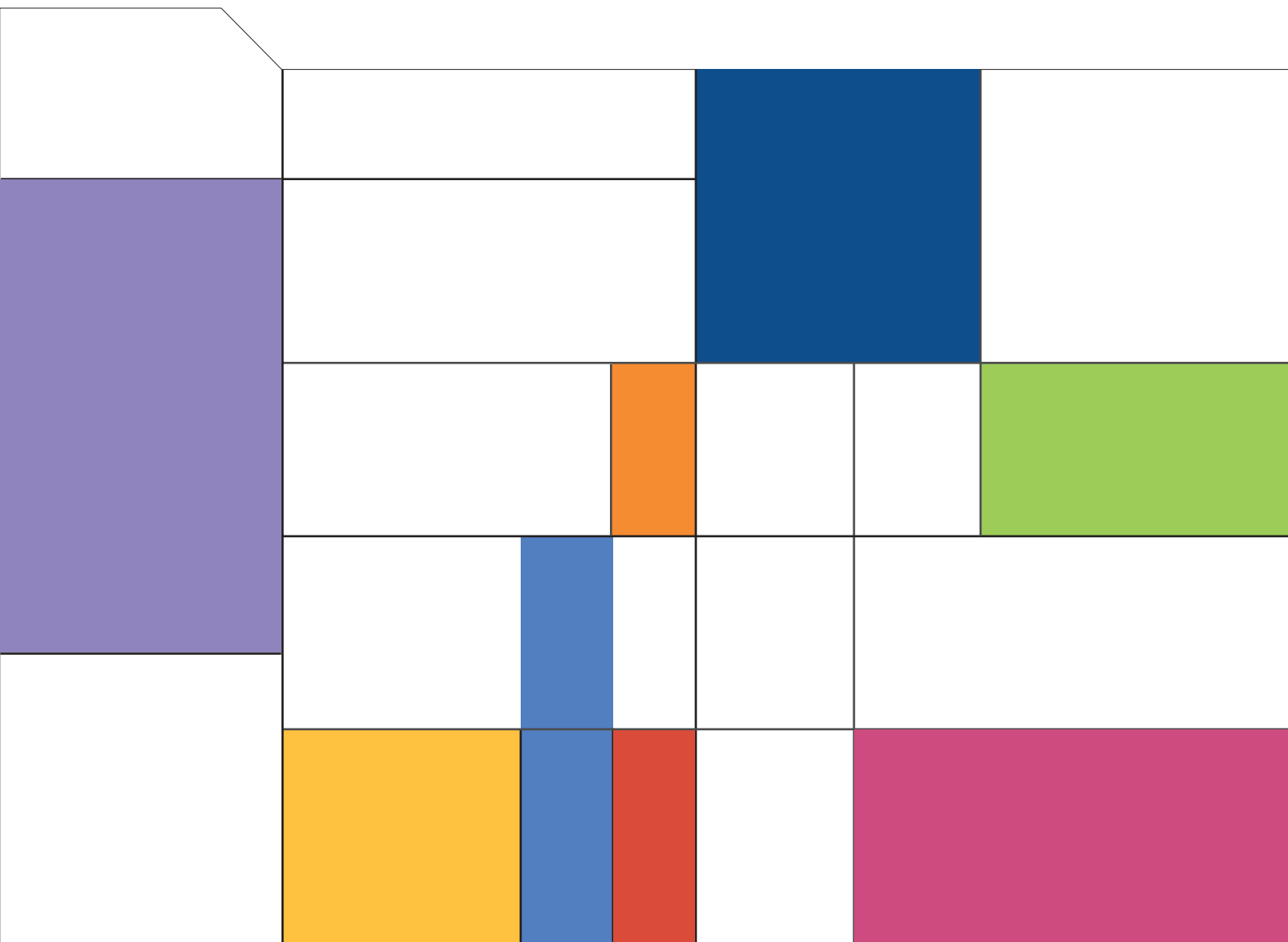




# OECD Journal Economic Studies





OECD Journal

# Economic Studies

Volume 2011

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## Foreword

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

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# OECD Productivity Growth in the 2000s: A Descriptive Analysis of the Impact of Sectoral Effects and Innovation

by

Julien Dupont, Dominique Guellec and Joaquim Oliveira Martins\*

*This paper brings together the latest data and OECD productivity indicators in different areas with the aim of reviewing the main productivity trends over the past decade, comparing the United States, Europe and to some extent Japan. Concerning economy wide indicators of productivity, the slowdown appears to be due to a significant slowdown in investment in information and communication technologies (ICT) followed by a decrease in multi-factor productivity (MFP). However, a new set of indicators of MFP growth by industry shows that the decline of productivity is particularly marked in sectors such as construction and market services. Looking for possible explanations of the decline, a marked slowdown in innovation emerged as the most likely cause. It concludes that, if no new wave of innovation materialises, comparable in size to the one of the late 1990s (around notably the Internet), the OECD trend productivity growth is not likely to resume at its end-1990s level. Only a recovery in innovation itself could trigger a sustainable recovery in productivity in the major OECD countries.*

JEL classification: E22, O31, O32, O47

Keywords: Productivity, convergence, innovation, growth accounting

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Labour productivity growth in the OECD has declined significantly since 2004. The post 2004 slowdown in OECD countries was driven first by the United States, but is also marked in Japan while productivity is nearly stable in the EU (slowing down in the United Kingdom and Sweden, about stable in other countries). In certain EU countries the productivity slowdown started in fact after 2001, in Germany notably, but also in France; that is also the case in Canada and Australia. In contrast, productivity had accelerated markedly in the United States and slightly in the United Kingdom between 2002 and 2004: but 2005-07 productivity growth is significantly lower than the 1995-2001 performance.

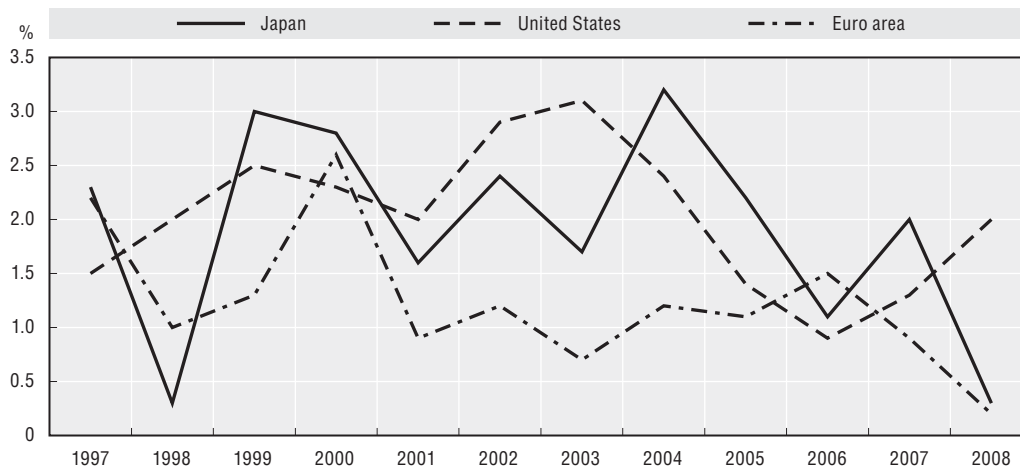
The emergence of significant within OECD productivity gaps during the late 1990s triggered a lively debate on their causes, in particular the role of structural policies. However, the recent productivity trends in the United States put this debate into a different perspective. In this context, this paper describes productivity growth patterns across main OECD countries, focusing on the role of some specific factors, such as innovation and the construction sector. These have played a significant role in the building of expectations about the real economy and influenced the dynamics of the crisis, as well as having an impact on possible exit strategies.

Section 1 describes the decreasing productivity gap among major OECD countries at the level of the total economy, based on productivity indicators from the OECD Productivity database.<sup>1</sup> It uses growth accounting methods, decomposing labour productivity and GDP growth into the contribution of capital deepening and the growth in multi-factor productivity (MFP). Section 2 asks which sectors are responsible for the slowdown in US labour productivity growth. Section 3 provides more detailed information, based on net capital stock estimates and MFP growth at the industry level that have been computed in the framework of the OECD Productivity database by industry (hereafter, PDBi).<sup>2</sup> Section 4 focuses on the links between innovation and the productivity cycle. This empirical analysis raises issues about productivity measurement and the need of timely and disaggregated productivity estimates. Section 5 concludes.

## 1. United States vs. Europe: divergence and convergence of productivity

Discussion about why the United States historically maintained higher productivity growth rates than Europe usually focuses on a structural policy gap: labour conditions (hiring and firing), product market regulations, and the uptake of technology. Figure 1 provides labour productivity (per hour worked) trends across the United States, the Euro zone and Japan. After the emerging gap in the late 1990s, a striking feature is a convergence “to the bottom” after 2003. By 2007, all major OECD areas were running at approximately the same productivity growth rate, at around 1-1.5%. Actually, a productivity gap appears again in 2008 with a turnaround of productivity in the United States at around 2%, while in the Euro zone productivity growth slowed down significantly in the aftermath of the crisis to less than 0.5%. The connexion between these productivity trends, expectations and the crisis is still a subject for research (see Mulligan, 2009).

Figure 1. **Labour productivity<sup>1</sup> growth at the total economy level**  
Annual growth rates



1. Labour productivity is defined as GDP per hour worked; where GDP for each country refers to its Gross Domestic Product, in national currency, at constant prices, OECD base year 2000, and output for country groups/zones. GDP refers to the Gross Domestic Product, in US dollars, at constant prices, constant PPPs, OECD base year 2000. Labour input is defined as total hours worked of all persons employed. The data are derived as average hours worked from the *OECD Employment Outlook*, *OECD Annual National Accounts*, *OECD Labour Force Statistics* and national sources, multiplied by the corresponding and consistent measure of employment for each particular country.

Source: OECD Productivity Database, August 2009.

### 1.1. A decomposition of labour productivity

Assuming a standard Cobb-Douglas function and constant returns to scale, the growth in labour productivity can be decomposed into the MFP growth and the contribution of capital deepening defined as the weighted capital input relative to the weighted labour input:

$$\ln\left(\frac{LP_t}{LP_{t-1}}\right) = \ln\left(\frac{MFP_t}{MFP_{t-1}}\right) + s^K * \ln\left(\frac{\left(\frac{K_t}{H_t}\right)}{\left(\frac{K_{t-1}}{H_{t-1}}\right)}\right) \quad (1)$$

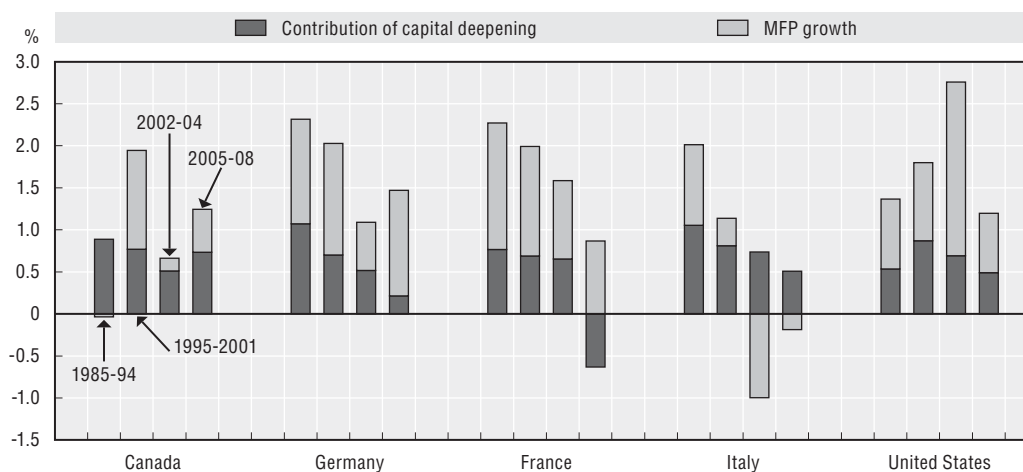
Where  $LP$  represents labour productivity,  $MFP$  represents multi-factor productivity,  $s^K$  represents the share of capital income in total income,  $K$  represents the capital input, and  $H$  represents total hours actually worked in a specific industry.<sup>3</sup> Growth in capital deepening refers to the growth in the aggregate flow of capital services minus the growth in aggregate hours worked. Growth in capital deepening has a positive effect on labour productivity because a larger amount of capital per worker should increase the output per worker.

Using this decomposition, Figure 2 shows the two main drivers of labour productivity during the period 1985-2008. The contribution of capital deepening to labour productivity growth slowed over the last decade in all the large countries analysed here, except Canada. However, trends in MFP growth differ markedly across countries. From 1985 to 2004, MFP growth supported labour productivity in Germany, France and the United States. Canada experienced a sharp decline in MFP during 2002-08 compared with 1995-2001. Even more so did Italy, where growth turned negative after 2001. An acceleration of MFP is noticeable in the United States for the years 2002-04, but since then it has been growing at a much slower pace. Overall, the slowdown of labour productivity growth over the whole

period 1985-2008 was driven more by the deceleration in MFP growth than by the contribution of capital deepening in most OECD countries. This stresses the usual fact about the importance of technology for aggregate productivity.

**Figure 2. The decomposition of labour productivity growth in MFP growth and capital deepening, 1985-94, 1995-2001, 2002-04, and 2005-08**

Average annual growth rates

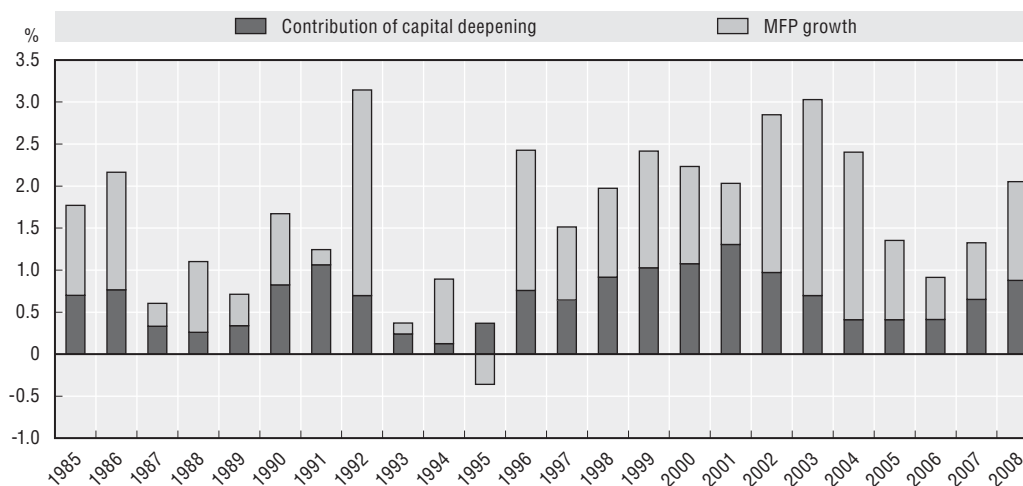


Source: OECD Productivity Database, September 2009.

Figure 3 gives more detail, year by year, on the evolution of this decomposition of labour productivity for the United States. An interesting feature is an apparent revival of MFP and capital deepening since 2006.

**Figure 3. The decomposition of labour productivity growth in MFP growth and capital deepening in the United States**

Annual growth rates



Source: OECD Productivity Database, September 2009.

### **1.2. The role of Information and Communication Technologies (ICT) for labour productivity**

The impact of technological changes on productivity growth has already been assessed in several studies (*e.g.* OECD 2003b, Colecchia and Schreyer 2001). The contribution of ICT capital in GDP growth is measured using capital services by type of assets and the OECD productivity database, measured as variations of productive capital stocks. The contribution of ICT capital reflects two effects, the growth rate of the input and its relative importance in production.

In the United States, ICT explains the bulk of capital's contribution to GDP growth. However, the contribution of ICT capital to GDP growth fell in most OECD countries between the periods 1985-2001 and 2001-06. Figure 4 shows some evidence for a significant effect of deceleration in the contribution of ICT capital to GDP growth in the period 2000-03 in the United States. Over the same period, the contribution of non-ICT capital only decreased slightly. Then, the contribution of ICT capital to GDP growth remained stable over the years after 2004. The average service life of ICT equipment being shorter than that for non-ICT capital, the influence of fluctuations in real investment is more important for ICT capital services than for non-ICT, and the ICT capital services are more sensitive to the business cycle (see OECD 2003 and Colecchia and Schreyer 2002). The 2000 break in the rising contribution of ICT confirms the hypothesis of a break in ICT investment after the burst of the Internet bubble.

In contrast, MFP growth accelerated from 2001 to 2003, presumably reacting with some lag to the accumulation of ICT investments of the late 1990s. After 2003, MFP growth declined, probably also reflecting with a lag the slowdown in ICT investment (Figure 4).

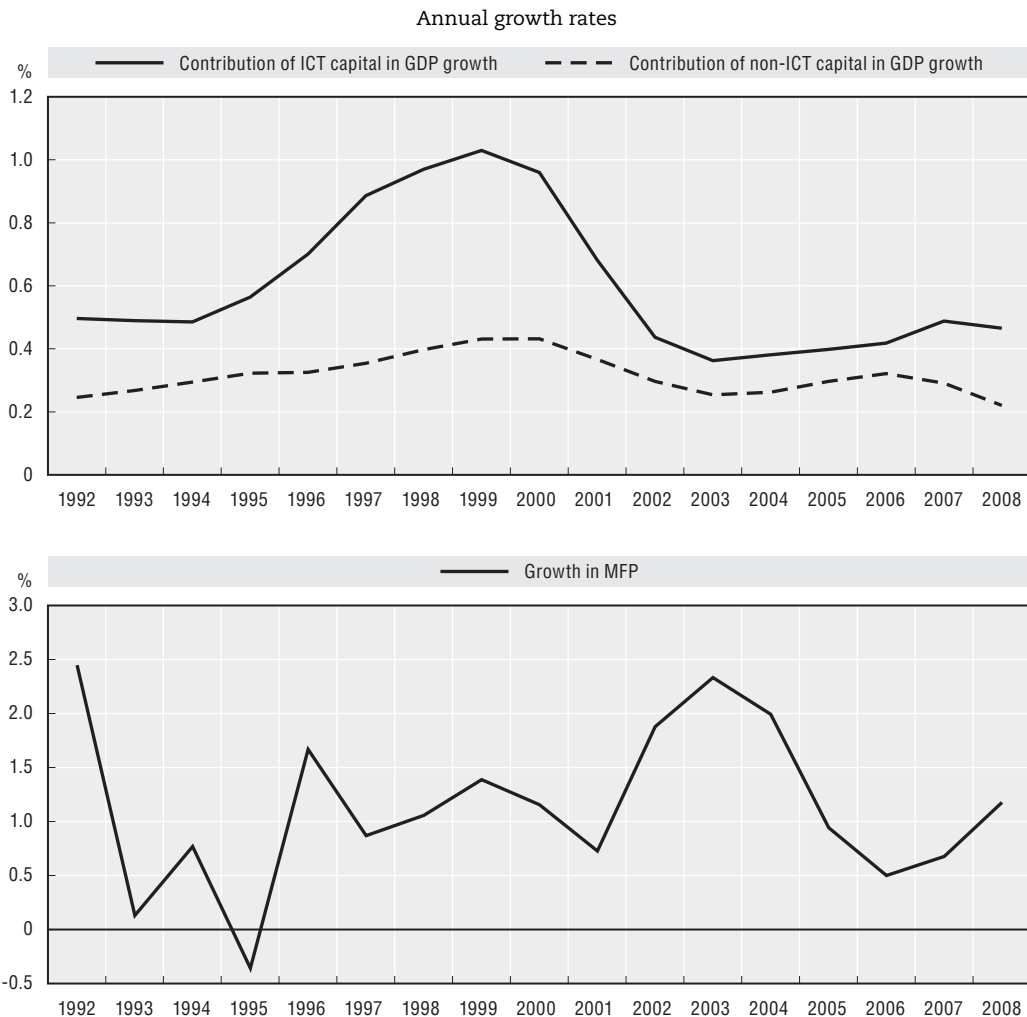
Figure 5 shows the contribution of ICT capital goods to GDP growth in France, Germany, Italy, Sweden and the United Kingdom compared with the United States. The contribution of ICT capital to GDP growth strongly increased when comparing periods 1985-94 and 1995-2001, before decreasing sharply in all countries (comparing periods 1995-2001 and 2002-04). As already shown in previous studies (OECD 2004), the decline of the contribution of ICT capital to economic growth following the slowdown of economic activity does not suggest that ICT capital goods were more affected than other types of capital goods because the share of ICT investment in total capital formation remained high. However, it is noticeable that the contribution of ICT capital was less significant in France, Germany and Italy than in Sweden, the United Kingdom or the United States in the years 1995-2001.

### **1.3. Growth accounts**

Having analysed the components of labour productivity growth, a growth accounting approach can be presented. At the total economy level, growth accounting is a weighted average of labour and capital inputs (weights are respective shares in total costs). For example, the contribution of labour to growth in value added is measured as the speed with which labour input grows, multiplied by the relative importance of labour captured by its share in total costs. The growth contribution of capital is measured in a similar way so that the growth contribution reflects two effects, the growth rate of inputs and their relative importance in production.

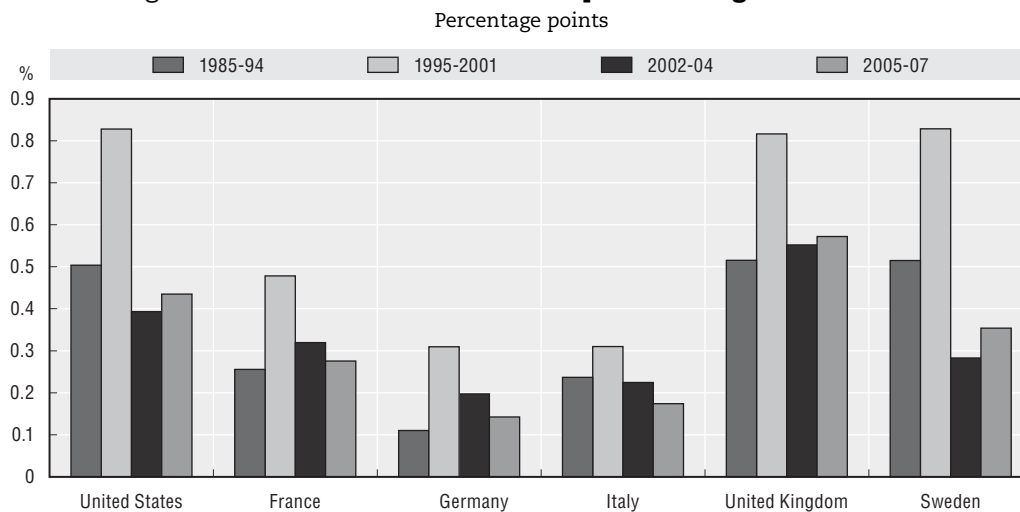
At the aggregate level, from 1992 to 2008, GDP growth in the United States was for a large part driven by growth in capital and MFP. Growth in capital accounted for around

Figure 4. **Contribution of ICT and non-ICT capital in GDP growth in the United States**



Source: OECD Productivity Database, September 2009.

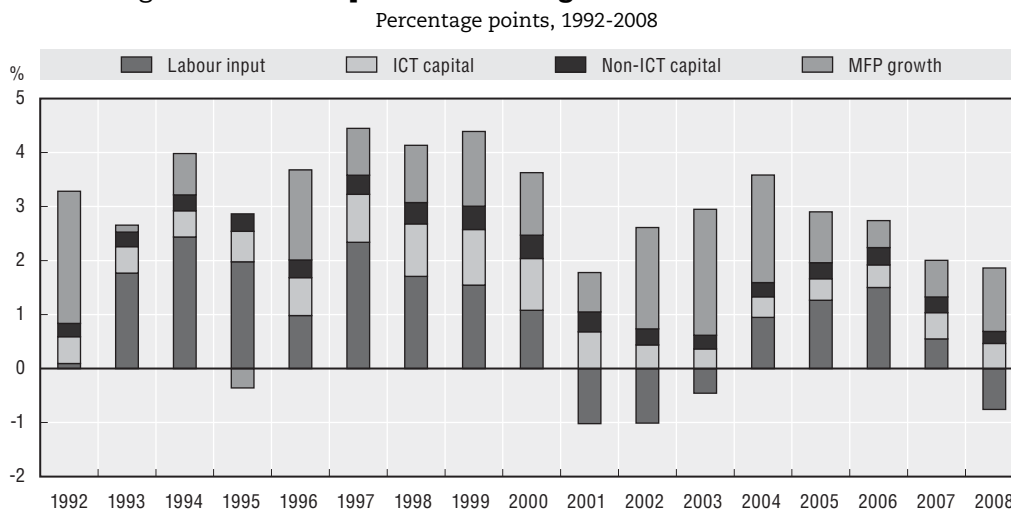
Figure 5. **The contribution of ICT capital to the growth in GDP**



Source: OECD Productivity Database, September 2009.

0.9 percentage point of GDP growth from 1992 to 2008. Over the same period, ICT capital services represented between 0.6 percentage points of the growth in GDP. Growth in labour input was also significant. However, looking at the most recent years allows understanding the changes in productivity in the United States. From 2001 to 2003, the contribution of labour input is negative in the United States while the growth in MFP increases significantly. An opposite evolution can be observed during the following years, i.e. a slowdown in MFP growth and an increase in the contribution of labour input. But again, in 2008 the contribution of labour input is negative while the growth in MFP is rising, the contribution of capital remaining stable (Figure 6).

Figure 6. **The components of GDP growth in the United States**



Source: OECD Productivity Database, October 2009.

Figure 7, comparing the components of GDP growth of France, Germany and Italy, suggests that GDP growth was for a large part driven by growth in capital and MFP. Growth in labour input was less important than in the United States.

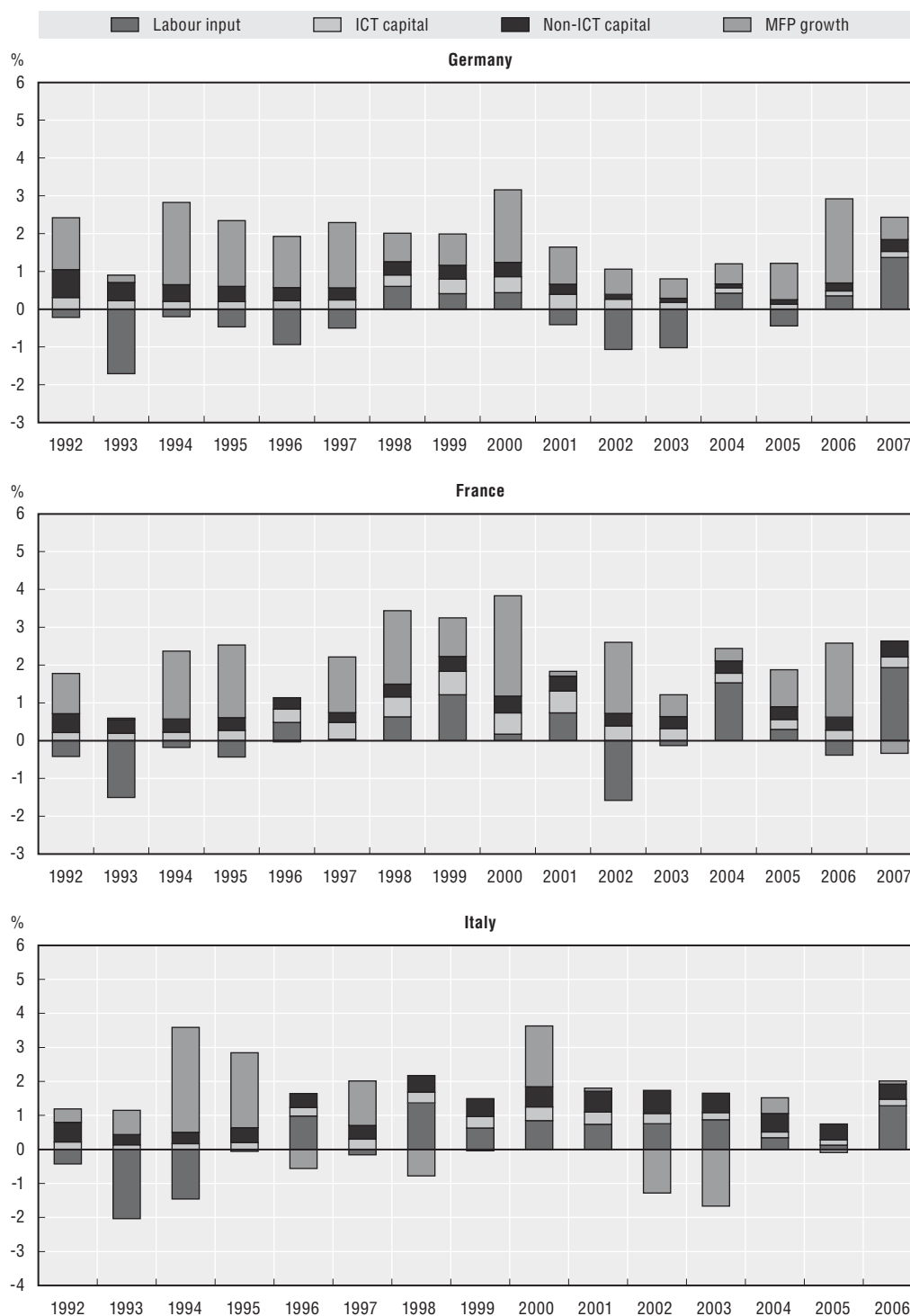
## 2. Which sectors are responsible for the slowdown of labour productivity growth in the United States?

More disaggregated data can help to understand which sectors are responsible for the slowdown of the labour productivity growth in the United States (measurement issues are discussed in the Annex). To identify which sectors are responsible for this, Figure 8 breaks US productivity growth into six sectors: total industry (01-99 based on ISIC Rev.3), manufacturing (15-37 in ISIC Rev.3), construction (45 in ISIC Rev.3), business sector services excluding real estate (50-67, 71-74 based on ISIC Rev.3), non agricultural business sector excluding real estate (10-67, 71-74 based on ISIC Rev.3) and financial intermediation.

While the picture for some industries (financial intermediation) is somewhat volatile, growth rates in MFP are significantly lower since 2004 than in previous years. However, an important driver in the decline of MFP is the construction sector, which accounts for 6% of the total value added (see Table 1 below) but due to poor productivity performance has been a significant drag on aggregate productivity. MFP growth in the US construction sector is negative from 2000, while the contribution of labour input accounts positively on the

**Figure 7. The components of GDP growth in Germany, France and Italy**

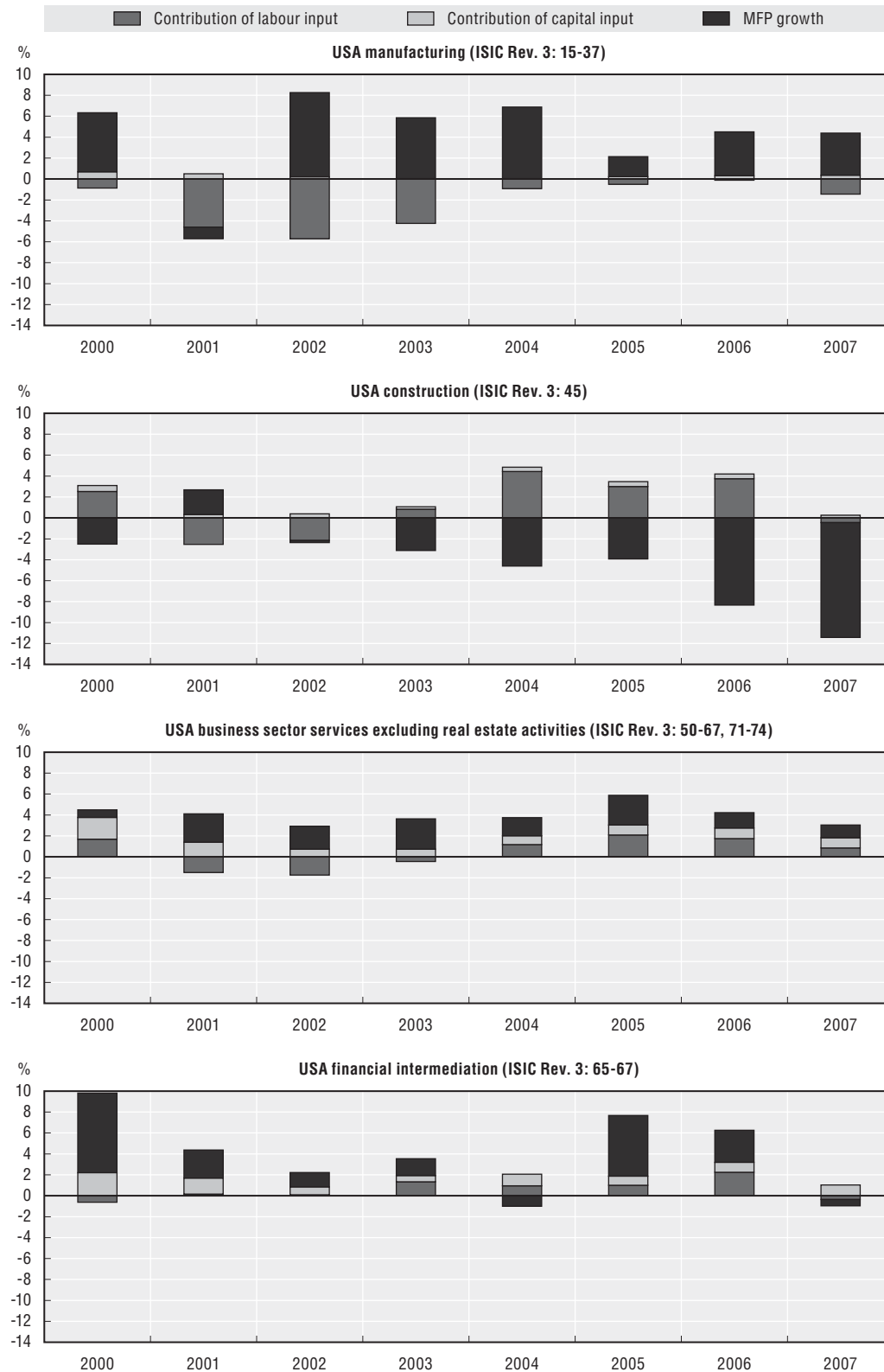
Percentage points, 1992-2008 or latest year available



Source: OECD Productivity Database, October 2009.

**Figure 8. Growth accounts by industry in the United States**

Contributions in %, 2000-08 or latest year available



Source: OECD Productivity Database by industry (preliminary estimates), September 2009.

Table 1. **Value added and employment shares by industry, average 2004-07**

|               |             | Agriculture,<br>hunting, forestry<br>and fishing | Industry<br>including energy | Manufacturing | Construction | Business sector<br>services <sup>1</sup> | Financial<br>intermediation |
|---------------|-------------|--------------------------------------------------|------------------------------|---------------|--------------|------------------------------------------|-----------------------------|
| ISIC Rev.3    |             | 01-05                                            | 10-41                        | 15-37         | 45           | 50-67, 71-74                             | 65-67                       |
| United States | Value added | 1.3                                              | 19.1                         | 14.7          | 5.3          | 47.5                                     | 9.0                         |
|               | Employment  | 1.6                                              | 11.1                         | 10.3          | 6.3          | 45.3                                     | 4.3                         |
| France        | Value added | 2.6                                              | 17.1                         | 15.2          | 6.9          | 44.5                                     | 5.7                         |
|               | Employment  | 3.5                                              | 14.2                         | 13.5          | 6.6          | 41.2                                     | 3.1                         |
| Italy         | Value added | 2.6                                              | 24.1                         | 21.3          | 7.0          | 42.5                                     | 5.6                         |
|               | Employment  | 4.2                                              | 21.2                         | 20.5          | 7.6          | 38.5                                     | 2.5                         |
| Germany       | Value added | 1.1                                              | 29.1                         | 26.2          | 4.5          | 40.0                                     | 5.4                         |
|               | Employment  | 2.2                                              | 20.5                         | 19.5          | 5.7          | 41.0                                     | 3.2                         |

1. Excluding real estate.

Source: OECD STAN Database for Industry Analysis, October 2009.

growth in GDP. By contrast, for business services, the growth in MFP accounts positively in GDP growth in the years from 2000 while the contribution of labour input declined noticeably over the same period.

The picture in the sector of financial intermediation differs as the growth in MFP contributes significantly more to the growth in GDP in 2005 and 2006 compared with previous years. Hence, Figure 8 suggests a positive effect of the direct and indirect use of ICT-related financial intermediation on productivity growth. The development of new financial instruments related to increased use of ICT instruments might explain this trend in productivity in this sector. Moreover, the contribution of labour input rose over this period. However, both growth in MFP and the contribution of labour productivity to the growth in GDP growth were negative in 2007.

### 3. Productivity trends by industry in France, Germany and Italy

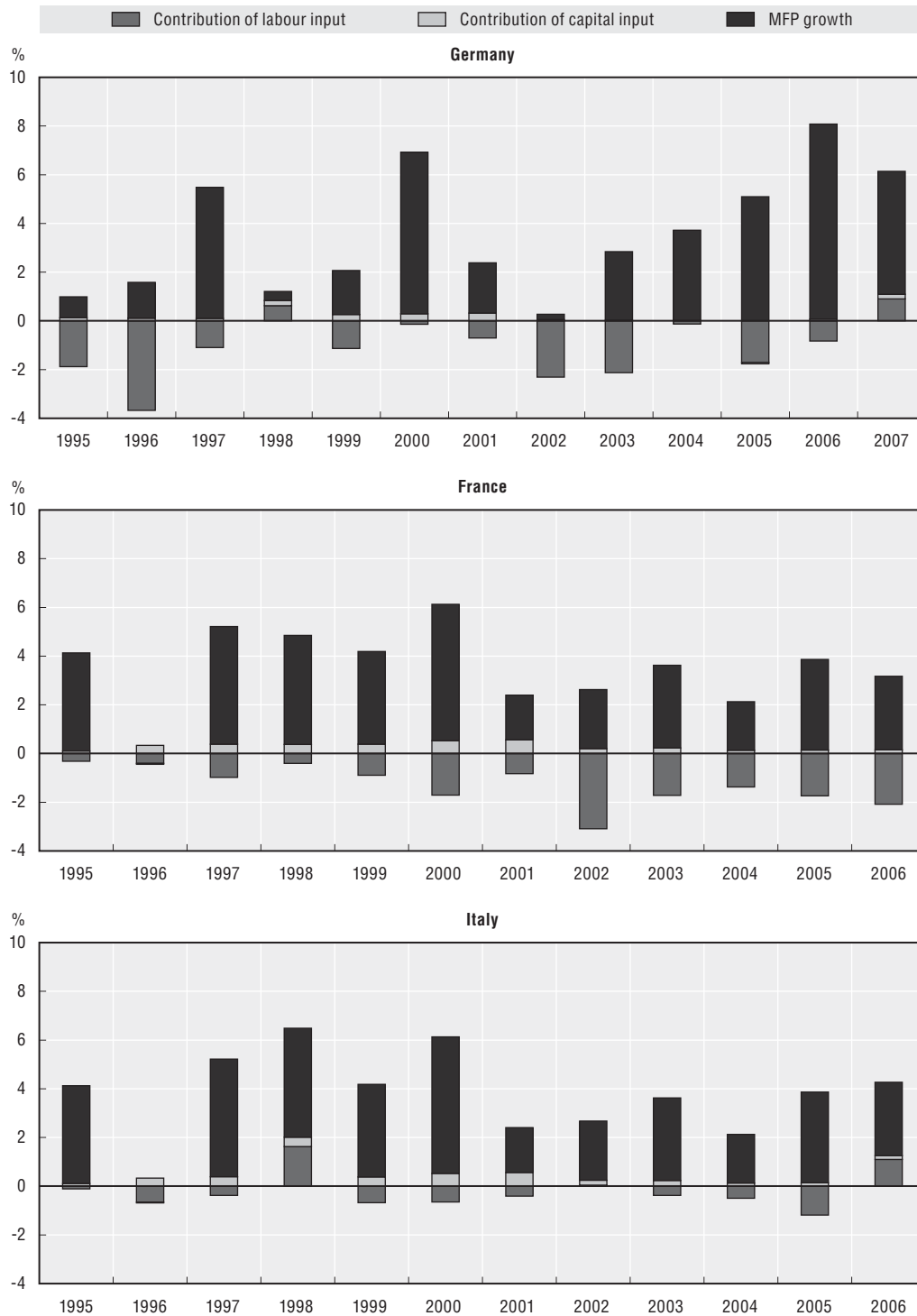
The growth accounts by sector in the main European OECD countries (namely France, Germany, and Italy) are illustrated next. Figures 9 to 11 compare MFP growth and input contributions with the growth in value added in the manufacturing, construction, and financial intermediation sectors. The components of growth follow similar patterns in European countries but diverge from those observed in the United States, especially from 2004.

