips curve

The general specification of the model is the same as for the backward-looking Phillips curve, except for the addition of an intercept term (τ) and the lagged level of inflation. The restriction between the intercept and the coefficient on lagged inflation (θ) such that τ/θ is equal to the central banks inflation objective is tested for each country. When the inflation objective is specified as a range then the mid-point of the range is taken to be the implicit target. For countries where inflation targeting has not been officially adopted, namely Japan and Estonia, inflation expectations have not been constrained to any specific value in the Phillips curve.

Detailed estimation results for the anchored expectations specification are given in Table A1.2.

Notes

1. Due to the longer span of data, headline CPI inflation is used for Canada, Greece, Portugal and the United Kingdom.
2. The sum of the autoregressive parameters is constrained to vary between 0.7 and 0.9 in order to ensure the stationarity of the unemployment gap.

Table A1.1. **Backward-looking Phillips curve estimation results**

Dependent variable $\Delta\pi$	USA		JPN		DEU		FRA		ITA		GBR		CAN	
	1998Q2-2014Q1		1998Q1-2014Q1		1998Q1-2014Q1		1998Q1-2013Q4		1998Q1-2014Q1		1998Q2-2014Q1		1998Q1-2014Q1	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst														
$\Delta\pi(-1)$	-0.668	0.000	-0.410	0.001	-0.543	0.000	-0.801	0.000	-0.707	0.000	-0.502	0.000	-0.842	0.000
$\Delta\pi(-2)$	-0.519	0.003	-0.105	0.186	-0.464	0.001	-0.132	0.434	-0.404	0.000	-0.586	0.000	-0.651	0.000
$\Delta\pi(-3)$	-0.268	0.093			-0.281	0.039	0.012	0.929			-0.327	0.016	-0.477	0.005
$\Delta\pi(-4)$	-0.280	0.035			-0.245	0.026					-0.370	0.004	-0.283	0.036
$\Delta\pi(-5)$														
*U-U**	-0.002	0.838	-0.016	0.627	-0.012	0.502	-0.044	0.255			-0.045	0.450	-0.016	0.732
$U(-1)+U^*(-1)$									-0.004	0.810				
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$	-0.022	0.777							0.052	0.249	0.214	0.050	0.099	0.036
$\omega^m(-4)*(\pi^m(-4)-\pi(-4))$											-0.068	0.523	0.035	0.409
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$	0.045	0.064			-0.017	0.639	0.024	0.467					0.036	0.210
Dummies														
Adj R2	0.297		0.156		0.261		0.479		0.332		0.245		0.338	

Dependent variable $\Delta\pi$	AUS		AUT		BEL		CHE		CHL		COL		CZE		DNK	
	1998Q1-2014Q1		1998Q1-2013Q4		1998Q1-2014Q1		1998Q1-2014Q1		1998Q1-2014Q1		2001Q1-2014Q1		2002Q1-2013Q4		1998Q1-2013Q4	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst																
$\Delta\pi(-1)$	-0.658	0.000	-0.488	0.000	-0.385	0.003	-0.577	0.000	0.292	0.016	-0.537	0.000	-0.391	0.005	-0.637	0.000
$\Delta\pi(-2)$	-0.448	0.000	-0.292	0.015	-0.236	0.074			0.186	0.142	-0.718	0.000			-0.233	0.072
$\Delta\pi(-3)$	-0.250	0.016	-0.320	0.004					-0.123	0.310	-0.485	0.001				
$\Delta\pi(-4)$									-0.412	0.001	0.173	0.199				
$\Delta\pi(-5)$																
*U-U**	-0.004	0.981	-0.111	0.044	0.019	0.821	-0.017	0.738	-0.105	0.121	-0.291	0.038	-0.012	0.859	-0.032	0.103
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$			0.186	0.003	0.031	0.566	0.060	0.125			0.205	0.064	0.064	0.249	0.012	0.631
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$	0.111	0.336							0.212	0.000	0.145	0.031				
Dummies	2000Q3															
Adj R2	0.515		0.372		0.098		0.322		0.573		0.823		0.145		0.278	

Table A1.1. **Backward-looking Phillips curve estimation results** *(cont.)*

	ESP		EST		FIN		GRC		HUN		IRL		ISL		ISR	
Dependent variable $\Delta\pi$	1998Q4-2014Q1		2000Q1-2013Q4		1998Q1-2013Q4		1998Q1-2014Q1		2001Q3-2013Q4		1998Q1-2013Q4		1998Q1-2014Q1		1998Q1-2014Q1	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst	-0.038	0.309														
$\Delta\pi(-1)$	-0.866	0.000	-0.456	0.000	-0.341	0.013	-0.559	0.000	-0.299	0.024	-0.208	0.039	-0.480	0.000	-0.549	0.000
$\Delta\pi(-2)$	-0.198	0.119			-0.264	0.050	-0.274	0.070			-0.197	0.045			-0.321	0.010
$\Delta\pi(-3)$					-0.185	0.169	-0.134	0.374			0.059	0.599				
$\Delta\pi(-4)$							-0.145	0.278					-0.157	0.136		
$\Delta\pi(-5)$																
*U-U**	-0.008	0.515	-0.007	0.582	0.001	0.990	-0.019	0.260	-0.169	0.356	-0.013	0.418	-0.224	0.001	-0.277	0.084
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$			0.163	0.000	0.132	0.040			0.097	0.006	0.142	0.015	0.161	0.000		
$\omega^m(-2)*(\pi^m(-2)-\pi(-2))$																
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$	0.090	0.037	0.103	0.089												
Dummies											2009Q1, 2009Q4				1999Q1	
Adj R2	0.528		0.420		0.084		0.193		0.215		0.448		0.383		0.216	