GDP growth in the manufacturing sector was for a large part driven by growth in MFP in most of the main OECD countries as shown in Figure 9. However, the growth in MFP for construction was negative and declined markedly in the United States over the period 2003-07. Figure 10 suggests that MFP growth in the construction sector was also negative in France, Germany and Italy during most of this period but a noticeable increase in MFP growth in financial intermediation (Figure 11) also occurs during the years 2005-07 in most of these countries, confirming the potential role of the development of new financial services.

This analysis underlines the need for timely productivity estimates both at sectoral and total economy level. In this context, the first set of productivity by industry estimates computed by the OECD provides useful information for productivity analysis and can be linked to the measurement of innovation effects. A further development would require a decomposition of the capital input by type of asset in order to illustrate the role of ICT in

**Figure 9. Growth accounts in manufacturing**

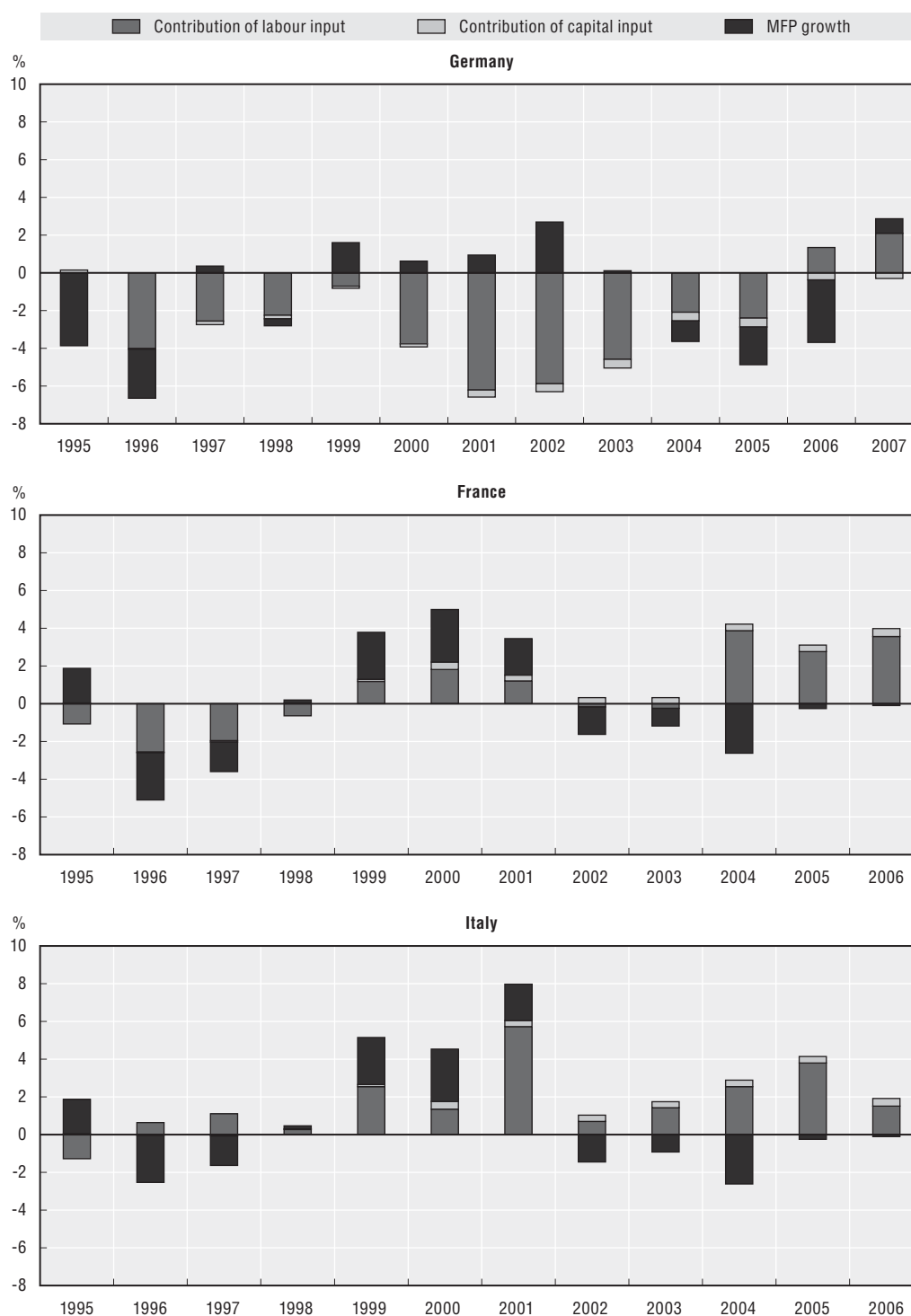
Percentage points, 1992-2008 or latest year available



Source: OECD Productivity Database by industry (preliminary estimates), October 2009.

**Figure 10. Growth accounts in construction**

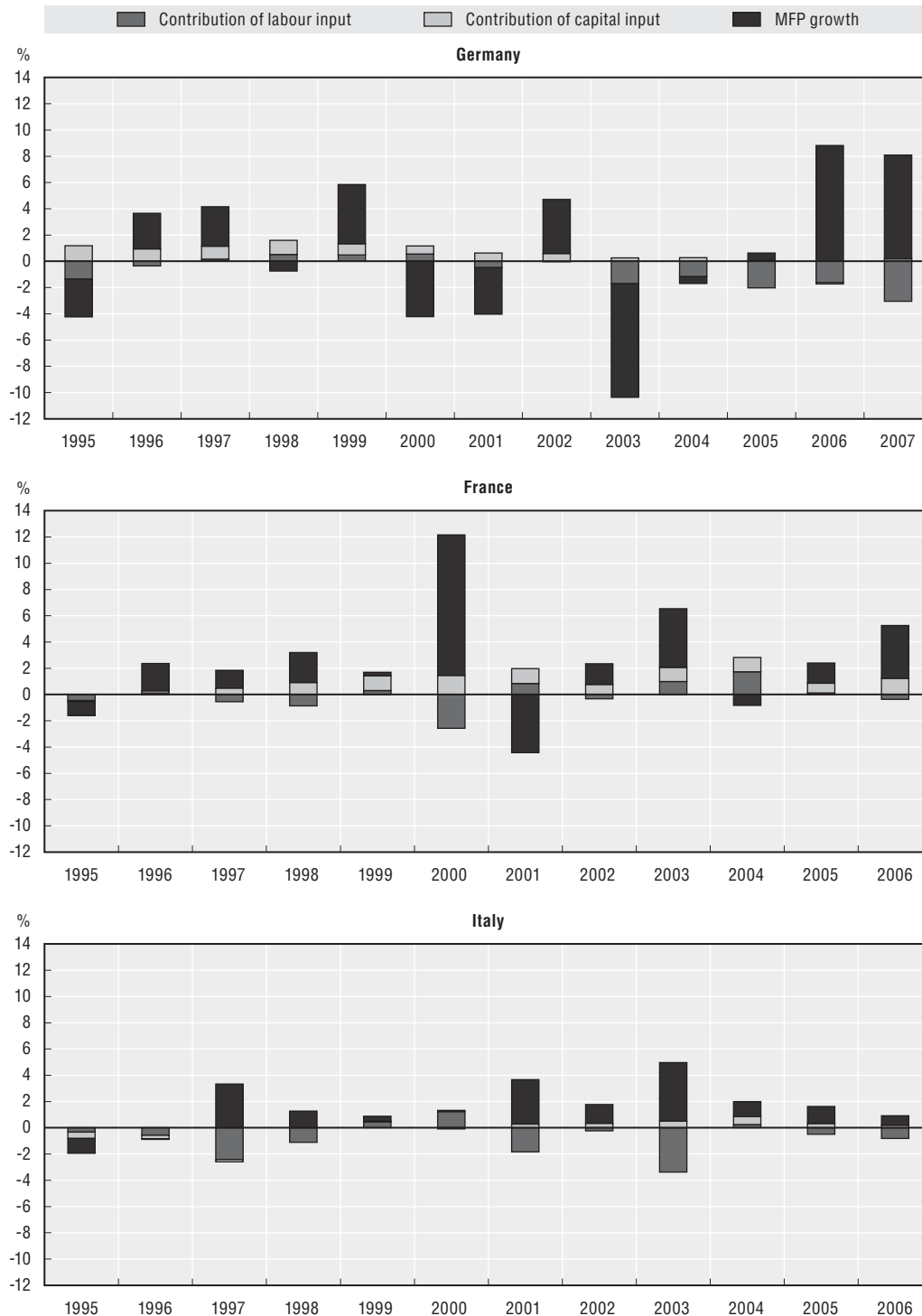
Percentage points, 1992-2008 or latest year available



Source: OECD Productivity Database by industry (preliminary estimates), October 2009.

**Figure 11. Growth accounts in financial intermediation**

Percentage points, 1992-2008 or latest year available



Source: OECD Productivity Database by industry (preliminary estimates), October 2009.

the changes in productivity over recent years. This type of approach has been developed in the context of the EU-KLEMS Project (Timmer et al., 2007), but currently estimates for the most recent years are not yet available.

#### 4. Innovation and the productivity cycle

The analysis above has shown that a slowdown in productivity started long before the current crisis: in fact trend productivity slowed down after the Internet bubble burst of 2001, after having accelerated in the late 2000s in some countries. Looking at the components of productivity growth, we have seen that: i) the contribution of ICT capital dropped after the 2001 crisis (although the contribution of non-ICT capital did not decline significantly); and ii) MFP dropped in 2004-05, depending on countries. What could explain this change in trend productivity? Economic analysis points to three major potential culprits:

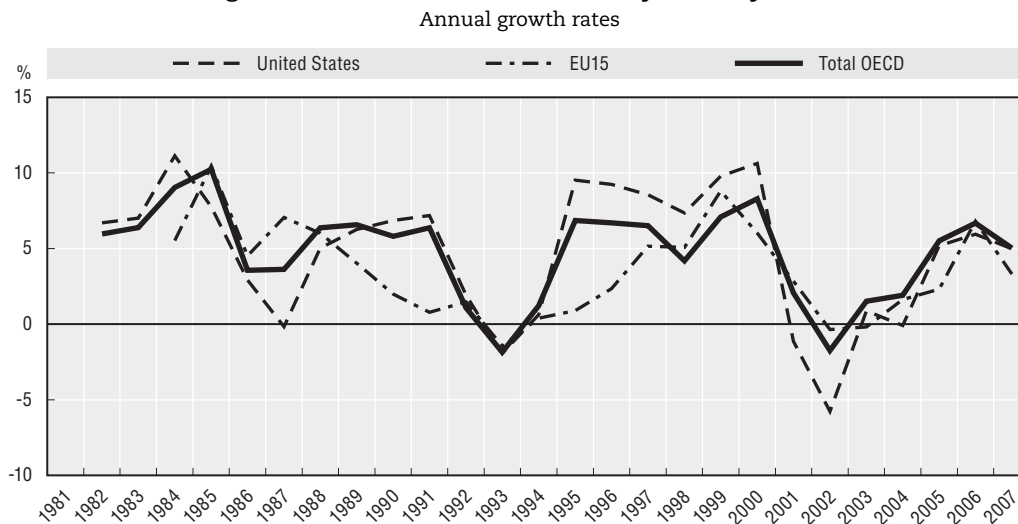
- *The business cycle*: according to most studies, economic downturns have a negative, although possibly lagged impact on productivity growth, due notably to the declining intensity of work and lags in lay-offs. This explanation does not seem to correspond to the current cycle. As showed above, productivity slowed down when economic growth was still positive, and it picked up in the United States just a few months after the crisis started in the course of 2007. Hence no visible pattern designates the business cycle as an explanation here.
- *Human capital*: education and skills are major factors of productivity growth in the long term. Human capital explains much of cross-country differences in productivity levels. However human capital is a quite slow moving variable, which would not trigger rapid changes in the pace of productivity, like those which occurred in recent years.
- *Innovation*: the impact of innovation on productivity is demonstrated by many studies both theoretical and empirical, at the enterprise, sectoral or national level. New products and new processes allow increases in the quality and variety of products and in the efficiency of productive activities, all components of productivity growth. Many quantitative studies have related productivity to indicators of innovation, usually expenditure in research and development (R&D), which is the most widely available indicator of innovation at international level. There is a convergence of the literature towards a highly positive impact: for instance Guellec and van Pottelsberghe (2004) find that an increase in business R&D expenditure by 1% can increase MFP by 0.1 to 0.2% at the national level. Thus, innovation is a candidate for explaining the slowdown in productivity growth of the early century. For this link to be valid there should be a slowdown or a decline in indicators of innovation at a similar time (the literature sees a rather short lag, of one to two years for the bulk of the impact of innovation on productivity). Accordingly, three indicators of innovation are examined below: business funded R&D, patent applications and trademark registrations. None of these indicators is perfect, notably the fact that none of them actually reflects the whole scope of innovation. However, they appear to be extremely complementary to each other, each reflecting one stage of the innovation process. Hence, taken together, they offer a quite reliable measure of innovation, and if they point into the same direction their common message should be rather robust.

#### 4.1. Business funded R&D

R&D (research and development) expenditure is an investment which results in new knowledge, new products or processes (see the *Frascati Manual*, OECD 2002). R&D can be funded by government or by business. Government funded R&D aims mainly at producing new fundamental knowledge or satisfying social needs like health or defence. Hence it is not expected to impact productivity as currently measured. Business funded R&D results in new processes and new products, and is expected to increase productivity when it is successful. Normally business funded R&D is pro-cyclical, as it is subject to financing constraints (available cash puts a limit on R&D expenditures as financial markets are reluctant to fund an investment with high risk and little collateral).

As shown in Figure 12, businesses increased significantly their R&D expenditure in the late 1990s, notably in the United States (an average growth rate of about 9% a year in 1995-2000) but also, to a lesser extent, in the EU. After a trough in 2001-02, particularly deep in the United States, business funded R&D recovered progressively in 2003 on, but it did not then achieve growth rates as high as in the late 1990s in the United States and in the EU (around 3% a year only). As the cost of capital was not significantly higher in the latter period than in the former, this slowdown could be explained by a decline in technological opportunities as perceived by businesses.

Figure 12. **Business funded R&D by country/zone**



Source: OECD, Research & Development Statistics (RDS) Database, October 2009.

#### 4.2. Patents

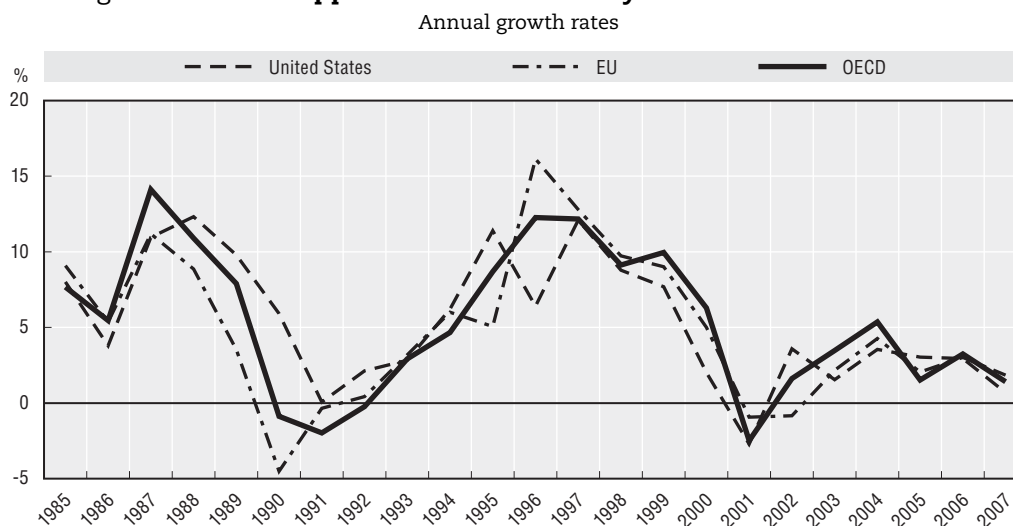
Patents are legal titles which provide their holder an exclusive right for exploiting (implementing, selling) an invention. Patent counts are used as an indicator of the pace of invention (*Patent statistics Manual*, OECD 2009): although these indicators have drawbacks and must be interpreted with care, they also carry unique information, and in the past, accelerations in patent filings have usually been associated with accelerations in inventions (the highest growth of patent numbers ever occurred in the 1880s, when electrical technology and modern chemistry were invented—the “second industrial revolution”). Patents are applied to and granted by national or regional offices, like the

European Patent Office (EPO), to applicants coming from any country and seeking protection on the concerned market for their invention. Figure 13 reports patent applications to the EPO, classified by “priority year” (the year of first filing world-wide, which is the closest to the actual invention date).

Patent applications accelerated sharply in the mid to late 1990s all over OECD countries (Figure 13). After a significant drop in the crisis of the early 2000s, patent applications recovered after 2002. However, the growth rate then was on average 3% a year in OECD, against almost 10% in the late 1990s.

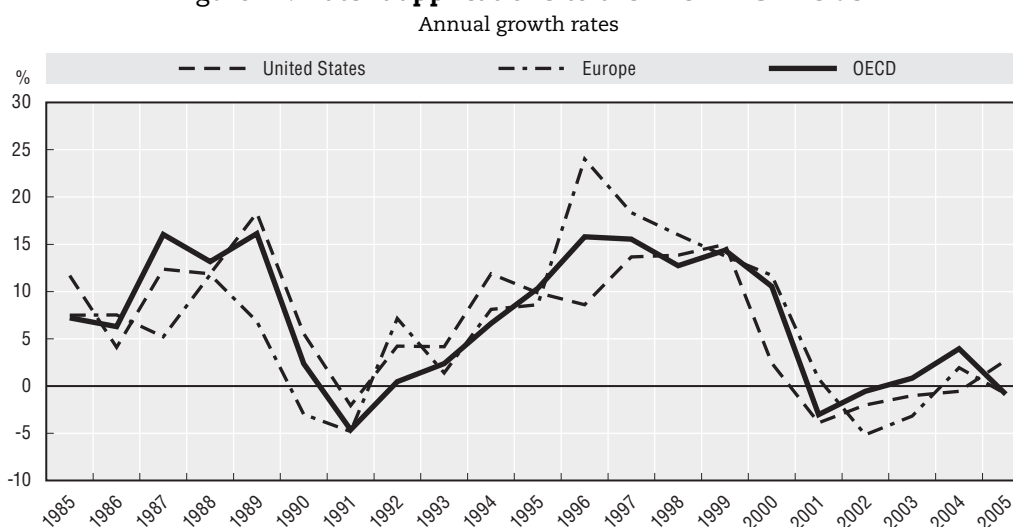
When looking at the technology field composition, it turns out that ICT played a key role in this dynamic (see Figure 14). In the mid to late 1990s, whereas ICT patent applications were about one-third of all applications, they contributed to more than half to aggregate growth. ICT patent applications increased by around 15% a year in the second half of the 1990s, and they were down to about 0 to 5% in the 2000s.

Figure 13. **Patent applications at the EPO by location of the inventors**



Source: OECD, PATSTAT Database, October 2009.

Figure 14. **Patent applications to the EPO in ICT fields**

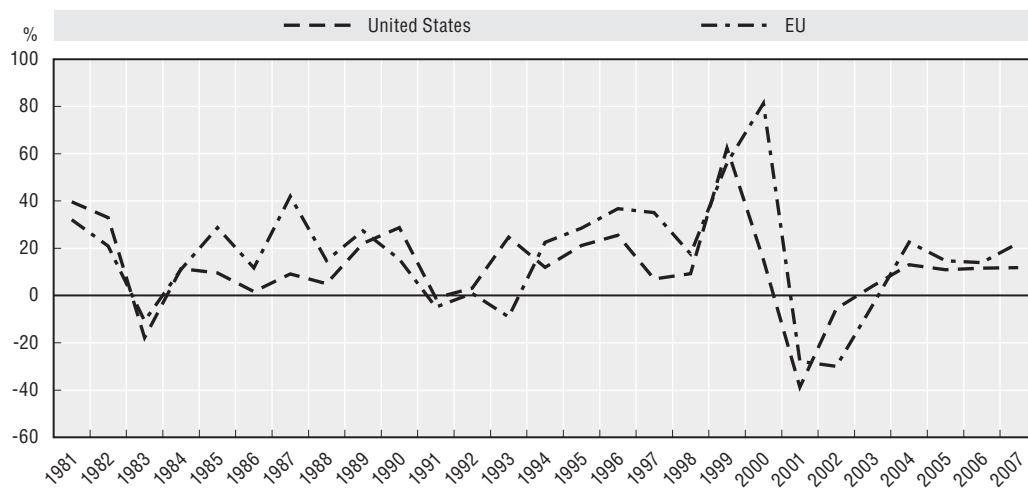


### 4.3. Trademarks

Trademarks are legal protection for distinctive signs of products, such as names or logos. Trademark activity reflects the introduction of new goods or services on the market, or changes in marketing strategies for existing products. It is therefore related to innovation, including non technological innovation. More than R&D, which is an investment, and patents, which reflect inventions, trademarks are really a downstream indicator, reflecting commercialised products. Trademarks are filed at the country level, to the national office in charge, by applicants from any country. Trademarks are filed at the USPTO for new products and marketing targeting the US market.

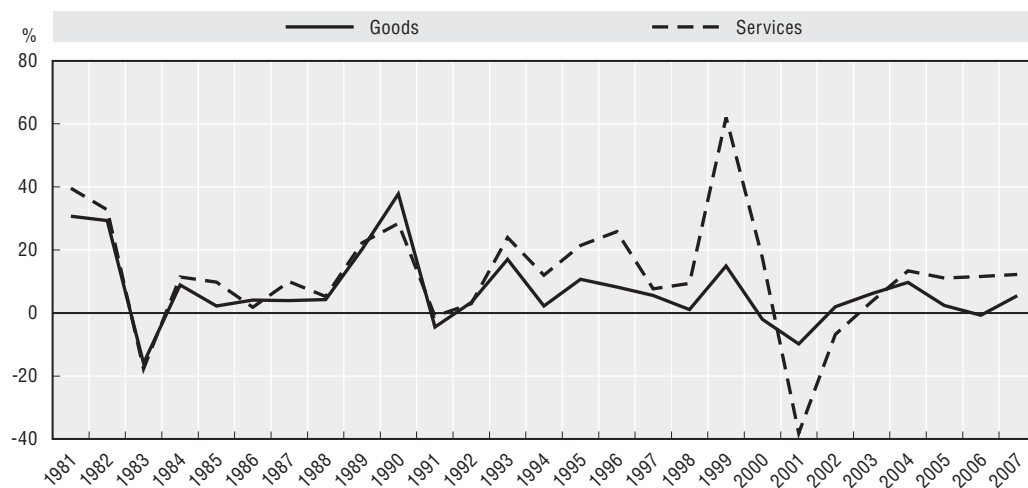
Trademark filings are pro-cyclical (Figure 15) as they are driven notably by the size of the market. Filings to the USPTO surged in the period 1995-2000, growing on average by 18.0% a year for EU holders and 12.8% for US holders. The growth was led by service related

Figure 15. **Trademarks filed to the USPTO by US and European companies**  
Annual growth rates



Source: USPTO, Trademarks Database, 2008.

Figure 16. **Trademarks filed to the USPTO by OECD entities**  
Annual growth rates



Source: USPTO, Trademarks Database, 2008.

marks, and it culminated in 1999 and 2000, in connection with the internet bubble: many internet related marks were filed during these years, reflecting both actual new services and also the anticipation of possible future services for which companies and individuals were acquiring pre-emptive rights.

Contrary to services, trademarks for goods did grow in the late 1990s in line with their long-term trend. The drop in total trademarks in 2001-02 was sharp, and it was stronger for services than for goods. The recovery that followed has been significant, but the pace in 2003-07 was much lower than in the late 1990s: 6.9% for US holders and 9.5% for EU holders per year on average. The difference between the two periods is higher for services than for goods, although services continue to outpace goods after 2004.

On the basis of these indicators, it makes sense to conclude that the pace of innovation has been slower since the crisis of the early 2000s than it was in the late 1990s. The latter experienced the “IT wave”, or “internet wave”, with a surge in innovation relating to (and driven by) information technology and the internet. This translated into an acceleration of R&D, patent and trademark filings altogether. All indicators of innovation dropped during the internet bubble burst (Table 2), and when they recovered, after 2003, they did not regain their trajectory of the late 1990s, but instead their average growth of the previous period, before the internet wave acceleration. The lead role of IT in this dynamic is shown by the fact that trademarks relating to services and IT-related patents explain the acceleration and subsequent slowdown.

**Table 2. Comparison of 1995-2000 and 2003-07**

Average annual growth rates

|       | Business funded R&D |         | EPO Patent applications |         | USPTO Trademarks |         |
|-------|---------------------|---------|-------------------------|---------|------------------|---------|
|       | 1995-2000           | 2003-07 | 1995-2000               | 2003-07 | 1995-2000        | 2003-07 |
| EU    | 4.7                 | 2.8     | 9.6                     | 2.7     | 18.0             | 9.5     |
| US    | 9.2                 | 3.4     | 8.1                     | 2.4     | 12.8             | 6.9     |
| Japan | 3.7                 | 4.9     | 12.0                    | 2.1     | 13.7             | 2.1     |
| OECD  | 6.6                 | 4.1     | 9.7                     | 3.0     | 13.0             | 7.0     |

This slowdown in IT innovation would explain why businesses reduced investment in IT equipment and software after 2003 (hence the drop in the contribution of IT capital to GDP growth): the efficiency gains to be expected from new capital relative to already installed ones were smaller than before as the rate of improvement had weakened. In turn, the slowdown in MFP occurred later, after the slowdown in investment, in 2005-06. One explanation for this, in accordance with the economic literature on technical change, would be that the learning effects that come with new technology and allow users to make the best of them in terms of productivity progressively declined, as the installation of new equipment itself declined. It took a few years for that to happen, as there is normally a lag between implementation and learning (usually attributed to the time needed to train workers, adapt the organisation, acquire complementary assets etc.).

## 5. Concluding remarks

This paper reviewed the main productivity trends over the past decade, comparing the United States, European countries and to some extent Japan. The slowdown in productivity appeared to be due to a significant deceleration in ICT investment followed by a decrease

in multi-factor productivity. The decline of productivity was particularly marked in some sectors, such as construction, and market services. Looking for possible explanations of the decline, a marked slowdown in innovation emerged as the most likely candidate.

Taking a forward-looking view, what are the prospects for a productivity recovery, following the current downturn? If no new wave of innovation materialises, comparable in size to the one of the late 1990s, it is unlikely that trend productivity growth could resume at its end-1990s level. Instead, the type of regime of the mid-1970s to mid-1990s could prevail again. The acceleration in US productivity observed after 2008 is due to a massive reduction in the labour force and, therefore, does not seem sustainable. Only a recovery in innovation itself could trigger a sustainable recovery in productivity.

## Notes

1. See [www.oecd.org/std/productivity](http://www.oecd.org/std/productivity).
2. The net capital stocks and MFP growth estimates have been developed in the framework of the OECD STAN Database for Industry Analysis (STAN). They should be released in late 2010 or early 2011 and aim to complement the productivity indicators already available for the whole economy level in the OECD Productivity Database which remains the OECD reference for productivity measurement. See the annex for more details on the method used for PDBi.
3. The measure of total hours worked is an incomplete measure of labour input because it does not account for changes in the skill composition of workers over time, such as educational attainment and work experience. Adjustment for such attributes would provide a more accurate indication of the contribution of labour to production. In the absence of these adjustments, as is the case in the series shown here, more rapid output growth due to a rise in skills of the labour force are captured by the MFP residual, and not attributed to labour. This should be kept in mind when interpreting rates of MFP growth.

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## ANNEX

*The Measurement of MFP by Industry*

Estimates of Multi-Factor Productivity (MFP) growth at the industry level have been computed in the framework of the *OECD Productivity Database* by industry (hereafter, PDBi). The method used for PDBi is, as far as possible, consistent with the one used for the aggregate level released in the *OECD Productivity Database* (hereafter PDB). The MFP measures are developed in the framework of the *OECD STAN Database for Industry Analysis* (STAN). The guiding principles in the construction of PDBi indicators are to consider industry aggregates as single units in the calculation process, to exclude real estate activities, and to represent capital by a single type of asset. According to the methodology described in OECD manuals and applied at the total economy level in the *OECD Productivity Database*, a satisfactory measure of capital input is provided by the productive stock which is designed to capture the productive capacity of capital goods, and by implication the flow of capital services. However, the accuracy of capital services increasing with a rising degree of asset detail, this measure requires investment time-series by type of asset. Therefore, industry-level measures of capital services would, in principle, require data on investment by industry and by type of asset (especially a breakdown of ICT equipment into computer hardware and telecommunications equipment as well as software). This information not being currently available in the STAN database, a simplified measure based on harmonised net capital stocks by industry (and excluding as far as possible the residential sector) has been implemented. This simplified measure allows to approximate growth in total factor productivity according to the Solow definition.

Under the assumptions of perfect competition and constant returns to scale, growth in total factor productivity can be defined as the Solow residual, and then written as following:

$$\Delta \ln(\text{MFP}) = \Delta \ln(q) - \alpha \cdot \Delta \ln(l) - (1 - \alpha) \cdot \Delta \ln(k) \quad (2)$$

Where  $\alpha$  is the revenue share of labour ( $wL/PQ$ ),  $q$  the volume value-added,  $l$  the labour input, and  $k$  the capital input computed as described below. For each industry, labour input is represented by the total hours worked of all persons engaged from STAN. When total hours worked are missing, the total hours worked of employees or the hours worked at the level of the total economy is split into the STAN industry breakdown using the structure of employment.<sup>1</sup>

Estimation of industry-level multi-factor productivity requires the measurement of the labour input, the capital input and the growth rate in production. The capital input of a specific industry is represented by a single type of asset and computed applying geometric depreciation rates to the Perpetual Inventory Method (PIM), which estimates the

constant prices values of capital stocks still in use by summing the original investment data for this asset over its lifetime. A standard approach with geometric rates of depreciation  $\delta$  is applied to obtain harmonised net capital stocks by industry. Then, the capital stock at the beginning of period  $t$ ,  $K^t$ , is as follows:<sup>2</sup>

$$K^{t+1} = K^t + [I^{t+1} - \delta \cdot (I^t / 2 + K^t)] \quad (3)$$

then

$$K^{t+1} = K^t (1 - \delta) + I^t (1 - \delta/2) \quad (4)$$

It is important to note that  $K^t$  is a measure of the capital stock and not of the capital services. This reflects absence of investment data cross-classified by asset and industry. Thus, unlike the PDB data, PDBi capital input is not a measure of capital services.

The initial net capital stocks  $K^0$  is approximated for the year 1984 by the cumulative depreciated investment of previous years, using the long-run growth rate of investment volume:<sup>3</sup>

$$K^0 = \frac{GFCK_{1984}}{(\delta_{1984} + (\frac{GFCK_{1983}}{GFCK_{1960}})^{(1/(1983-1960))} - 1)} \quad (5)$$

Depreciation rates by industry and by asset ( $\delta_{i,k}$ ) are collected from the EUKLEMS database and adjusted establishing the equality between their average weighted by the ratio between investment in a particular industry and investment for the total industries (from STAN), and the asset specific depreciation rates ( $\delta_k^{PDB}$ ) at the level of the total economy from PDB, to take into account some country-specific conditions:

$$\sum_i \left( \frac{GFCF_i}{GFCF_{Tot}} \right) \delta_{i,k} = \delta_k^{PDB} \quad (6)$$

Then, country-specific depreciation rates by industry ( $\delta_i$ ) are calculated as the weighted average of asset-specific depreciation rates ( $\delta_{i,k}$ ) and using shares of net capital stocks of asset  $k$  ( $K_k^t$ ) in the aggregate net capital stocks ( $K_{Tot}^t$ ) at the level of the total economy from PDB<sup>4</sup> as weights:

$$\delta_i = \sum_k \left( \frac{K_k^t}{K_{Tot}^t} \right) \delta_{i,k}^t \quad (7)$$

The consistency with PDB is also ensured by the use of an exogenous rate of return.<sup>5</sup> This way, an independent estimate for the remuneration of capital input is generated. The user cost of capital is:

$$R_i = P_i \cdot \left( \left( i - \frac{\Delta CPI^e}{CPI} \right) + \delta_i - \left( \frac{\Delta P_i^e}{P_i} - \frac{\Delta CPI^e}{CPI} \right) \right) \quad (8)$$

where  $i$  is the representative long-run nominal interest rate, and  $\delta_i$  the depreciation rate of the representative asset in the industry  $i$  computed as above. Assuming that expectations about investment prices  $P_i$  follow approximately expectations about CPI, the user cost of capital is equal to the anticipated real interest rate plus the anticipated depreciation times the beginning of the period stock price of the representative asset in the industry  $i$ :

$$R_i = P_i \cdot (RIR + \delta_i) \quad (9)$$

where the real interest rate  $RIR = (1+r^*) \cdot (1-p_t) - 1$

The expected real rate of return  $r^*$  is assumed to be constant but country specific for the whole period. The constant real rate of return is computed by taking the long-run average of annual real rates of return. These are measured as observed nominal rates

(un-weighted average of interest rate with different maturities) deflated by the consumer price index (CPI),  $p_t$  representing the expected overall inflation rate.

Then  $R$  represents the user cost per unit of capital stock at constant dollars for an industry as:

$$R_i \equiv P_i \cdot [((1+r)/(1+p)) - 1 + \delta_i] \quad (10)$$

The labour share of a specific industry is computed taking into account the mixed income effect:

$$\alpha_i = \frac{(WL_i \cdot (\frac{EMPN_i}{EMPE_i}))}{(WL_i \cdot (\frac{EMPN_i}{EMPE_i}) + RK_i)} \quad (11)$$

with  $WL$  the compensation of employees,  $EMPN$  the total employment,  $EMPE$  the number of employees, and  $RK$  computed as described above. MFP is estimated according to equation (2). As already mentioned, the main drawback of the simplified approach outlined above is that it neglects capital services and is therefore not the recommended measure for capital input and productivity calculations.<sup>6</sup>

## Notes

1. Full-time equivalent, full-time equivalent employees, total employment or employees (priority order) have been used as proxies.
2. See *Measuring Capital: OECD Manual, second edition* (OECD, 2009a) for more detailed information.
3. GFCK refers to volume of gross fixed capital formation time-series available in STAN that are backward extrapolated to 1960 using volume investment time-series from *OECD Annual National Accounts Database*. GFCF refers to gross fixed capital formation at current prices from the *STAN Database*. More information on STAN variables is available at the following address: [www.oecd.org/sti/stan/](http://www.oecd.org/sti/stan/).
4. When  $K^t$  is not available from PDB, estimates for the United States are used as a benchmark.
5. See Schreyer, Dupont and Bignon (2003) for a description of the method and the *Measuring Capital: OECD Manual* (OECD 2009a, pp. 85-87) for an overall discussion on this issue.
6. Net capital stock and capital services could differ unless the unrealistic case applies where the prices of all types of assets move at the same rate and each type of asset depreciates at the same rate.



# Current Account Imbalances: Can Structural Reforms Help to Reduce Them?

by

Clovis Kerdrain, Isabell Koske and Isabelle Wanner\*

*This article explores the impact of structural policies on saving, investment, and current accounts in OECD and non-OECD economies. Since the current account effects of structural reforms are often complex and ambiguous from a theoretical perspective, new OECD empirical analysis is carried out. Reduced-form equations are estimated for a panel of 30 OECD countries as well as for a panel/cross-section of 117 OECD and non-OECD countries that relate saving, investment and current accounts to policy indicators and a set of macroeconomic control variables. This work suggests that structural reforms may influence saving, investment and current accounts through their impact on macroeconomic conditions such as productivity growth or public revenues and expenditures, but also more directly: i) higher social spending (in particular on health care) is found to lower the saving rate and thereby to weaken the current account, most likely reflecting lower precautionary saving; ii) product market liberalisation temporarily boosts investment and thus also weakens the current account; iii) financial market deregulation may lower the saving rate, though only in less developed countries; iv) stricter employment protection may be associated with lower saving rates if unemployment benefits are low, as well as with higher investment rates possibly due to greater substitution of capital for labour. A scenario analysis indicates that fiscal consolidation and structural reforms in the main world economies could significantly reduce current global imbalances, possibly by about one-third.*

*JEL Classification:* E21, E22, F41, H55, K31, K20, G18, H23

*Keywords:* Saving; investment; current account; social welfare system; labour market regulation; product market regulation; financial market regulation; taxation

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Global saving and investment imbalances had widened markedly in the years prior to the crisis, involving both OECD countries and non-OECD countries. Though the crisis brought some reversal of this trend with current account imbalances narrowing from around mid-2007 to mid-2009, the recent upswing was accompanied by a renewed widening of global imbalances. Under unchanged policies the decline in national saving-investment gaps is thus likely to have been at least partially a temporary phenomenon, and the issue of imbalances is set to return in the medium to long run.

Current accounts result from global general equilibrium conditions that are driven by multiple factors, including domestic structural policy settings in financial, product and labour markets as well as tax and social welfare systems.<sup>1</sup> While the primary goal of structural reforms is not to address global saving-investment imbalances, they can have more or less persistent side effects on the saving and investment decisions of households and firms as well as on public saving and investment. Against this background, this paper investigates the relationship between structural policies and saving, investment, and current account balances, focusing on five different policy areas: social welfare systems, labour market policy, product market regulation, financial market regulation, and tax policy. With this focus in mind, the paper does not explore the drivers of global current account imbalances in general, nor does it assess the extent to which they represent disequilibria.

The discussion in this paper is positive in the sense that it assesses the likely impact of structural policies on the saving and investment behaviour of private agents, and thereby on current accounts, without addressing the desirability of policy changes. To the extent that national saving-investment gaps are the result of utility-maximising behaviour in the absence of any distortions – for example, they could reflect a desire by households to smooth consumption over time – the rationale for policy intervention might only be found by assessing whether these gaps cause any global or systemic risk, which is not within the scope of this paper. But it may also be the case that the gaps reflect underlying domestic distortions, which can be narrowed by domestic policy interventions. Even so, the goal of such interventions should be to maximise overall welfare, not to reduce saving-investment gaps *per se*. In fact, removing distortions to increase welfare may narrow or widen national saving-investment gaps, depending on the type of the distortion.

The present study investigates the link between domestic structural policies and the GDP shares of saving, investment and the current account both from a theoretical and an empirical perspective. In the empirical part, a set of reduced-form equations are estimated for a panel of 30 OECD countries as well as for a panel/cross-section of 117 OECD and non-OECD countries that relate the GDP shares of, respectively, saving, investment and the current account balance to policy indicators and a set of control variables. The following main conclusions emerge from the analysis:

- Theoretically, structural policies can influence the saving and investment decisions of firms and households through a variety of different channels. To the extent that households attempt to smooth consumption over time, any reform that affects

temporarily the growth of income or the real rate of interest should temporarily influence the saving rate of households. Moreover, policies may affect the precautionary saving behaviour of households by altering the level of uncertainty they are facing and/or their insurance against adverse events (though the saving rate should change only temporarily as a result, until the new optimal precautionary wealth stock is reached). The investment rate, in turn, should be influenced by all policies that affect the cost of capital and/or the return on investment projects. Due to the wide range of different channels and the complex interactions between them, the sign and the size of the link between structural policies and saving and investment remains largely an empirical question.

- The empirical analysis suggests that structural policy reforms may influence saving and investment by altering macroeconomic conditions. In particular, policies that foster productivity growth are found to lead to a boost in saving and investment ratios in the medium to long run. The relative size of the estimated coefficients on productivity growth hints at a negative net impact of productivity-enhancing reforms on the current account position through this channel. Similarly, policy reforms that involve changes in public revenues and expenditures and are fiscally non-neutral will alter a country's total saving rate and thereby its current account, reflecting evidence that Ricardian equivalence holds only partially.
- There is some evidence that structural policies have an influence on saving and investment on top of any impact that works through changes in these macroeconomic conditions. *First*, there is evidence that higher social spending (in particular on health care) is associated with a lower saving rate and a weaker current account, most likely reflecting lower precautionary saving of households. *Second*, there are some indications that removing competition-unfriendly product market regulation boosts investment, though this effect is likely to be only temporary. *Third*, financial market deregulation tends to lower the saving rate in less developed countries. *Fourth*, stricter employment protection legislation (EPL) may be associated with lower saving rates, but only in countries where unemployment benefits are low. Stricter EPL also appears to raise the investment rate, at least in OECD countries, possibly linked to greater substitution of capital for labour. *Fifth*, while no robust effects of tax reforms on investment rates could be discerned here using aggregate macroeconomic data, existing firm and sector-level evidence suggests that a lower tax burden on firms boosts business investment and thereby weakens the current account.
- The empirical analysis also gives some insight into which potential links between structural policies and saving and investment rates might be less relevant in practice. In particular, while deregulated financial markets could in theory strengthen the current account effects of other reforms by facilitating consumption smoothing, the empirical analysis does not provide any evidence that financial market reforms alter the impact of other policy reforms on the saving and investment behaviour of private agents. Also, there is no evidence that structural policies influence the speed at which firms and households adjust their saving and investment behaviour in response to changes in macroeconomic conditions.

The analysis suggests that a number of structural reforms that are desirable on efficiency and/or welfare and equity grounds would be associated with a reduction of global imbalances by narrowing the gaps between domestic saving and investment in several major economic areas. In particular:

- Developing social welfare systems in China and other Asian economies would fulfil an important social goal in its own right, and as a side-effect would reduce the need for

precautionary saving. This would moderate current account imbalances in those countries that are running surpluses. The empirical estimates suggest, for example, that all else being equal a financed increase in public social spending on health in China by 1 percentage point of GDP might reduce total saving by as much as 2½ percentage points of GDP (though the standard deviation around this point estimate is 0.9).

- Reforms to improve the sustainability of pension systems will reduce current account surpluses (or raise deficits) if they increase the length of the working life and have the opposite effect if they take the form of cuts in replacement rates.
- Removing competition-unfriendly product market regulation could encourage higher capital spending. The empirical analysis suggests, for example, that aligning the level of economy-wide product market regulation in Japan and Germany with OECD best practice could raise private investment in these countries by respectively 0.6 and 0.7 percentage points of GDP in the short run.
- Financial market reforms that raise the sophistication and/or depth of financial markets may relax borrowing constraints in emerging economies and thus help to reduce the high saving rates observed in some of them. For example, if China implemented reforms that led to a liberalisation of its financial system similar in magnitude to that achieved over 1995-2005, the total saving rate could drop by over 3 percentage points of GDP.
- The removal of policy distortions that encourage consumption, such as tax deduction of interest payments on mortgages in the absence of taxation of imputed rent, might help increase household saving in a number of countries, including the United States.
- While structural reforms can contribute to reducing current account imbalances in countries that are running surpluses, their potential to reduce imbalances in deficit countries is found to be more limited. In the latter group of countries, other policy actions that are desirable *per se*, such as fiscal consolidation, could help achieve a more balanced external position.
- A scenario analysis indicates that the necessary fiscal tightening required to stabilise debt-to-GDP ratios in OECD countries by 2025 could reduce the size of global imbalances – measured as the GDP-weighted sum of countries' absolute saving-investment-gap-to-GDP ratios – by almost one-sixth. If, in addition, Japan, Germany and China were to deregulate their product markets and China were to raise public health spending by 2 percentage points of GDP (in a fiscally neutral way) and liberalise its financial markets, global imbalances could decline by twice as much.
- While the fiscal tightening assumed in the scenario analysis would also contribute to a narrowing of intra-euro-area imbalances, the size of the effect would be more muted. A lowering of employment protection in Spain, Portugal and Greece would also only slightly reduce the overall size of intra-euro-area imbalances, but saving-investment gaps of these three countries would fall considerably.

The remainder of this document is structured as follows: Section 1 starts with a brief overview of recent aggregate saving, investment and current account developments, focusing on those countries and regions that have contributed most to global current account imbalances. Section 2 then outlines the main theoretical channels through which structural policies may influence private saving and investment behaviour. Section 3 discusses existing evidence on these channels and presents new empirical results regarding the impact of structural policy changes on saving, investment and

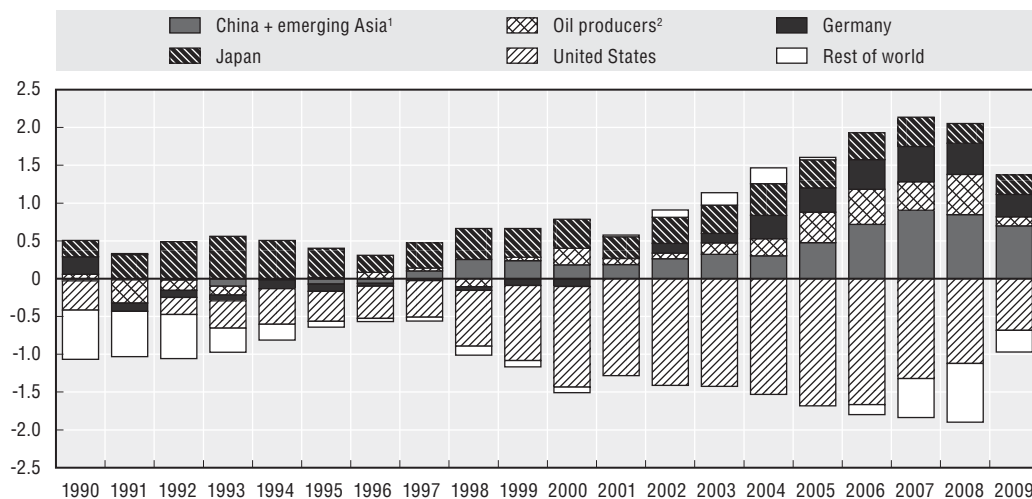
current accounts. These results are then used in Section 4 to simulate the impact of possible policy reform packages on global and intra-euro-area imbalances.

## 1. Recent current account developments and their explanations

Global current account imbalances had widened markedly in the years preceding the crisis with the United States the main contributor on the deficit side and several of the fast-growing Asian and oil-producing countries as well as Japan and Germany the main contributors on the surplus side (Figures 1 and 2). While the euro area's current account balance with the rest of the world was relatively small, a number of individual member countries recorded sizeable and growing deficits (in particular Greece, Portugal and Spain) or surpluses (next to Germany, mainly the Netherlands). Examining changes in saving and investment patterns highlights that rising saving rates in surplus countries and falling saving rates in deficit countries were the dominant driver behind the divergence in current account positions. In the United States, total saving dropped by around 3½ percentage points between the mid-1990s and 2007, while in China and oil-producing countries the total saving rate rose by about 15 percentage points of GDP over the same period. A few countries have also experienced sizable changes in investment rates. These include in particular Japan, where total investment has fallen by about 10 percentage points of GDP over the past two decades, and Spain, where it has risen by the same amount between the mid-1990s and 2007, before beginning to fall back sharply.

Figure 1. **Global imbalances 1990-2009**

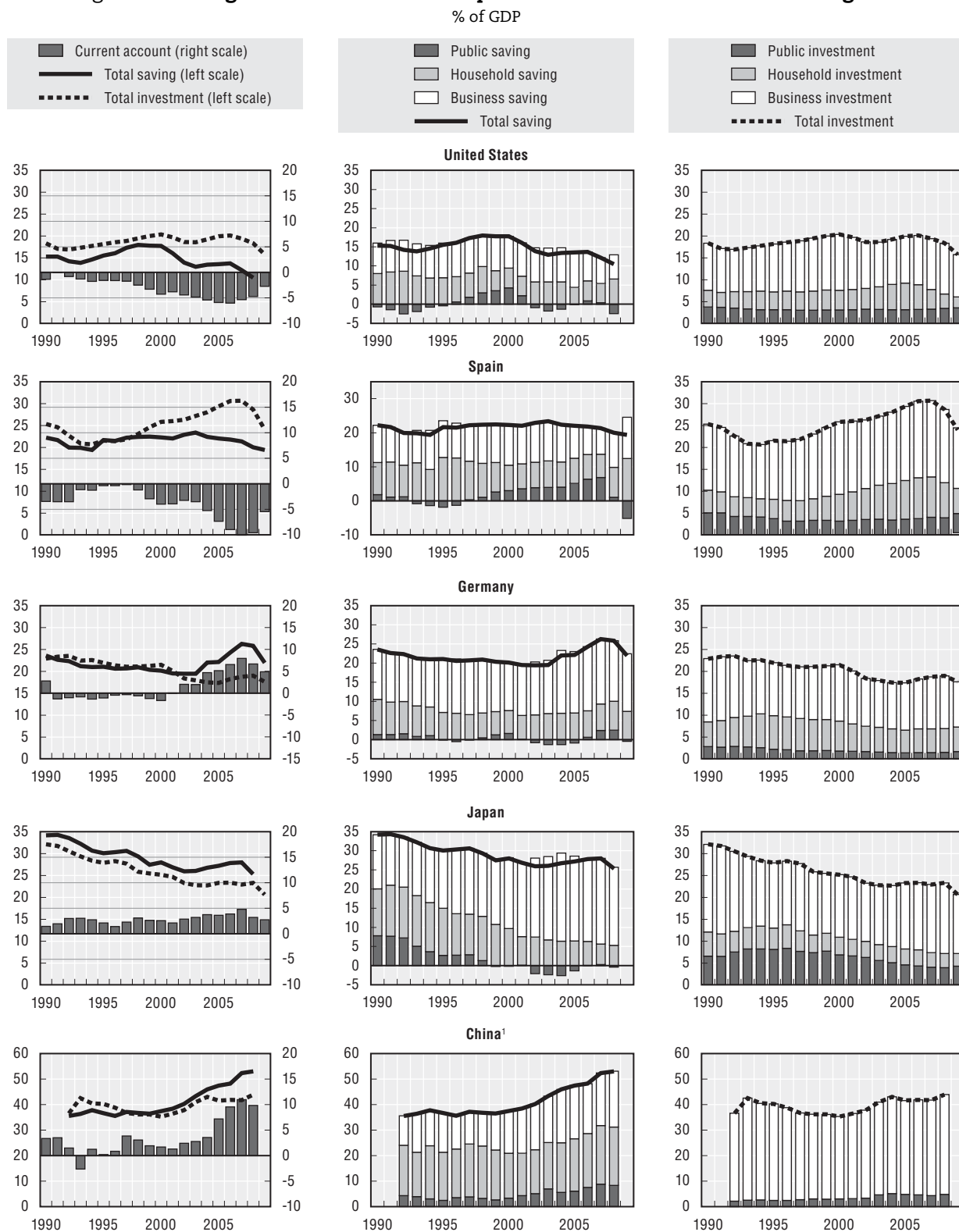
Current account balances, % of world GDP



1. Hong Kong (SAR China), Malaysia, Philippines, Singapore, Vietnam, Thailand, India, Indonesia.

2. Azerbaijan, Kazakhstan, Brunei Darussalam, Bahrain, Iran, Kuwait, Oman, Libya, Yemen, Ecuador, Trinidad and Tobago, Venezuela, Angola, Congo, Gabon, Sudan, Saudi Arabia.

These persistent saving-investment gaps are reflected in international capital flowing mainly from emerging markets in Asia and oil-producing countries towards advanced economies, in particular the United States. This direction of capital flows is surprising at first glance since higher expected (marginal) rates of return would imply that emerging markets should instead attract capital from advanced countries. A number of explanations have been put forward to explain the global widening of saving-investment imbalances as

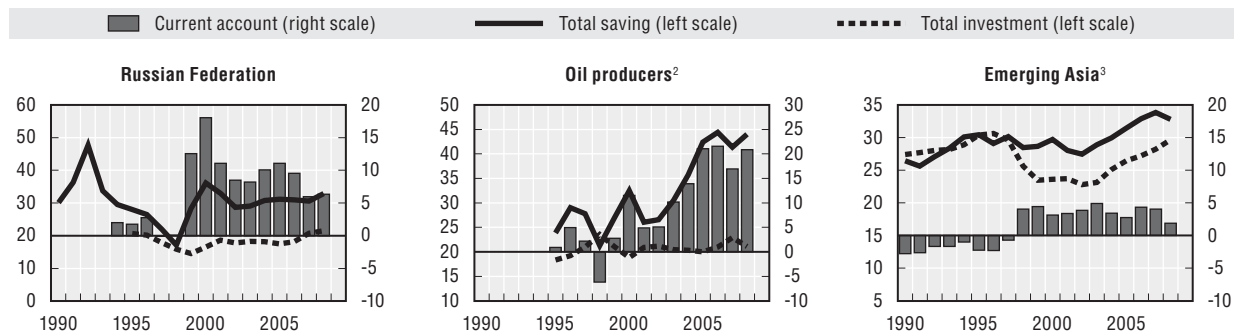
Figure 2. **Saving and investment developments in selected countries and regions**

1. Only private (white) and public (shaded) investment rates are shown.

2. Azerbaijan, Kazakhstan, Brunei Darussalam, Bahrain, Iran, Kuwait, Oman, Libya, Yemen, Ecuador, Trinidad and Tobago, Venezuela, Angola, Congo, Gabon, Sudan, Saudi Arabia.

3. Hong Kong (SAR China), Malaysia, Philippines, Singapore, Vietnam, Thailand, India, Indonesia.

Figure 2. **Saving and investment developments in selected countries and regions (cont.)**  
% of GDP



1. Only private (white) and public (shaded) investment rates are shown.
2. Azerbaijan, Kazakhstan, Brunei Darussalam, Bahrain, Iran, Kuwait, Oman, Libya, Yemen, Ecuador, Trinidad and Tobago, Venezuela, Angola, Congo, Gabon, Sudan, Saudi Arabia.
3. Hong Kong (SAR China), Malaysia, Philippines, Singapore, Vietnam, Thailand, India, Indonesia.

well as the implied direction of capital flows (see *e.g.* Bracke *et al.*, 2008, for an overview). Most of these explanations take a macroeconomic perspective and do not allow for a major role of structural policy settings – with the exception of financial market regulation. The main arguments put forward include the following:

- *The series of financial crises that struck some emerging and developing countries in the late 1990s and early 2000s:* In the aftermath of these crises, most emerging countries – including those that had escaped crisis like China – began to build up large foreign exchange reserves as an insurance device against the risk of balance-of-payments crises (Bernanke, 2005; Gruber and Kamin, 2007; Jeanne and Ranciere, 2008).
- *The surge in oil prices which boosted income in oil-exporting countries:* To the extent that oil-exporting countries attempt to smooth consumption over time, this rise in their income may explain the pick-up in total saving, in particular since these countries are extracting a finite resource.<sup>2</sup> Together with the lack of domestic investment opportunities, this surge in saving resulted in net capital outflows.
- *Insufficient financial market development in many fast-growing emerging countries:* Regional financial market imperfections, together with an increasing demand for a store of value, may have resulted in an insufficient supply of safe assets and triggered net capital flows to regions where safe assets were perceived to be produced, notably the United States (Caballero *et al.*, 2008; Caballero and Krishnamurthy, 2009). By creating borrowing constraints, the financial market imperfections may also have prevented households in emerging markets from borrowing against future income (Ju and Wei, 2006).
- *“Dark matter”:* Official statistics may overstate the US net foreign debt by not properly accounting for US intangible assets such as insurance services (safe investments) and knowledge services (organisational knowledge and brand recognition). The argument is based on the observation that US net interest income from abroad has remained positive, meaning that US foreign investments, properly measured at their income-generating capacity, must exceed US foreign investors’ claims on the United States (Hausmann and Sturzenegger, 2005).
- *Other factors that are likely to have played at least some role include:* i) the decline in business cycle volatility in many developed countries prior to the crisis, which might have been perceived as permanent by households thus inducing them to reduce their

precautionary savings (Fogli and Perri, 2006); ii) asset price booms, partly related to low interest rates against a background of low business cycle and inflation volatility,<sup>3</sup> which may have pushed down saving rates in several advanced countries such as the United States and the United Kingdom by raising perceived wealth and relaxing credit constraints; iii) population ageing that may have contributed to a decline in the saving rates of some advanced economies (Bernanke, 2005); iv) policies by several fast-growing Asian economies aimed at keeping exchange rates undervalued so as to promote exports; and v) the creation of the European Economic and Monetary Union and the introduction of the euro which may have contributed to intra-euro area imbalances by driving real interest rates down substantially in some of the periphery countries.

The economic crisis was accompanied by a substantial narrowing of global saving-investment gaps as well as by a change in their composition. As for saving, household saving rates in developed countries rose from their pre-crisis levels on account of tighter credit conditions, rising labour market uncertainty and efforts to make up for the sudden wealth losses. The increase in household saving was particularly large in several deficit countries such as the United States, the United Kingdom, and Spain. In most OECD countries, higher household saving was, however, more than offset by lower government saving, implying that changes in saving behaviour contributed to a narrowing of imbalances foremost in surplus countries. The latter also applies to oil-exporting countries, where the high saving rates dropped on account of collapsing oil prices, thus reducing current account surpluses. As for investment, total investment rates fell substantially in the majority of countries, driven by falling business investment and, at least in those countries that had experienced house price and construction booms in the run-up to the crisis, falling residential investment. By contrast, the total investment rate rose noticeably in China, owing largely to the sizeable policy stimulus, thereby reducing the current account surplus. As argued by OECD (2010a), the narrowing of global saving-investment gaps is unlikely to be permanent; as the recovery unfolds and output gaps close, saving-investment gaps are widening again.

## 2. Structural policy reforms and current accounts: some theoretical links

Any reform that influences aggregate saving or investment will likely also alter a country's current account position. This section discusses the broad channels through which structural policies could influence the saving and investment behaviour of firms and households (more specific discussion of each individual reform area is provided in Section 3 when presenting the results of the empirical analysis). Current account constellations are the outcome of a global general equilibrium and thus do not only depend on domestic economic conditions but also on the conditions abroad. For simplicity, the discussion below assumes that no reforms take place in the rest of the world or at least that any such reforms are smaller in the magnitude of their effects than those in the domestic economy. Moreover, the focus mainly is on structural policies that affect domestic settings rather than on policies that directly affect capital flows (e.g. corporate tax reforms, removal of restrictions on trade and foreign direct investment). Partly for this reason, the discussion abstracts from the fact that any change in the domestic saving-investment gap must be accompanied by a corresponding change in net capital inflows/outflows and thus a change in the saving-investment gap in the rest of the world.<sup>4</sup> The discussion below also abstracts from adjustment mechanisms that ensure that changes in

the saving-investment balance are matched by corresponding changes in the current account balance, not least real exchange rate adjustments.<sup>5</sup>

## 2.1. Theoretical linkages between structural reforms and saving

Structural policy reforms may influence the saving behaviour of private agents through a variety of channels. In particular, to the extent that households attempt to smooth consumption over time, structural policies may influence private saving rates by changing income patterns over the lifecycle, the uncertainty of these income streams, or the real rate of interest. In turn, reforms may change income patterns by affecting either productivity growth (*e.g.* product market reforms) or the age-income profile (*e.g.* pension reforms):

- *The productivity growth channel:* Structural reforms that raise productivity may affect the overall private saving rate through both a composition effect and changes in the saving rates of individual households. The *composition effect* emerges because the income gain from higher productivity is likely to benefit workers more than retirees and the former tend to have a higher propensity to save (Modigliani, 1966).<sup>6</sup> *Individual saving rates may also change* as households smooth consumption over time (Friedman, 1957). The direction and size of the impact will depend on whether the change in permanent income reflects an increase in current or future income and on whether income changes temporarily or permanently (see Box 1 and Fournier and Koske, 2010, for a more thorough discussion).<sup>7</sup> Structural reforms such as product or labour market deregulation or reforms that increase financial market efficiency are usually thought to be associated with a temporary rise in the growth rate of income and thus a permanent shift in its future level, which sets in some time after the reform is implemented. This should lead to a temporary fall in the household saving rate, which, if large enough, may dominate the composition effect and the aggregate saving rate may actually decline in the aftermath of a reform before rising again once the income effects of the reform set in.
- *The age-income profile channel:* Structural reforms can also affect individual households' saving rates by altering the lifecycle pattern of income streams. For example, a pension reform that unexpectedly reduces the benefit replacement rate should increase the saving rates of the working-age population as households attempt to accumulate more wealth in order to offset the effect of lower future pensions on consumption in retirement.<sup>8</sup> By contrast, unexpected increases in the statutory retirement age should reduce the saving rates of workers as they have more years to accumulate wealth and fewer years during which to spend this wealth.<sup>9</sup> At an aggregate level the saving impact of pension reforms would be expected to show up only temporarily, as in the long run, the amount saved during the working period should broadly match the amount spent during retirement, in line with unchanged individual preferences.<sup>10</sup>
- *The uncertainty channel:* Households hold a certain amount of precautionary wealth as a cushion against unexpected adverse events such as unemployment, sickness or disability. This amount of precautionary wealth, and with it the level of precautionary saving, depends on the risk aversion of the household, the probability of adverse events and their expected severity. While policy is unlikely to affect the risk aversion of households, it may well affect the other two factors. For example, a lowering of employment protection has an ambiguous effect on the saving rate, since the higher likelihood of dismissal should increase precautionary saving, while the higher labour turnover should lower it by reducing the expected length of unemployment spells.

### Box 1. The theoretical impact of productivity shocks on saving and the current account\*

Structural reforms such as product or financial market deregulation typically lead to a gradual, but ultimately permanent, rise in the level of productivity. The size and even the sign of the associated impact on the saving behaviour of private agents, and thereby on a country's current account position, are theoretically ambiguous and depend on many factors. These include, in particular, consumers' preferences for consumption smoothing, their beliefs in whether the rise in the level of productivity is permanent or temporary, and the productivity effects of the reforms in tradable *versus* non-tradable sectors. To illustrate these channels, Fournier and Koske (2010) simulate a number of productivity shocks in a simple two-country DSGE model that distinguishes between tradable and non-tradable goods. For simplicity, the model features flexible prices and abstracts from capital accumulation, thereby focusing solely on the links between productivity and saving. Consumers live infinitely and have perfect foresight, so that they anticipate the consequences of a shock and adjust their consumption and labour supply accordingly. Also, the issue of precautionary saving behaviour is not dealt with in the model. The following main conclusions emerge from the analysis:

- The immediate current account impact of a gradual and ultimately permanent rise – and correctly interpreted as such by households – in overall productivity hinges crucially on whether consumers are more concerned about inter-temporal consumption smoothing (i.e. keeping overall consumption stable over time) or intra-temporal consumption smoothing (i.e. keeping the composition of the consumption basket stable). If households have a high propensity to smooth consumption over time, a reform that boosts aggregate productivity will be associated with a weakening of the current account position in the short run as consumers try to benefit from the future rise in income to consume more already today. This temporary deterioration in the current account is then gradually reversed as productivity rises towards its new level. By contrast, the current account may strengthen in the immediate aftermath of a reform if consumers have a low propensity for inter-temporal consumption smoothing, because households postpone their consumption increase to benefit from lower prices in the future as productivity rises (all else being equal, the fall in prices leads to a higher real rate of interest; see also Dornbusch, 1983).
- Reforms that boost productivity solely in the tradable goods sector unambiguously lead to a weakening of the current account in the short run, which is gradually reversed once the productivity increase sets in. The short-run current account reaction is driven by two factors: *First*, consumers try to benefit from the future rise in income by consuming more already today and *second*, they frontload consumption since the relative price of non-tradable goods is seen as rising over time. Since both effects work in the same direction the magnitude of the current account reaction is larger than in the case of an economy wide shock (where the second effect partially offsets the first or even outweighs it if consumers have a low propensity to smooth consumption over time). For structural reforms that boost productivity only in the non-tradable goods sector, the direction of the short-run current account reaction is ambiguous and depends on consumers' preferences for intra-temporal *vs.* inter-temporal consumption smoothing, similarly to the consequences of an economy-wide shock.
- If a reform boosts the level of productivity only temporarily – or if economic agents perceive the impact of the reform as such – and consumers have a strong preference for consumption smoothing, the current account temporarily strengthens as households save part of the higher income for the future: they foresee a decrease of income and save accordingly.

\* This box is based on Fournier and Koske (2010), "A Simple Model of the Relationship between Productivity, Saving and the Current Account", *OECD Economics Department Working Paper*, No. 816.

Reforms that alter the sectoral specialisation of economies may also influence precautionary saving by changing the volatility of GDP growth (a lowering of product market regulation in services sectors may raise their share of output which may in turn lower overall output volatility and precautionary saving).

- *The interest rate channel:* Structural reforms may also affect the saving behaviour of households through changes in the real rate of interest that they face. For example, a strengthening of competition in the banking sector should reduce the spread between borrowing and lending rates by squeezing the profit margins of banks (and reduce the shadow real borrowing rate even more by relaxing quantitative constraints). Likewise, tax reforms should affect the saving decisions of firms and households through their impact on the after-tax rate of return on saving and interest expenses on loans. The ultimate impact on the saving rate is ambiguous, however, and depends on the relative sizes of the substitution, income and wealth effects (with the latter depending again on whether households are net lenders or net borrowers).

## **2.2. Theoretical linkages between structural reforms and investment**

Since firms weigh the returns on an investment project against its cost when making their investment decisions (Jorgenson, 1963; Hall and Jorgenson, 1967), structural reforms can influence the investment rate by altering the cost of the investment good, the revenue that the investment will generate and/or the uncertainty of that revenue stream:

- *The cost channel:* Structural reforms that reduce the cost of an investment project – *e.g.* by lowering the price of investment goods or the cost of financial capital – should increase the investment rate by raising the profitability of marginal investment projects. Examples include financial reforms that reduce lending margins, tax reforms that increase depreciation allowances, or the relaxation of competition-unfriendly regulation in capital goods sectors that lowers the price of investment goods.<sup>11</sup>
- *The revenue channel:* Reforms that boost the expected revenues from investment projects stimulate investment. Therefore, reforms that boost total factor productivity (TFP) growth on a long-lasting basis (*e.g.* improvements in innovation frameworks that address innovation failures and durably raise overall R&D spending) or temporarily (*e.g.* efficiency-enhancing tax reforms) should have permanent and temporary positive effects on overall investment, respectively.<sup>12</sup> While product market deregulation should push up the investment rate through temporarily higher TFP growth, this effect may be counteracted, at least in the short run, by the reduction in rates of return on capital for incumbent firms associated with the squeeze in profit margins (Alesina *et al.*, 2005).
- *The uncertainty channel:* Relaxing the assumption of certainty that underpins the cost of capital theory, structural reforms may also influence the investment rate by altering the level of uncertainty in a context where investment is at least partly irreversible (Abel and Eberly, 1994).<sup>13</sup> In this sense reforms that reduce uncertainty (*e.g.* by broadening prudential regulation or by strengthening property rights) should raise the investment rate.

### 2.3. Further channels of influence of structural reforms

A number of additional channels may shape the impact of structural reforms on saving, investment and current accounts:

- *Expectations of future structural policy settings:* The magnitude and, potentially, the direction of the saving/investment response to a structural policy change may depend on the credibility of the reform. For example, while a productivity-enhancing reform would usually reduce the saving rate if the reform is considered as permanent, it could instead induce households to save more if they expect the reform to be fully taken back in the future (see the discussion in Box 1). By the same token, firms and households might change their behaviour even in the absence of a reform if they believe that the status quo cannot be maintained. For example, if households believe that the national pension system is unsustainable, they might increase their saving even before the government actually decides to undertake reforms that cut into pension wealth. Moreover, uncertainty about a structural reform should boost saving and lower investment through the uncertainty channel discussed above.
- *Financial market imperfections and the interdependence between saving and investment decisions:* In imperfect financial markets, the saving and investment decisions of households and firms may not be independent from each other. For example, if information asymmetries drive a wedge between the internal and external cost of finance, companies might be reluctant to pay out dividends and instead use the funds to finance investment projects.<sup>14</sup> Similarly, households are likely to accumulate a certain amount of wealth before purchasing property. Consequently, policies that influence the investment decisions of economic agents are likely to also alter their saving decisions, with ambiguous effects on the current account position. Similarly, international financial market imperfections and/or home bias in consumption may reduce the mobility of capital across countries, thereby causing aggregate saving and investment rates to be correlated, the so-called Feldstein-Horioka puzzle. Policy settings such as financial market regulation (e.g. barriers to entry in the banking sector, or macro-prudential regulatory settings such as maximum housing loan-to-value ratios) may impact the degree of interdependence between saving and investment decisions.
- *The speed of shock transmission:* The influence of structural policy changes on saving, investment and current accounts might be mediated by certain factors. In particular, the exchange rate regime may affect the speed at which actual saving and investment adjust to this new equilibrium – though it is unlikely to affect this new equilibrium itself – following a reform. Under a fixed exchange rate regime and sticky prices, the lack of an external adjustment mechanism should slow down adjustment, implying more persistent real exchange rate and current account disequilibria.<sup>15</sup> Similarly, structural policies themselves may influence the speed of shock transmission. For example, a reduction in regulatory burdens may enhance the ability of firms to adjust their capital stock to productivity shocks, and thus the speed at which investment reacts to such shocks.
- *Interactions between policies and between policies and macroeconomic conditions:* Structural policies may interact with other policies or with macroeconomic conditions to influence the saving and investment behaviour of firms and households. For example, the impact of lower employment protection on the precautionary saving behaviour of households might be smaller where high unemployment benefits already provide some insurance

against the risk of job loss. Likewise, wealth effects on saving could be larger in countries with more developed financial markets (Boone et al., 2001). Also, housing policy reforms such as removing land-use restrictions, raising taxes on vacant undeveloped lands, or relaxing competition-unfriendly regulation in the construction industry may amplify the reaction of housing investment to changes in demand (OECD, 2010b).

### 3. Empirical analysis of the effect of structural policies on saving, investment and current accounts

#### 3.1. The empirical set-up

Given the theoretical complexities and ambiguities discussed in the previous section, the impact of structural reforms on saving, investment and current accounts ultimately remains an empirical issue. It is explored here by estimating a series of reduced-form equations that relate the GDP shares of, respectively, saving, investment and the current account balance to policy indicators and a set of control variables. The policy indicators span five different policy areas: social welfare systems, regulation in labour, product and financial markets, and taxation.<sup>16, 17</sup> The systematic analysis of the link between policies and saving, investment and current accounts is to be seen as the main novelty of this paper. The data limitations associated with the use of policy indicators imply a number of costs in terms of the methodology (for example, endogeneity issues cannot fully be addressed in the estimation procedure).

Taking a macroeconomic perspective allows examining a large set of countries simultaneously and exploiting a broad range of reform experiences. However, the discussion of the empirical results and their implications will also draw on recent microeconomic evidence on the link between structural policies and saving and investment, which tends to be narrower in scope but more robust to variations in, for example, the samples or the econometric methods than macroeconomic cross-country time-series analysis. The empirical analysis consists of two main parts:

- *Cross-country/time-series regressions* in the form of error correction models (ECMs) for an unbalanced panel data set covering 30 OECD countries.<sup>18</sup> By using an error correction specification the response of the dependent variable to a changes in one of the explanatory variables may be stronger in the short run than in the long run and also differ in its sign. The latter could, for example, be important for the saving rate response since households smooth consumption over time and reforms typically trigger through the economy only gradually. As it is likely that structural policy reforms have a different impact on public and private saving and investment – with some reforms likely to have virtually no impact on public saving/investment – the error correction models are estimated for both total and private saving and investment. Baseline equations are first estimated that only feature the control variables as explanatory factors, and in a second step, the policy indicators are introduced separately in the baseline specification. Since the real interest rate may be endogenous, robustness tests are carried out to verify whether the results are sensitive to dropping the real interest rate from the set of control variables. Unless explicitly mentioned in the text, this modification did not alter the conclusions of the analysis. Some of the policy variables are also interacted with the error correction parameter to investigate whether structural reforms affect the speed of adjustment to long-term equilibrium, and with some of the control or other policy variables to test for policy interactions (see Box 2 for details on the specifications). As

this analysis did not provide strong evidence of such interaction effects, the discussion below only briefly touches upon these results.

- *Cross-section and cross-country/time-series regressions* for a total of 117 OECD and non-OECD economies over the period 1993 to 2008.<sup>19</sup> While this second dataset is more limited in its time dimension and in the range of policies, it allows studying a broader set of countries and also facilitates the analysis of policies with little time variation. In a first step, baseline equations are estimated that relate the GDP shares of saving, investment and current account balances to a set of macroeconomic control variables, and in a second step these baseline equations are augmented by structural policy indicators (see Box 2 for details).<sup>20</sup> To look beyond short-term fluctuations and limit the possibility of measurement error, the regressions are carried out on non-overlapping five-year averages of the data.<sup>21</sup> For some of the policy variables data are only available for a single five-year time window (or even for just a single year), in which case the analysis is reduced to a pure cross-section regression. To deal with the potential endogeneity of the real interest rate, all specifications are also estimated without this variable (results not shown).

#### Box 2. Details on the empirical set-up

The baseline dynamic panel regressions for the OECD sample take the following general form:

$$\Delta Y_{it} = \alpha(Y_{it-1} - \delta_i - \lambda_t - \tau_i t - \beta X_{it-1}) + \sum_{j=1}^3 \Phi_j \Delta Y_{it-j} + \sum_{j=0}^3 B_j \Delta X_{it-j} + \varepsilon_{it} \quad (1)$$

where the dependent variable  $Y$  is alternatively the saving or investment to GDP ratio for the overall economy (public plus private) or the private sector, or the current account balance as a share of GDP.  $X$  is a vector of control variables,  $\varepsilon$  is an error term, and the indices  $i$  and  $t$  denote country and year.<sup>1</sup> Insignificant short-run dynamic terms are dropped from the specification to obtain a parsimonious model.<sup>2</sup> Equation (1) is estimated using the ordinary least squares estimator with standard errors that are robust to contemporaneous correlation and heteroskedasticity.<sup>3, 4</sup> All variables included in the ECMs are either stationary around a constant mean or trend-stationary (see Kerdrain *et al.*, 2010, Table A1.4). In the current account equations, all explanatory variables are converted into deviations from a GDP-weighted cross-country average to emphasize that current accounts are influenced both by domestic and foreign economic conditions. The average is calculated across all countries for which data are available for a given year.<sup>5</sup> The saving and investment equations, by contrast, feature the absolute values of all explanatory variables.<sup>6</sup>

Since the results may be sensitive to the choice of deterministic regressors, all specifications are estimated including: i) only country fixed effects (to control for unobserved cross-country heterogeneity such as differences in institutions, non-economic factors and differences in national accounting rules); ii) country and period fixed effects (the latter controlling for unobserved shocks that affect all countries simultaneously); and iii) country fixed effects and country-specific time trends (the latter capturing *e.g.* policy reforms or trending macroeconomic variables such as inflation).<sup>7</sup> While the inclusion of these deterministic regressors increases the number of coefficients to be estimated, thus rendering the model less parsimonious, not controlling for them could potentially lead to a sizeable omitted variable bias.<sup>8</sup> Furthermore, standard tests for the significance of the deterministic regressors generally reject the hypothesis that they are jointly equal to zero across countries. The discussion of the results mainly focuses on the specifications that feature both country and period fixed effects. While the results for specifications with country fixed effects only are very similar and therefore not shown in the paper, the results for the specifications with country fixed effects and country-specific time trends can be found in Kerdrain *et al.* (2010).

### Box 2. Details on the empirical set-up (cont.)

Three different analyses are carried out to investigate the impact of structural policies on saving, investment, and the current account. The first analysis investigates whether structural policies have an impact on top of any impact that works through changes in the macroeconomic variables that are already included in the baselines. This is done by including the structural policy indicators as separate explanatory variables both in the short run and in the long run of the baseline specification (1):

$$\Delta Y_{it} = \alpha(Y_{it-1} - \delta_i - \lambda_t - \tau_i t - \beta X_{it-1} - \gamma P_{it-1}) + \sum_{j=1}^3 \Phi_j \Delta Y_{it-j} + \sum_{j=0}^3 B_j \Delta X_{it-j} + \sum_{j=0}^3 \Gamma_j \Delta P_{it-j} + \varepsilon_{it} \quad (2)$$

where  $P$  is a policy indicator.<sup>9</sup> The policy indicators are introduced one-by-one into the baseline specification and also simultaneously (taking a single indicator from each policy area). While the latter approach has the advantage of reducing the risk of omitted variable bias, it reduces the size of the sample. Introducing indicators from different policy areas simultaneously does in general not affect the conclusions compared with a one-by-one approach. Sensitivity analysis is carried out to verify whether the results are robust to sample variations, namely to: i) exclusion of influential data points; and ii) exclusion of individual countries from the sample (see Kerdrain *et al.*, 2010, for details on the results).