	KOR		LUX		LVA		MEX		NLD		NOR		NZL		POL	
Dependent variable $\Delta\pi$	1999Q1-2014Q1		1998Q1-2014Q1		1998Q4-2014Q1		2000Q1-2013Q4		1998Q1-2013Q4		1998Q1-2014Q1		1998Q1-2014Q1		1998Q1-2013Q4	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst							-0.033	0.193								
$\Delta\pi(-1)$	-0.334	0.016	-0.478	0.000	-0.207	0.124	-0.192	0.130	-0.723	0.000	-0.557	0.000	-0.438	0.000	-0.393	0.003
$\Delta\pi(-2)$	0.010	0.933	-0.268	0.057	0.027	0.837	-0.072	0.499	-0.396	0.004	-0.228	0.081			-0.075	0.573
$\Delta\pi(-3)$			-0.004	0.976			0.531	0.000							-0.063	0.637
$\Delta\pi(-4)$							0.078	0.479								
$\Delta\pi(-5)$																
*U-U**	-0.013	0.822	0.082	0.583	-0.034	0.168	-0.050	0.229	-0.059	0.107	-0.058	0.584	-0.081	0.474	-0.059	0.194
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$					0.088	0.055	0.005	0.832	0.026	0.415					0.091	0.019
$\omega^m(-2)*(\pi^m(-2)-\pi(-2))$					0.066	0.164							-0.040	0.490		
$\omega^m(-4)*(\pi^m(-4)-\pi(-4))$															-0.066	0.097
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$	0.067	0.006					0.052	0.002			-0.020	0.845				
Dummies																
Adj R2	0.133		0.167		0.081		0.324		0.360		0.196		0.176		0.165	

Table A1.1. **Backward-looking Phillips curve estimation results** *(cont.)*

Dependent variable $\Delta\pi$	PRT		SVK		SVN		SWE		TUR	
	1998Q1-2013Q4		1998Q1-2014Q1		1999Q1-2013Q4		1998Q1-2014Q1		2004Q1-2013Q4	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst			-0.220	0.014					0.533	0.542
$\Delta\pi(-1)$	-0.530	0.000	-0.740	0.000	-0.431	0.000	-0.761	0.000	-0.407	0.049
$\Delta\pi(-2)$	-0.416	0.003	-0.383	0.000			-0.429	0.001	-0.013	0.945
$\Delta\pi(-3)$			-0.379	0.000						
$\Delta\pi(-4)$			-0.298	0.003						
$\Delta\pi(-5)$			-0.166	0.046						
*U-U**	-0.027	0.394	-0.133	0.012	-0.097	0.145	-0.058	0.254	-0.107	0.378
$\omega^{m}(-1)*(\pi^{m}(-1)-\pi(-1))$	0.203	0.047					0.092	0.379	0.080	0.461
Dummies			1999Q3, 2003Q1		1999Q3, 2008Q4				2004Q2	
Adj R2	0.211		0.758		0.530		0.382		0.041	

Note: $\Delta\pi$ is the change in Q-o-Q core CPI inflation for all countries except for Canada, Greece, Portugal and the United Kingdom, for which headline CPI inflation has been chosen. $\omega^{m*}(\pi^{m}-\pi(-1))$ indicates the real import price inflation weighted by import penetration and $\omega^{oil*}(\pi^{oil}-\pi(-1))$ indicates real oil price inflation weighted by oil intensity of production.
Source: OECD calculations.

Table A1.2. **Anchored expectations Phillips curve estimation results**

Dependent variable $\Delta\pi$	USA		JPN		DEU		FRA		ITA		GBR		CAN	
	1998Q2-2014Q1		1998Q1-2014Q1		1998Q1-2014Q1		1998Q1-2013Q4		1998Q2-2014Q1		2000Q1-2014Q1		1995Q3-2014Q1	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst	0.235	0.003	-0.024	0.385										
$\Delta\pi(-1)$	-0.844	0.000			-0.539	0.000	-0.869	0.000	-0.876	0.000	-0.843	0.000	-0.805	0.000
$\Delta\pi(-2)$	-0.744	0.000			-0.473	0.001	-0.278	0.057			-0.786	0.000		
$\Delta\pi(-3)$	-0.541	0.002			-0.313	0.023					-0.782	0.000		
$\Delta\pi(-4)$											-0.753	0.000		
$\Delta\pi(-5)$											-0.709	0.000		
$\pi(-1)$	-0.549	0.002	-0.870	0.000	-0.223	0.032	-0.175	0.061	-0.637	0.000	-0.491	0.008	-0.780	0.000
$U\text{-}U^*$			-0.124	0.004	-0.042	0.088	-0.054	0.107						
$U(-1)+U^*(-1)$	-0.018	0.044							-0.030	0.055	-0.072	0.092		
$U(-2)+U^*(-2)$													-0.050	0.036
$\omega^m*(\pi^m-\pi)$	0.179	0.000												
$ma(\omega^m)$											0.430	0.000		
$\omega^m(-1)*(\pi^m-\pi(-1))$					0.098	0.031			0.060	0.146			0.058	0.066
$\omega^{oil}*(\pi^{oil}-\pi)$											0.154	0.073		
Dummies											VAT			
Adj R2	0.460		0.463		0.304		0.510		0.422		0.772		0.441	