Some of the policy variables change only slowly over time, in which case a fixed effects estimation of equation (2) is likely to produce inaccurate point estimates (Beck, 2001; Beck and Katz 2001). To circumvent this problem while keeping the fixed effects approach, a special estimator is applied that essentially relies on a random effects model for the almost-time-invariant explanatory variables and a fixed-effects model for the remaining ones (further details on this estimator can be found in the Annex). This estimator is used for all policy variables, for which the share of the cross-country variance in the total variance exceeds 75%, a threshold inspired by the rules of thumb of Plümper and Troeger (2007). These are employment protection legislation (and its sub-components), public social spending (total, old-age and health) and the statutory retirement age (see Kerdrain *et al.*, 2010, Table A1.3). In practice, however, the use of the special estimator leads to results that are very close to those of a simple fixed-effects estimator (indicating that also the choice of the threshold is not crucial).<sup>10</sup>

The second type of analysis explores whether structural policies have an impact on the speed of adjustment to long-term equilibrium. For example, by reducing capital stock adjustment costs, product market deregulation could speed up the adjustment of the investment-to-GDP ratio to its new equilibrium level following an exogenous shock (Alesina *et al.*, 2005). This is done by interacting the error correction parameter  $\alpha$  with a policy indicator  $P$  (measured as deviation from the sample average to facilitate interpretation):

$$\Delta Y_{it} = -(\alpha + \varphi(P_{it} - \bar{P})) (Y_{it-1} - \delta_i - \lambda_t - \tau_i t - \beta X_{it-1}) + \sum_{j=1}^3 \Phi_j \Delta Y_{it-j} + \sum_{j=0}^3 B_j \Delta X_{it-j} + \varepsilon_{it} \quad (3)$$

A positive (negative) sign of  $\varphi$  means that a higher value/score on a certain policy indicator is associated with a faster (slower) convergence to the new equilibrium. Specification (3) relies on the long run of the baseline specification and thus ignores any permanent effects of policies on saving and investment rates.

The third type of analysis explores the extent to which interactions across different policies, as well as across policies and macroeconomic conditions, matter. For example, the link between employment protection and precautionary saving may be expected to vary depending on the generosity of unemployment benefits. To this end, specification (2) which estimates only average effects of policies is extended to allow for interactions between two different policy indicators  $P^1$  and  $P^2$  [specification (4)] or between a policy indicator  $P^1$  and a macroeconomic variable  $X^1$  [specification (5)]. Following standard practice,

**Box 2. Details on the empirical set-up (cont.)**

the interactions are specified as multiplicative terms, which take the form of products of deviations of policies and macroeconomic variables from their sample means:

$$\Delta Y_{it} = \alpha(Y_{it-1} - \bar{\delta}_i - \lambda_t - \tau_i t - \beta X_{it-1} - \gamma P_{it-1}^1 - \mu P_{it-1}^2 - \tau(P_{it-1}^1 - \bar{P}^1)(P_{it-1}^2 - \bar{P}^2)) + \sum_{j=1}^3 \Phi_j \Delta Y_{it-j} + \sum_{j=0}^3 B_j \Delta X_{it-j} + \sum_{j=0}^3 \Gamma_j \Delta P_{it-j}^1 + \sum_{j=0}^3 \Omega_j \Delta P_{it-j}^2 + \sum_{j=0}^3 T_j \Delta((P_{it-j}^1 - \bar{P}^1)(P_{it-j}^2 - \bar{P}^2)) + \varepsilon_{it} \quad (4)$$

$$\Delta Y_{it} = \alpha(Y_{it-1} - \bar{\delta}_i - \lambda_t - \tau_i t - \beta X_{it-1} - \gamma P_{it-1}^1 - \tau(X_{it-1}^1 - \bar{X}^1)(P_{it-1}^1 - \bar{P}^1)) + \sum_{j=1}^3 \Phi_j \Delta Y_{it-j} + \sum_{j=0}^3 B_j \Delta X_{it-j} + \sum_{j=0}^3 \Gamma_j \Delta P_{it-j}^1 + \sum_{j=0}^3 T_j \Delta((X_{it-j}^1 - \bar{X}^1)(P_{it-j}^1 - \bar{P}^1)) + \varepsilon_{it} \quad (5)$$

Where  $\bar{P}^1$ ,  $\bar{P}^1$  and  $\bar{X}^1$  are the sample means (across countries and over time) of  $P^1$ ,  $P^2$  and  $X^1$ , respectively, and other variables are denoted as before.

The analysis that involves the broader country set of both OECD and non-OECD economies is based on the following equation:

$$\tilde{Y}_{it} = \alpha + \beta \tilde{X}_{it} + \gamma \tilde{P}_{it} + \varepsilon_{it} \quad (6)$$

where a tilde denotes a five-year average and all other notations are as before. A simple static specification is preferred to a dynamic one in the spirit of equation (2) because of the very limited the time-series dimension of the data set. The equation is estimated with linear least squares, using a variance-covariance matrix that is robust to country-specific heteroskedasticity. In a first step, equation (6) is estimated relating the GDP shares of saving, investment and current account balances only to macroeconomic control variables. In a second step, structural policy indicators are introduced one-by-one into these baseline specifications. The broader dataset is also used to test for policy interactions:

$$\tilde{Y}_{it} = \alpha + \beta \tilde{X}_{it} + \gamma \tilde{P}_{it}^1 + \varpi \tilde{P}_{it}^2 + \kappa(\tilde{P}_{it}^1 - \bar{\tilde{P}}^1)(\tilde{P}_{it}^2 - \bar{\tilde{P}}^2) + \varepsilon_{it} \quad (7)$$

where  $\bar{\tilde{P}}^1$  and  $\bar{\tilde{P}}^2$  are the sample means (across countries and over time) of respectively  $\tilde{P}^1$  and  $\tilde{P}^2$ .

The empirical strategy has a number of shortcomings which have to be kept in mind when interpreting the results. *First*, the approach does not explicitly account for the joint determination of current accounts and some of the explanatory variables (e.g. interest rates), potentially leading to an endogeneity bias. *Second*, it does not allow distinguishing between different types of shocks (e.g. temporary versus permanent shocks, expected versus unexpected shocks, credible versus non-credible shocks). The analysis is thus likely to capture an average effect across heterogeneous reform experiences, which reduces chances of obtaining significant and robust results.<sup>11</sup> *Third*, the approach treats saving and investment decisions separately. As discussed in the previous section this assumption of independence between saving and investment is unlikely to be fulfilled, especially during earlier periods of the sample when the Feldstein-Horioka puzzle was still strong. *Fourth*, structural policies are likely to influence saving and investment decisions through changes in the macroeconomic control variables, reducing the chances of finding significant coefficients on the policy variables themselves.<sup>12</sup>

**Box 2. Details on the empirical set-up (cont.)**

1. It might be more natural to think of equation (1) in terms of an autoregressive distributed lag (ARDL) model linking the (stationary) level of  $Y$  to its lags as well as to current and lagged levels of  $X$  and  $P$ . The ECM is strictly equivalent to an ARDL model, but gives direct estimates of the longer-run effects – i.e. cumulated over years – of the explanatory variables.
2. Lag delegation is done by successively dropping the least significant variable until all coefficients have an individual  $p$ -value below 10%. Note that once some lags are dropped from the dynamic part of the ECM, it is no longer necessarily equivalent to an unrestricted autoregressive distributed lag (ARDL) model.
3. Controlling for autocorrelation is less relevant in the context of an ECM due to the inclusion of lagged dependent variables. Lagrange multiplier tests indeed indicate that the residuals do not suffer from autocorrelation. Alternative variance-covariance matrices that are robust to arbitrary heteroskedasticity and within-country serial correlation or country-specific heteroskedasticity (but not to correlation between residuals for different countries) produce very similar conclusions.
4. Although the fixed effects estimates are biased in the presence of the lagged dependent variable, alternative estimators such as the GMM procedure proposed by Arellano and Bond (1991) are disregarded as the bias is likely to be small for our dataset (Judson and Owen, 1999), in particular for the estimate of  $\beta$ , which is the ultimate interest of this study.
5. The maximum set of countries includes Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. While in principle calculating the average across all countries for which data are available might cause sudden jumps in the data in years where a large country is added to the list, calculating the average alternatively over the G7 economies and only for years for which data are available for all of them is found to hardly affect the results.
6. Measuring all variables relative to a world average as in the current account equations (not shown in the paper) produces very similar results.
7. While dynamic panel regressions with fixed effects may produce biased results when the time dimension of the panel  $T$  is small and the number of cross sections  $N$  is large (e.g. Nickell, 1981), the average  $T$  in the regressions is generally large enough for the bias to be sufficiently small to be ignored.
8. In order not to increase the number of regressors and reduce degrees of freedom too much, linear time trends, period fixed effects and country fixed effects are not considered all together in a single specification.
9. For all policy variables that capture social welfare no short-run dynamics are included in the specification since some years of data had to be interpolated for these variables.
10. No lagged differences are included for these variables in the regressions since they show little dynamics over time.
11. In cases where the direction of impact differs across different types of shocks, the sign of the estimated coefficient may still give some hints on how economic agents perceived the shock, however.
12. A two-stage approach which would properly address the problem by first estimating the impact of structural policies on the macroeconomic variables and then incorporating the results in the saving, investment and current account equations is beyond the scope of this paper.

**3.2. The impact of macroeconomic conditions****3.2.1. Saving**

The baseline saving equations feature the real interest rate, the growth rates of productivity (measured as real GDP per worker) and the terms of trade, the youth and old-age dependency ratios and the government budget balance (Table 1).<sup>22, 23</sup> The results for the OECD sample are fairly robust to alternative specifications (see Kerdrain *et al.*, 2010).<sup>24</sup> The positive impact of productivity growth on saving in the medium to long run is consistent with a standard life cycle framework: to the extent that higher productivity growth benefits workers more than retirees and saving rates per age remain unchanged, the higher saving rate of workers generates an increase in the aggregate saving rate. The positive relationship between improvements in the terms-of-trade and the aggregate saving rate can be explained by households smoothing consumption in the face of a transitory level shock.<sup>25</sup> The effect appears to be stronger for oil exporting countries (see Kerdrain *et al.*, 2010), which is not surprising given that the terms of trade of these countries are highly influenced by the price of a finite resource. The short-run dynamics do not provide any evidence of overshooting with the transition of saving rates to the new equilibrium following a shock to the growth rates of productivity or the terms of trade being rather smooth. The regressions for the broader data set confirm the positive

Table 1. **Baseline estimation results for OECD sample 1965-2008: Country and period fixed effects**

|                                                | SAVT                 | SAVP                 | INVT                 | INVP                 | CA                   |
|------------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <b>Long-run relationship</b>                   |                      |                      |                      |                      |                      |
| User cost of capital                           |                      |                      | -0.150**<br>(0.062)  | -0.249***<br>(0.070) | -0.113<br>(0.157)    |
| Productivity growth                            | 1.063***<br>(0.386)  | 0.542**<br>(0.250)   | 1.908***<br>(0.343)  | 1.912***<br>(0.335)  | -1.497***<br>(0.530) |
| Change in population aged 15-64                |                      |                      | 1.938***<br>(0.526)  | 0.982**<br>(0.481)   | -4.550***<br>(1.654) |
| Change in terms of trade                       | 0.427***<br>(0.130)  | 0.172**<br>(0.083)   |                      |                      | 0.489***<br>(0.162)  |
| Real long-term interest rate                   | -0.623***<br>(0.233) | -0.486**<br>(0.205)  |                      |                      | 0.012<br>(0.324)     |
| Old-age dependency ratio                       | -0.547***<br>(0.145) | -0.330**<br>(0.156)  |                      |                      | -0.680***<br>(0.216) |
| Youth dependency ratio                         | 0.294**<br>(0.146)   | 0.432***<br>(0.142)  |                      |                      | 0.259*<br>(0.141)    |
| Government net lending                         | 0.322***<br>(0.118)  | -0.596***<br>(0.107) |                      |                      | 0.008<br>(0.160)     |
| <b>Short-run dynamics</b>                      |                      |                      |                      |                      |                      |
| Error correction parameter                     | -0.182***<br>(0.038) | -0.223***<br>(0.037) | -0.176***<br>(0.025) | -0.178***<br>(0.028) | -0.210***<br>(0.038) |
| $\Sigma\Delta$ Dependent variable              | -0.114***<br>(0.040) |                      | 0.154***<br>(0.057)  | 0.152***<br>(0.058)  |                      |
| $\Sigma\Delta$ User cost of capital            |                      |                      | 0.039***<br>(0.013)  | -0.038***<br>(0.011) |                      |
| $\Sigma\Delta$ Productivity growth             | 0.222***<br>(0.055)  | 0.042<br>(0.079)     | 0.207***<br>(0.034)  | 0.253***<br>(0.030)  | -0.234**<br>(0.096)  |
| $\Sigma\Delta$ Change in population aged 15-64 |                      |                      | 0.422***<br>(0.106)  |                      | -1.106***<br>(0.362) |
| $\Sigma\Delta$ Change in terms of trade        | 0.100***<br>(0.014)  | 0.047***<br>(0.016)  |                      |                      | 0.135***<br>(0.023)  |
| $\Sigma\Delta$ Real long-term interest rate    | -0.071**<br>(0.028)  | -0.049*<br>(0.027)   |                      |                      | -0.143***<br>(0.055) |
| $\Sigma\Delta$ Old-age dependency ratio        | 0.562**<br>(0.240)   | 0.248***<br>(0.365)  |                      |                      |                      |
| $\Sigma\Delta$ Youth dependency ratio          | -0.522***<br>(0.146) | -0.342*<br>(0.179)   |                      |                      | -0.742***<br>(0.276) |
| $\Sigma\Delta$ Government net lending          | 0.178***<br>(0.033)  | -0.416***<br>(0.042) |                      |                      | 0.114*<br>(0.062)    |

Robust standard errors in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level. SAVT, SAVP, INVT, INVP, and CA denote the GDP shares of respectively total saving, private saving, total investment, private investment, and the current account balance. All models include country and period fixed effects.

relationship between total saving rates and changes in productivity and the terms of trade, with the magnitudes of the estimated effects being very close to the medium to long-run effects found in the dynamic panel regressions for OECD countries (Table 2).

The old-age dependency ratio turns out to be negatively related to the aggregate saving rate in the medium to long run, in line with the standard life-cycle hypothesis that older people tend to have a higher propensity to consume out of income than people of working age (Modigliani and Ando, 1963). The point estimate implies that a 1 percentage point increase in the old-age dependency ratio reduces total saving by about half a percentage point of GDP in the medium to long run, which is in line with the findings of

other recent studies (*e.g.* Cheung *et al.*, 2010) and with the estimate obtained in the regression for OECD and non-OECD countries.<sup>26, 27</sup> While the baseline specifications shown in Table 1 suggest that a rise in the youth dependency ratio temporarily reduces saving rates in OECD countries but leads to an increase in saving rates in the medium to long run, this result appears to be sensitive to the choice of deterministic control variables (*i.e.* country and period fixed effects, only country fixed effects or country fixed effects and country-specific time trends) and to the inclusion of the real interest rate.<sup>28</sup> Improvements in government budget balances have a significantly positive effect on total saving in the medium to long run, but reduce household saving, potentially due to (partial) Ricardian equivalence.<sup>29</sup> The private saving offset is estimated at around two-thirds, which is somewhat larger than the magnitudes found in previous studies (*e.g.* Cheung *et al.*, 2010; Röhn, 2010). Changes in the real interest rate also have a significant influence on saving behaviour, with a 1 percentage point increase in the real interest rate lowering private saving by about half a percentage point of GDP.<sup>30</sup> One interpretation is that, on average across countries, the income effect of an interest rate change outweighs its substitution and wealth effects.

Looking at the in-sample and out-of-sample fit of the estimated baseline saving equations shows that fitted saving rates track actual rates fairly well for most countries in-sample (see Kerdrain *et al.*, 2010), though this is clearly driven by the lagged dependent variables for at least some of them. To explore the out-of-sample forecasting properties of the equations, they are estimated until 2000 and then used to dynamically forecast the GDP shares of saving and investment until 2008. Since the period fixed effects do not exhibit any clear trend, they are set equal to zero over the forecasting horizon. The out-of-sample fit varies considerably across countries, though in general actual saving rates lie within the 90% confidence interval around the forecast.<sup>31</sup> For example, while the equations track the actual saving rate fairly well for Japan, Germany, the United Kingdom, Australia and the Netherlands, they perform rather poorly for the United States, Spain and Norway. This rather poor forecasting performance for some countries could be explained by the omission from the baseline equations of structural policy variables which may explain at least some of the recent changes in saving rates.<sup>32</sup>

### 3.2.2. Investment

The baseline investment specifications feature the user cost of capital (or the real interest rate when based on the second sample that involves non-OECD countries), productivity growth and the growth rate of the working-age population, and yield results that are qualitatively in line with existing empirical evidence.<sup>33</sup> The regressions for the OECD sample indicate that higher TFP growth, a higher growth rate of the working-age population or lower cost of capital raise investment rates in the medium to long run (Table 1). The user cost effect is consistent with the notion that higher user costs lower the returns on investment projects and confirms the findings of previous OECD work (*e.g.* Vartia, 2008; Schwellnus and Arnold, 2008). The point estimate implies that a 1 percentage point increase in the user cost of capital reduces private investment by a quarter of a percentage point of GDP in the medium to long run, which is somewhat smaller than the magnitude implied by other studies (Cummins *et al.*, 1994). As it turns out, a fall in the interest rate is found to raise saving by slightly more than investment. The short-run dynamics suggest that, following a shock to any of the three explanatory variables, half of the full adjustment of the private investment rate to the new equilibrium is achieved within four years. The results are very robust to alternative choices of

deterministic regressors and to the omission of influential data points (see Kerdrain *et al.*, 2010).<sup>34</sup> Moreover, the conclusions are confirmed by the regressions for the broader data set of OECD and non-OECD countries (Table 2).<sup>35</sup> The out-of-sample forecasting performance of the estimated investment equations varies considerably across countries (see Kerdrain *et al.*, 2010). For example, the equations produce a very good forecast for the United States and, to a lesser extent, for the Netherlands. In the case of Germany, the United Kingdom and Norway, the equations perform well at least during more recent years, though they are not able to predict movements in the investment rate at the beginning of the forecasting period (*i.e.* in 2001/2002).<sup>36</sup>

Table 2. **Baseline estimation results for OECD/non-OECD sample**

|                                 | SAVT                 | INVT                | CA                   |
|---------------------------------|----------------------|---------------------|----------------------|
| Real interest rate              | -0.101***<br>(0.031) | -0.069**<br>(0.033) | -0.059<br>(0.046)    |
| Productivity growth             | 0.326*<br>(0.196)    | 1.146***<br>(0.308) | -1.011<br>(0.659)    |
| Change in population aged 15-64 |                      | 0.514*<br>(0.282)   | 0.454<br>(0.924)     |
| Change in terms of trade        | 0.263**<br>(0.120)   |                     | 0.501***<br>(0.131)  |
| Old-age dependency ratio        | -0.572***<br>(0.139) |                     | -0.323*<br>(0.175)   |
| Youth dependency ratio          | -0.281***<br>(0.044) |                     | -0.223***<br>(0.063) |
| Number of cross sections        | 96                   | 117                 | 97                   |
| Number of observations          | 240                  | 314                 | 245                  |

Note: Robust standard errors in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level. SAVT, INVT, and CA denote the GDP shares of respectively total saving, total investment, and the current account balance.

### 3.2.3. Current account

The current account equations feature all macroeconomic variables that have a significant influence on total saving, total investment or both and yield results that are broadly consistent with the regression results for the two components.<sup>37</sup> The regressions for OECD countries indicate that changes in productivity, changes in the size of the working-age population, and changes in the terms of trade have a lasting impact on current account positions (Table 1). However, the current account equations do not provide any evidence that the real interest rate has a lasting impact on current account positions. The somewhat counter-intuitive relative magnitudes of the medium- to long-run interest rate elasticities found in the saving and investment rate equations do thus not carry over to the current account equation. As for the user cost of capital, the real interest rate and the dependency ratios, the results are sensitive to the precise specification used (see Kerdrain *et al.*, 2010). Overall, the results are consistent with those from comparable studies (*e.g.* Chinn and Ito, 2007; Cheung *et al.*, 2010). In the regression for OECD and non-OECD countries only the two dependency ratios and terms-of-trade changes come out as significant (Table 2).

### 3.2.4. Implications for the impact of structural policies

Insofar as structural policies affect the macroeconomic variables included in the baseline specifications, significant coefficients on these variables imply that these reforms should ultimately also affect saving and investment rates. In particular, there is growing evidence that removing anti-competitive product market regulation, relaxing overly stringent employment protection legislation and fostering the completeness and depth of financial markets all boost productivity growth.<sup>38</sup> The empirical results in Tables 1 and 2 would therefore imply that such reforms also have a negative impact on the current account position. Similar implications can be derived from the significant influence of government fiscal balances on saving since structural reforms can, and often do have side-effects on public budgets.<sup>39</sup>

### 3.3. The impact of social welfare reform

The empirical analysis shows that a higher GDP share of public spending on health is associated with lower saving rates (Tables 3 and 4), in line with the notion that improvements in the coverage and/or quality of social welfare schemes reduce the need for precautionary saving.<sup>40</sup> The effect appears to be especially strong under low initial levels of social spending (Table 5 and Figure 3, panel A), consistent with existing evidence (e.g. Furceri and Mourougane, 2010; Baldacci *et al.*, 2010). The point estimates for the OECD sample imply that, on average, a 1 percentage point increase in the GDP share of public health spending reduces total and private saving rates by over 1½ percentage points in the medium to long run. The standard deviation around this point estimate is high, however. For other areas of social welfare, the analysis yields less robust results. The results depend in particular on the choice of deterministic control variables, with higher total public social spending,<sup>41</sup> higher public social spending on old age<sup>42</sup> and higher and more long-lasting unemployment benefits only found to reduce saving rates in specifications that feature country-specific time trends (see Kerdrain *et al.*, 2010).<sup>43, 44</sup> The current account regression results are in line with those obtained for saving, with more developed public health care systems being associated with weaker current account positions.

These findings are broadly consistent with micro studies on the saving impact of social welfare schemes. Higher unemployment benefit replacement rates have been found to reduce household saving on US state-level data (Engen and Gruber, 2001).<sup>45</sup> Likewise, several studies show that a broader coverage and better quality of public health insurance schemes discourage private saving (e.g. de Nardi *et al.*, 2006; Jappelli *et al.*, 2006; Maynard and Qiu, 2009; Chou *et al.*, 2003), though the size of the effect differs across different types of households. Regarding China more specifically, there is recent evidence that government health spending (or lack thereof) affects individual household saving rates (OECD, 2010c; Barnett and Brooks, 2010; Chamon and Prasad, 2010). Other relevant design features of social welfare systems include the asset tests associated with means-tested social programmes, which may discourage saving in order to qualify for benefits (see Hubbard *et al.*, 1995; Gruber and Yellowitz, 1999; Nam, 2008; and McKernan *et al.*, 2007 for some evidence for the United States).<sup>46</sup>

Regarding pension reforms, the present analysis suggests that increasing the statutory retirement age by one year reduces total and private saving by around half a percentage point of GDP in the medium to long run (Table 3), a finding that is robust to variations in the sample (Kerdrain *et al.*, 2010).<sup>47, 48</sup> This negative relationship is consistent with the notion that a higher retirement age prolongs the period during which to accumulate wealth and

Table 3. **The impact of structural policies on saving, investment and current accounts in OECD countries**

Baseline equations augmented with structural policy indicators

|                                               | SAVT                 |                      | SAVP                 |                     | INVT                |                     | INVP                |                     | CA                   |                    |
|-----------------------------------------------|----------------------|----------------------|----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------------|--------------------|
|                                               | LR                   | SR                   | LR                   | SR                  | LR                  | SR                  | LR                  | SR                  | LR                   | SR                 |
| <b>Social security programmes</b>             |                      |                      |                      |                     |                     |                     |                     |                     |                      |                    |
| Unemployment benefit replacement rate         | 0.008<br>(0.067)     |                      | -0.029<br>(0.052)    |                     |                     |                     |                     |                     | -0.090<br>(0.088)    |                    |
| Public social spending, total                 | -0.165<br>(0.191)    |                      | -0.260<br>(0.206)    |                     |                     |                     |                     |                     | -0.185<br>(0.304)    |                    |
| Public social spending, old age               | 0.099<br>(0.564)     |                      | -0.005<br>(0.499)    |                     |                     |                     |                     |                     | -0.008<br>(0.518)    |                    |
| Public social spending, health                | -1.889***<br>(0.612) |                      | -1.549***<br>(0.523) |                     |                     |                     |                     |                     | -2.269***<br>(0.626) |                    |
| Standard retirement age                       | -0.516*<br>(0.291)   |                      | -0.664**<br>(0.283)  |                     |                     |                     |                     |                     | -0.351<br>(0.396)    |                    |
| <b>Labour market policy</b>                   |                      |                      |                      |                     |                     |                     |                     |                     |                      |                    |
| Employment protection legislation (EPL)       | -0.456<br>(0.576)    |                      | 0.068<br>(0.431)     |                     | 1.043**<br>(0.439)  |                     | 0.626*<br>(0.346)   |                     | -1.711**<br>(0.948)  |                    |
| EPL on regular contracts                      | 0.170<br>(0.943)     |                      | 0.595<br>(0.821)     |                     | 0.262<br>(0.695)    |                     | 0.181<br>(0.444)    |                     | -0.980<br>(1.188)    |                    |
| EPL on temporary contracts                    | -0.270<br>(0.375)    |                      | -0.052<br>(0.314)    |                     | 0.819***<br>(0.290) |                     | 0.589***<br>(0.218) |                     | -1.033*<br>(0.583)   |                    |
| <b>Financial market regulation</b>            |                      |                      |                      |                     |                     |                     |                     |                     |                      |                    |
| Credit to the private sector (% of GDP)       | -3.954***<br>(1.262) | 0.593*<br>(0.315)    | -2.987**<br>(1.362)  | -1.133**<br>(0.470) | 1.842<br>(1.180)    | 1.126**<br>(0.451)  | 1.896*<br>(1.019)   | 0.970**<br>(0.452)  | -2.930<br>(1.848)    |                    |
| Stock Market Capitalisation (% of GDP)        | -1.744<br>(2.391)    | -0.342<br>(0.544)    | -0.821<br>(1.421)    | -0.389<br>(0.720)   | 0.181<br>(1.435)    |                     | 1.979<br>(2.220)    | 1.036**<br>(0.498)  | -2.636<br>(1.918)    |                    |
| Stock market trade (% of GDP)                 | -1.085<br>(1.184)    | -0.594***<br>(0.206) | -1.065<br>(0.662)    | -0.442**<br>(0.214) | -0.332<br>(0.697)   |                     | 0.250<br>(0.692)    | 0.312*<br>(0.179)   | -1.057<br>(0.902)    | -0.692*<br>(0.326) |
| Financial reform index                        | 0.016<br>(0.087)     |                      | -0.076<br>(0.104)    |                     | 0.146<br>(0.131)    |                     | 0.153<br>(0.117)    |                     | -0.096<br>(0.168)    |                    |
| <b>Product market regulation</b>              |                      |                      |                      |                     |                     |                     |                     |                     |                      |                    |
| Regulation in seven non-manufacturing sectors |                      |                      |                      |                     | 0.150<br>(0.375)    | -0.543**<br>(0.221) | 0.270<br>(0.355)    | -1.002**<br>(0.390) | -0.866<br>(0.598)    |                    |

Note: Robust standard errors in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level. SAVT, SAVP, INVT, INVP, and CA denote the GDP shares of, respectively, total saving, private saving, total investment, private investment, and the current account balance. LR = long run, SR = short run. For social welfare programmes no short-run dynamics are included in the specifications due to linear interpolation of the data. All specifications include country and period fixed effects.

shortens the period during which to live off that wealth, and it is also supported by other recent studies (e.g. Kirsanova and Sefton, 2007). As regards pension benefits, the existing empirical evidence indicates that a cut in benefits is associated with higher private saving rates in the aftermath of the reform. Exploiting the Italian pension reform of 1992, Attanasio and Brugiavini (2003) demonstrate that this effect is particularly high for workers between 35 and 45. Feng et al. (2009) show that the pension reform for enterprise employees implemented in China in the late 1990s boosted the household saving rate.<sup>49</sup> The scarce evidence that exists on the relative impact of unfunded versus funded schemes is more mixed, with tentative evidence that countries with a pay-as-you-go system tend to have lower saving rates (Samwick, 2000).

**Table 4. The impact of structural policies on saving, investment and current accounts: OECD/non-OECD sample**

Baseline equations augmented with structural policy indicators

|                                             | INVT                | SAVT               | CA                  |
|---------------------------------------------|---------------------|--------------------|---------------------|
| Employment law index                        | -2.130<br>(2.870)   | -3.201<br>(5.230)  | -4.204<br>(5.719)   |
| Unemployment benefits                       |                     | -2.832<br>(3.947)  | -1.834<br>(3.275)   |
| Public health expenditure (% of GDP)        |                     | -0.725<br>(0.491)  | -0.992**<br>(0.465) |
| Ease of doing business index                | -0.014<br>(0.012)   |                    | -0.003<br>(0.026)   |
| Cost of starting a business (% of GNI)      | -0.009**<br>(0.004) |                    | -0.005<br>(0.004)   |
| Days required to start a business           | 0.008<br>(0.010)    |                    | 0.015<br>(0.017)    |
| Number of procedures to register a business | -0.229**<br>(0.110) |                    | 0.245<br>(0.202)    |
| Financial reform index                      | -0.082<br>(0.093)   | -0.311*<br>(0.172) | 0.042<br>(0.148)    |

Note: Robust standard errors in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level. SAVT, INVT, and CA denote the GDP shares of, respectively, total saving, total investment, and the current account balance.

### 3.4. The impact of labour market reform

There is ample evidence at the micro level that higher income uncertainty is associated with larger wealth holdings by households (or higher saving/lower consumption), though the size of the effect appears to differ widely across studies, potentially related to the focus on different countries.<sup>50</sup> The empirical analysis conducted in this paper does not provide strong evidence that the stringency of employment protection legislation (EPL) impacts the private or total saving rate in OECD countries.<sup>51, 52</sup> The insignificance of this variable may reflect two offsetting effects, as more stringent protection reduces the probability of job loss, but also lengthens the expected unemployment spell after dismissal. This explanation is consistent with existing evidence that perceived job security is actually weaker in high-EPL countries (Clark and Postel-Vinay, 2009). For the broader country dataset, however, there is some evidence that lower employment protection is associated with higher saving rates, but only in countries with low or no unemployment benefits (Table 5 and Figure 3, panel B).<sup>53</sup> Other labour market indicators (e.g. the level of the minimum wage and the bargaining power of unions) are not found to have a significant influence on saving rates (results not shown).

As regards investment, employment protection is the only one of the labour market indicators considered that is found to have a robust impact, and only for the sample of OECD countries. Stricter EPL appears to be associated with higher GDP shares of both private and total investment, a finding that applies to both the overall index of employment protection and the sub-index for temporary workers (Table 3).<sup>54, 55</sup> One potential explanation for this result is that while the implicit and explicit costs associated with stronger protection might discourage FDI to countries with higher EPL,<sup>56</sup> domestic firms may instead react by substituting capital for labour,<sup>57</sup> and the latter effect may dominate on average across OECD countries. The point estimates imply that a one-standard-deviation rise in the EPL indicator boosts private investment by around half a

Table 5. **Results for interaction effects**  
OECD/non-OECD sample

|                                                                                           | SAVT                 | SAVT                 | SAVT                 |
|-------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|
| Real interest rate                                                                        | -0.076<br>(0.063)    | -0.603***<br>(0.182) | -0.118***<br>(0.045) |
| Productivity growth                                                                       | 0.532<br>(0.324)     | 0.506<br>(0.582)     | 0.277<br>(0.282)     |
| Change in terms of trade                                                                  | 0.333**<br>(0.132)   | 0.289<br>(0.260)     | 0.115<br>(0.149)     |
| Old-age dependency ratio                                                                  | -0.461**<br>(0.223)  | -0.336<br>(0.266)    | -0.493***<br>(0.149) |
| Youth dependency ratio                                                                    | -0.286***<br>(0.053) | -0.205***<br>(0.059) | -0.223***<br>(0.043) |
| Public health expenditure (% of GDP)                                                      | -1.128**<br>(0.558)  |                      |                      |
| Public health expenditure (% of GDP) squared                                              | 0.375***<br>(0.137)  |                      |                      |
| Employment law index                                                                      |                      | -4.230<br>(5.332)    |                      |
| Unemployment benefits                                                                     |                      | -1.373<br>(3.993)    |                      |
| Employment law index * Unemployment benefits                                              |                      | 23.270*<br>(13.376)  |                      |
| Financial reform index                                                                    |                      |                      | -0.444**<br>(0.222)  |
| GDP per capita relative to the United States                                              |                      |                      | 6.759*<br>(3.993)    |
| Financial reform index * GDP per capita relative to the United States                     |                      |                      | 0.176<br>(0.627)     |
| F-test for joint significance of policy variables and interaction term ( <i>p</i> -value) | 0.017                | 0.248                | 0.077                |
| Number of cross sections                                                                  | 90                   | 54                   | 58                   |
| Number of observations                                                                    | 170                  | 54                   | 161                  |

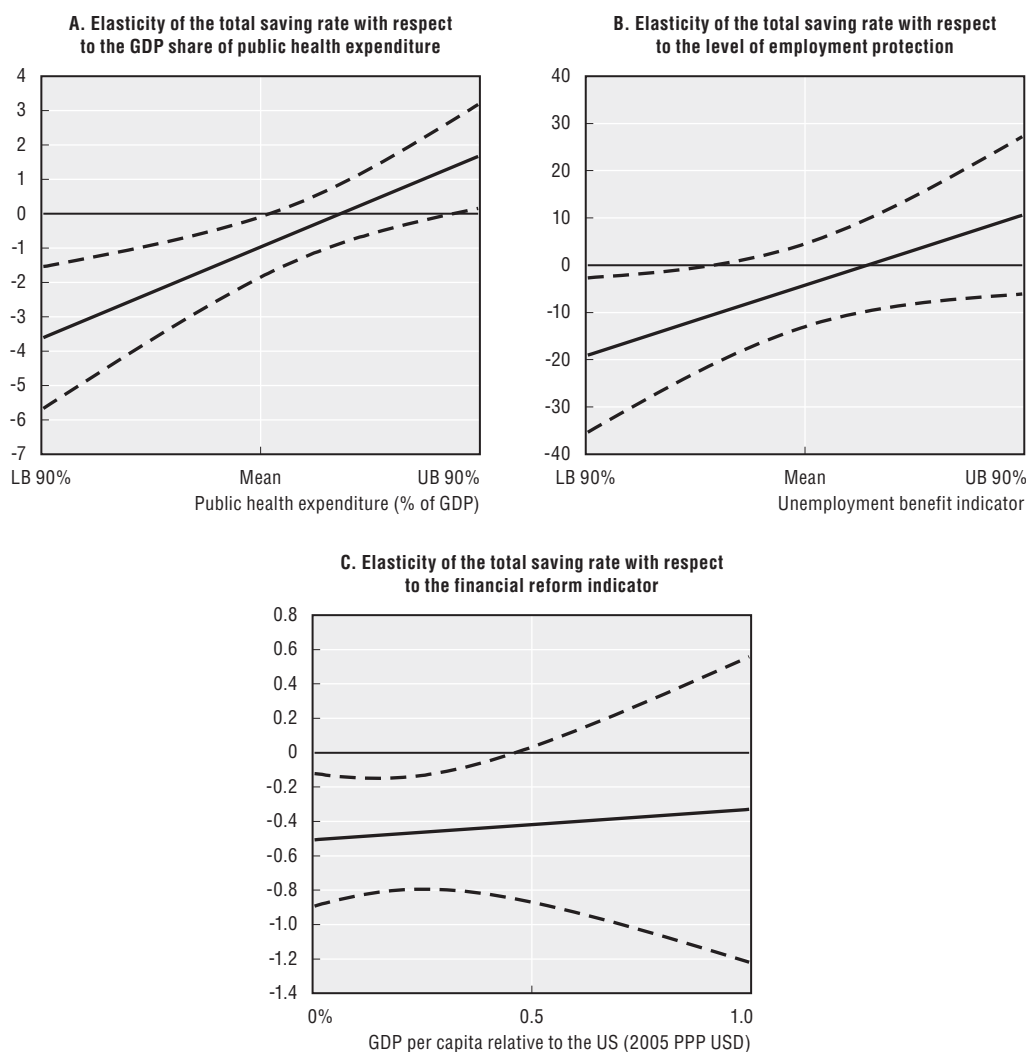
Note: Robust standard errors in parentheses. \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level. SAVT denotes the GDP share of total saving.

percentage point of GDP and total investment by around 1 percentage point of GDP in the medium to long run.<sup>58</sup> This rise in investment is likely to be partially offset in the short run through a temporary fall in productivity growth (see Barnes *et al.*, 2011 for an estimate of the GDP per capita effects of EPL reform). The current account regressions point to a negative link between a country's level of employment protection and its current account position, in line with the favourable investment effects of strict EPL.<sup>59, 60</sup>

### 3.5. The impact of product market reform

Product market reform can influence investment in several conflicting ways (Alesina *et al.*, 2005): i) reductions in entry barriers may increase output and capital accumulation by reducing the mark-up of prices over marginal costs; ii) reductions in red tape and other forms of regulatory burdens can lower the costs of expanding the capital stock for incumbent firms and thus enhance their capacity to respond to changes in fundamentals;<sup>61</sup> iii) in the presence of information asymmetries, internal and external sources of financing may not be perfectly substitutable, and reductions in mark-ups may depress investment; iv) to the extent that product market reforms are accompanied by the privatisation of public enterprises that had been heavy investors, investment may fall despite the decline

Figure 3. Results for interaction effects: OECD/non-OECD sample



in the shadow cost of entry; v) product market reforms may affect the GDP share of investment by altering the sectoral specialisation of the economy towards sectors that are less/more capital intensive or rely less/more on investment goods with a high rate of depreciation.<sup>62</sup>

The empirical analysis suggests that product market deregulation boosts private investment and total investment, but that this effect vanishes after a few years (Table 3).<sup>63</sup> Taken at face value, the magnitude of the coefficient implies that an improvement in the regulation index similar in size to that achieved in the average OECD country over 1998-2008 is associated with an increase in total investment by about 0.4 percentage points of GDP in the year following the reform (Kerdrain *et al.*, 2010, Figure A1.7).<sup>64</sup> While this direct effect is rather small, it is likely to be amplified substantially through the indirect effect that works through higher productivity growth (Boulhol *et al.* 2008 and Barnes *et al.*, 2011). This is

relatively small and likely to be offset by a fall in investment. The level of product market regulation does, however, not appear to affect the speed at which the investment-to-GDP ratio adjusts to its new equilibrium level following an exogenous shock.<sup>65</sup> Previous studies on the issue also generally conclude that a reduction in regulation is associated with higher investment. Alesina et al. (2005) find for a panel of OECD countries that this effect is particularly large for a removal of entry barriers. Regarding public ownership, the authors find that privatisation is associated with higher investment rates, suggesting that privatisation is, on average, associated with lower shadow costs of entry and that this outweighs the effect of less overinvestment. Vartia (2008) and Griffith and Harrison (2004) also provide evidence that less regulation is associated with a higher investment rate. As for the current account, the empirical analysis does not provide any robust evidence for an impact of product market regulation.<sup>66</sup>

### **3.6. The impact of financial market reform**

The impact of financial market reform on the saving behaviour of firms and households is theoretically ambiguous. On the one hand, reforms that increase the depth and/or sophistication of domestic financial markets might reduce saving by relaxing borrowing constraints and by lowering the need for precautionary saving through better portfolio diversification, at least provided adequate prudential regulation is in place. On the other hand, financial market development might increase saving by widening saving opportunities, which should allow the supply of financial services to better match individual preferences, risk aversion and income profiles. In addition, financial market development might influence saving by altering rates of return and lending margins (e.g. by lowering transaction costs), with the direction of the impact depending on the relative strength of the substitution and income effects.

Financial market regulation indicators are inherently difficult to construct with many studies not using policy indicators but intermediate outcome indicators which suffer from potential endogeneity. For the OECD sample, the study relies on both outcome and policy indicators to measure financial market reform and the results appear to be highly sensitive to the choice of the indicator. While the outcome indicators tend to point to a negative relationship between financial market development and saving rates, this is generally not confirmed by the financial reform index of Abiad et al. (2010), which combines a wide range of policy indicators on financial sophistication and liberalisation: The financial reform index comes out significantly negative only when dropping the real interest rate from the set of control variables.<sup>67</sup> These mixed results are consistent with the existing empirical literature.<sup>68</sup> One possible explanation for the mixed results is the existence of threshold effects whereby the negative effect from the removal of borrowing constraints may dominate in early stages of financial development, whereas the positive impact from broader supply and expected returns may become predominant at later stages (Ferrucci and Miralles, 2007). The analysis for the broader sample that includes both OECD and developing countries lends some support to this explanation, with the financial reform index by Abiad et al. (2010) found to be significantly negatively related to the total saving rate (Table 4). The effect appears to hold only for countries with GDP per capita levels below half of the US level (Table 5 and Figure 3, panel C). There is no robust evidence that the depth and sophistication of financial markets influence the saving effects of other structural policies, or that it affects the speeds at which households and firms adapt their saving behaviour in response to changes in fundamentals.

Financial market deregulation should stimulate investment, not least by lowering the cost of acquiring and evaluating information on prospective projects and by reducing the risk of resource mismanagement through easier monitoring of investments (OECD, 2003a). However, to the extent that financial repression is associated with households supplying cheap capital to enterprises, liberalisation may raise the cost of capital and thus lower investment. As stressed by Caballero (2006) and Caballero *et al.* (2008), financial market imperfections in emerging and developing countries might be one reason why these countries have invested in advanced countries such as the United States rather than domestically. While a positive link between financial development and investment is supported by several recent studies (*e.g.* OECD, 2003a; Cheung *et al.*, 2010; Dorrucci *et al.*, 2009),<sup>69</sup> the empirical analysis conducted in this paper yields somewhat ambiguous results, with the coefficient either positive or insignificant depending on the choice of the proxy for financial market regulation and the specification.<sup>70</sup> Similarly, this study does not find strong evidence that financial market development weakens the current account position, unlike several other studies (Chinn and Ito, 2007; Kennedy and Sløk, 2005; Dorrucci *et al.*, 2009).<sup>71</sup>

### 3.7. The impact of tax reform

Tax reforms may affect household saving through a variety of different channels, not least via the after-tax rate of return on saving or via asymmetric tax treatment of different types of capital income (*e.g.* tax deductibility of interest expenses on loans in the absence of taxation of imputed rent). While the limited availability of time series data on capital gain tax rates and the interest rate deductibility of mortgages does not allow an investigation of these effects here, a number of individual-country studies have concluded that a reduction in the after-tax rate of return (*e.g.* by cutting down tax deduction of interest expenses) boosts the saving rate (*e.g.* Summers, 1984, for the United States; Koskela and Virén, 1994, for Denmark, Sweden and Finland). To the extent that higher-income households have a higher propensity to save, a more progressive income tax system may be associated with a lower aggregate saving rate, *ceteris paribus*. The empirical analysis does not yield robust evidence in favour of such a link, with the coefficient on income tax progressivity being significantly negative or insignificant, depending on the precise specification and sample (results not shown). As for tax-deferred retirement saving vehicles, several studies find that they boost private saving (Poterba *et al.*, 1996; Rossi, 2009), whilst others point to sizeable crowding-out, at least for some types of households (Attanasio *et al.*, 2004; Corneo *et al.*, 2009). Looking at various pension-unrelated savings accounts, OECD (2007) concludes that tax-preferred accounts create new savings only when moderate-income households participate in them.

Lower corporate tax rates (or larger capital depreciation allowances) should raise investment by reducing the user cost of capital.<sup>72</sup> Although the significant negative coefficient on the (not tax-adjusted) user cost of capital variable in the baseline specification is consistent with this link, the empirical analysis in this paper does not find support for a direct negative effect of corporate taxes when introducing them as separate explanatory variables in the investment equations.<sup>73</sup> Studies that make use of sector or firm-level data generally find that lower corporate tax rates or higher depreciation allowances are associated with higher investment (*e.g.* Vartia, 2008; Schwellnus and Arnold, 2008; Hassett and Hubbard, 2002).<sup>74</sup>

#### 4. Quantifying the impact of policy reforms on current account imbalances

The empirical results presented in the previous section (see Table 6 for an overview) are used to obtain illustrative estimates of the side effects of possible growth-enhancing policy reform packages on saving-investment gaps. While the reform packages are chosen to yield a double dividend by both boosting growth *and* reducing saving-investment gaps, some other desirable reforms ignored in the simulations may well be associated with a widening of external positions. Given the likelihood of and need for major fiscal tightening across the OECD over the coming years, the packages also incorporate fiscal tightening scenarios. The (dynamic) simulations rely on the coefficient estimates obtained for the saving and investment rate equations in Table 1, which prove to be more robust than the current account equations.<sup>75</sup> For the purpose of the simulations, the equations are transformed into deviations from the cross-country average to account for the fact that relative (rather than absolute) movements in macroeconomic and structural policy settings drive saving-investment gaps in equilibrium. A total of four scenarios are created, two global scenarios that look at 27 OECD countries<sup>76</sup> plus China, and two euro area scenarios.<sup>77</sup> In both cases, one scenario exclusively considers changes in fiscal positions, while the other also assumes the implementation of structural reforms. The results of this rather simplistic simulation exercise need to be interpreted with care. Most importantly, the simulations treat saving and investment separately and abstract from possibly heterogeneous interest rate responses (in particular to fiscal tightening). Specific caution is warranted when interpreting the results for China since the simulations mostly rely on the coefficient estimates obtained with the OECD panel dataset.<sup>78</sup> Moreover, some of the coefficients used in the simulations are rather imprecisely estimated, meaning that the precise magnitudes of the saving-investment gap effects of policy reforms are surrounded by a high degree of uncertainty.

Table 6. **Overview of the estimated effects of structural policies on saving, investment and current accounts**

|                                                          | Total saving | Total investment | Current account |
|----------------------------------------------------------|--------------|------------------|-----------------|
| <b>Macroeconomic conditions</b>                          |              |                  |                 |
| Increase in productivity growth                          | +            | +                | –               |
| Increase in the user cost of capital                     |              | –                | (+)             |
| Increase in the growth rate of working-age population    |              | +                | –               |
| Increase in the rate of change of the terms of trade     | +            |                  | +               |
| Increase in the real rate of interest                    | –            |                  | (–)             |
| Increase in the old-age dependency ratio                 | –            |                  | –               |
| Increase in the youth dependency ratio                   | +            |                  | +               |
| Increase in government net lending                       | +            |                  | (+)             |
| <b>Structural policies</b>                               |              |                  |                 |
| Improvement in coverage/quality of social welfare system | –            |                  | –               |
| Increase in retirement age                               | –            |                  | (–)             |
| Lowering of employment protection                        | 0            | –                | +               |
| Product market deregulation                              |              | +                | (–)             |
| Financial market deregulation                            | 0/–          | 0/+              | (0/–)           |

Note: +, –, 0 denote, respectively, a significant rise, a significance fall, and no significant change in the dependent variable. The reported results refer to the medium- to long-run effect in all cases but product market regulation reform, where the short-run effect is shown. Results for the current account regressions are reported in parentheses if the findings from the preferred saving and investment equations imply an impact which cannot be detected in the current account estimates. The lower half of the table reports the impact of structural policies over and above any impact that works through changes in macroeconomic conditions (e.g. product market deregulation may raise investment not only directly but also indirectly through higher productivity growth).

Figure 4 shows the simulated response of saving rates in selected countries under both the global and the euro area fiscal scenario (relative to a no-change baseline), and Figure 5 illustrates the implied impact on the size of global and intra-euro-area imbalances (measured as the GDP-weighted sum of the absolute saving-investment-gap-to-GDP ratios of all countries in the region).<sup>79</sup> All countries with the exception of China (which is assumed to leave its budget balance unchanged) are assumed to adjust their underlying primary balance so as to stabilise the debt-to-GDP ratio over the long term, as embodied in the long-term baseline scenario presented in the *OECD Economic Outlook 87*.<sup>80</sup> Fiscal tightening is implemented in equal steps over a period of 15 years (see Table 7 for an overview of the magnitude and timing of fiscal measures).

Figure 4. **Simulated current account impact of illustrative structural reforms and fiscal consolidation scenarios**

Percentage point deviation from no-change scenario

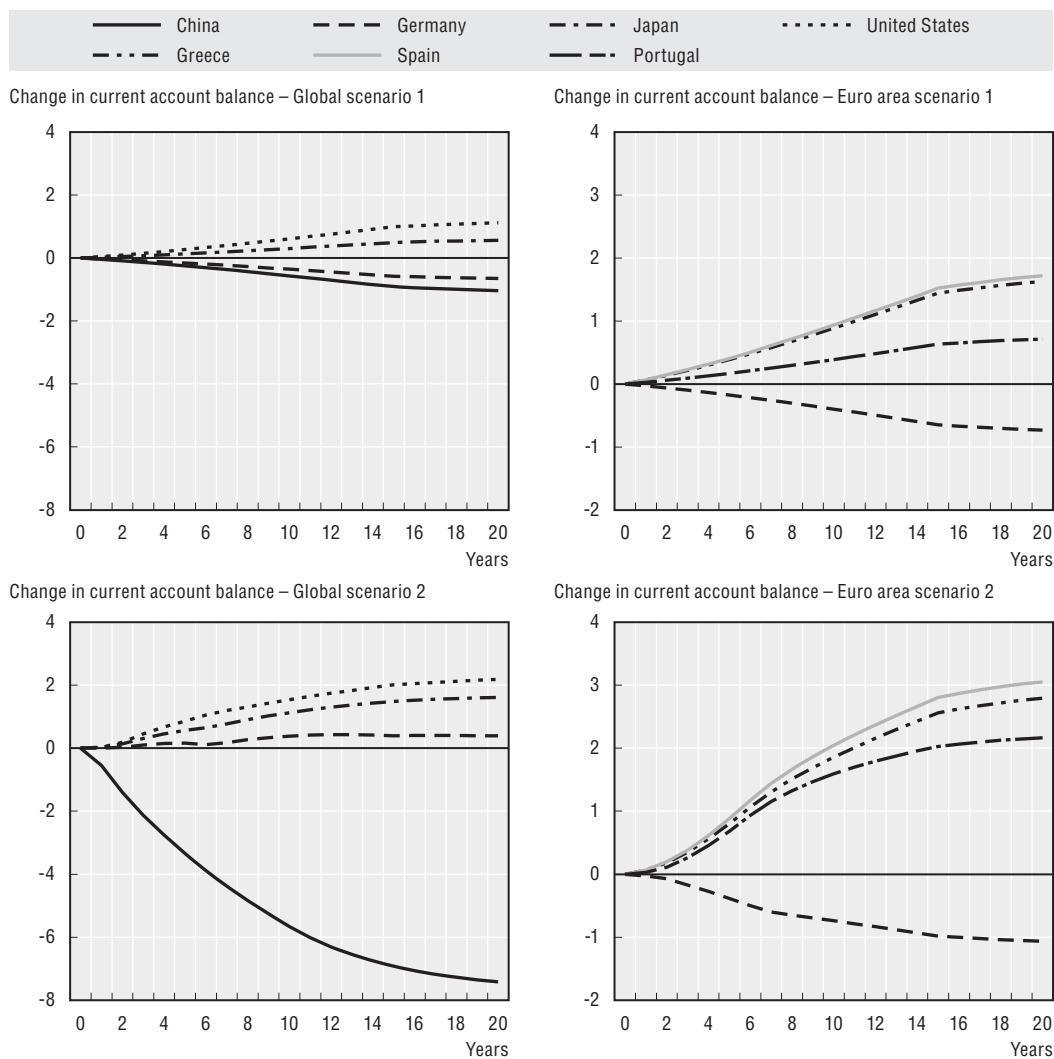


Table 7. **Assumptions underlying the scenario analysis**

|                                                                  | Change in government net lending              | Product market reform (change in economy-wide PMR indicator)          | Change in public social spending on health    | Financial market reform (change in FRI) | Labour market reform (change in EPL indicator) |
|------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------|------------------------------------------------|
| <b>Global scenarios</b>                                          |                                               |                                                                       |                                               |                                         |                                                |
| United States                                                    | 7.3% of GDP, split evenly over first 15 years |                                                                       |                                               |                                         |                                                |
| Japan                                                            | 5.4% of GDP, split evenly over first 15 years | –0.25, split evenly over first 5 years                                |                                               |                                         |                                                |
| Germany                                                          | 1.3% of GDP, split evenly over first 15 years | –0.46, split evenly over first 5 years                                |                                               |                                         |                                                |
| China                                                            |                                               | –0.80, split over first 10 years with larger reforms in first 5 years | 2% of GDP, split evenly over 1st and 2nd year | 6.50, split evenly over first 10 years  |                                                |
| Unweighted average of other countries in the region <sup>1</sup> | 4.5% of GDP, split evenly over first 15 years |                                                                       |                                               |                                         |                                                |
| <b>Euro area scenarios</b>                                       |                                               |                                                                       |                                               |                                         |                                                |
| Germany                                                          | 1.3% of GDP, split evenly over first 15 years | –0.46, split evenly over first 5 years                                |                                               |                                         |                                                |
| Spain                                                            | 9.6% of GDP, split evenly over first 15 years |                                                                       |                                               |                                         | –2.41, split evenly over first 5 years         |
| Portugal                                                         | 6.2% of GDP, split evenly over first 15 years |                                                                       |                                               |                                         | –2.58, split evenly over first 5 years         |
| Greece                                                           | 9.3% of GDP, split evenly over first 15 years |                                                                       |                                               |                                         | –2.16, split evenly over first 5 years         |
| Unweighted average of other countries in the region <sup>2</sup> | 4.7% of GDP, split evenly over first 15 years |                                                                       |                                               |                                         |                                                |
| <b>Specifications</b>                                            | Table 1 (SAVT)                                | Table 3 (INVT)                                                        | Table 5 (SAVT)                                | Table 5 (SAVT)                          | Table 3 (INVT)                                 |

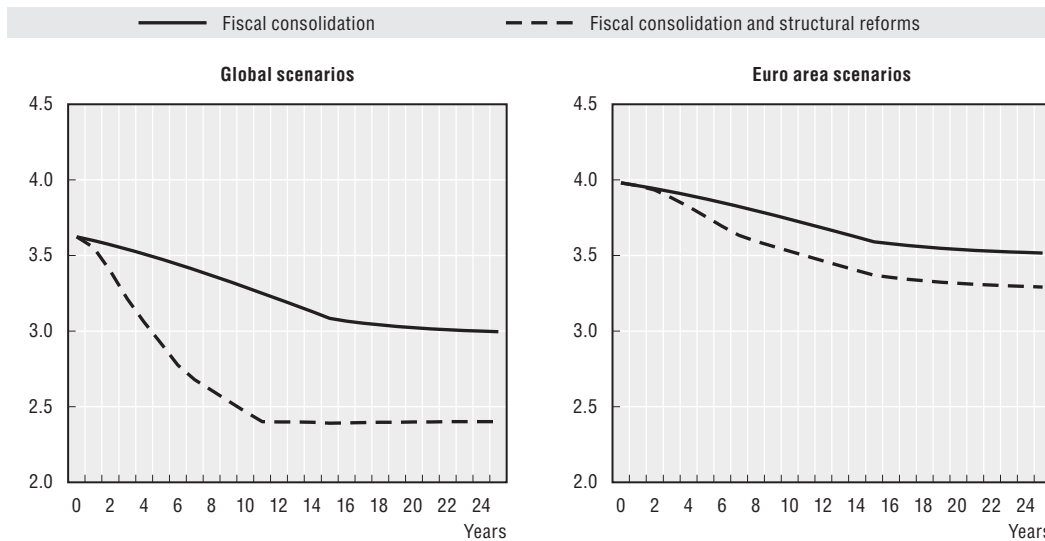
1. Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Korea, Netherlands, New Zealand, Norway, Poland, Portugal Slovak Republic, Spain, Sweden Switzerland, United Kingdom.
2. Austria, Belgium, Finland, France, Ireland, Italy, Netherlands, Slovak Republic.

Overall, as fiscal tightening would be stronger in deficit countries than in surplus countries, global and intra-euro-area imbalances would narrow as a result of fiscal consolidation, although only to a limited extent (Figure 5). Fiscal consolidation in the United States would raise the aggregate saving rate, thereby reducing the country's saving-investment gap. However, due to private saving offsets and due to the simultaneous fiscal tightening in other countries, the gap would decline by less than the improvement in the government's budget balance, i.e. by just 0.6 percentage points of GDP over the next decade and by about 1¼ percentage points of GDP over the full 25 year simulation horizon considered here. In Japan, fiscal tightening would raise the currently positive saving-investment gap by slightly over half a percentage point of GDP over the next two decades. In Germany, the positive saving-investment gap would fall, reflecting the smaller effort needed to stabilise the debt-to-GDP ratio compared with other countries. As for other euro area countries, fiscal tightening would, for example, reduce the saving-investment gap in Spain, Portugal and Greece.

The second set of scenarios investigates how saving-investment gaps would be affected if countries were to implement structural reforms in addition to the fiscal measures. The reform packages that underlie the scenarios are designed with the view to reducing current account imbalances in countries with sizeable deficits or surpluses. However, other desirable, growth-enhancing structural reforms ignored here may or may not be associated with a reduction in saving-investment gaps.<sup>81</sup> In the global scenario,

Figure 5. **Simulated impact of structural reforms and fiscal consolidation on a summary measure of global and intra-euro-area imbalances**

% of region-wide GDP



Note: The size of imbalances is measured as the sum of the absolute saving-investment-gap-to-GDP ratios of all countries in the region, weighted by 2009 GDP (in current USD). The starting values are based on the current-account-to-GDP ratios in 2009. Global scenario 1 and Euro area scenario 1 only feature fiscal adjustment, whereas Global scenario 2 and Euro area scenario 2 feature fiscal adjustment and structural reforms.

Source: Simulations based on assumptions presented in Table 7.

Japan, Germany and China are assumed to deregulate their product markets so as to align their level of regulation with OECD best practice (defined as the average of the top three performing countries). In addition, China is assumed to implement over the next decade financial market reforms that are similar in magnitude to those undertaken between 1995 and 2005, and to increase social spending on health by 2 percentage points of GDP, split equally over the first and second years. The increase in public health spending is assumed to be fiscally neutral, so that the government budget balance remains unchanged. For the euro area scenario it is assumed that Germany deregulates its product markets and that Spain, Portugal and Greece deregulate their labour markets, aligning the level of their EPL indicator to OECD best practice (see Table 7 for an overview of the magnitudes and timing of simulated structural reforms). This second set of scenarios accounts both for the direct effect of product market reforms, based on the preferred specifications from Section 3, and for their indirect impact via higher productivity growth, using estimates by Boulhol *et al.* (2008).<sup>82</sup>

The removal of competition-unfriendly product market regulation in Japan, Germany, and China would temporarily reduce the saving-investment gaps of all three countries. In the year after the reform is fully phased in, the investment rate of Germany would be 0.4 percentage points above its pre-reform level, whereas those of Japan and China would be 0.15 and 0.2 percentage points higher, respectively. The increase in public health expenditure in China would reduce the country's saving-investment surplus by a further 4 percentage points of GDP, with more than half of the adjustment complete after about five years.<sup>83</sup> The decline in the surplus attributable to structural reforms could reach over 5 percentage points of GDP if China also were to implement financial market reforms. Overall, a combination of fiscal tightening/loosening and structural reforms would reduce

global imbalances by about one-third over the forecast horizon, compared with one-sixth in the pure fiscal scenario (Figure 5). Similarly, the structural reforms that underpin the euro area scenario would contribute to a narrowing of intra-euro-area imbalances. While, overall, the size of this effect would be rather modest, saving-investment gaps would be reduced significantly in the smaller euro area countries (Figure 4).<sup>84</sup> The simulated contribution of structural reforms to the reduction in global and intra-euro area imbalances represents a lower-bound estimate since their indirect impact through changes in macroeconomic conditions is not fully taken into account.<sup>85</sup> Moreover, it should be kept in mind that the summary measure of imbalances used here implicitly takes zero current accounts as the benchmark. It seems plausible that observed current account imbalances are at least partially an equilibrium phenomenon, so that there would be no need to bring them fully back to zero. To the extent that this is the case, the share of any undesirable imbalance that could be reduced through structural reforms would be bigger than computed here.<sup>86</sup>

## Notes

1. Within the scope of this paper, structural policy reforms are defined as all reforms that may enhance long-run living standards, as analysed for instance by the OECD in its *Going for Growth* process.
2. This mechanism was strengthened insofar as the corresponding income loss in oil-importing countries was considered as temporary.
3. Some authors have also pointed towards too lax monetary policy (in particular in the United States) as a source of too low interest rates (e.g. Obstfeld, 2010; Obstfeld and Rogoff, 2009), though this view is heavily disputed (for example, Bernanke, 2010, concludes that there is little empirical support for this proposition).
4. Equilibrium may also be restored through changes in other macroeconomic variables and in particular in interest rates.
5. For example, a reform that boosts consumption would put upward pressure on the relative price of non-tradables and thereby weaken the trade balance to a point where the current account balance equals the (new) saving-investment balance.
6. In countries where private pensions are dominant, retirees might also gain from increased profits.
7. If a distinction is made between tradable and non-tradable goods, the saving impact of an income shock will also depend on whether consumers are more concerned about keeping overall consumption stable over time, or keeping the composition of the consumption basket stable and on the sector in which the shock occurs, since disturbances that affect the relative price structure over time also affect the optimal path of consumption and external borrowing (Dornbusch, 1983 and Fournier and Koske, 2010).
8. Aglietta et al. (2007) provide simulations of the impact of different pension reforms on aggregate saving in an overlapping-generations model.
9. This holds insofar as the effective retirement age also rises, as has typically been the case in the aftermath of past increases in the statutory retirement age across OECD countries (see, e.g. Duval, 2003). However, if the effective retirement age increases by less than the statutory age and individuals self-finance retirement ahead of the statutory age in order to stick with their original retirement plans, the saving rate might temporarily increase following the reform.
10. Although individuals may leave some of their wealth to their heirs, the size of the bequest should not rise indefinitely over generations.
11. Ultimately, the investment decision of a firm should not depend on the absolute price of an investment good but on its relative price vis-à-vis alternative factors for production. In this sense, reforms that affect the price of labour or other inputs should also influence the investment rate, with the size and the direction of the impact depending on the rate of substitution between production factors. For example, Alesina et al. (2002) show that higher government spending on

wages has a sizable negative impact on private investment and attribute this result to wage spillovers between the public and private sectors.

12. The productivity-induced rise in profits may at least partially be offset by higher real interest rates or by declining world market prices – as has happened in the 1990s and 2000s in some countries that enjoyed large productivity gains in the production of ICT goods.
13. Higher uncertainty can be thought of as raising the magnitude by which the return on investment must exceed its cost (Dixit and Pindyck, 1994) or by directly raising costs (Abel and Eberly, 1994).
14. This may have been one reason why the surge in corporate profits in China over the past decade translated in an increase in retained earnings rather than in higher dividend payouts (*e.g.* Jha *et al.*, 2009). It may also explain why companies in advanced economies increased net savings during the recent crisis.
15. This may partially explain for instance the persistent and sizeable imbalances within the euro area.
16. See Kerdrain *et al.* (2010) for further details on the policy indicators used as well as on data sources and construction.
17. The impact of indicators of overall institutional quality is not addressed in the analysis since a recent OECD study could not find any significant effect of this factor on saving and investment rates (Cheung *et al.*, 2010).
18. All OECD member countries apart from Chile, Israel and Slovenia. The time dimension of the sample varies by country and by specification with the maximum time period covered being 1965 to 2008.
19. 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.
20. For this broader country set no data on private saving and investment rates are available.
21. For all macroeconomic control variables, a five-year average is calculated whenever data are available for at least three years; otherwise, the data point is reported as missing. For policy variables, an average is calculated whenever data are available for at least one year. For some of the policy variables data are only available for a single five-year time window (or even just a single year), in which case the analysis is reduced to a pure cross-section regression.
22. The budget balance is excluded from the static regressions that involve non-OECD countries as data for this variable are available only for a very small number of non-OECD countries.
23. Other variables that were initially included in the baseline regressions for the OECD sample but later dropped due to insignificance or lack of robustness include the GDP shares of the capital stock and the net foreign asset position, inflation, inflation volatility, GDP growth volatility, and the unemployment rate.
24. The main exceptions are the youth dependency ratio and the real interest rate which are neither significant for total nor for private saving in a pure – but arguably inappropriate – country fixed-effect regression that neither controls for common shocks nor for country-specific time trends. Moreover, the coefficient on the youth dependency ratio changes its sign when including country-specific time trends instead of period fixed effects.
25. An improvement in a country's terms of trade increases real income, measured as the purchasing power of its exports, therefore affecting private saving in the same way as income growth (*e.g.* Ostry and Reinhart, 1991). The finding of a significantly positive relationship with the terms of trade is in line with other macroeconomic studies on the determinants of saving (*e.g.* Ferrucci and Miralles, 2007; de Mello *et al.*, 2004; de Serres and Pelgrin, 2003; Loayza *et al.*, 2000).
26. While the expected longer longevity which is typically associated with a rise in the old-age dependency ratio and which may encourage younger people to increase their saving rate may counteract the effect of a higher share of dis-savers, the latter effect apparently dominates.
27. The medium to long-run elasticities obtained from the regressions for OECD countries and the elasticity obtained from the regression for OECD and non-OECD countries are very close to those reported, for example, by Cheung *et al.* (2010) and Furceri and Mourougane (2010).
28. While the negative short-run effect is consistent with the typical humped-shaped saving rate profile across age cohorts, the positive medium- to long-run effect could be explained by medium-

- aged households increasing their saving rate in response to a rise in the youth dependency ratio to prepare for future education expenses.
29. The results should be interpreted with care, however, since the specifications do not control for possible reverse causality between government budget balances and saving rates.
  30. This elasticity is close to that obtained in previous OECD work (de Serres and Pelgrin, 2003; de Mello *et al.*, 2004) and somewhat larger than that obtained here for the broader OECD/non-OECD sample.
  31. The baseline specifications with country-specific time trends tend to produce somewhat better out-of-sample forecasts (results not shown).
  32. Equations that feature policy variables yield indeed better out-of-sample forecasts for a number of countries, including in particular Spain and the United States.
  33. A number of other variables were initially included in the dynamic panel baseline specifications but were later dropped because of insignificance. These are the GDP shares of the capital stock and the net foreign asset position and GDP growth volatility.
  34. The results are also robust to a change in the precise calculation of the user cost variable. For example, when assuming a uniform depreciation rate of 11.8% (which corresponds to the sample mean) across countries and time, a 1 percentage point decline in the user cost of capital is estimated to raise total and private investment by respectively 0.26 and 0.20 percentage points of GDP.
  35. The real interest rate effect appears to be about five times larger for OECD than for non-OECD economies, whereas for the other explanatory variables, there is no evidence that elasticities differ between OECD and non-OECD countries.
  36. Equations that feature policy variables yield better out-of-sample forecasts for several countries, including Japan, Germany and the United Kingdom, among others.
  37. The set of explanatory variables does not feature the real exchange rate since it is jointly determined with the current account.
  38. For product market regulation see, for example, Scarpetta and Tressel (2002), Nicoletti and Scarpetta (2003), Conway *et al.* (2006) and the literature review by Schiantarelli (2008); for employment protection legislation see, for example, Scarpetta and Tressel (2002; 2004) and Bassanini and Venn (2007); for financial market reform see, for example, de Serres *et al.* (2006) and the literature surveys by Levine (2005) and Papaioannou (2007); and for innovation policy, see Box (2009).
  39. Though quantitatively of minor importance (especially in the short to medium run), it should be noted that structural policies may affect saving and investment also through the demographic variables. Examples include improvements in the availability of early childcare places (which might raise fertility) or improvements in health care provision (which might increase longevity).
  40. The finding is robust to variations in the sample and in the precise specification (see Kerdrain *et al.*, 2010).
  41. Total public social spending includes, among others, public spending on old age, survivors, incapacity-related benefits, health, family, active labour market programmes, unemployment, and housing.
  42. Public social spending on old age includes, among others, spending on pensions and residential care/home-help services.
  43. Insofar as the social welfare reforms affect the level of employment (*e.g.* in the case of pension or unemployment benefit reform) they should also alter investment. However, this effect is likely to be of secondary importance, as also suggested by the current account regressions.
  44. When dropping the real interest rate from the set of control variable, total public social spending comes out as significantly negative also in the model with period and country fixed effects.
  45. According to Engen and Gruber (2001), cutting the unemployment benefit replacement rate by half would increase gross financial asset holdings by 14% for the average worker.
  46. Specifically, the authors examine the means tests of the AFDC/TANF programs (Aid to Families with Dependent Children and Temporary Assistance for Needy Families) and of Medicaid. However, Hurst and Ziliak (2006) and Sullivan (2006), also looking at the AFDC/TANF programs, cannot find any evidence that means tests discourage asset holding.

47. While the variable is insignificant in the specification with country-specific time trends (see Kerdrain *et al.*, 2010), this result may be due to the specific way in which such reforms are implemented – namely step-wise increases in the retirement age phased in over a period of several years – which make the variable essentially collinear to a linear combination of a country-specific dummy and a country-specific trend.
48. While a rise in the retirement age may temporarily boost the saving rate through higher productivity growth, this indirect effect is likely to be too small to offset the direct effect in a noticeable way (see Barnes *et al.*, 2011 for an estimate of the GDP per capita effect of a rise in the retirement age).
49. Attanasio and Brugiavini (2003) look at a simultaneous rise in the retirement age and a cut in the level of benefits. The positive relationship could thus be interpreted in the sense that the effect of the benefit cut dominates or that the analysis captures the immediate impact of an increase in the retirement age with individuals increasing their saving in order to self-finance a retirement ahead of the new retirement age so as to stick to their pre-reform retirement plans.
50. Income risk is typically measured by either the variance of income over time (*e.g.* Guariglia and Rossi, 2002; Zhou, 2003; Hurst *et al.*, 2005; Bartsch, 2006) or by self-reported information on the future employment and/or earnings outlook (*e.g.* Lusardi, 1997; Harris *et al.*, 2002; Carroll *et al.*, 2003; Benito, 2006). Regarding the magnitude of the effect, Lusardi (1997) finds, for example, that precautionary wealth accumulation ranges from one-fifth to one-quarter of the total wealth accumulation of Italian households, whereas Hurst *et al.* (2005) conclude that precautionary wealth accounts for less than 10% of total household wealth in the United States.
51. Although the variable comes out as significant in the specification that features country-specific time trends (see Kerdrain *et al.*, 2010), this result does not appear to be robust across different country samples.
52. Bassanini *et al.* (2010) point out that the indicator of employment protection on temporary contracts must be handled with care due to strong enforcement issues in several OECD countries. However, restricting the sample to countries with good law enforcement – defined as those with an average score on two enforcement indicators (integrity of the judicial system and the enforcement of contracts) that is above the median of the sample (see Bassanini *et al.*, 2010) – does not change the results.
53. No evidence of such an interaction effect is found for the OECD sample (results not shown), possibly reflecting the higher level of benefits in these countries (which, during the sample period, was generally above the significance threshold found for the broader country set).
54. However, stronger employment protection may be detrimental to investment in specific sectors. For example, OECD (2003b) provides some indicative evidence that ICT investment is lower in countries with strong EPL, which may reflect higher workforce adjustment costs that limit firms' profitability from investments.
55. The finding is robust to most (though not all) variations in the specification (see Kerdrain *et al.*, 2010, Tables A1.8 and A1.11) and also to variations in the sample, including the omission of countries with poor law enforcement (see Kerdrain *et al.*, 2010, Table A1.9 and Figures A1.15 and A1.16).
56. Detrimental effects of strict EPL on FDI inflows are confirmed by several recent studies (*e.g.* Haaland *et al.*, 2003; Nicoletti *et al.*, 2003; Görg, 2005; Javoric and Spatareanu, 2005).
57. There is even some evidence that strict employment protection in a firm's home country makes this firm reluctant to relocate abroad, at least temporarily (Dewit *et al.*, 2009).
58. By construction, the values of the EPL indicator range from 0 to 6. In 2008, the average value across all OECD countries was 1.94 and the standard deviation was equal to 0.85. For the average OECD country, a decline in the EPL indicator by one standard deviation would be equivalent to bringing it down to the stance observed, on average, in the five most liberal OECD countries (Australia, Canada, Ireland, the United Kingdom, and the United States).
59. The EPL indicators are, however, not statistically significant in the specification that features country-specific time trends (Kerdrain *et al.*, 2010, Table A1.8).
60. There is no evidence that labour market reforms affect the speed at which investment adjusts to its new equilibrium level following a macroeconomic shock to the economy (results not shown).
61. The more responsive investment is to the marginal profitability, the higher the steady state capital stock.

62. In the latter case only the *gross* investment rate is affected, whereas in all other cases it is also the *net* investment rate that changes.
63. Although the specification with country-specific time trends indicates that product market deregulation is detrimental to investment in the medium to long run, this result appears to be driven by a small number of countries. Previous studies on the link between product market regulation and investment also use specifications without time trends (e.g. Vartia, 2008).
64. Figure 4 shows the investment effect of a *one-standard-deviation* increase in the indicator of regulation in seven non-manufacturing industries. By construction, the values of the indicator on regulation in seven non-manufacturing industries range from 0 to 6. In 2007, the average value across all OECD countries was 2.13 and the standard deviation was equal to 0.63. For the average OECD country, a decline in the regulation indicator by one standard deviation would be equivalent to bringing it close to the stance observed in some of the most liberal OECD countries (Australia, Denmark and Spain, where regulation is estimated to be somewhat more stringent than in the most liberal countries, Germany and the United Kingdom).
65. The regressions for the broader country dataset which make use of the World Bank's *Doing Business* indicators also point to a possible negative link between some regulations and investment (Table 4).
66. By reducing precautionary saving through higher job turnover, product market deregulation may also affect the saving rate.
67. The outcome indicators are the GDP shares of stock market capitalisation and stock market trade (which have the disadvantage of being driven by changes in the valuation of listed companies, thus capturing wealth effects) and credit to the private sector (which is likely to be endogenous to saving decisions).
68. For example, Loayza *et al.* (2000), Bandiera *et al.* (2000) and Sarantis and Stewart (2001) find a negative impact of financial market development on saving rates, whereas Cheung *et al.* (2010) and Hüfner and Koske (2010) are unable to establish a significant link.
69. Moreover, Henry (1999) provides some evidence that stock market liberalisation leads to private investment booms in less developed countries.
70. The specifications with time trends even point to a detrimental effect of financial market reforms in the medium to long run, though the significance of this effect hinges crucially on the set of countries that are included in the regression.
71. This negative effect of financial development on current accounts has been found to be greater in the presence of a strong legal system that increases the returns on investment through increased transparency and predictability of economic activity (Chinn and Ito, 2007).
72. If capital markets are not perfect there might be an additional effect beyond the user cost as taxes affect the after-tax earnings from existing projects and hence the internal funds available to finance future investment (see the discussion in Section 2).
73. As pointed out by Hassett and Hubbard (2002), investment and tax policy tend to move together over the business cycle, which makes it difficult to establish the user cost effect based on aggregate data. For example, policymakers introduce investment tax credits when investment is perceived to be low and remove them when investment is perceived to be high (Cummins *et al.*, 1994; OECD, 2009).
74. Tax policies affect individual firms differently as the composition of the capital stock varies across firms, making it possible to identify the effect of tax policies based on *differences* in investment response across different types of firms.
75. These coefficient estimates from the baseline specifications in Table 1 are combined with coefficient estimates from other specifications in order to simulate the impact of structural reforms. An overview on the precise specifications used is provided in Table 7.
76. All OECD countries with the exception of Chile, Israel, Luxembourg, Mexico, Slovenia and Turkey, which are excluded due to data availability problems.
77. The results of the scenario analysis are consistent with any kind of exchange rate regime. It is implicitly assumed that the exchange rate adjusts so as to make the current account balance equal to the saving-investment gap.
78. Although the regressions for the OECD/non-OECD sample do not provide evidence that the effects of policies differ significantly between OECD and non-OECD countries, it cannot be ruled out that the elasticities would be different for a specific country such as China. Indeed, the size of the sample does not allow to properly test for coefficient heterogeneity for one particular country.

79. This measure of imbalances does not account for possible non-linearities (especially threshold effects), thus ignoring for instance that larger imbalances may be associated with disproportionately larger global systemic risk. However, giving more weight to larger surpluses and deficits by using the square instead of the absolute value of individual countries' current account balances yields qualitatively similar results.
80. However, the relatively modest pace of the assumed consolidation is such that in most cases the debt-to-GDP ratio first increases further before stabilising.
81. For example, if all OECD countries were to undertake product and labour market reforms so as to align their level of regulation with OECD best practice, the decline in global imbalances would be somewhat larger than found here.
82. See Table 3, column 1 in Boulhol et al. (2008).
83. Relaxing the assumption that the increase in health spending is fiscally neutral would lead to an even larger effect.
84. For instance, when using an unweighted measure of imbalances, the overall decline in intra-euro area imbalances due to fiscal measures and structural policies amounts to almost one-quarter.
85. Also, the simulations do not account for possible structural reforms in the United States that might boost saving and thus lower the size of global imbalances (e.g. a reduction of tax deductibility of interest payments on mortgages), the reason being the lack of empirical estimates of the size of the associated saving effects.
86. If by contrast (at least some) countries' observed and equilibrium current account positions were of opposite signs, the contribution of structural reforms to reducing "undesirable" imbalances would be less than computed here against the zero benchmark.

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## ANNEX

*Dealing with (almost) time-invariant explanatory variables*

While it is possible to estimate a fixed effects model with almost time-invariant variables, this is likely to produce inaccurate point estimates for the coefficients of these variables since the between variance (the variation across countries which is disregarded in a fixed effects regression) accounts for a large share of the total variance of these variables, whereas the within variance (the variation across time which is exploited for inference) only accounts for a small share (for time-invariant explanatory variables the model cannot be estimated at all). Several solutions are available to deal with this issue. First, the country-specific effects could be dropped from the specification, implicitly assuming that what is not already explained by the regressors in the equation – including omitted fixed effects – is randomly distributed and uncorrelated with the regressors. Second, this distribution could be explicitly taken into account by estimating a random effects model. Both solutions add information to the model in order to (better) identify the impact of almost time-invariant variables. However, both will be biased if some regressors are correlated with the country fixed effects, which is likely to be the rule rather than the exception in many applications, including the present one.