Dependent variable $\Delta\pi$	AUS		AUT		BEL		CHE		CHL		COL		CZE		DNK	
	1998Q1-2014Q1		1998Q1-2013Q4		1998Q3-2014Q1		1996Q1-2014Q1		2000Q3-2014Q1		2001Q1-2014Q1		1998Q1-2013Q4		1998Q1-2013Q4	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst							0.082	0.114					1.000	0.003	0.223	0.002
$\Delta\pi(-1)$	-0.959	0.000	-0.642	0.000	-0.813	0.000	-0.778	0.000	0.558	0.000	-0.697	0.000	-0.819	0.000	-0.760	0.000
$\Delta\pi(-2)$			-0.463	0.003							-0.958	0.000				
$\Delta\pi(-3)$											-0.715	0.000				
$\pi(-1)$	-0.971	0.000	-0.484	0.002	-0.757	0.000	-0.436	0.001	-0.089	0.094	-0.138	0.158	-0.574	0.000	-0.496	0.001
$U\text{-}U^*$	-0.316	0.026	-0.115	0.038	-0.082	0.044	-0.108	0.009	-0.159	0.011	-0.338	0.007	-0.272	0.009	-0.027	0.108
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$			0.128	0.051			0.040	0.250			0.241	0.026	0.096	0.104		
$\omega^{oil}*(\pi^{oil}-\pi(-1))$	0.252	0.001														
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$									0.176	0.001	0.117	0.071				
Dummies	2000Q3-4								2010Q1							
Adj R2	0.779		0.376		0.387		0.382		0.617		0.829		0.440		0.364	

Table A1.2. **Anchored expectations Phillips curve estimation results** *(cont.)*

Dependent variable Δπ	ESP		EST		FIN		GRC		HUN		IRL		ISL		ISR	
	1998Q4-2014Q1		2000Q3-2013Q4		1998Q1-2013Q4		1998Q1-2014Q1		2001Q3-2013Q4		1998Q1-2013Q4		1998Q1-2014Q2		1998Q1-2014Q1	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst			0.443	0.011											0.909	0.001
$\Delta\pi(-1)$	-0.865	0.000	0.349	0.011	-0.625	0.000	-0.729	0.000			-0.332	0.002	-0.693	0.000	-0.945	0.000
$\Delta\pi(-2)$	-0.581	0.002			-0.605	0.000	-0.543	0.002								
$\Delta\pi(-3)$							-0.533	0.002								
$\pi(-1)$	-0.708	0.001	-0.098	0.139	-0.357	0.015	-0.425	0.001	-0.637	0.000	-0.405	0.000	-0.305	0.000	-0.936	0.000
*U-U**	-0.031	0.009	-0.055	0.047	-0.200	0.056	-0.039	0.010	-0.252	0.037	-0.063	0.003	-0.104	0.018	-0.305	0.010
$\omega^m*(\pi^m-\pi(-1))$					0.279	0.000										
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$	0.040	0.608	0.093	0.101					0.030	0.420	0.104	0.057	0.212	0.000		
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$					0.062	0.319										
Dummies							VAT				2009Q1				1999Q1	
Adj R2	0.459		0.385		0.434		0.315		0.357		0.518		0.468		0.437	

Dependent variable Δπ	KOR		LUX		LVA		MEX		NLD		NOR		NZL		POL	
	1998Q4-2014Q1		1998Q3-2014Q1		1998Q1-2014Q4		2000Q1-2013Q4		1998Q1-2013Q4		1998Q1-2014Q1		1998Q1-2014Q1		1998Q1-2013Q4	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst					0.335	0.000					0.222	0.086	0.363	0.001	0.241	0.269
$\Delta\pi(-1)$	-0.521	0.000	-0.874	0.000	-0.443	0.000	-0.424	0.001	-0.807	0.000	-0.714	0.000			-0.499	0.000
$\Delta\pi(-2)$							-0.420	0.001							-0.257	0.067
$\Delta\pi(-3)$																
$\pi(-1)$	-0.317	0.005	-0.711	0.000	-0.465	0.000	-0.235	0.000	-0.628	0.000	-0.521	0.001	-0.934	0.000	-0.185	0.038
*U-U**	-0.081	0.102	-0.227	0.031	-0.096	0.000	-0.062	0.109	-0.078	0.026	-0.188	0.058	-0.202	0.020	-0.035	0.091
$\omega^m*(\pi^m-\pi(-1))$																
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$			0.016	0.113											0.074	0.048
$\omega^{oil}*(\pi^{oil}-\pi(-1))$			0.243	0.000												
$\omega^{oil}(-1)*(\pi^{oil}(-1)-\pi(-1))$	0.053	0.017					0.035	0.011								
Dummies					2009Q2											
Adj R2	0.250		0.640		0.539		0.429		0.394		0.309		0.461		0.229	