Plümper and Troeger (2007) propose a new three-step estimator to make inference about the impact of time-invariant and almost time-invariant regressors. However, as pointed out by Greene (2010) and Breusch *et al.* (2011), the procedure produces downward biased standard errors. Nonetheless, several important insights emerge from the Plümper and Troeger (2007) approach. First, almost-time invariant variables should be treated in the same way as time-invariant ones since they carry similar types of information. Second, even though the fixed-effects model produces unbiased estimates, departing from the fixed-effects model can be reasonable in order to gain efficiency and obtain coefficient estimates with a smaller variance. Third, it is possible to pursue this approach while still controlling at least partially for the presence of country-specific effects.

To formalise, let the model be of the following general form:

$$Y_{it} = X_{it}\beta + Z_{it}\gamma + u_i + \varepsilon_{it} \quad (A1)$$

where  $Y_{it}$ ,  $u_i$  and  $\varepsilon_{it}$  are scalars,  $X_{it}$  and  $Z_{it}$  are row-vectors, and  $1 \leq i \leq N$  and  $1 \leq t \leq T$ . The vector  $Z_{it}$  contains both time-invariant and almost-time invariant variables, while  $X_{it}$  contains the remaining regressors which have sufficient time-variation. The error terms  $\varepsilon_{it}$

are assumed to be centred and uncorrelated with each other and also uncorrelated with both  $X_{it}$  and  $Z_{it}$ . The country random effects  $u_i$  capture cross-country differences in  $Y_i$  that are not already captured by  $X_i$  and  $Z_i$  (where  $Y_i$ ,  $X_i$  and  $Z_i$  denote the averages of  $Y_{it}$ ,  $X_{it}$  and  $Z_{it}$  over time). It is assumed that the  $u_i$  follow some centred random distribution and are uncorrelated with all  $\varepsilon_{it}$ .

To estimate the model, one needs to instrument  $Z_{it}$ , meaning that a set of variables must be identified that are uncorrelated with the residual  $u_i + \varepsilon_{it}$  but correlated with  $Z_{it}$  (for simplicity, variables that are not part of the model are excluded as potential instruments).<sup>\*</sup> If no additional assumption is made about the correlation between  $(X_{it}, Z_{it})$  and  $u_i$ , the list of potential instruments reduces to  $(X_{it} - X_i, Z_{it} - Z_i)$ , from which (non-identifiable) purely time-invariant  $Z$ 's are dropped. Therefore, the fixed effects estimator becomes the proper instrumental variables estimator. If it is instead assumed that there is no correlation between  $(X_{it}, Z_{it})$  and  $u_i$ , the between information embedded in  $X_{it}$  and  $Z_{it}$  can be fully exploited. The list of exogenous variables is  $(X_{it}, Z_{it})$  and the optimal linear estimator is the classical random-effects estimator. The random-effects estimator is more efficient than the fixed-effects estimator, but only if this additional assumption is satisfied; otherwise the random-effects estimator is inconsistent and the fixed effects estimator should be preferred.

One way to achieve a reasonable consistency-efficiency trade-off between these two extreme alternatives is to use only some of the cross-sectional information embedded in  $X_{it}$  and  $Z_{it}$ . Assuming that sufficiently good inference on  $\beta$  can be made with the fixed effects estimator, additional information on  $X_{it}$  is not necessary, especially if it is also believed that  $X_{it}$  is more likely to be correlated with the  $u_i$  than  $Z_{it}$  is. Since  $\gamma$  is the problematic parameter and since one wishes to exploit the cross-country variations of  $Z_{it}$ , using  $Z_{it}$  as an instrument, but not necessarily directly  $X_{it}$ , looks natural.

Following these ideas, this paper uses an alternative estimator to obtain an estimate of the coefficient vector  $\gamma$ . The work builds upon the results of Breusch *et al.* (2011), who show that in the case of strictly time-invariant variables the estimator proposed by Plümper and Troeger (2007) is in fact an instrumental variable estimator. Defining  $\tilde{X}_{it}$  as the projection of  $X_{it}$  onto the orthogonal of  $Z_{it}$  and the country-dummies – i.e. the residual of a regression of  $X_{it}$  on  $Z_{it}$  and county dummies (if the entire  $Z_{it}$  is time invariant, then  $\tilde{X}_{it}$  simply reduces to  $\tilde{X}_{it} = X_{it} - X_i$ ) – then the set of instrumental variables could be either  $(X_{it} - X_i, Z_{it})$  or  $(\tilde{X}_{it}, Z_{it})$ . Both sets of instruments use the between information for  $Z_{it}$ , but not for  $X_{it}$ . To be consistent, it must be assumed that the  $Z_{it}$  are uncorrelated with the unobserved  $u_i$ , but no assumption is needed with respect to the joint distribution of  $u_i$  and  $X_{it}$ . While both sets of instruments could be used to estimate the model with generalised two-stage least squares, the second set is preferred in the application since it produces slightly more robust results than the first one (though the conclusions are comparable). Indeed, the generalised two-stage least squares approach with instruments  $(\tilde{X}_{it}, Z_{it})$  has the additional desirable property that the estimate of  $\beta$  is exactly equal to that obtained from the fixed-effects regression. Hence, if  $\text{cov}(Z_{it}, u_i)$  is in fact non-zero, then only the estimate of  $\gamma$  is biased, whereas the estimate of  $\beta$  is sheltered from this risk.

<sup>\*</sup> Baltagi (2008) discusses the instruments and the GLS correction that can be used to estimate the model in the case of time-invariant  $Z$ '.

While this estimator resembles that of Plümper and Troeger (2007) in its spirit, it is different in two important respects. *First*, the standard errors are trustworthy and, *second*, the feasible GLS method ensures higher efficiency. Even in the case when  $\text{cov}(Z_{it}, u_i)$  is non-zero, but remains small, the additional information used by the proposed estimator can still improve the estimate of  $\gamma$  relative to the fixed-effects estimator. Indeed, as demonstrated by Plümper and Troeger (2007) with some simulations, a small bias can be a fair cost for a much lower variance in terms of the root mean square error criterion.

# How Can Fiscal Councils Strengthen Fiscal Performance?

by  
Robert Hagemann\*

*There is growing interest in the role of independent fiscal institutions, or fiscal councils, in helping to improve fiscal performance. This article provides some guidance on the scope for improving fiscal performance through fiscal councils based on the available literature and the range of fiscal institutions in the OECD countries. The effectiveness of fiscal councils hinges on several factors, including having full autonomy within the scope of their mandates, active and unfettered dissemination of their analysis, and their credibility. Experience and empirical evidence suggest that delegating macroeconomic forecasting to an independent fiscal council can indeed reduce forecasting bias. There is some empirical evidence that independent fiscal institutions can buttress a government's capacity to comply with a numerical rule. Good fiscal institutions are a necessary condition for achieving disciplined fiscal performance. Experience demonstrates, however, that their existence is not sufficient. Without strong and sustained political commitment to a medium-term fiscal goal and, where relevant, to the mandate of a fiscal council, durable improvements in fiscal performance will remain elusive.*

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There is growing interest in the role of independent fiscal institutions, or fiscal councils, in helping to improve fiscal performance. At its most basic level, a fiscal council is a publicly-funded entity staffed by non-elected professionals mandated to provide non-partisan oversight of fiscal performance and/or advice and guidance – from either a positive or normative perspective – on key aspects of fiscal policy. The increased interest is found not only in academic circles and international organisations, but among governments as well. In the past several years alone, new institutions have been established in Canada, Ireland, Portugal, Sweden, and the United Kingdom.<sup>1</sup> As countries begin to grapple with the delicate challenge of consolidating the seriously-deteriorated fiscal positions stemming from the recent crisis, their search for institutional reforms that can deliver fiscal results and provide political cover may well lead to the establishment of yet more fiscal councils.

A fiscal council can contribute to improved fiscal performance in a variety of ways, but it is no “silver bullet” for securing and maintaining fiscal discipline. By depoliticising various aspects of fiscal policy, whether related to formulation or monitoring, fiscal councils can better inform voters on the actual state of fiscal policy and raise the political costs of fiscal indiscipline. There is increasing – albeit still very limited – empirical evidence that the presence of fiscal councils can contribute to better fiscal outcomes. At the same time, there remains some uncertainty over the direction of causation. A fiscally responsible government may wish to create a fiscal council to solidify the credibility it has already gained. Conversely, absent political will, there are no assurances that a new institution such as a fiscal council will help. As von Hagen (2010) has noted: “Fiscal councils may be helpful to strengthen the credibility of medium-term fiscal rules, but only in cases where the government has considerable commitment power to begin with.” Thus, a fiscal council could be either superfluous where strong political commitment is present, or ineffective where it is not.

The purpose of this article is to provide some guidance on the scope for improving fiscal performance through fiscal councils. This article synthesises the available literature on independent fiscal institutions. Section 1 provides a short overview of the principal issues at play, both in terms of the reasons for considering the introduction of a fiscal council (or strengthening existing ones) and key institutional considerations. Section 2 provides information on the range of fiscal institutions in the OECD (without pretence of universal coverage) to draw lessons from their experiences. Section 3 considers evidence on the effectiveness of fiscal councils, while Section 4 offers some concluding remarks.

## 1. The conceptual foundation of fiscal councils

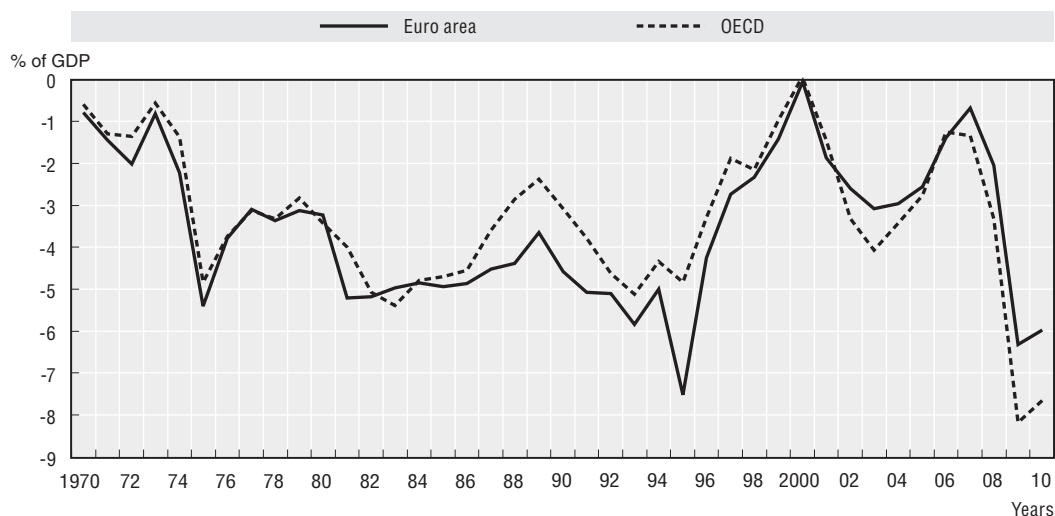
### 1.1. *The persistence of deficits*

Budgetary discipline requires that governments maintain fiscal positions that foster macroeconomic stability and sustainable growth. This in turn calls for counter-cyclical fiscal stances to help smooth output fluctuations, calibrated with sufficient vigilance to

ensure symmetric budgetary impacts over the cycle to avoid an excessive accumulation of public debt. A prudent stance would also allow for the build-up of fiscal cushions to enable governments to respond to unexpected shocks over the medium term and anticipated pressures over the long term, such as implied by population ageing (Heller, 2003; and Kumar and Ter-Minassian, 2007). The overall record in the OECD over the past several decades, however, largely reflects a much more lacklustre record of sustained high deficits and a widespread tendency to adopt and implement pro-cyclical fiscal positions during cyclical upswings, resulting in high levels of public debt.

Deficits have clearly been the norm throughout most of the industrialised world during the past several decades. The overall fiscal balance of OECD economies, as well as in the large majority of its member countries, was in deficit throughout virtually the entire three decades to 2007 (Figure 1). A number of countries, however, have achieved sustained fiscal consolidation, noticeably lowering public indebtedness. Still, in many countries, deficits have been accompanied by sustained high levels of public debt (Figure 2), leaving inadequate fiscal cushions to comfortably respond to the financial crisis. In turn, public debt has now reached post-World War II record levels in many cases. It is widely recognised that sustained high deficits over such long periods can be harmful to long-run economic growth and are incompatible with optimal fiscal strategies, such as tax smoothing. Deficit bias is thus problematic.

Figure 1. **General government net lending**



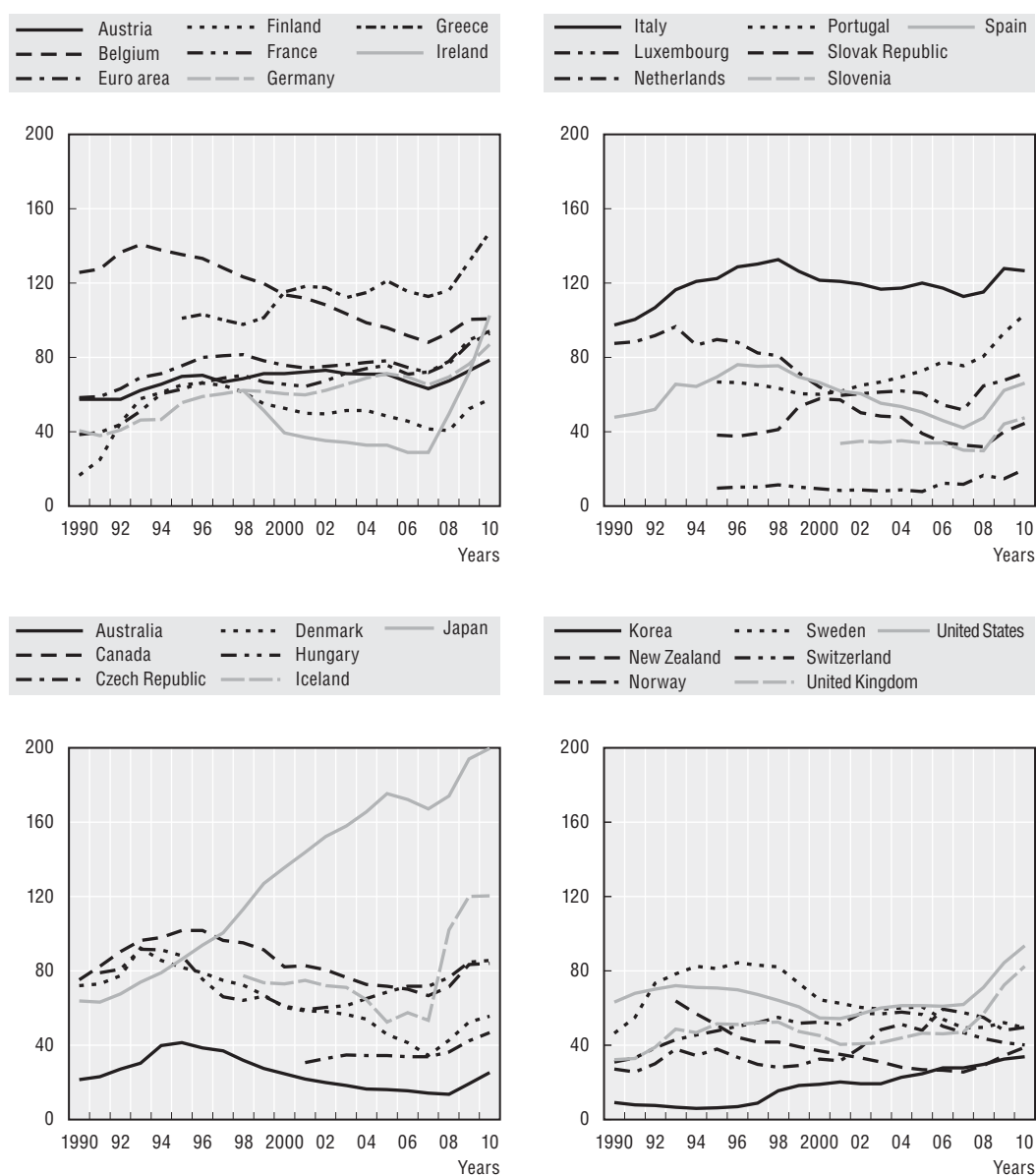
Source: OECD, OECD Economic Outlook 89 Database.

There is ample evidence that deficit bias is accompanied by pro-cyclicality bias as well. Although there are wide differences across regions and countries in the strength of automatic stabilisers, the cyclical movements of budget balances in general appear to be smaller than would result from the operation of the automatic stabilisers alone, implying a tendency toward offsetting discretionary policies (Balassone and Kumar, 2007). For instance, for industrial countries, on average, a 0.3% of GDP improvement in the overall nominal budget balance accompanies a one-percentage point of GDP increase in actual relative to potential output. Set against a larger actual average budgetary impact of automatic stabilisers of around ½ per cent of GDP (van den Noord, 2000; Bouthévilain et al.,

2001; and IMF, 2004), discretionary policies appear to result in a pro-cyclical fiscal stance. Moreover, the tendency toward pro-cyclicality is asymmetric, whereby discretionary policies offset the effects of automatic stabilisers during upturns but not during economic downturns (Balassone and Kumar, 2004).

Figure 2. **Gross public debt in OECD countries**

As a percentage of GDP, 1990-2010



Source: OECD, OECD Economic Outlook Database.

### 1.2. The political economy problem

The persistence of deficits over so long a period in so many countries suggests that factors other than economic conditions are at play. Nordhaus (1975) was among the first to posit a strong relationship between public spending and the political cycle. Researchers

have since focused increasingly on the interplay of political motivations on the one hand and accommodating budgetary practices and institutions on the other as a potentially key determinant of deficit bias (Poterba and von Hagen, 1999).

Political economy considerations are now widely recognised as crucial to understanding the deficit and pro-cyclical biases in fiscal policy. Several explanations are prominent in the literature. First, the deficit bias is related to the short-sightedness and selfishness of policymakers who initiate deficit-augmenting spending or tax-cutting programmes in the interest of re-election (Persson and Svensson, 1989; and Alesina and Tabellini, 1990). Policymakers' myopia is rooted in electoral uncertainty, which weakens their concern about the implications for future tax increases or expenditure cuts of their politically-motivated deficit-increasing favours. In turn, the fiscal behaviour of incumbent legislators will lead to higher deficits than desired by voters (Rogoff, 1990). This behaviour is facilitated by budgetary opacity that masks the fiscal truth, such as when policymakers are vague about economic assumptions underpinning the budget, or when they resort to creative accounting and off-budget financing schemes (von Hagen, 2010). Second, deficit bias can also arise from so-called "common pool" problems. Incumbents enhance their chances of re-election by maximising the marginal benefits of public goods or services (or tax breaks) to their own constituents without internalising to these same constituents the full marginal costs of those commitments. The "common pool" problem is especially problematic to disciplined overall fiscal policy when decentralised fiscal entities can partake in free-rider behaviour, neglecting the impact on the aggregate fiscal position.<sup>2</sup> A third potential cause of deficit and pro-cyclical bias is the well-known problem of time-inconsistency (Alesina and Tabellini, 1990), whereby stated *ex ante* policy positions that are consistent with the national interest are conveniently considered by policymakers to be less desirable *ex post*, when electoral and regional interests dominate. Problems of time inconsistency can also arise when a government saddles a successor (and possible rival) government with a larger debt burden, leaving it less fiscal "space" than otherwise to sustain existing programmes.

In theory, given sufficient transparency, financial markets ought to provide sanctions that are adequate to discourage fiscal indiscipline due to misguided discretion, through several channels (Debrun *et al.*, 2009). First, prospectively higher deficits would signal an increased risk that these would be monetised, raising inflation expectations and long-term interest rates, reducing policymakers' likely options for politically motivated fiscal initiatives. This effect could be further strengthened if credit spreads on public debt increase due to higher perceived risks of default. Second, policymakers may gradually fear the country's rising public debt is approaching a "tipping point", with politically costly near-term adverse effects on economic growth.<sup>3</sup> The evidence, however, is mixed on the extent to which financial markets effectively discipline fiscal profligacy. As a general rule, they tend to react with some delay.<sup>4</sup>

### 1.3. Institutional remedies

Institutional reforms are thought to hold the promise of modifying the decision calculus of policymakers to improve the prospect that fiscal policy will remain supportive of macroeconomic stability. A number of different instruments and approaches can improve policymakers' incentives. One option is to require that fiscal commitments be made clear via fiscal targets set out in a medium-term fiscal framework, with implementation buttressed by procedural and transparency requirements spelled out in a

fiscal responsibility law (Kumar and Ter-Minassian, 2007). New Zealand and Australia stand out in this context. Both committed, through legislation, to fiscal frameworks requiring that budgets take into account the long-term consequences of policies; when budgets depart from a prudent path, the government is obliged to explain how caution is to be restored to fiscal policy. The idea behind such legislation is to force future governments to actually have to repeal the law, which in turn could be politically costly.

Where political commitment is lacking or not sufficiently strong, however, numerical fiscal rules may hold promise of constraining the perverse incentives noted earlier.<sup>5</sup> Fiscal rules have gained popularity. In 1990, only seven countries worldwide had a fiscal rule; by early 2009, either national or supranational rules were in place in 21 advanced economies, 33 emerging markets, and 26 low-income countries (IMF, 2009). Such rules can improve fiscal performance when backed by sufficient political commitment and a fully transparent fiscal process. There is evidence of a positive link between the quality of numerical fiscal rules and fiscal discipline (European Commission, 2005 and 2009; Guichard *et al.*, 2007; and IMF, 2009). At the same time, numerical fiscal rules suffer from several weaknesses. First, unless carefully constructed, rules can in some circumstances (e.g. simple deficit and debt ceilings) result in pro-cyclicality (IMF, 2004). Second, rules can be harmful to the quality of public finances through inadvisable compositional effects when, for instance, pro-growth public investment is cut to respect an expenditure cap (Blanchard and Giavazzi, 2004). Third, where political will is lacking, rules can motivate creative accounting and off-budget operations, undermining transparency and, ultimately, democratic control over the budget (von Hagen and Wolff, 2006).

A third, and potentially complementary, option is the establishment of an independent fiscal body as a practical means of depoliticising fiscal policy. The principal purpose of creating such an entity is to reduce the risks of government failure arising from the problems noted above. At one extreme, one might envisage the complete delegation of authority for setting the fiscal balance and debt target to an independent fiscal authority (IFA), similar to the delegation of monetary policy to an independent central bank. Beyond hypothetical proposals, most of which are surveyed in Debrun *et al.* (2009), no such body exists or is likely to be created. As Kopits (2007) has noted, an IFA “is nonviable because of the difficulty of defining unambiguously a principal-agent relationship at arm’s length for the conduct of fiscal policy”. There are also several implementation problems. First, whereas a pre-defined range of inflation is the usual objective of monetary policy,<sup>6</sup> the twin objectives of fiscal policy – promoting stable economic growth and ensuring fiscal sustainability – can pose difficult conflicting policy challenges when there are uncertainties over the extent and appropriateness of discretionary counter-cyclical policy. Second, the target for monetary policy is usually a specific level of short-term interest rates or the rate of growth of the money supply, which are relatively straightforwardly measured and impacted with predictable lags. Finally, there tends to be fairly broad agreement on what constitutes an excessive rate of inflation. By contrast, consensus is lacking on what is an unsafe level of the fiscal deficit or the optimal level of public debt. As well, the instruments otherwise available to an independent fiscal agency – taxes and public expenditure – would, for distributional concerns, need to remain under the control of elected officials.<sup>7</sup> Thus, and not surprisingly, no country has yet outsourced the formulation of fiscal policy.

There are several ways in which an independent body, or a fiscal council, with more circumscribed responsibilities can potentially contribute to improved fiscal performance.

Broadly speaking, fiscal councils can help by limiting political influence over technical aspects of fiscal policy formulation (from either a positive or normative perspective) or monitoring. With respect to positive economic analysis, fiscal councils can intervene at any number of points in the policymaking process. They can be tasked with making independent macroeconomic forecasts, or providing assumptions or projections of key variables or parameters on which budget projections can be based. Indeed, as previously noted, an important source of deficit bias in practice is an overly optimistic macroeconomic scenario. Empirical evidence demonstrates that macroeconomic forecasts show no statistically significant bias when prepared by independent agencies, in contrast to forecasts in countries that rely on government agencies (Jonung and Larch, 2006; and Hallerberg et al., 2001).<sup>8</sup> Fiscal councils can also be tasked with making independent revenue and expenditure projections, whether based on current or prospective policies. Revenue projections are particularly prone to politically self-interested upward bias, since these create the *ex ante* fiscal space for planning higher spending than otherwise advisable.<sup>9</sup> Fiscal council assessments of long-run fiscal implications of tax and spending initiatives also can contribute to improving the transparency of budgetary decisions that are highly sensitive to demographic developments. In some instances, fiscal councils can be assigned a key role in monitoring fiscal performance under a politically agreed medium-term fiscal framework. Fiscal councils tasked with a mandate to undertake positive economic analysis play an indirect but potentially effective role in limiting politically-motivated deficit bias by improving transparency and helping to highlight the true cost of fiscal decisions.

Less than full delegation of fiscal policy does not, however, pre-empt assigning a normative role to an independent fiscal council. While final fiscal decisions are left to elected officials, a fiscal council's proposal regarding the appropriate stance of fiscal policy and a cautious budgetary path for securing sustainability can play a disciplining role by raising public pressure on officials. Where the government's credibility is particularly weak following a long period of poor fiscal performance, its commitment to a policy framework formulated on the basis of, or in concert with, the normative position of a fiscal council, can help garner public support. Indeed, broad agreement on the fiscal objective and a willingness of the government to fully integrate the fiscal council into the fiscal policymaking process are necessary pre-conditions for a fiscal council to be effective.

Fiscal councils will vary across countries due to a large number of country-specific factors. These include the underlying causes of the lack of fiscal discipline, the political landscape and the party structure, and the existing institutional budgetary arrangements and procedures. But whatever form the council takes and its delegated responsibility, four institutional features will predominate in all cases. First, the agency's mandate must satisfy several criteria. It should be unambiguous and achievable, and the delegated responsibility should have an economic rationale, such as to reduce deficit bias. Second, the agency needs to be assured full discretion in carrying out the tasks necessary to fulfillment of the mandate. Third, accountability is critical; elected officials must be able, on behalf of voters, to conduct *ex post* evaluations of the council's performance to ensure that the delegated powers are in fact being used in pursuit of the agency's mission. Finally, independence from political influence requires adequate firewalls, both in the staffing of the agency and in the latter's everyday operations. Moreover, independence is not unrelated to the agency's funding. The level of public funding must obviously be commensurate with the scope of the agency's mission, and should be protected from

politically-motivated reductions, notwithstanding the difficulties of distinguishing the latter from other apparent reasons.

## 2. The scope of existing fiscal councils

Although fiscal councils remain more the exception than the rule throughout the world, their number is growing. The impetus to create new independent fiscal councils comes both from generally positive experiences in countries in which they have existed, and from increasing support among international organisations for such agencies. The scope of and for independent fiscal institutions has been of interest in the European Commission for some time (see, for instance, European Commission, 2006), and among the staff of the IMF (see, for example, Annett *et al.*, 2005; and Kumar and Ter-Minassian, 2007). Recommendations to consider such agencies have appeared in a number of recent OECD *Economic Surveys*.

While stocktaking of fiscal councils is complicated by the variety of agencies that fit the generic definition of a fiscal council, most in OECD countries tend to fall into three non-exclusive categories.<sup>10</sup> A first set includes bodies that provide independent forecasts used in the formulation of the budget, or against which the official projections are, or can be, assessed. Also included in this group are entities that assess fiscal policy issues using positive rather than normative analysis such as assessing cyclical impacts on the budget or the fiscal implications of budgetary programmes (*e.g.* the medium- and long-term costs of a health care reform). A second group comprises entities with a mandate to provide normative views on the appropriateness of the overall stance of fiscal policy from, say, a cyclical perspective, or the desirable timeline to restore fiscal sustainability. A third category includes councils that are tasked with providing independent forecasts of macroeconomic and budgetary variables needed for the elaboration of the annual budget. Existing institutions include hybrids of these, however, that combine independent macroeconomic and budgetary projections with a mandate to assess performance relative to prior commitments to a medium-term fiscal framework or a numerical rule. Table 1 lists a number of independent fiscal institutions in the EU members of the OECD, together with an enumeration of their tasks. It should be borne in mind that the existence of an institution within the terms of this exercise does not imply that it has either a wide or *ex ante* mandate, or that it is effective in carrying out this role. From the earlier discussion, a particularly important distinguishing feature of a fiscal council is its *ex ante* role in economic diagnostics and providing input into budget formulation, along with (in some instances) real-time monitoring of compliance with an agreed fiscal rule. By contrast, public audit institutions included in the EU survey typically provide *ex post* assessment of performance. Fiscal councils in several other OECD countries are discussed below.<sup>11</sup>

### 2.1. Fiscal councils with a normative mandate

Throughout the OECD, especially in the European Union, the mandates of a number of different types of independent fiscal institutions include the possibility or requirement to take normative positions on various aspects of fiscal policy. Such institutions can include advisory bodies, independent research institutions, and some state audit offices. Where such institutions tend to be most effective is when they are formally integrated into the fiscal policy formulation and monitoring process, and when the government is required to

Table 1. **List of independent institutions considered in the EC study**

| General information         |                                                                               | Tasks to be filled                                                      |                                      |                                   |                                                 |                                              |                                       |                                        |                                                             |                                                                                |                                                                          |
|-----------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------|-----------------------------------|-------------------------------------------------|----------------------------------------------|---------------------------------------|----------------------------------------|-------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------|
|                             |                                                                               | Forecasts and projections of macroeconomic and/or budgetary assumptions |                                      |                                   |                                                 |                                              | Independent analysis on fiscal policy |                                        |                                                             |                                                                                |                                                                          |
|                             | Institution                                                                   | Macro forecasts                                                         | Forecasts for government expenditure | Forecasts for government revenues | Forecasts for government balance and debt level | Long-term projections of government finances | Analysis of budget                    | Monitoring of budgetary implementation | Estimates of short and long-term effects of policy measures | Analysis of whether budgetary plans and outcomes are in line with fiscal rules | Not explicitly in charge of any of these tasks, but fulfils some of them |
| Austria                     | Institute for advanced studies (HIS)                                          | X                                                                       |                                      |                                   | X                                               |                                              |                                       |                                        |                                                             |                                                                                |                                                                          |
| Austria                     | Institute for economic research (WIFO)                                        | X                                                                       |                                      |                                   | X                                               |                                              |                                       |                                        |                                                             |                                                                                |                                                                          |
| Austria                     | Government debt committee                                                     | X                                                                       |                                      |                                   |                                                 |                                              | X                                     |                                        |                                                             |                                                                                |                                                                          |
| Belgium                     | National audit institute                                                      | X                                                                       |                                      |                                   |                                                 |                                              |                                       | X                                      |                                                             |                                                                                |                                                                          |
| Belgium                     | High council on finance (HCF) – Section “Public Sector Borrowing Requirement” |                                                                         |                                      |                                   |                                                 |                                              |                                       |                                        |                                                             | X                                                                              | X                                                                        |
| Denmark                     | Danish Economic Council                                                       | X                                                                       | X                                    | X                                 | X                                               | X                                            |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Estonia                     | State Audit Office                                                            |                                                                         |                                      |                                   |                                                 |                                              |                                       |                                        |                                                             |                                                                                |                                                                          |
| France                      | Commission Économique de la Nation and Conférence Économique Annuelle         | X                                                                       |                                      |                                   | X                                               |                                              | X                                     |                                        |                                                             |                                                                                |                                                                          |
| France                      | Cours des Comptes                                                             |                                                                         |                                      |                                   |                                                 |                                              |                                       | X                                      |                                                             |                                                                                |                                                                          |
| Germany                     | Working Party on tax revenue forecasting                                      |                                                                         |                                      | X                                 |                                                 |                                              |                                       |                                        |                                                             |                                                                                |                                                                          |
| Germany                     | Joint Economic Forecast by 6 leading research institutions (JEF)              | X                                                                       | X                                    | X                                 | X                                               |                                              |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Germany                     | Council of Economic Experts on Overall Economic Trends                        | X                                                                       |                                      |                                   |                                                 | X                                            |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Germany                     | Advisory Board to the Federal Minister of Finance                             |                                                                         |                                      |                                   |                                                 |                                              |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Greece                      | Center of Planning and Economic Research (KEPE)                               | X                                                                       | X                                    | X                                 |                                                 |                                              |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Hungary                     | State Audit Office (ASZ)                                                      |                                                                         |                                      |                                   |                                                 |                                              | X                                     | X                                      |                                                             | X                                                                              |                                                                          |
| Hungary <sup>1</sup>        | Fiscal Council of Hungary                                                     | X                                                                       | X                                    | X                                 | X                                               |                                              | X                                     | X                                      |                                                             | X                                                                              |                                                                          |
| Italy                       | ISAE                                                                          | X                                                                       | X                                    | X                                 | X                                               |                                              |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Luxembourg                  | Court of Auditors                                                             |                                                                         |                                      |                                   |                                                 |                                              |                                       |                                        |                                                             |                                                                                | X                                                                        |
| Netherlands                 | The Netherlands Bureau for Economic Policy Analysis (CPB)                     | X                                                                       | X                                    | X                                 | X                                               | X                                            | X                                     | X                                      | X                                                           | X                                                                              |                                                                          |
| Portugal                    | Court of Auditors                                                             |                                                                         |                                      |                                   |                                                 |                                              |                                       | X                                      |                                                             |                                                                                | X                                                                        |
| Spain                       | Court of Auditors                                                             |                                                                         |                                      |                                   |                                                 |                                              | X                                     | X                                      |                                                             | X                                                                              |                                                                          |
| Spain                       | National Committee of local administration                                    |                                                                         |                                      |                                   |                                                 |                                              |                                       |                                        |                                                             |                                                                                |                                                                          |
| Slovenia                    | Macroeconomic Analysis                                                        | X                                                                       |                                      |                                   |                                                 |                                              |                                       | X                                      |                                                             |                                                                                |                                                                          |
| Sweden <sup>2</sup>         | Fiscal Policy Council                                                         | X                                                                       |                                      |                                   |                                                 | X                                            | X                                     |                                        | X                                                           | X                                                                              |                                                                          |
| Sweden                      | National Institute of Economic Research                                       | X                                                                       | X                                    | X                                 | X                                               | X                                            |                                       |                                        |                                                             |                                                                                | X                                                                        |
| United Kingdom              | National Audit Office                                                         |                                                                         |                                      |                                   |                                                 |                                              | X                                     |                                        |                                                             |                                                                                |                                                                          |
| United Kingdom <sup>3</sup> | Office of Budget Responsibility (OBR)                                         | X                                                                       | X                                    | X                                 | X                                               | X                                            |                                       |                                        | X                                                           | X                                                                              |                                                                          |

1. Author's assessment. The Fiscal Council of Hungary was essentially disbanded by the newly elected government in late 2010.

2. Author's assessment, based on answers to 2008 EC questionnaire. The mandate is to monitor and evaluate the quality of the government's economic forecasts and underlying models.

3. Based on HM Treasury “Draft: Charter for Budget Responsibility” (HM Treasury, 2010).

Source: “National independent institutions”, Chapter III, *Public Finances in EMU*, 2006, except where noted.

Table 1. List of independent institutions considered in the EC study (cont.)

| General information         |                                                                               | Tasks to be filled                                                             |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
|-----------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------|--------|
|                             |                                                                               | Normative reports and/or recommendations on fiscal policy                      |                                                                             |                                              |                                                                                |                                                          |                                                                         | Others |
|                             |                                                                               | Normative statements in budgetary plans and respect of the fiscal policy rules | Assessment of the budget/alternative quantification of the measures therein | Proposals for changes in the budgetary plans | Normative statements on implementation of fiscal plans/respect of fiscal rules | Alert function to signal a possible deviation from plans | Recommendation in case a slippage to initial fiscal plans is identified |        |
| Austria                     | Institute for advanced studies (HIS)                                          |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Austria                     | Institute for economic research (WIFO)                                        |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Austria                     | Government debt committee                                                     |                                                                                |                                                                             | X                                            |                                                                                |                                                          |                                                                         |        |
| Belgium                     | National audit institute                                                      |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Belgium                     | High council on finance (HCF) – Section “Public Sector Borrowing Requirement” |                                                                                |                                                                             | X                                            | X                                                                              | X                                                        | X                                                                       |        |
| Denmark                     | Danish Economic Council                                                       |                                                                                |                                                                             | X (Federated entities)                       | X                                                                              | X                                                        | X                                                                       |        |
| Estonia                     | State Audit Office                                                            |                                                                                |                                                                             |                                              | X                                                                              | X                                                        | X                                                                       |        |
| France                      | Commission Économique de la Nation and Conférence Économique Annuelle         |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| France                      | Cours des Comptes                                                             |                                                                                |                                                                             |                                              | X                                                                              |                                                          |                                                                         |        |
| Germany                     | Working Party on tax revenue forecasting                                      |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Germany                     | Joint Economic Forecast by 6 leading research institutions (JEF)              |                                                                                |                                                                             |                                              |                                                                                |                                                          | X                                                                       | X      |
| Germany                     | Council of Economic Experts on Overall Economic Trends                        |                                                                                |                                                                             |                                              |                                                                                |                                                          | X                                                                       |        |
| Germany                     | Advisory Board to the Federal Minister of Finance                             |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         | X      |
| Greece                      | Center of Planning and Economic Research (KEPE)                               |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Hungary                     | State Audit Office (ASZ)                                                      |                                                                                | X                                                                           |                                              | X                                                                              |                                                          |                                                                         |        |
| Hungary <sup>1</sup>        | Fiscal Council of Hungary                                                     |                                                                                | X                                                                           | X                                            | X                                                                              | X                                                        | X                                                                       |        |
| Italy                       | ISAE                                                                          |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Luxembourg                  | Court of Auditors                                                             |                                                                                | X                                                                           |                                              |                                                                                | X                                                        | X                                                                       |        |
| Netherlands                 | The Netherlands Bureau for Economic Policy Analysis (CPB)                     |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Portugal                    | Court of Auditors                                                             | X                                                                              |                                                                             |                                              | X                                                                              |                                                          |                                                                         |        |
| Spain                       | Court of Auditors                                                             |                                                                                |                                                                             |                                              | X                                                                              |                                                          |                                                                         |        |
| Spain                       | National Committee of local administration                                    |                                                                                | Only local finances                                                         |                                              |                                                                                |                                                          |                                                                         |        |
| Slovenia                    | Macroeconomic Analysis                                                        |                                                                                |                                                                             |                                              |                                                                                |                                                          |                                                                         |        |
| Sweden <sup>2</sup>         | Fiscal Policy Council                                                         |                                                                                |                                                                             |                                              |                                                                                | X                                                        | X                                                                       |        |
| Sweden                      | National Institute of Economic Research                                       | X                                                                              |                                                                             |                                              | X                                                                              |                                                          |                                                                         |        |
| United Kingdom              | National Audit Office                                                         | X                                                                              |                                                                             |                                              |                                                                                |                                                          |                                                                         | X      |
| United Kingdom <sup>3</sup> | Office of Budget Responsibility (OBR)                                         | X                                                                              |                                                                             |                                              |                                                                                | X                                                        |                                                                         |        |

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Source: “National independent institutions”, Chapter III, *Public Finances in EMU*, 2006, except where noted.

consider the recommendations made by the agency. Several such institutions stand out in the OECD area.