Table A1.2. **Anchored expectations Phillips curve estimation results** *(cont.)*

Dependent variable $\Delta\pi$	PRT		SVK		SVN		SWE		TUR	
	1998Q1-2013Q4		1998Q1-2014Q2		1998Q1-2013Q4		1998Q1-2014Q1		1998Q1-2013Q4	
	COEF	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*	*COEF*	*PVALUE*
Cst			2.173	0.000	0.824	0.020			-0.654	0.001
$\Delta\pi(-1)$	-0.807	0.000	-0.893	0.000	-0.751	0.000	-0.998	0.000	-0.763	0.000
$\Delta\pi(-2)$					-0.638	0.003				
$\pi(-1)$	-0.551	0.000	-0.751	0.000	-0.629	0.005	-0.920	0.000	-0.544	0.000
*U-U**	-0.074	0.002	-0.137	0.038	-0.188	0.017	-0.164	0.002	-0.506	0.047
$\omega^m(-1)*(\pi^m-\pi(-1))$	0.111	0.059					0.207	0.018	0.549	0.036
$\omega^m(-1)*(\pi^m(-1)-\pi(-1))$			0.055	0.462						
Dummies										
Adj R2	0.447		0.459		0.282		0.563		0.339	

Note: Q-o-Q core CPI inflation has been adopted for all countries, except Australia, Colombia, Finland, United Kingdom, Greece, Luxembourg and Portugal, for which headline CPI inflation has been chosen. $\omega^{m*}(\pi^m-\pi(-1))$ indicates the real import price inflation weighted by import penetration and $\omega^{oil*}(\pi^{oil}-\pi(-1))$ indicates real oil price inflation weighted by oil intensity of production. ma(ω^m) represents a 3-year moving average of real import price inflation.
Source: OECD calculations.

Figure A1.1. **New estimates of equilibrium unemployment**

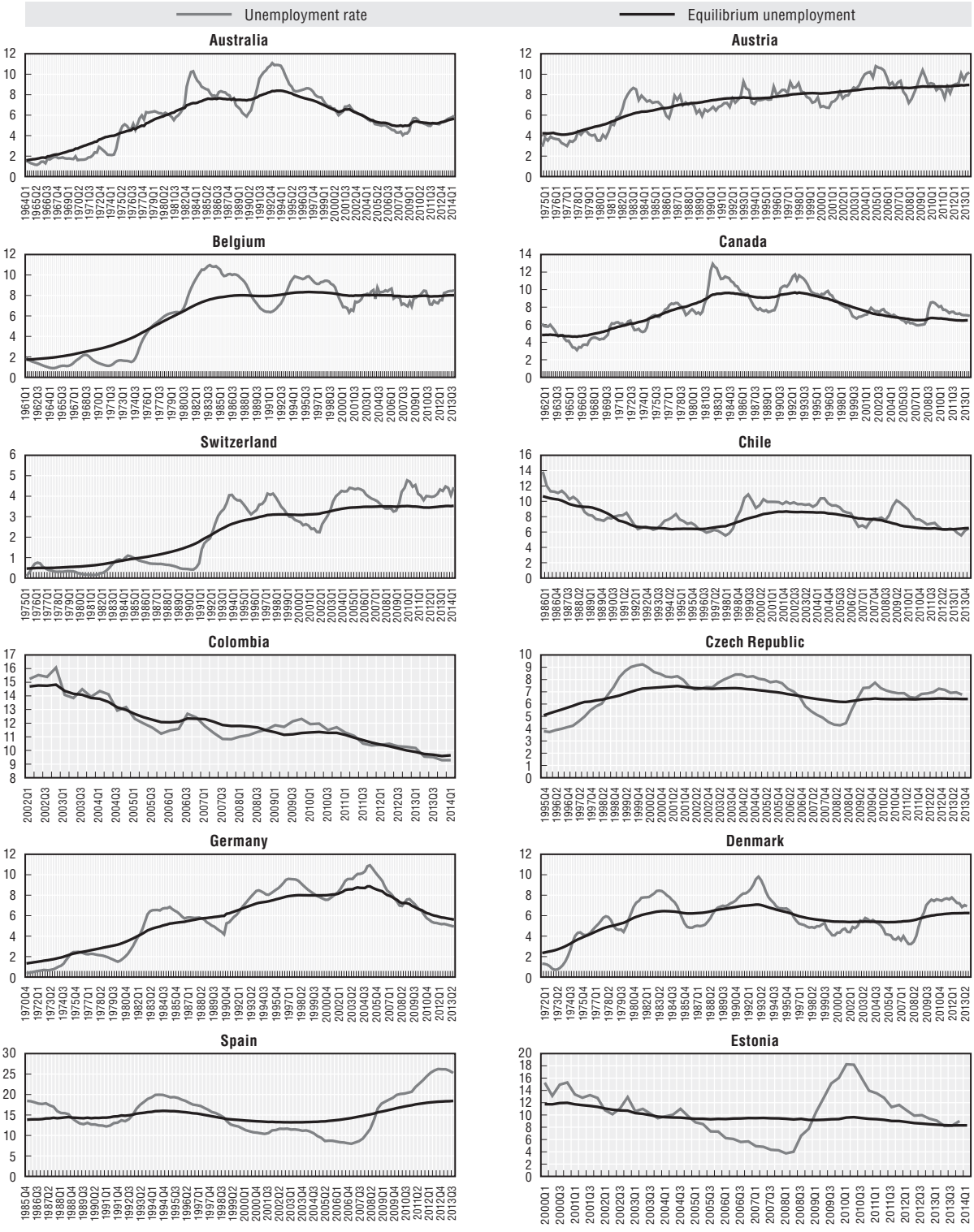


Figure A1.1. **New estimates of equilibrium unemployment** *(cont.)*

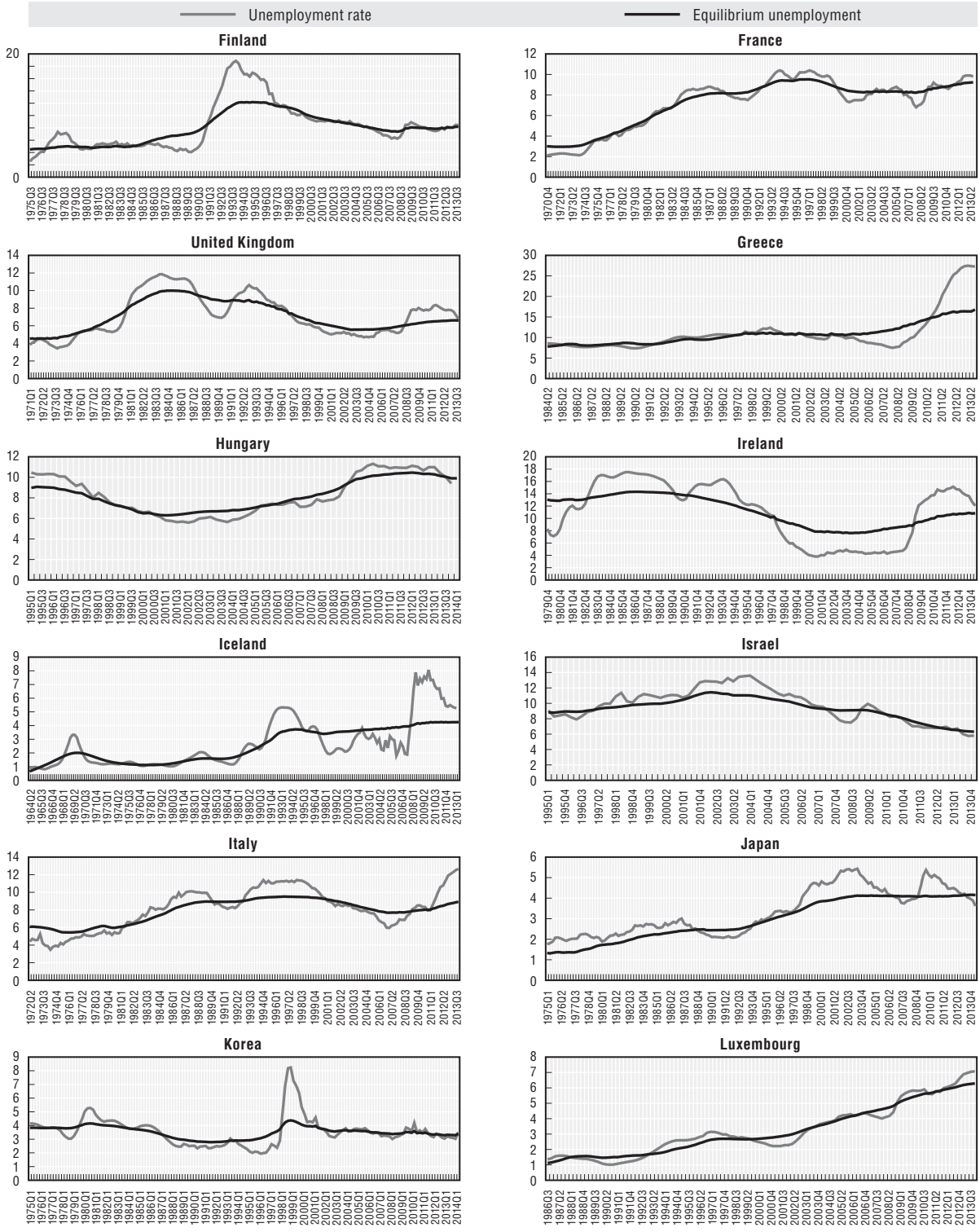
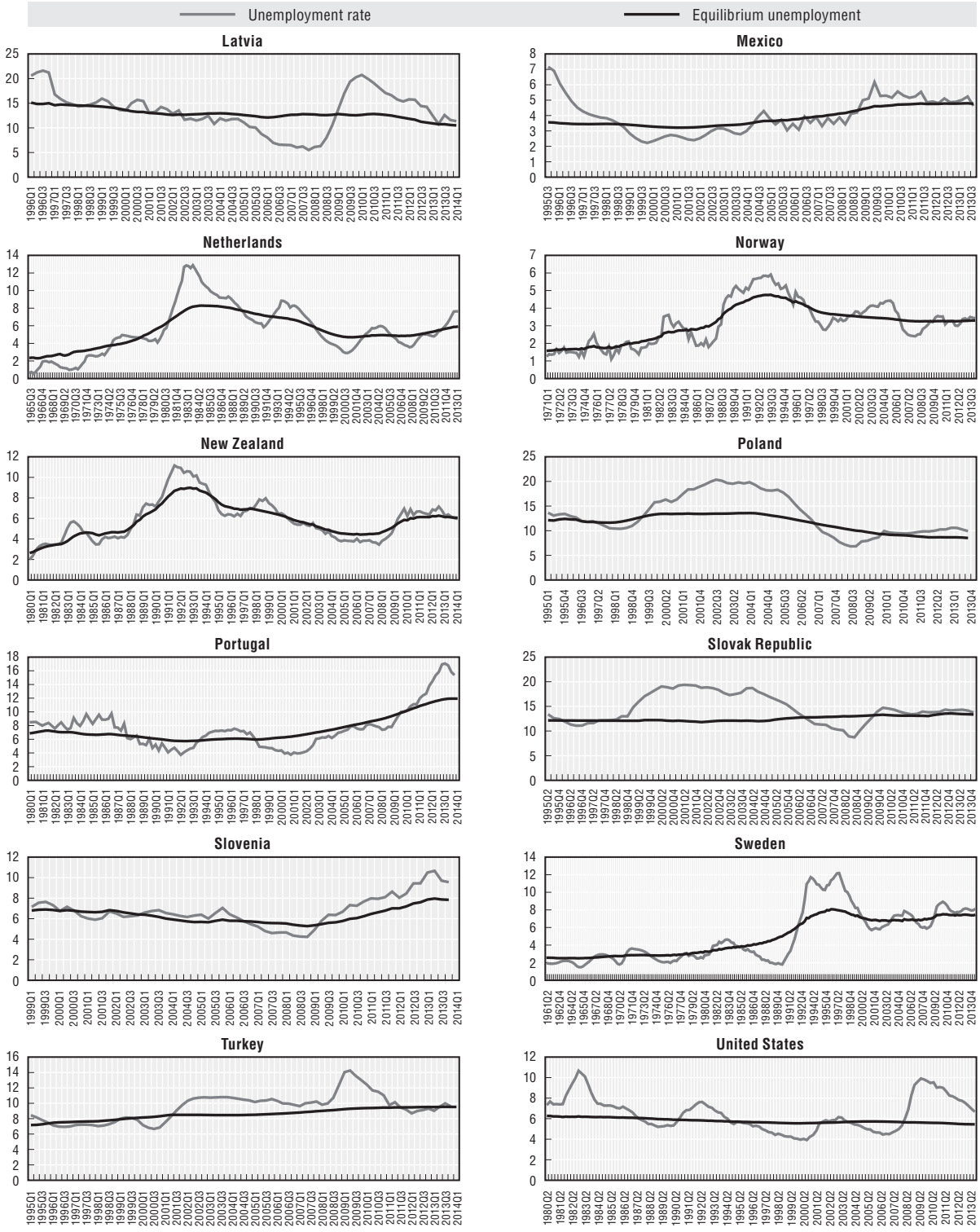


Figure A1.1. **New estimates of equilibrium unemployment** *(cont.)*



Note: The estimates of the equilibrium unemployment refer to the backward-looking Phillips curve before 1998Q1 and to the anchored expectations Phillips curve from 1998Q1 onwards. For consistency purposes, the initial estimates of equilibrium unemployment in 1998Q1 obtained with the new modelling framework have been constrained to minimise the revision to the existing estimate from the previous method.

Source: OECD Analytical Database, and OECD calculations.

ANNEX 2

Formal tests of the anchoring of inflation expectations

A break in the relationship between long-term inflation expectations and inflation has been investigated for six major OECD countries over the period 1990-2014. For this purpose a measure of the expected log-run inflation rate is taken from the *Survey of Professional Forecasters* as inflation expected at a horizon of between 6 and 10 years ahead. This expected rate of inflation, π_t^e is regressed on a constant, α_1, representing a possible long-run anchor for inflation expectations, and lagged headline inflation, π_{t-1}:

$$\pi_t^e = \alpha_1 + \alpha_2 \pi_{t-1} + \varepsilon_t \qquad [2.1]$$

Standard unit root tests for actual inflation, long-run inflation expectations, and the estimated error term in [2.1] suggest actual and expected inflation are I(1) processes and the error series are stationary.