In Austria, the Government Debt Committee (GDC) has a mandate to regularly assess the status of fiscal policy, taking into account macroeconomic circumstances, with a particular focus on the quality of public finances and the outlook for debt sustainability. Its twelve members are public finance experts nominated by the federal government, various national policy institutions, and representative bodies of Austrian communities, cities and states. It receives funding and staffing from the Austrian National Bank. The GDC disseminates to the public its annual report that contains recommendations made to the government via the Minister of Finance. As in Belgium (see below), the GDC has proved effective in helping to control sub-national borrowing in a federal context (von Hagen, 2010).

Belgium's High Council on Finance (HCF) is an advisory body formed initially in 1936 but strengthened in 1989 to help promote budget co-ordination and fiscal discipline in Belgium's federal system, and to contribute to the design and implementation of fiscal policy.<sup>12</sup> While the HCF has several tasks, including making long-run ageing-related expenditure projections and providing regular assessments of various aspects of fiscal policy, its most vital role is normative insofar as it is charged with recommending the budget targets for the general government and its subsectors that are consistent with the borrowing requirement implied by the Stability Programme. Several assessments (Debrun et al., 2009; Lebrun, 2006; and Coene, 2010) point to the HCF as having been highly effective in achieving disciplined fiscal policy during the 1990s, driven in part by the desire to be positioned to adopt the euro in 1999, and by social consensus and strong political will to stabilise and consolidate fiscal policy. Interestingly, the same research points to the lesser influence of the HCF during the post-euro adoption period than before.

In Denmark, the Economic Council is an advisory body that not only provides macroeconomic forecasts but also undertakes analyses of a variety of fiscal policy issues related to the functioning of the public sector, the tax system, fiscal sustainability and the fiscal stance, on the basis of which it issues policy recommendations. The council is also charged with monitoring compliance with current fiscal rules, issuing recommendations as needed to ensure compliance.

In 2007, Sweden created the Fiscal Policy Council with a mandate to assess the extent to which the government achieves its policy objectives of long-run sustainability, a surplus target, a ceiling on central government spending, and a fiscal stance consistent with the cycle), and to monitor and evaluate the transparency of the budget and the quality of the government's economic forecasts. The Fiscal Policy Council's first major challenge arose in relation to one of Sweden's fiscal policy objectives: ensuring an appropriate cyclical stance of policy. Despite strong resistance from the government, the council eventually prevailed in promoting the larger fiscal impulse it deemed warranted following the onset of the recent worldwide financial crisis. This characterisation of effectiveness has to be seen, however, from the perspective of the Fiscal Policy Council's mandate, which includes advising on the appropriate stance of fiscal policy.

Finally, Hungary established a fiscal council in 2009 to strengthen historically-weak fiscal policy formulation and implementation. The council was effectively disbanded in late 2010, however, following elections that swept into office a new government strongly opposed to the independent body's legal authorities (Box 1).

### Box 1. **The brief life of the Fiscal Council of Hungary**

The brief life of the Fiscal Council of Hungary is instructive regarding the importance of political and policy commitment by the government to the creation of a new independent budgetary institution.

The Fiscal Council of Hungary was established in 2009 on legislation enacted in 2008 (the Law on Fiscal Responsibility). The legislation and creation of the Fiscal Council were part of an adopted rules-based fiscal policy framework. Its special mandate was to help restore sustainability of fiscal policy and to promote fiscal transparency. Its tasks included making macroeconomic forecasts and projections for key budgetary variables to serve as the baseline for the annual budget. In addition to biannual medium-term baseline (current legislation) projections, it was to prepare macro-fiscal projections that incorporated the effects of each budget bill in time for legislative action. The Council also made methodological suggestions for fiscal policy planning, and commented on the budget bill and other legislation with fiscal impacts, “costing” all significant tax and expenditure proposals. Importantly, the Fiscal Council monitored compliance with Hungary’s fiscal rules (including the pay-go rule and the debt limit requirement), but relied on dissuasive methods – through pressure from the public and financial markets – rather than coercion. Following an early start, and despite a shortage of staff in the initial stage, the Council issued its first baseline projection in anticipation of the 2010 budget, and maintained a high level of activity during 2009 and 2010.

Events in 2010 set the stage for a very considerable weakening, if not the effective demise, of the Council. Following general elections in May, the new government, elected by a two-thirds majority, viewed with considerable suspicion all policies and institutional changes implemented by the previous government. Unhappy with the Council’s critical assessment of the new government’s medium-term budget strategy spelled out in its 2011 budget proposal, the Government set in motion legislative and other steps to weaken the Council by disbanding the Office of the Council (i.e. the technical staff of the Council), changing the composition of the Council, and narrowing considerably the Council’s remit. In turn, the Council has effectively been reduced to a part-time body with no specific responsibilities in applying fiscal transparency and sustainability (Kopits, 2011).

## 2.2. **Fiscal councils providing independent analysis of fiscal issues**

Fiscal councils that provide independent analyses of fiscal issues play an important role in informing the government and the public about the budgetary implications of select policy issues. The next paragraphs elaborate the mandates and set-ups of several.

The Canadian Parliament enacted in 2006 the Federal Accountability Act (FAA). Among other things, the FAA established the Parliamentary Budget Officer (PBO), modelled on the US Congressional Budget Office. The mandate of the PBO is to provide the legislature objective analysis of the nation’s finances, the government’s estimates, and trends in the economy and, upon request by a committee or parliamentarian, estimates of the cost of any proposal for matters over which the Parliament has jurisdiction. As a Governor-in-Council appointment, the PBO serves “at pleasure”. In turn, the PBO can be dismissed without cause by the Prime Minister, which potentially weakens the agency’s political independence. The FAA provides for free and timely access to government data and information needed to fulfill the PBO’s mandate. The PBO promotes value by relying on assistance from experts, accountability through dissemination of its products and through

public debate, and non-partisanship by operating in an open and transparent manner. Experience during its first years of operation highlights the importance of having a clear mandate and a secure budget (Box 2).

### Box 2. **Canada's Parliamentary Budget Officer**

Following parliamentarians' frustrations over persistent Department of Finance under-projection of budget deficits during the 1980s and of surpluses during the 1990s, and recognising the Parliament's lack of technical expertise in accurately estimating the costs of large-scale federal projects, the Canadian Parliament enacted in 2006 the Federal Accountability Act (FAA). The FAA is aimed at addressing issues of conflict of interest, restrictions on election financing, improving administrative transparency, oversight and accountability. Among other offices also created by the FAA, the legislation established the Parliamentary Budget Officer (PBO), modeled on the US Congressional Budget Office. The PBO began operations in 2008. The PBO is an officer of the Library of Parliament, and holds office for a renewable period of not more than five years. The mandate of the PBO is to provide the legislature objective analysis of the nation's finances, the government's estimates and trends in the economy, and, upon request by a committee or parliamentarian, to estimate the cost of any proposal for matters over which the Parliament has jurisdiction. As a Governor-in-Council appointment, the PBO serves "at pleasure". In turn, the PBO can be dismissed without cause by the Prime Minister, which weakens the agency's political independence. The FAA provides for free and timely access to government data and information needed to fulfill the PBO's mandate.

The PBO uses an open and transparent operating model that promotes value by relying on assistance from experts, accountability through dissemination of its products and through public debate, and non-partisanship by operating in an open and transparent manner. There are two divisions. The Economic and Fiscal Analysis Division is responsible for analysis of economic trends and public finances. The Division is staffed with professional economists experienced with the working environment and models at the Department of Finance, the Bank of Canada and the Canadian Revenue Agency. The Revenue and Expenditure Analysis Division is responsible for costing proposals and budgetary estimates.

During its first years of operation, the PBO encountered a number of parliamentary and government challenges to its interpretation of its mandate following the release of its first two reports. The first was the PBO's analysis of the fiscal impact of Canada's Afghanistan involvement, whose dissemination, albeit expected from the outset, was challenged by the parliamentarians who considered, despite *ex ante* agreement to its release, that the report should have been submitted first to Parliament on a confidential basis. The second release was of the PBO's first economic and fiscal outlook highlighting a projected recession in 2009 and the first deficit in a decade. Political displeasure with both releases resulted in a withholding of increased budgetary resources for the PBO, only to be reversed in the 2010-2011 Budget.

Experience during the early years of the PBO points to the need for several reforms going forward. These include: i) making the PBO a fully independent authority appointed by the Parliament and serving during good performance rather than at pleasure; ii) transparency is best assured if its principle and the release of analysis are enshrined in legislation; and iii) resources need to be commensurate with the mandate (Page, 2010).

In the United States, the Congressional Budget Office (CBO) was established in 1974 to provide Congress with independent analyses of the costs and long-term effects of budget proposals. Its mission is to provide objective, non-partisan, and timely analyses to aid in economic and budgetary decisions on the wide array of programmes covered by the federal budget, and the information and estimates required for the Congressional budget process. The CBO produces a considerable number of reports each year, and regularly testifies before Congress. Its work is non-partisan, and the Director is appointed without regard to political affiliation and solely on the basis of his/her fitness to perform the duties for a four-year term (even when the balance of power in Congress switches). The CBO's reputation for credible and impartial analysis has helped it become a central player in the annual budgeting process and in budget monitoring (Blöndal *et al.*, 2003). Among the CBO's most important contributions to the annual budget process is the preparation of its baseline against which are assessed budget proposals, including the President's. The CBO's baseline, however, is constrained by the legal requirement that it be based on current law rather than the most likely policy scenario. While its analyses can focus on the impacts of any fiscal proposal, the CBO conducts only positive analysis; the agency does not engage in policy prescription.

The Netherlands' Central Planning Bureau (CPB) is a major source of objective and independent analysis and forecasting. Since its inception in 1945, it has gained considerable respect for its independence and expertise. The agency's independence is attributable to a number of factors. First, its funding from public sources is both adequate and secure enough to provide the agency sufficient freedom to set its own research agenda. Second, its independence is maintained through a *quid pro quo*; its independence from political interference requires that the agency itself not interfere in the political debate (Bos and Teulings, 2010). The CPB's main responsibilities are to provide independent macroeconomic and budgetary forecasts, but its remit also includes analysis of a wide range of topics, including the welfare state, the labour market, regulation and international economics, among others. It also undertakes cost-benefit analysis of large-scale public projects, as well as long-run studies, such as on welfare, the environment, and the impact of population ageing on Dutch public finances. While making no normative prescriptions, its forecast is co-ordinated with submission of the government's budget, and incorporates the estimated economic and budgetary impacts of proposed fiscal policy measures. Significantly, the CPB's activities and contributions to the preparation of the budget are not mandated, but have become routine practice. In fact, the CPB plays a special role tailored to Dutch coalition politics insofar as all political parties submit their economic programmes to the CPB for assessment, which facilitates comparisons. Moreover, employers' and employees' organisations also rely on CPB forecasts for wage negotiations. The CPB stands out as an institution that has over the decades become fully integrated into the policymaking process while retaining a solid reputation for professionalism and impartiality in its analysis. This aspect of the CPB is considered "best practice" by the IMF (IMF, 2006).

In Portugal, the government has recently established the independent Fiscal Policy Council to help contribute to fiscal consolidation and the restoration of fiscal sustainability.<sup>13</sup> Once operational, the Council's remit calls for the body to assess the Government's macroeconomic scenarios and the consistency of the budget with those scenarios as well as with the Government's fiscal rule, analyse the sustainability of public debt, taking into account existing commitments (with special emphasis on pensions and

health), assess the fiscal state of regions and local governments and public enterprises, monitor budgetary outturns, and provide the Council's opinion on any issue it considers likely to significantly impact the public finances.

In the United Kingdom, the new coalition government established the Office of Budget Responsibility (OBR) during 2010 to help bolster the credibility of the Government's commitment to a balanced structural budget during its term.<sup>14</sup> The OBR consists of a three-member Committee for Budget Responsibility elected by Parliament, and a technical support staff. The overarching remit of the OBR is to monitor progress toward fulfillment of the Government's mandate through preparation of the macroeconomic forecast that underpins the budget, and real-time assessments of fiscal-related legislation. The OBR also undertakes debt sustainability analysis.

Finally, the Government of Ireland has created the Fiscal Advisory Council as part of a broader reform of the country's public financial management architecture. The independent Council's remit, spelled out in a new Fiscal Responsibility Bill, is centered on assessing the appropriateness and soundness of the Government's macroeconomic projections and the fiscal stance. The Council will also assess the extent to which the Government's budget and its execution are consistent with the agreed fiscal rules, also established in the Fiscal Responsibility Bill.<sup>15</sup>

### 3. Assessing the effectiveness of fiscal councils

Empirical evidence of the effectiveness of fiscal councils is of three sorts. First, country-specific experiences have been investigated for a few countries. These perforce attempt to compare fiscal performance by using indicators before and after the existence of a fiscal council, or before and after a fundamental change. Second, the European Commission (2006) drew inferences and conclusions about effectiveness from responses to its questionnaire, in conjunction with descriptive material and empirical studies. Third, using information collected by the European Commission's survey, Debrun and Kumar (2008) constructed a number of quantitative indicators that characterise the set-up, independence and desired influence of fiscal councils, which they use to gauge the impact of fiscal councils on fiscal discipline.

#### 3.1. Country-specific studies

##### 3.1.1. Belgium

Belgium is a useful case for assessing the possible effectiveness of fiscal councils, given the strong mandate handed to the HCF, and the fact that the government is legally required to adopt the macroeconomic forecasts of the Federal Planning Bureau (FPB). Indeed, the fiscal councils in Belgium have been purposefully given relatively strong mandates; Debrun and Kumar (2008) compute a comparatively high index of *de jure* influence for Belgium's fiscal councils. Belgium is also a good candidate because its experience with fiscal councils spans two decades of contrasting incentives emanating from the country's membership in the EU, with the 1990s dominated by policies to support euro adoption.

Two studies suggest that fiscal councils contributed to improved fiscal performance. While recognising the complexity of the exercise, Lebrun (2006) measures the extent to which reduced bias in macroeconomic forecasts prepared by the FPB (and used in budget formulation) via a decomposition of forecasting errors (specifically the mean square error)

during the period 1994-2005 into the “bias proportion” (attributable to systematic over- or under-estimation), the variance proportion, and the covariance proportion. The very small values for the bias proportion provide strong evidence that “... FPB forecasts can be considered as unbiased” (Lebrun, 2006, p. 331). The author also painstakingly examines the reasons for which fiscal consolidation was stronger than already programmed throughout the period, and finds that growth surprises (i.e. higher GDP growth than on which the budgets were formulated) were not behind the better budgetary performance. In turn, discretionary policy actions must have contributed to better-than-expected outcomes. While cautioning that the roles of the fiscal councils need to be seen as complements to and not substitutes for political commitment, the author concludes that the reduced forecasting bias and the increased policy transparency arising from the strong co-ordinating role of the HCF, which have helped the government resist pressures for higher spending, contributed to better performance.<sup>16</sup>

In a more recent study, Coene (2010) assesses the effectiveness of the HCF by constructing a synthetic annual index of effectiveness.<sup>17</sup> Specifically, the index (values ranging from 0 to 5, with the higher value suggesting greater impact) each year depends on answers to five questions answered through a careful review of the extent to which HCF recommendations impacted fiscal policy. These questions were: i) Does each year’s report contain a single clear recommendation for budget targets over the medium and long term? ii) Is the recommendation consistent with previous (“vintage”) recommendations? iii) Does the recommendation simply mimic the government’s Stability Programme? iv) Has the recommendation been explicitly adopted by the government? and v) Have the recommended budgetary targets been met? Succinctly, “... the highest value for the indicator is reached in cases where the section elaborates a clear recommendation, that is not at odds with the section’s previous views and is independent from – or, at least, cannot be tracked back to – government intentions and that is formally adopted and, ultimately, complied with by the government”<sup>18</sup> (Coene, 2010, p. 14). While recognising the need for caution in interpreting the indicator (not least because of the substantial degree of expert judgment needed for its construction), the paper concludes that the HCF has been quite effective in promoting fiscal consolidation during the period 1990-1998. At the same time, the paper concludes that the section’s effectiveness declined measurably during the next decade, which was likely due to the unusually strong political resolve during the 1990s to achieve euro adoption.

### 3.1.2. Chile

Fiscal policy in Chile has largely remained conservative during the past two decades. This is reflected in a trend decline in gross and net central government debt and growth in net foreign assets. This good performance is attributable to several factors: sustained political commitment to prudent policy; the adoption of a fiscal rule and a fiscal framework; and the enactment of a Fiscal Responsibility Law. Also present are the two independent advisory bodies – the Advisory Committee on Trend GDP and the Advisory Committee for the Reference Copper Price – that play a role in macroeconomic and budgetary forecasting without, however, having full responsibilities. The fiscal rule, in place since 2001, limits the growth of budgeted central government spending to an estimate of the growth of “structural” revenue, subject to achieving a targeted structural budget balance, which has remained set at a surplus of 1% of GDP. The over-riding objective is to ensure both fiscal sustainability and output stabilisation. As the rule focuses on a

cyclically-adjusted budget balance, key determinants include the projected output gap and “structural” revenues. The former, of course, depends heavily on estimates of potential output, which in turn hinges on the growth of labour, capital and total factor productivity. Chile’s revenue flows depend significantly on trend copper prices. In turn, the delegation of responsibility for projections of these key variables to non-partisan advisory bodies helps to limit potential forecasting bias. At the same time, the methodology itself for estimating the output gap remains the responsibility of the Ministry of Finance, which reserves a large margin for discretion. Schmidt-Hebbel (2010) has noted that back-casting of potential growth suggests that the output gap was likely over-estimated during 2001-2008, resulting in excessive spending and a pro-cyclical outcome. Over-estimates of trend copper prices also contributed to pro-cyclicality. Despite the legally-binding projections from the two advisory bodies, the Government (Ministry of Finance) is left with substantial leeway to define the overall resource envelope.

### **3.1.3. United Kingdom and Hungary**

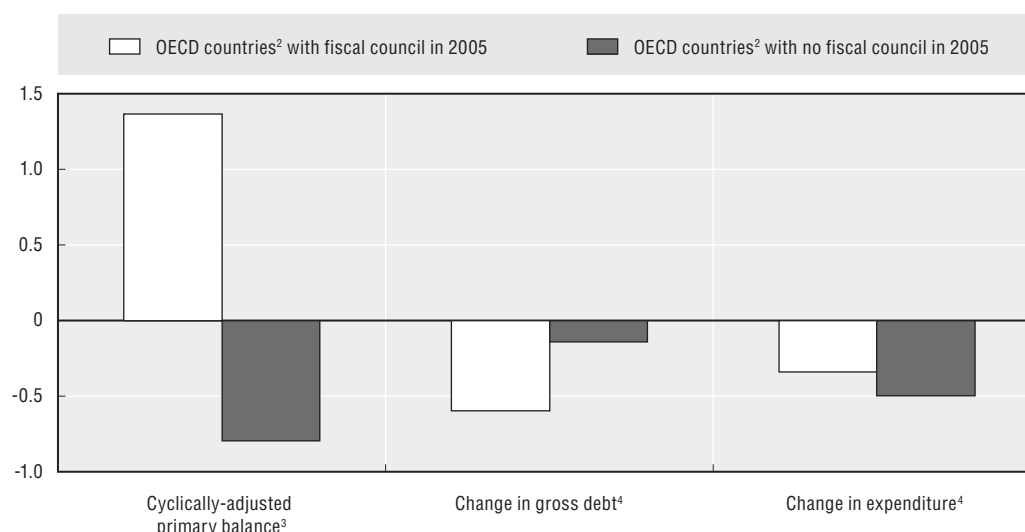
Kopits (2011) provides an illuminating comparison of the experiences of the United Kingdom and Hungary during 2010. As he notes, ignoring the many differences between the two countries, some “stylized” facts about the influence of policy signaling on market expectations can be gleaned from the concurrent demise of the Fiscal Council of Hungary (see Box 1) and the establishment of the broadly similar OBR. In the United Kingdom, the newly-elected centre-right Government, bolstered by the presence of the OBR, immediately took steps to restore fiscal sustainability through entitlement reforms and revenue measures. By contrast, the new centre-right Government of Hungary quickly abandoned the rules-based framework in place for several years, and adopted budgetary measures that in fact have no impact on the structural budget balance. During 2010, market reactions were favourable to the former and unfavourable to the latter. Short- and long-term interest rate spreads on sovereign paper widened in Hungary while they fell continuously in the United Kingdom. The contrasting market reactions are also evident in divergent credit default swap spreads in the two countries (Kopits, 2011).

### **3.2. European Commission Survey**

The European Commission combined inferences from answers to select questions with descriptive analyses and numerous studies in the literature in arriving at a number of conclusions about the potential effectiveness of independent fiscal institutions covered in its survey.

First, as previously noted, pro-cyclical bias arising from overly-optimistic macroeconomic or budgetary forecasts can be reduced or eliminated by delegating responsibility to an independent agency. Second, by a large majority, fiscal councils have a perceptible impact on the public’s awareness of fiscal issues, often triggering public debate. Third, while not controlling for a number of variables that could account for such differences, the Commission noted that fiscal performance (measured by several fiscal indicators) during the period 1995-2005 was superior in countries having at least one surveyed institution than in countries with none. Figure 3 shows the same indicators of fiscal performance over the same period as covered by the European Commission, but updated to take into account data revisions and extended to include non-EU OECD countries.

Figure 3. **Budgetary developments and fiscal councils**<sup>1</sup>  
1995-2005



1. Fiscal councils as defined in EC (2009), *Public Finances in EMU – 2009* and OECD calculations.

2. OECD countries excluding Chile, Mexico, Slovenia and Turkey.

3. Average balance over the period.

4. Average yearly change over the period.

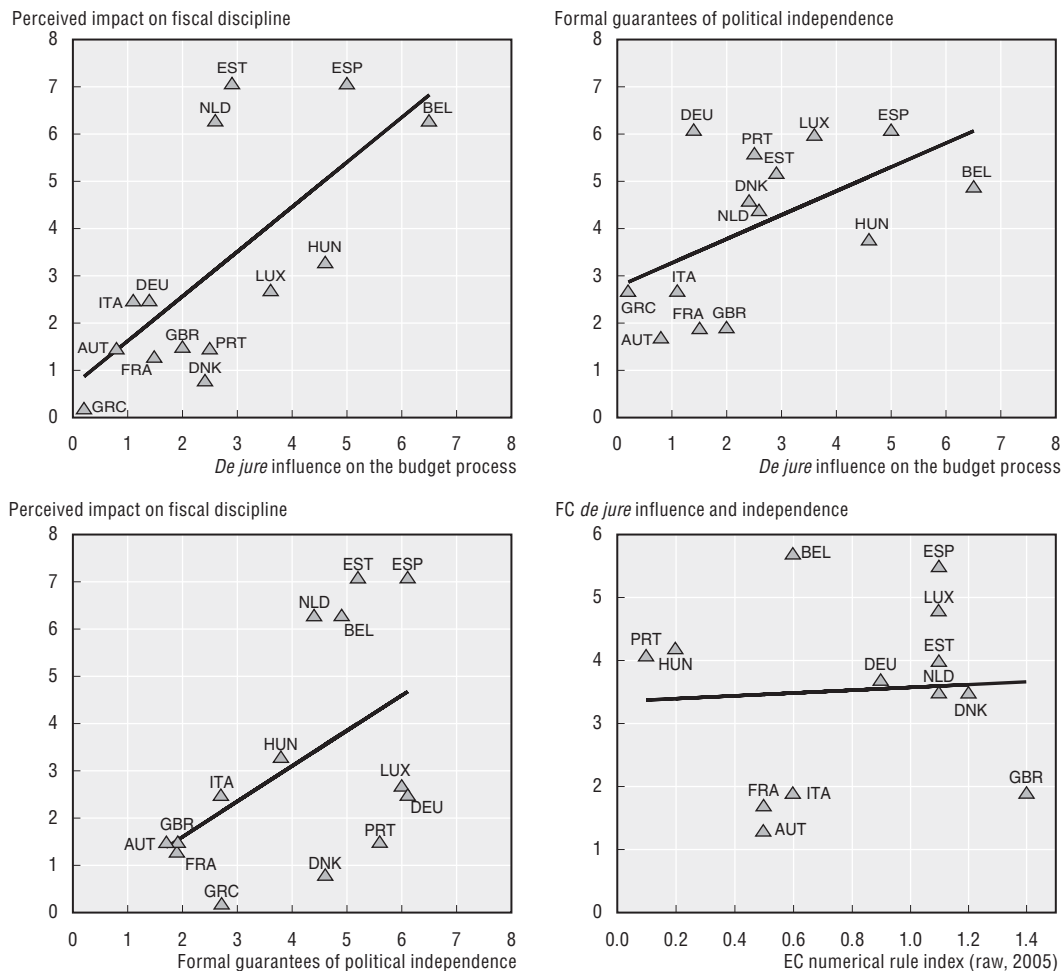
Source: OECD, OECD Economic Outlook Database.

### 3.3. Cross-country evidence

A pertinent empirical question is the extent to which fiscal councils, without delegated fiscal policymaking authority, have measurable influence on fiscal outcomes. Debrun and Kumar (2008) set out to investigate this question using the detailed information on the features of fiscal institutions collected in the EC's survey of independent fiscal institutions. The authors constructed indices that characterise the set-up, independence and the potential influence of the agencies on the budgetary process, including via public debate. They use a weighting scheme that emphasises the agencies' role in preserving fiscal discipline, and in helping to implement rules where relevant. The authors' particular interest is in the channels through which the councils might have an impact. One premise is that the greater the degree of restraint exercised by the fiscal council or the greater the guarantee of independence from political interference, the greater the likelihood of perceived or actual impact on performance.

The authors' results suggest that fiscal councils may indeed be influential. Their results are reproduced in Figure 4. There is a strong relationship between *de jure* influence exerted by a fiscal council and its perceived impact on fiscal performance, as well as between the perceived impact on fiscal performance and formal guarantees of independence. There is also a positive relationship between *de jure* influence and the guarantees of independence, which the authors interpret as suggesting "countries instituting such agencies seemed serious in their willingness to strengthen the council's effectiveness". (Debrun and Kumar, 2008, p. 490). At the same time, these results should be interpreted with caution given the heterogeneity of the independent fiscal bodies included in the data set. For instance, the data set includes state audit offices, most of which, as previously noted, are tasked solely with *ex post* assessment of fiscal and budgetary performance, whereas fiscal councils are expected to have an *ex ante* impact on fiscal policy formulation.

Figure 4. **Potential channels of impact of fiscal councils and relationship between fiscal councils and fiscal rules**



Source: Debrun and Kumar (2008).

## 4. Conclusions

This paper has attempted to provide an overview of the reasons for and experience with independent fiscal councils. Theoretical arguments for delegating some aspects of fiscal policy to independent institutions have become widely accepted. Deficit bias can become entrenched in fiscal systems plagued by inadequate transparency, which politicians can exploit in the pursuit of their own individual interests (*viz.* re-election) with insufficient regard for the average voter and the nation as a whole. As well, medium-term fiscal commitments can be breached through time-inconsistent policies that future governments find more convenient *ex post* than deemed appropriate *ex ante*. Institutional reforms, including all those that increase the transparency of fiscal policy formulation and implementation, are now widely seen as a necessary condition for restoring and sustaining fiscal discipline.

Some types of reform are more compelling than others. Where fiscal policy has not been anchored by a medium-term focus and fiscal targets that can ensure growth-promoting and sustainable fiscal stances, numerical rules can potentially play a helpful

role. But experience has shown that rules can be easily breached, even as appearances may suggest otherwise for a while through creative accounting and off-budget transactions. In turn, there is growing advocacy for independent fiscal institutions to play a stronger role in helping both to enhance the transparency of policy in a number of ways and to depoliticise key aspects of fiscal policy.

Totally depoliticising fiscal policy via full delegation of responsibility for the fiscal balance is neither theoretically founded nor democratically advisable. First, there is considerable uncertainty regarding the optimal level of the deficit and debt, and consequently little hope for political consensus regarding the appropriate target to set. Second, fiscal policy in all respects has distributional consequences; deficits can redistribute to or from future generations, and within generations, depending upon the reasons for which debt is incurred. With accountability in democracies imposed through the ballot box, deferring full responsibility to technocrats in fiscal institutions would interfere with a fundamental right of the voter. Thus, while fiscal councils can in many instances be handed normative mandates – to offer views of what is technically deemed an appropriate fiscal stance – an illuminated legislature ought to remain the final arbiter.

At the same time, and well short of delegating full policymaking authority, independent fiscal councils can be assigned mandates that contribute to more disciplined fiscal policy. These include responsibility for, or contributions to, macroeconomic forecasting for the purposes of budget formulation, to reduce bias. These also include independent forecasts of key budgetary variables that can be prone to politically-motivated bias, such as overly optimistic revenue projections (which create fiscal “space” to boost unfunded spending) and under-projection of long-run costs of legislative initiatives. Given the complexities of many public programmes, and the associated challenges of understanding their impacts in terms of both efficiency and distribution, the general public can be well served by the funding of independent institutions mandated to undertake analysis of fiscal issues, simulate policy alternatives, make macroeconomic forecasts under different fiscal scenarios, etc. By informing politicians and the public about the larger implications of fiscal initiatives, a fiscal council can help pre-empt deficit bias arising from common pool problems. More informed voters are more able to hold politicians accountable, which in turn contributes to better democratic decision-making.

Influence through such fiscal councils hinges on several factors. First, the agency must have full autonomy to establish its work priorities within the scope of its mandate. Second, there must be active and unfettered dissemination of the agency’s analyses and reports. Indeed, surveys of fiscal councils throughout the EU reveal considerable conviction that dissemination and media support have visible impact on the debate over policy issues. Third, credibility is gained through sustained, high quality and visibly independent analyses (i.e. political feathers get ruffled occasionally) over long periods of time. Indeed, the most effective institutions may well be those, such as the CBO in the US and the HCF in Belgium (among others), that are given the time needed to establish credibility, which in turn reduces their vulnerability to political tampering. The recent experience in Hungary is instructive in this regard.

Experience and empirical evidence suggest that delegating macroeconomic forecasting to an independent fiscal council can indeed reduce forecasting bias and, therefore, the deficit bias that would otherwise follow. Given the intertwining of the macro economy and budget policy, the most effective delegation of economic forecasting will be

obtained when there is close interaction between the government agency or agencies most responsible for budget formulation and the forecasting fiscal council, as in several countries, including Belgium and the Netherlands. While the forecasts of some agencies are binding (e.g. the FPB in Belgium), influence can also be achieved by lesser requirements, as in Germany, where the government has to justify an alternative outlook from that of independent experts.

There is some empirical evidence that fiscal institutions can buttress a government's capacity to comply with a numerical rule. Such support can come through a range of activities to ensure compliance, including the preparation of baseline macro forecasts and a current services budget, and verifying adherence to transparency standards and best budgeting practices.

A key question surrounding the decision to create a fiscal council is why such an entity would have a potentially greater disciplining effect than existing unofficial and academic bodies or persons? In smaller countries with a relatively less-developed infrastructure of unofficial bodies, the creation of a fiscal council enables the pooling of local expertise (creating analytical synergies) and access to financial and informational resources not otherwise available to unofficial bodies. In larger countries, however, where unofficial bodies are prevalent and potentially influential through the media and by active participation in public policy debates, a principal advantage gained from the creation of a fiscal council is the latter's access to the more detailed confidential data normally restricted to legislative and executive agencies. In all countries, however, a desired benefit to the government of creating an official fiscal council is to signal the government's commitment to good behaviour.

Good fiscal institutions are a necessary condition for achieving disciplined fiscal performance. Experience demonstrates, however, that their existence is not sufficient. Without strong and sustained political commitment to a medium-term fiscal goal and, where relevant, to the mandate of a fiscal council, durable improvements in fiscal performance will remain elusive.

## Notes

1. A fiscal council was also established in Hungary in 2009. It experienced a tumultuous short life, however, having been *de facto* terminated in late 2010 following the elections in May 2010. See Box 1.
2. This can pose a particular problem in monetary unions where the centralisation of monetary policy can reduce each member's incentive to maintain a disciplined fiscal stance (Beetsma and Bovenberg, 1999).
3. Reinhart and Rogoff (2009) find that public debt levels of 90% of GDP and higher in industrialised economies are associated with noticeably lower rates of economic growth.
4. See Wachtel and Young (1987), Balassone et al. (2004), Engen and Hubbard (2004), and Gale and Orzag (2004).
5. See, for instance, Kopits and Symansky (1998) and Kopits (2001).
6. Output stabilisation is occasionally an additional objective. In some countries, the unemployment rate is also a partial objective of monetary policy, as in the United States.
7. This is less pertinent for the overall levels of taxes and spending than for their structure.
8. This may be a greater concern in small countries with relatively fewer private institutions providing independent macro forecasts than in larger countries.

9. This is not to say, however, that there are not countries in which the government, out of fiscal prudence, purposefully projects revenues conservatively at times.
10. Some have suggested that international organisations themselves, such as the IMF, OECD, and European Commission, also play a role as quasi-independent institutions, since their macroeconomic and fiscal analyses and policy prescriptions are in principle unaffected by purely political considerations. At the same time, none of these has either the resources or the detailed country-specific knowledge needed to undertake the adequate and real-time analysis needed for thorough fiscal oversight (Kopits, 2010).
11. Fiscal councils in non-EU OECD countries are not included in the table because of the absence of information on these entities collected from a similar questionnaire as used by the European Commission. Inclusion of the Fiscal Council of Hungary (which commenced operations after the European Commission's 2008 survey) in the table has been done in consultation with the Fiscal Council of Hungary.
12. The National Accounts Institute (NAI) also plays a significant independent role in Belgium, since it provides macroeconomic forecasts.
13. See *Portuguese Fiscal Policy Council Working Group*: [www.cfinpub.org/en-US/OsEstatutos/Pages/OsEstatutos.aspx](http://www.cfinpub.org/en-US/OsEstatutos/Pages/OsEstatutos.aspx).
14. See [www.hm-treasury.gov.uk/data\\_obr\\_index.htm](http://www.hm-treasury.gov.uk/data_obr_index.htm).
15. See "Establishment of Irish Fiscal Advisory Council", [www.finance.gov.ie/viewdoc.asp?DocID=6927](http://www.finance.gov.ie/viewdoc.asp?DocID=6927).
16. More recently, however, the government was required, due to the inflexibility of the law, to use the somewhat dated macro projections of the FTB notwithstanding that these, due to rapidly changing economic circumstances, had become overly optimistic.
17. It should be noted that the author of the paper is a senior member of the HCF.
18. Here, "section" refers to the Public Sector Borrowing Requirement Section of the HCF.

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# **Are ICT Users More Innovative? An Analysis of ICT-Enabled Innovation in OECD Firms**

by  
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*The aim of this study is to assess the effects of information and communications technologies (ICTs) on firms' capabilities to innovate in a selection of OECD countries. Our findings support the hypothesis that ICTs act as an enabler of innovation, particularly for product and marketing innovation, in both manufacturing and services. However, we did not find any evidence that ICT use increases the capability of a firm to co-operate, to develop innovation in-house or to introduce products new to the market. These results suggest that ICTs enable firms to adopt innovation but they do not increase their "inventive" capabilities.*

*JEL Classification: D22, O31, C25, C26*

*Keywords: ICT, Innovation, micro data, Conditional Maximum Likelihood*

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The aim of this study is to assess the effects of information and communications technologies (ICTs) as an enabler of innovation in a selection of OECD countries. Innovation refers to product, process, organisational and marketing innovations (see OECD/Eurostat, *Oslo Manual*, 2005).

ICTs have the potential to increase innovation by speeding up the diffusion of information, favouring networking among firms, enabling closer links between businesses and customers, reducing geographic limitations and increasing efficiency in communication.

Previous analysis confirms that ICTs play an important role in enabling business innovation, *e.g.* Brynjolfsson and Hitt, 2000; Gago and Rubalcaba, 2007; Crespi *et al.*, 2007; Eurostat, 2008; Van Leeuwen, 2008; Polder *et al.*, 2009. These studies, however, differ as regards their methodology and country coverage or they do not focus on the link between ICT use and innovation.

The main contribution of the present study is to address the effects of ICT use on innovation in a cross-country perspective based on a comparable data set and according to a common methodology.

The study is based on two statistical sources: the ICT Business Survey and the Innovation Survey. Information from these two surveys has been linked at the firm level. Due to confidentiality reasons, the analysis has been carried out by a network of national researchers with access to the micro-data, based on the same econometric model set by the OECD.

The network consisted of 14 researchers<sup>1</sup> from nine countries: Canada, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

We adopted a simple approach, which is to test whether the expected effects of ICT use on innovation are supported by the data. The research, therefore, consists of a set of 19 testable hypotheses about the effects of ICT use on innovation, grouped under three themes:

- Innovation capabilities
- Innovation trajectories
- Co-operation in innovation.

As innovation is considered a key determinant of business productivity, the findings of this study would be relevant for businesses and policy makers alike.

The study is organised as follows. Section 1 summarises the main findings by previous studies. Section 2 introduces the definitions of innovation and ICT use. Section 3 presents the dataset used in this study while Sections 4 and 5 discuss the research questions and the methodology, respectively. The main findings are discussed in Section 6. Finally, Section 7 draws the main conclusions and makes suggestions for further work.

## 1. Previous findings

Business innovation is regarded as a key determinant of both individual business success and national economic growth. At the micro level, business innovation has the potential to increase consumer demand through improved product or service quality and simultaneously decrease production costs. More importantly, strong business innovation at a macro level increases multifactor productivity thus lifting international competitiveness, economic growth and real per capita incomes. Therefore, it is of great interest to businesses and policy makers alike to identify those factors which stimulate innovation and to understand how these factors interact.

ICT is a valuable source of business innovation because it provides substantial efficiency gains. As Koellinger (2005) puts it “ICT makes it possible to reduce transaction costs, improve business processes, facilitate co-ordination with suppliers, fragment processes along the value chain (both horizontally and vertically) and across different geographical locations, and increase diversification.”

Each of these efficiency gains provides an opportunity for innovation. For example, IT automated system links lead to more streamlined business processes and allow staff to be more responsive to emerging customer needs. Similarly, technologies which allow staff to effectively communicate and collaborate across wider geographic areas will encourage strategies for less centralised management, and more flexible external relations, all of which involve different types of innovative activity.

Getton, Gali and Parham (2004) have suggested two additional reasons why business use of ICT encourages innovative activity. Firstly, ICT is a “general purpose technology” which provides an “indispensable platform” upon which further productivity-enhancing changes, such as product and process innovations, can be based. For example, a business which establishes a web presence sets the groundwork from which process innovations, such as electronic ordering and delivery, can be easily developed. In this way, adopting general purpose ICT makes it relatively easier and cheaper for businesses to develop innovations.

Secondly, the spillover effects from ICT usage, such as network economies, can be sources of productivity gains. For example, staff in businesses which have adopted broadband Internet are able to collaborate with wider networks of academics and international researchers more closely on the development of innovations and keep abreast of current consumer trends. These are spillover benefits because the R&D efforts of other researchers in the collaborative group can be appropriated by all.

Information and communication technologies can also be seen as a source of innovation because they enable closer links between businesses, their suppliers, customers, competitors and collaborative partners. These agents are all understood to be important sources of ideas for innovation. By enabling closer communication and collaboration, ICT assists businesses to be more responsive to innovation opportunities and provides significant efficiency gains. For example, having ICTs such as broadband Internet, web presence and automated system linkages, helps businesses to keep up with customer trends, monitor competitor's actions and get rapid users' feedback, thereby assisting them to exploit opportunities for all types of innovation.

Previous econometric analysis confirms that ICTs play an important role in enabling business innovation. Gago and Rubalcaba (2007) find that businesses that invest in ICT,

particularly those which regard their investment as very important, or strategically important, are significantly more likely to engage in services innovation.