A number of tests on the estimated coefficients of [2.1)] over different sub-samples are shown in Table A2.1, and can be summarised are as follows:

- Long-term inflation expectations appear sensitive to movements in the headline rate of inflation prior to 1998, with estimates of α_2 statistically significant for five of the six countries (the exceptions being the United States). Conversely, after 1998 lagged inflation has little power in explaining long-term inflation expectations and a restriction that $\alpha_2 = 0$ is accepted for all countries.
- For the post-1998 period, the constant α_1 remains statistically significant and close to 2% for all countries, consistent with relatively well-anchored inflation expectations. On the other hand, the constant term is also significant for most countries in the pre-1998 sample.
- A naïve model, that inflation expectations are fully adaptive and so immediately adjust to the lagged inflation rate, the joint restriction $\alpha_1 = 0$ and $\alpha_2 = 1$, is rejected over all sample periods.
- A model implying that inflation is anchored at 2%, consistent with the joint restriction $\alpha_1 = 2$ and $\alpha_2 = 0$, is accepted for four of the six countries over the post-1998 sample, but rejected for all countries over the pre-1998 sample.

Table A2.1. **Estimation results explaining inflation expectations**

	USA	DEU	FRA	ITA	GBR	CAN
Full sample						
α_1	2.52***	1.58***	1.76***	1.20***	2.25***	2.05***
α_2	0.14	0.4***	0.37	0.79***	0.23	-0.05
H_0: $\alpha_1 = 0$	*R*	*R*	*R*	*R*	*R*	*R*
H_0: $\alpha_2 = 0$	***NR***	*R*	***NR***	*R*	*R*	***NR***
H_0 : ($\alpha_1 = 2$; $\alpha_2 = 0$)	*R*	*R*	***NR***	*R*	*R*	***NR***
H_0 : ($\alpha_1 = 0$; $\alpha_2 = 1$)	*R*	*R*	*R*	*R*	*R*	*R*
Pre-1998						
α_1	2.96	2.18***	1.82***	1.48***	2.24***	2.16***
α_2	0.32	0.21**	0.79***	0.82***	0.96*	0.20**
H_0: $\alpha_1 = 0$	***NR***	*R*	*R*	*R*	*R*	*R*
H_0: $\alpha_2 = 0$	***NR***	*R*	*R*	*R*	*R*	*R*
H_0 : ($\alpha_1 = 2$; $\alpha_2 = 0$)	*R*	*R*	*R*	*R*	*R*	*R*
H_0 : ($\alpha_1 = 0$; $\alpha_2 = 1$)	*R*	*R*	*R*	*R*	*R*	*R*
Post-1998						
α_1	2.44***	1.74***	1.85***	1.90***	2.17***	1.99***
α_2	-0.04	-0.01	-0.01	-0.01	0.14	0.00
H_0: $\alpha_1 = 0$	*R*	*R*	*R*	*R*	*R*	*R*
H_0: $\alpha_2 = 0$	***NR***	***NR***	***NR***	***NR***	***NR***	***NR***
H_0 : ($\alpha_1 = 2$; $\alpha_2 = 0$)	*R*	*R*	***NR***	***NR***	***NR***	***NR***
H_0 : ($\alpha_1 = 0$; $\alpha_2 = 1$)	*R*	*R*	*R*	*R*	*R*	*R*

*, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. R = Chi-Squared statistics and F-tests statistics both indicate rejection of the null hypothesis at the 10% level or below; NR = indicate no rejection of the null hypothesis. Equations are estimated by OLS using the Newey and West (1987) covariance matrix corrections for residuals' autocorrelation and heteroskedasticity.

Source: OECD calculations based on data from *Consensus Economics* and headline inflation.

ANNEX 3

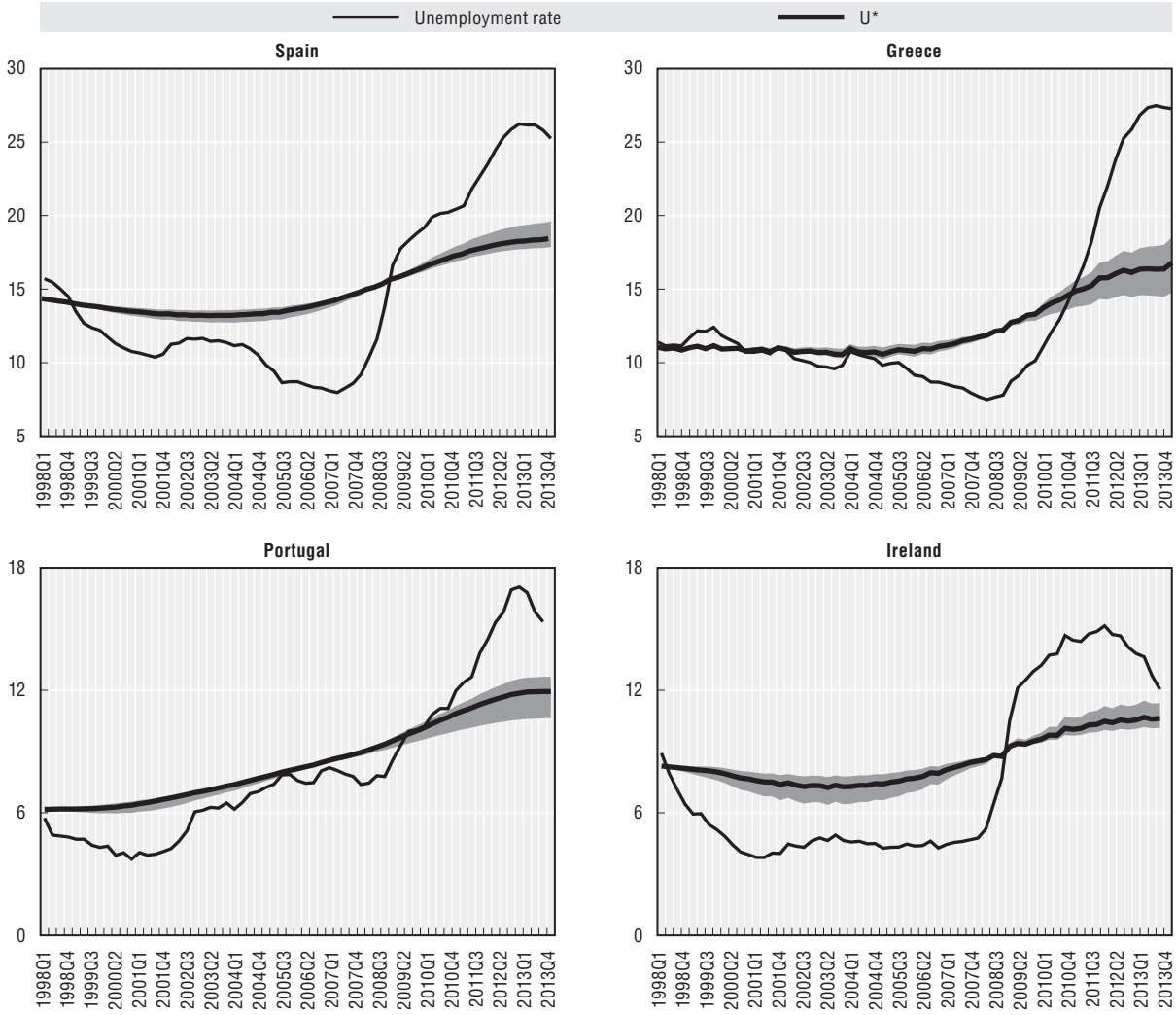
Sensitivity to the transition variance calibration

To assess the robustness of the results from the anchored expectation approach, sensitivity tests have been performed to alternative choices of the variance σ_v^2 of the error term in the random walk equation modelling the equilibrium unemployment U* [1.4]. The value of such variance relative to the one of the error term in the Phillips curve equation [1.1] is generally termed signal-to-noise ratio and it controls the smoothness of estimates of equilibrium unemployment. The higher the value of the signal-to-noise ratio, *ceteris paribus*, the more volatile is the estimated U*.

Alternative values of σ_v^2 have been tested for a sample of countries where unemployment has recently increased most. The shaded band in Figure A3.1 represents values of the equilibrium unemployment rate that would still generate coefficients on the unemployment gap which are at least as significant as in the preferred Phillips curve equation. Since very low values of σ_v^2 would trigger the pile-up problem (see Annex 1), the tests on alternative choices of σ_v^2 have considered the restriction that the signal-to-noise ratio always remains within the range of reasonable values identified in the literature (Laubach, 2001; Staiger et al., 1997b). More specifically, the signal-to-noise ratio has been constrained to a range between 0.05 and 0.15, a range first estimated by Staiger et al. (1997b) and largely respected by the literature on the NAIRU.

The analysis confirms that estimates of equilibrium unemployment under the anchored expectation specification are sensitive to the choice of the variances of the error terms in the state space equations, particularly towards the end of the estimation sample. However, the margin of this sensitivity does not seem unduly alarming, but rather underlines the importance of having a strongly significant unemployment gap in the Phillips curve. Thus, plausible values for the equilibrium unemployment rate at the end-point of the estimation period (i.e. 2014Q1) remain confined in a range of ± 1 percentage point on average around the central estimate.

Figure A3.1. **Sensitivity tests to alternative choices of parameters in the state space equations**



Note: The shaded band shows the range of estimates for the equilibrium unemployment rate obtained by changing the variance parameters in the state space equation, while at the same time maintaining the statistical significance of the unemployment gap in the preferred Phillips curve equation.
Source: OECD calculations.

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(13 2015 01 1 P) ISSN 1995-2848 – 2015

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ISSN 1995-2848
VOLUME 2015 (1 ISSUE)
13 2015 01 1 P