The Eurostat ICT impacts project (Eurostat, 2008) reveals that – on average – ICT usage is positively related to firm performance. The strength of these results varies over countries, however, and it also appears that the benefits of different types of ICT usage are industry specific. Van Leeuwen (2008) shows that e-sales and broadband use affect productivity significantly through their effect on innovation output. Broadband use, however, only has a direct effect on productivity if R&D is not considered as an input to innovation.

This approach is further developed by Polder *et al.* (2009). Their study finds out that ICT investment is important for all types of innovation in services, while it plays a limited role in manufacturing, being only marginally significant for organisational innovation.

Another line of literature points to the importance of ICT for organisational innovation (see Brynjolfsson and Hitt, 2000 for a survey). Case studies reveal that the introduction of information technology is combined with investment in intangible assets and a transformation of the firm and of its relation with suppliers and customers. Electronic procurement, for instance, increases the control of inventories and decreases the costs of co-ordinating with suppliers, and ICT offers the possibility for flexible production: just-in-time inventory management, integration of sales with production planning, etc. A lack of proper control for intangible assets is seen as a possible candidate for explaining the differences in productivity growth that are observed between Europe and the United States.

The available econometric evidence at the firm level shows that a combination of investment in ICTs and changes in organisations and work practices facilitated by these technologies contributes to firms' productivity growth. Crespi *et al.* (2007) use CIS data for the United Kingdom and find a positive effect of the interaction between IT and organisational innovation on firm performance. They also find a significant effect of competition on organisational innovation.

These results confirm recent findings that ICTs are an important enabler for capturing and processing knowledge in the innovation through-put stage. In addition, the observed industry differences suggest that new ICT applications, such as broadband connectivity and e-commerce, are more important in services than in manufacturing.

This paper makes a number of contributions to the existing literature.

First, while most studies investigate the effects of ICT use on innovation in one country, this paper provides evidence for a larger set of countries based on a common methodology.

Second, different studies adopt different measures of ICT use but they do not provide justification for preferring one measure over the other. This paper, on the contrary, compares alternative measures of ICT use and their statistical relationship to innovation.

Third, ICTs are analysed as an enabler of innovation, so that the intensity of ICT use and the introduction of an innovation are modelled as the result of a simultaneous choice by the firms.

Finally, the paper directly addresses the issue of endogeneity of ICT use, which is generally neglected in previous studies.

## 2. Definitions

### 2.1. Innovation

The Oslo Manual defines an “innovation” (OECD/Eurostat 2005, p. 46) as:

“... the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.”

A product innovation is the introduction of a good or service that is significantly improved with respect to its characteristics or intended uses and includes significant improvements in technical specifications, components and materials, incorporated software and user friendliness or other functional characteristics (Oslo Manual 2005, p. 48). Design changes which do not involve a significant change in the product’s functional characteristics or intended use, such as a new flavour or colour option, are not product innovations. Product innovations in services can include significant improvements in how the product is provided, such as home pick-up or delivery services, or other features which improve efficiency or speed.

A process innovation is a new or significantly-improved production or delivery method, including significant changes in techniques, equipment and/or software (Oslo Manual 2005, p. 49). For example, introduction of a new automation method on a production line, or in the context of ICT, developing electronic system linkages to streamline production and delivery processes, are both process innovations. With respect to services, it is often difficult to distinguish a product and process innovation. The Oslo Manual (2005, p. 53) contains the following guidelines to distinguish the two types of innovation:

- ❖ If the innovation involves new or significantly-improved characteristics of the service offered to customers, it is a product innovation.
- ❖ If the innovation involves new or significantly-improved methods, equipment and/or skills used to perform the service, it is a process innovation.

An organisational or managerial innovation is the implementation of a new or significantly-improved method of the firm’s business practices, workplace organisation or external relations. It requires more than mere organisational change or restructure. In fact, the organisational method must not have been previously used by the business and must be the result of strategic decisions taken by management (Oslo Manual 2005, p. 49). Examples include implementation of a new method for distributing responsibilities and decision-making among employees, decentralising group activity, developing formal or informal work teams, new types of external collaboration with research organisations or the use of outsourcing or sub-contracting for the first time (Oslo Manual 2005, p. 52).

A marketing innovation is the implementation of a new or significantly-improved marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. The marketing method must not have been previously used by the firm and must be part of a new marketing concept or strategy representing a significant departure from the firm’s existing methods (Oslo Manual 2005, p. 50).

The OECD has recommended that countries collect qualitative survey data on innovation activities. These qualitative measures of innovation are more encompassing than traditional innovation measures. For example, measures such as R&D expenditure per employee, patents received or sales derived from new products will not encompass all the innovative efforts of a business and will be biased towards particular types of innovation.

## 2.2. ICT use

The definition of ICT use by firm is less clear-cut and codified. Computer use does not seem a relevant criterion any longer, as virtually all firms use the computer. The use of a computer network seems to be a more appropriate measure of ICT use, although the information technology in use (*e.g.* Extranet, WAN, etc.) may have different effects on innovation.

Given the dominance of IP-based networks, one may reasonably argue that Internet use, particularly broadband Internet, is what makes a firm an ICT user. Some previous studies (Eurostat, 2008) have pointed out that the percentage of broadband connected employees is a better measure of the intensity of ICT use by firms.

As there is no unique measure of the intensity of ICT use, we explored the correlation between the probability to innovate and a set of potential indicators for ICT use available from the ICT Business Surveys: the number of web facilities; the number of automatic IT links; the share of employees with a broadband connection to the Internet; the value of e-sale; the value of e-purchasing; the presence of a firm's web page; the first factor from a factor analysis of all the above indicators; the simple average of the above indicators.

The number of web facilities and the number of automatic IT links turned out to have the highest correlation to innovation in all countries. Therefore, our econometric analysis included either one of these two variables as a measure of the intensity of ICT use.

The number of web facilities is computed from the answers to the following questions ("Eurostat model for a Community Survey on ICT Usage and e-Commerce in Enterprises 2006"):

| B9. Did the Web Site of your enterprise provide the following facilities during January 2006?<br>(your enterprise as <i>provider</i> of internet services) |                          |                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
|                                                                                                                                                            | Yes                      | No                       |
| a) Marketing the enterprise's products                                                                                                                     | <input type="checkbox"/> | <input type="checkbox"/> |
| b) Facilitating access to produce catalogues and price lists                                                                                               | <input type="checkbox"/> | <input type="checkbox"/> |
| c) Providing after-sales support                                                                                                                           | <input type="checkbox"/> | <input type="checkbox"/> |

Firms are asked to answer all questions with yes or no. Therefore, the indicator varies between 0 (firms have no web facilities) to 3 (firms have all web facilities).

The number of automatic IT links is based on the answers to the following questions from the same survey:

| A9*. Did your enterprise's IT systems for managing orders link automatically with any of the following IT systems, during January 2006? |                          |                          |
|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
|                                                                                                                                         | Yes                      | No                       |
| a) Internal system for re-ordering replacement supplies                                                                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| b) Invoicing and payment systems                                                                                                        | <input type="checkbox"/> | <input type="checkbox"/> |
| c) Your system for managing production, logistics or service operations                                                                 | <input type="checkbox"/> | <input type="checkbox"/> |
| d) Your suppliers' business systems (for suppliers outside your enterprise group)                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| e) Your customers' business systems (for customers outside your enterprise group)                                                       | <input type="checkbox"/> | <input type="checkbox"/> |

Firms are asked to answer all questions with yes or no. Therefore, the indicator varies between 0 (firms have no automatic IT link) to 5 (firms have all automatic IT links).

Strictly speaking, neither of these two indicators is a measure of the intensity of ICT use by firms. They are rather a measure of the sophistication or scope of ICT use. However, both indicators are correlated to the intensity of use. Adding a new web facility or a new automatic link to the firm's IT system is costly and a firm would not undertake such an investment if it did not use it.

Clearly, firms with the same automatic IT links or web facilities may use them differently and our indicators would not capture these differences. In addition, IT links and web facilities seem biased towards the use of ICTs for e-commerce and e-business but they may be a poorer proxy for other ICT-enabled activities relevant for innovation, *e.g.* communication.

Bearing these limitations in mind, in the rest of this study we will regard the number of web facilities and of automatic IT links as a measure of the intensity of ICT use by firms.

### 3. The dataset

The project relies on two statistical sources: 1. the ICT Business Survey; and 2. the Innovation Survey.

The ICT Business Survey follows the OECD Model Survey in virtually all OECD countries. Therefore, comparable statistics on ICT use in firms are easily available in all countries.

Innovation surveys, on the contrary, tend to be more country-specific. The Community Innovation Survey (CIS) is a noticeable exception, as the same questionnaire is submitted to firms in all EU countries participating in the survey. In general, however, the definitions of innovation comply with the recommendations of the *Oslo Manual* (OECD/Eurostat, 2005). This is the case for two non-EU countries included in this study: Canada and Switzerland.

The analysis of the ICT effects of innovation requires "linking" the ICT survey and the Innovation survey at the level of firm. Therefore, the sample for the analysis is limited to those firms that responded to both the ICT survey and the Innovation survey.

Table 1 shows the number and percentage of firms in the latest available Innovation survey that also responded to the ICT survey in the countries considered in the present study.

**Table 1. Number of firms that responded both to the ICT and the Innovation survey – latest year available**

|                     | Year | Total | As a % of all firms in the Innovation Survey |               |          |
|---------------------|------|-------|----------------------------------------------|---------------|----------|
|                     |      |       | Whole economy                                | Manufacturing | Services |
| Canada <sup>1</sup> | 2007 | 488   | 7                                            | 7             | –        |
| Italy               | 2004 | 4 391 | 29                                           | 33            | 25       |
| Ireland             | 2005 | 584   | 30                                           | 47            | 16       |
| Luxembourg          | 2007 | 369   | 49                                           | 51            | 49       |
| Netherlands         | 2007 | 3 549 | 61                                           | 61            | 60       |
| Norway              | 2006 | 1 421 | 33                                           | 34            | 33       |
| Portugal            | 2005 | 1 476 | 20                                           | 16            | 24       |
| Spain               | 2006 | 4 570 | 14                                           | 13            | 15       |
| Sweden              | 2006 | 561   | 17                                           | 14            | 20       |
| Switzerland         | 2008 | 2 555 | 100                                          | 100           | 100      |
| United Kingdom      | 2006 | 706   | 13                                           | 10            | 19       |

1. Imperfect match between ICT and Innovation surveys.

Table 1 shows that:

- ❖ In most countries, only a small percentage of firms in the Innovation survey also responded to the ICT survey. This percentage is particularly low for services. This raises an issue of representativeness of the joint ICT-Innovation sample, which is likely to be biased towards manufacturing industries and large firms.
- ❖ In many countries, the total number of firms in the joint ICT-Innovation sample is relatively small. This implies that the number of variables that we can consider in an econometric analysis is fairly limited.

The above limitations result from the survey design currently in place for most surveys in a large majority of countries. Traditionally, surveys have been designed to estimate representative “averages” for the population and for selected groups of the population. In order to reduce the burden on the respondents, samples for different surveys have been designed as to reduce overlapping or even to exclude it (*e.g.* the ICT survey and the CIS in France).

As the capability to analyse micro data increases, largely due to ICT, the survey design has to be reconsidered in order to facilitate data linking between different surveys *and/or* to merge questions from different survey – *e.g.* ICT and Innovation surveys – into the same one. Both strategies have significant implications in terms of costs for the Statistical Offices and burden for the respondents. Therefore, an assessment by the NSOs on how to meet the demand for micro data is becoming increasingly necessary.

The present analysis is based on data on manufacturing and services in all countries except Canada, where the matching between the ICT and Innovation surveys was possible only for firms in manufacturing due to the different statistical units used in the two surveys (firms for the ICT and establishment in the Innovation survey).

### Box 1. List of testable hypotheses by theme

#### 1. Innovation capabilities

- Hypothesis 1:* The probability to innovate increases with the intensity of ICT use.
- Hypothesis 1a:* The probability to introduce a new product increases with the intensity of ICT use.
- Hypothesis 1a1:* The probability to introduce a new good increases with the intensity of ICT use.
- Hypothesis 1a2:* The probability to introduce a new service increases with the intensity of ICT use.
- Hypothesis 1b:* The probability to introduce a new process increases with the intensity of ICT use.
- Hypothesis 1c:* The probability to introduce a new organisational model increases with the intensity of ICT use.
- Hypothesis 1d:* The probability to introduce new marketing methods increases with the intensity of ICT use.

**Box 1. List of testable hypotheses by theme (cont.)****2. Innovation trajectories**

- Hypothesis 2:* Among all firms introducing a new product, the probability to introduce a product new-to-the-market (as opposed to new-to-the-firm) increases with the intensity of ICT use.
- Hypothesis 3:* Among all firms introducing a new product, the probability to introduce a new product developed in-house or in co-operation with other firms (as opposed to “developed by other firms”) increases with the intensity of ICT use.
- Hypothesis 4:* Among all firms introducing a new process, the probability to introduce a new process developed in-house or in co-operation with other firms (as opposed to “developed by other firms”) increases with the intensity of ICT use.
- Hypothesis 5a:* Among all innovative firms, the probability to innovate in organisation OR marketing increases with the intensity of ICT use.
- Hypothesis 5b:* Among all innovative firms, the probability to innovate in organisation AND marketing increases with the intensity of ICT use.
- Hypothesis 5c:* Among all innovative firms, the probability to innovate in organisation increases with the intensity of ICT use.
- Hypothesis 5d:* Among all innovative firms, the probability to innovate in marketing increases with the intensity of ICT use.
- Hypothesis 6a:* Among all innovative firms, the probability that product innovations are integrated to marketing innovations increases with the intensity of ICT use.
- Hypothesis 6b:* Among all innovative firms, the probability that process innovations are integrated to organisation innovations increases with the intensity of ICT use.
- Hypothesis 6c:* Among all innovative firms, the probability that product innovations were integrated to organisation OR marketing innovations increases with the intensity of ICT use.
- Hypothesis 6d:* Among all innovative firms, the probability that process innovations were integrated to organisation OR marketing innovations increases with the intensity of ICT use.

**3. Co-operation in innovation**

- Hypothesis 7:* Among all innovative firms, the probability to innovate in co-operation with other firms or institutions increases with the intensity of ICT use.

**4. Research questions**

The aim of this research project is to assess the effects of ICTs as an enabler of innovation.

ICT has the potential to increase innovation by speeding up the diffusion of information, favouring networking among firms, reducing geographic limitations, and increasing efficiency in communication.

These effects can be analysed by looking at whether the use of ICT in firms is associated with:

1. A higher probability to innovate;
2. Specific features of innovation; and
3. A higher probability to co-operate in innovation.

We adopted a simple approach, which is to test whether the expected effects of ICT use on innovation are supported by the data. Therefore, the research consists of a set of 19 testable hypotheses about the effects of ICT use on innovation, grouped under three themes (see Box 1).

## 5. The model

The above hypotheses have been tested through a series of “probit equations with endogenous regressors” (Wooldridge, 2002; pp. 472-478). The probability to introduce an innovation with specific features (*e.g.* product, marketing, new-to-the-market, *etc.*) is modelled as a function of:

- the intensity of ICT use;
- whether the firm carried out R&D;
- the firm’s size (number of employees); and
- the educational attainments of its employees (as a proxy of skills).

Endogeneity in this context arises from the fact that innovative capability may depend not only on ICT, R&D, firm’s size and skills, but also on other firms’ characteristics which cannot be observed, *e.g.* the capability, specific to each firm, to combine these factors. Therefore, innovative firms are more likely to see the opportunities from ICT and to use it more. In these circumstances, the ICT variable would simply capture unobserved differences in the firms’ capability to innovate, rather than the effects on ICT use on innovation.

In order to control for the potential endogeneity of the ICT variable, we used an Instrumental Variable (IV) approach. We tested a number of variables from the ICT Business survey which could be used as an IV, *i.e.* they are expected to be correlated to ICT use but not to innovation. The variable e-government turned out to be a valid instrument in all countries except the Netherlands and Switzerland, where we used the lagged ICT variable as an IV.

The variable e-commerce is computed from the answers to the following questions (“Eurostat model for a Community Survey on ICT Usage and e-Commerce in Enterprises 2006”):

| B7*. Did your enterprise interact with public authorities in the following ways, during 2005?            |                          |                          |
|----------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
|                                                                                                          | Yes                      | No                       |
| a) For obtaining information                                                                             | <input type="checkbox"/> | <input type="checkbox"/> |
| b) For obtaining forms, <i>e.g.</i> tax forms                                                            | <input type="checkbox"/> | <input type="checkbox"/> |
| c) For returning filled-in forms, <i>e.g.</i> provision of statistical information to public authorities | <input type="checkbox"/> | <input type="checkbox"/> |
| d) Submitted a proposal in an electronic tender system (e-procurement)                                   | <input type="checkbox"/> | <input type="checkbox"/> |

Firms are asked to answer all questions with yes or no. The value e-government is computed as 0, if the firm answers no to all questions, or 1, if the firm answers yes to at least one question. Firms with higher ICT use also use e-government more (except in the

Netherlands and in Switzerland) but there is no reason to expect e-government to reflect unobserved differences in the firms' capability to innovate.

The lagged value of the ICT use was used as an IV based on similar reasons: firms with a higher use of ICT in the past also use ICT more at present but past ICT use is not likely to be correlated to unobserved differences in the firms' capability to innovate at present.

In more formal terms, we started with the following model:

$$Inno_i^* = \beta_0 + \beta_1 \ln(size_i) + \beta_2 R\&D_i + \beta_3 skills_i + \sum_j \gamma_j D_{j,i} + u_i \quad (1)$$

$$ICT_i = \delta_0 + \delta_1 \ln(size_i) + \delta_2 R\&D_i + \delta_3 skills_i + \delta_4 IV_i + v_i \quad (2)$$

$$Inno_i = 1 \text{ if } Inno_i^* > 0; Inno_i = 0 \text{ otherwise} \quad (3)$$

$$D_{j,i} = 1 \text{ if } ICT_i = j; D_{j,i} = 0 \text{ otherwise} \quad (4)$$

where  $i = 1, 2, \dots, N$  indicates the firms;  $j = 1, 2, \dots, 5$  the frequency of ICT use;  $R\&D$  is equal to 1 if the firm carries out  $R\&D$ , 0 otherwise; and  $(u_i, v_i)$  is assumed to have a zero mean, bivariate normal distribution and to be independent of all exogenous variables in (2).

If  $u_i$  and  $v_i$  are correlated,  $ICT$  is endogenous and the Probit estimates of all variables in (1) are biased. Under the assumption of joint normality of  $(u_i, v_i)$ , we can write:

$$u_i = \theta v_i + e_i \quad (5)$$

where  $e_i \sim N[0, \text{Var}(u_i) - \text{Cov}(u_i, v_i)]$ .

Therefore, the above model can be rewritten as:

$$Inno_i^* = \beta_0 + \beta_1 \ln(size_i) + \beta_2 R\&D_i + \beta_3 skills_i + \sum_j \gamma_j D_{j,i} + \theta \hat{v}_i + e_i \quad (6)$$

where  $\hat{v}_i$  are the OLS residuals<sup>2</sup> of equation (2).

Equation (6) was estimated through a "two-stage conditional maximum likelihood" (Rivers and Vuong, 1988) with firm or industry random effects. And the Average Partial Effects (APEs) computed as the average of the Partial Effects (PEs) across  $\hat{v}_i$ .

Three countries (the Netherlands, Norway and Sweden) estimated the model as a 2-period panel with firms' random effects and industry dummies; due to data limitations, the remaining six countries estimated a cross-section with industries' random effects.<sup>3</sup>

In general, panel estimation permits a better control for unobserved differences in the firms' capability to innovate, so that the estimated effects of  $ICT$  may be larger in cross-country regressions. However, our cross-section estimates do not seem systematically larger than the panel estimates.

The model can be interpreted as a simultaneous model, where the decision to innovate and to use  $ICT$ s is taken jointly. In this sense, the model does not predict that  $ICT$  use is the cause of innovation, rather that  $ICT$ s are an *enabler* of innovation: firms use  $ICT$ s as a tool or a "platform" for innovation.

## 6. Main findings

Tables 2 and 3 show the findings of our analysis.<sup>4</sup> The intensity of  $ICT$  use was measured as the number of web facilities (0 to 3) in Table 2 and as the number of automated IT links (0 to 5) in Table 3. Both  $ICT$  use variables provide similar results, although the estimates based on the number of automated IT links are less stable. Therefore, in what follow, we will focus on the results based on the number of web facilities.

## **6.1. Innovation capabilities**

### **6.1.1. ICT use increases the probability to innovate**

The number of web facilities increases the probability to innovate for the manufacturing firms in four countries out of eight. The increase is the highest in Spain and Italy, where firms with three web facilities are 81% and 66%, respectively, more likely to innovate than firms with no web facilities. In Canada and the United Kingdom the increase is 26% and 22%, respectively. Firms with two web facilities in Norway are 8% more likely to innovate, although the effect becomes non significant for a higher number of facilities.

The number of web facilities increases the probability to innovate for the service firms in five countries out of seven. The increase is the highest in Spain and Italy, where firms with three web facilities are over 60% more likely to innovate than firms with no web facilities. In Norway and the United Kingdom the increase is 27% and 26%, respectively. Firms with three web facilities in Switzerland are 7% more likely to innovate than firms with no web facilities.

### **6.1.2. ICT use increases the probability to introduce a new product both in manufacturing and services**

The number of web facilities increases the probability to introduce a new product for the manufacturing firms in five countries out of eight. The increase is the highest in the Netherlands, where firms with three web facilities are 81% more likely to innovate in product than firms with no web facilities. The increase is 31% both for Canada and Italy. In the United Kingdom and Spain the increase is 23% and 11%, respectively. Firms with two web facilities in Norway are 14% more likely to introduce a new product, although the effect becomes non significant for a higher number of facilities.

The effect of ICT on the probability to introduce a new product in manufacturing seems limited to new goods. In fact, the effect on the probability to introduce a new service is lower or not significant.

The number of web facilities increases the probability to introduce a new product for the service firms in six countries out of seven. The increase is the highest in the United Kingdom and Italy, where firms with three web facilities are 32% and 21% more likely to innovate in product than firms with no web facilities. In Norway, the Netherlands, and Switzerland, the increase is 14%, 13 and 12%, respectively, while it is 8% in Spain.

The effect of ICT use on the probability to introduce a new product in services mainly occurs through new services. The only exception is the Netherlands, where the effect of web facilities is higher on new goods (32%) than on new services (14%).

### **6.1.3. ICT use has a significant effect on the probability to introduce a process innovation**

A significant effect of web facilities on the probability to introduce a new production process in manufacturing was found only in Italy, the Netherlands and Switzerland. In these countries, firms with three web facilities are 35%, 12% and 7% more likely to innovate in process than firms with no web facilities.

As for services, a significant effect was found in Spain (37%), Italy (27%) and Norway (16%).

Table 2. Increase in the probability to innovate associated with the intensity of ICT use (number of web facilities) – Manufacturing

|                                    | Canada         |       |       | Italy          |       |       | Luxembourg     |      |     | Netherlands    |       |       | Norway         |       |       | Spain          |       |       | Switzerland    |      |      | United Kingdom |      |       |
|------------------------------------|----------------|-------|-------|----------------|-------|-------|----------------|------|-----|----------------|-------|-------|----------------|-------|-------|----------------|-------|-------|----------------|------|------|----------------|------|-------|
| Number of web facilities           | 1              | 2     | 3     | 1              | 2     | 3     | 1              | 2    | 3   | 1              | 2     | 3     | 1              | 2     | 3     | 1              | 2     | 3     | 1              | 2    | 3    | 1              | 2    | 3     |
| <b>Innovation capabilities</b>     |                |       |       |                |       |       |                |      |     |                |       |       |                |       |       |                |       |       |                |      |      |                |      |       |
| 1. Any innovation (%)              | 13**           | 22*** | 26*** | 31***          | 50*** | 66*** | 71             | 94   | 87  | 61             | 95    | 98    | 5              | 8*    | 7     | 35**           | 68*** | 81*** | n.a.           | n.a. | n.a. | ..             | 14** | 22*** |
| 1a. New product (%)                | 19***          | 29*** | 31*** | 19***          | 30*** | 31*** | 9              | 20   | 17  | 45***          | 70*** | 81*** | 3              | 14*** | 10    | -3             | 6*    | 11*** | n.a.           | n.a. | n.a. | 11*            | 15** | 23*** |
| 1a1. New good (%)                  | 16***          | 27*** | 34*** | 19***          | 26*** | 29*** | ..             | ..   | ..  | 49***          | 69*** | 77*** | 2              | 9*    | 0     | -5             | 4     | 9***  | n.a.           | n.a. | n.a. | ..             | 15** | 22*** |
| 1a2. New service (%)               | -43            | -59   | -52   | 4**            | 12**  | 9*    | ..             | ..   | ..  | 5              | 4     | 5     | 1              | 3*    | 8***  | -6             | 2     | 3     | n.a.           | n.a. | n.a. | 7*             | 9*   | 8*    |
| 1b. New process (%)                | -1             | 11    | 5     | 19***          | 26*** | 35*** | -14            | -13  | -13 | 3              | 7     | 12*** | -1             | 4     | -4    | 28             | 44    | 54    | n.a.           | 2    | 7*   | ..             | ..   | ..    |
| 1c. New organisation (%)           | 5              | 10    | 24**  | 19***          | 31*** | 43*** | 10             | 40** | -1  | 7              | 13*** | 16*** | 2              | 6     | 1     | 3              | 8***  | 13*** | n.a.           | n.a. | n.a. | 12*            | 13*  | 19*** |
| 1d. New marketing (%)              | 7              | 22*** | 29*** | 19***          | 23*** | 38*** | 7              | 23** | 4   | 18***          | 26*** | 36*** | 7*             | 20*** | 18*** | 6              | 7***  | 16*** | n.a.           | n.a. | n.a. | ..             | ..   | 18*** |
| <b>Innovation trajectories (%)</b> |                |       |       |                |       |       |                |      |     |                |       |       |                |       |       |                |       |       |                |      |      |                |      |       |
| 2. New-to-the-market (%)           | 7              | 20*   | 12    | 3              | 11    | 0     | 26             | 24   | -2  | 3              | -3    | 2     | 3              | 5     | 4     | 12             | -5    | -5    | n.a.           | 5    | 10*  | ..             | ..   | ..    |
| 3. Prod. in-house/co-op. (%)       | n.a.           | n.a.  | n.a.  | 2              | 2     | 4     | ..             | ..   | ..  | 65             | 95    | 98    | -1             | -2    | -2    | 9              | -4    | 5     | n.a.           | n.a. | n.a. | n.a.           | n.a. | n.a.  |
| 4. Proc. in-house/co-op. (%)       | n.a.           | n.a.  | n.a.  | 0              | 1     | 3     | ..             | ..   | ..  | -8             | -3    | -8    | 4              | -3    | -1    | -14            | -2    | -1    | n.a.           | n.a. | n.a. | ..             | ..   | ..    |
| 5a. Org. or marketing (%)          | -3             | 0     | 14    | 1              | 3     | 11*** | ..             | ..   | ..  | 4              | 12**  | 16**  | 5              | 13*** | 11*   | 6              | 1     | 7**   | n.a.           | n.a. | n.a. | ..             | ..   | ..    |
| 5b. Org. and marketing (%)         | 4              | 17**  | 23**  | 9***           | 9***  | 20*** | 5              | 31*  | 6   | 13**           | 16**  | 28**  | 5              | 15*** | 7     | 3              | 5     | 13*** | n.a.           | n.a. | n.a. | ..             | ..   | ..    |
| 5c. Organisation (%)               | -4             | -4    | 10    | -1             | 3     | 7*    | -1             | 18   | -3  | -1             | 3     | 10**  | 1              | 6     | -2    | 0              | -2    | 1     | n.a.           | n.a. | n.a. | ..             | ..   | ..    |
| 5d. Marketing (%)                  | 6              | 22**  | 27**  | 11***          | 10*** | 23*** | 6              | 21   | 2   | 17***          | 26*** | 37*** | 8*             | 23*** | 20*** | 8              | 7**   | 17*** | n.a.           | n.a. | n.a. | ..             | ..   | 15*   |
| 6a. Prod. and marketing (%)        | 13*            | 27*** | 27**  | 5*             | 9*    | 16*** | 0              | 1*   | 0   | 8*             | 14*** | 18*** | 8              | 20*** | 14*   | 5              | -1    | 7*    | n.a.           | n.a. | n.a. | ..             | ..   | 23**  |
| 6b. Proc. and org. (%)             | -11            | -11   | -2    | 6*             | 14*** | 15*** | -20            | 0    | -10 | 2              | 5     | 7     | -41            | -57   | -73   | 12             | 3     | 5*    | n.a.           | n.a. | n.a. | ..             | ..   | ..    |
| 6c. Prod. and mktg/org. (%)        | 10             | 15    | 29**  | 3              | 8***  | 11*** | ..             | ..   | ..  | 9              | 14**  | 17**  | 3              | 15*** | 8     | 17             | 1     | 8     | n.a.           | n.a. | n.a. | ..             | 14*  | 19**  |
| 6d. Proc. and mktg/org. (%)        | -11            | -5    | -2    | 6***           | 10*** | 15*** | -22            | -7   | -20 | 4              | 6     | 12    | 0              | 12**  | 1     | 7              | 3     | 6     | n.a.           | n.a. | n.a. | 30**           | 40** | 39**  |
| <b>Co-operation in innovation</b>  |                |       |       |                |       |       |                |      |     |                |       |       |                |       |       |                |       |       |                |      |      |                |      |       |
| 7. Co-op. (%)                      | n.a.           | n.a.  | n.a.  | 6***           | 3*    | -1    | ..             | ..   | ..  | 2              | 6     | 1     | 0              | 1     | -3    | -2             | -6    | -3    | n.a.           | n.a. | n.a. | ..             | 16*  | 14*   |
| Data                               | Cross-section  |       |       | Cross-section  |       |       | Cross-section  |      |     | Panel          |       |       | Panel          |       |       | Cross-section  |       |       | Panel          |      |      | Cross-section  |      |       |
| Estimation                         | Random Effects |       |       | Random Effects |       |       | Random Effects |      |     | Random Effects |       |       | Random Effects |       |       | Random Effects |       |       | Random Effects |      |      | Random Effects |      |       |
| No. of observations                | 488            |       |       | 2 479          |       |       | 128            |      |     | 675            |       |       | 1 697          |       |       | 2 569          |       |       | 1 888          |      |      | 632            |      |       |

\* Significant at 10%.

\*\* Significant at 5%

\*\*\* Significant at 1%.

.. : Non significant.

n.a.: Not available.

Table 2. **Increase in the probability to innovate associated to the intensity of ICT use (number of web facilities) – Services (cont.)**

| Number of web facilities          | Italy          |       |       | Luxembourg     |     |     | Netherlands    |       |       | Norway         |       |       | Spain          |       |       | Switzerland    |      |       | United Kingdom |       |       |
|-----------------------------------|----------------|-------|-------|----------------|-----|-----|----------------|-------|-------|----------------|-------|-------|----------------|-------|-------|----------------|------|-------|----------------|-------|-------|
|                                   | 1              | 2     | 3     | 1              | 2   | 3   | 1              | 2     | 3     | 1              | 2     | 3     | 1              | 2     | 3     | 1              | 2    | 3     | 1              | 2     | 3     |
| <b>Innovation capabilities</b>    |                |       |       |                |     |     |                |       |       |                |       |       |                |       |       |                |      |       |                |       |       |
| 1. Any innovation (%)             | 42***          | 60*** | 61*** | -6             | -4  | 5   | 1              | 3     | 3     | 14***          | 23*** | 27*** | 37***          | 47*** | 60*** | n.a.           | n.a. | 7***  | 17***          | 18*** | 26*** |
| 1a. New product (%)               | 17***          | 22*** | 21*** | 3              | 10  | 24  | 4              | 14**  | 13**  | 4              | 10**  | 14**  | 6              | 3     | 8***  | n.a.           | n.a. | 12**  | 21***          | 23**  | 32*** |
| 1a1. New good (%)                 | 10***          | 11*** | 10*** | 2              | 8   | 9   | 29***          | 35*** | 32*** | 3              | 6*    | 0     | 10             | 0     | 3     | n.a.           | n.a. | 10*** | ..             | ..    | ..    |
| 1a2. New service (%)              | 13***          | 18*** | 18*** | 3              | 16  | 24* | 0              | 10*   | 14**  | 2              | 6*    | 14*** | 3              | 3     | 8***  | n.a.           | n.a. | n.a.  | 21**           | 23**  | 32*** |
| 1b. New process (%)               | 21***          | 22**  | 27**  | -13            | -8  | -9  | -7             | -1    | -2    | 7              | 8**   | 16*** | 30             | 30*** | 37*** | n.a.           | n.a. | n.a.  | ..             | ..    | ..    |
| 1c. New organisation (%)          | 32***          | 49*** | 46*** | -6             | -20 | -7  | 0              | 10    | 5     | 5              | 9*    | 19*** | 10             | 34*** | 42*** | n.a.           | n.a. | n.a.  | 18***          | 16*** | 23*** |
| 1d. New marketing (%)             | 7***           | 10*** | 14*** | -4             | -4  | 5   | 12**           | 22*** | 38*** | 7              | 16*** | 22*** | 10             | 4***  | 10*** | n.a.           | n.a. | n.a.  | 12***          | 17*** | 18*** |
| <b>Innovation trajectories</b>    |                |       |       |                |     |     |                |       |       |                |       |       |                |       |       |                |      |       |                |       |       |
| 2. New-to-the-market (%)          | -3             | 5     | 14    | 17             | 10  | 10  | 1              | 16**  | -2    | -10            | -19   | 1     | 71             | 7     | 13    | n.a.           | n.a. | n.a.  | ..             | ..    | ..    |
| 3. Prod. in-house/co-op. (%)      | 5              | -8    | 14    | -13            | -17 | -8  | 6              | 9*    | 1     | 2              | 5     | 8     | -18            | 7     | 1     | n.a.           | n.a. | n.a.  | 19**           | 19**  | 18*   |
| 4. Proc. in-house/co-op. (%)      | 4              | -6    | 9     | ..             | ..  | ..  | -11            | 0     | 3     | 1              | -3    | 12    | 15             | 4     | 8     | n.a.           | n.a. | n.a.  | 0              | 0     | 0     |
| 5a. Org. or marketing (%)         | -1             | 5*    | 1     | 0              | -23 | -10 | 5              | 14**  | 12*   | 2              | 6     | 8     | -38            | 3     | 4     | n.a.           | n.a. | n.a.  | 12**           | ..    | ..    |
| 5b. Org. and marketing (%)        | 5              | 9**   | 15*** | -3             | -6  | 5   | -8             | -1    | 4     | -7             | -2    | 12    | 11             | -3    | 5     | n.a.           | n.a. | n.a.  | 34**           | 44**  | 43**  |
| 5c. Organisation (%)              | -4             | 3     | -3    | 1              | -29 | -15 | -5             | 3     | -3    | -7             | -7    | 4     | -34            | 1     | 2     | n.a.           | n.a. | n.a.  | ..             | ..    | ..    |
| 5d. Marketing (%)                 | 7**            | 10**  | 18*** | -3             | -2  | 8   | 12**           | 22*** | 40*** | 1              | 10    | 17    | 7              | 0     | 7     | n.a.           | n.a. | n.a.  | ..             | 19*   | 16*   |
| 6a. Prod. and mktg (%)            | 8              | 6     | 5     | -37            | -57 | -60 | 3              | 8     | 25*** | -1             | 7     | 9     | 18             | -5    | -3    | n.a.           | n.a. | n.a.  | 27**           | 27**  | 32**  |
| 6b. Proc. and org. (%)            | 4              | 3     | 5     | -8             | -9  | -11 | 12*            | 11*   | 17**  | -3             | -10   | 3     | -15            | 4     | 6     | n.a.           | n.a. | n.a.  | ..             | ..    | ..    |
| 6c. Prod. and mktg/org. (%)       | 6**            | 4*    | 6**   | 0              | -2  | 8   | -4             | 9     | 8     | 3              | 11    | 13    | 21             | -1    | 2     | n.a.           | n.a. | n.a.  | 29***          | 27*** | 38*** |
| 6d. Proc. and mktg/org. (%)       | 5**            | 5**   | 4     | -4             | -8  | -4  | 13*            | 14**  | 22*** | 3              | 2     | 14    | -15            | 4     | 7     | n.a.           | n.a. | n.a.  | ..             | ..    | ..    |
| <b>Co-operation in innovation</b> |                |       |       |                |     |     |                |       |       |                |       |       |                |       |       |                |      |       |                |       |       |
| 7. Co-op. (%)                     | 3              | 4*    | 3     | -2             | -4  | 0   | 16***          | 17*** | 22*** | -15            | -15   | -17   | -1             | 3     | 8     | n.a.           | n.a. | n.a.  | ..             | ..    | ..    |
| Data                              | Cross-section  |       |       | Cross-section  |     |     | Panel          |       |       | Panel          |       |       | Cross-section  |       |       | Panel          |      |       | Cross-section  |       |       |
| Estimation                        | Random Effects |       |       | Random Effects |     |     | Random Effects |       |       | Random Effects |       |       | Random Effects |       |       | Random Effects |      |       | Random Effects |       |       |
| No. of observations               | 1 912          |       |       | 210            |     |     | 600            |       |       | 1 273          |       |       | 2 201          |       |       | 1 469          |      |       | 1 069          |       |       |

\* Significant at 10%.

\*\* Significant at 5%

\*\*\* Significant at 1%.

.. : Non significant.

n.a.: Not available.

Table 3. Increase in the probability to innovate associated to the intensity of ICT use (number of IT links) – Manufacturing

|                                   | Canada         |       | Italy          |       |       |       |       | Luxembourg     |     |      |     |     | Netherlands    |     |      |       |       | Norway         |    |      |      |      | Spain          |       |       |       |       | United Kingdom |       |       |       |       |
|-----------------------------------|----------------|-------|----------------|-------|-------|-------|-------|----------------|-----|------|-----|-----|----------------|-----|------|-------|-------|----------------|----|------|------|------|----------------|-------|-------|-------|-------|----------------|-------|-------|-------|-------|
| Number of IT links                | 1-2            | 3-5   | 1              | 2     | 3     | 4     | 5     | 1              | 2   | 3    | 4   | 5   | 1              | 2   | 3    | 4     | 5     | 1              | 2  | 3    | 4    | 5    | 1              | 2     | 3     | 4     | 5     | 1              | 2     | 3     | 4     | 5     |
| <b>Innovation capabilities</b>    |                |       |                |       |       |       |       |                |     |      |     |     |                |     |      |       |       |                |    |      |      |      |                |       |       |       |       |                |       |       |       |       |
| 1. Any innovation (%)             | 25             | 14    | ..             | ..    | ..    | ..    | ..    | -1             | 26* | 28*  | 32  | 27  | -8             | -3  | 1    | -3    | 1     | 2              | -1 | 8*** | 2    | 0    | 58             | 76    | 83    | 86    | 90    | ..             | ..    | 7**   | ..    | ..    |
| 1a. New product (%)               | 13             | -6    | 17***          | 25*** | 26*** | 33*** | 45*** | -1             | -4  | 18   | -25 | 14  | -12            | 1   | 6*** | 1     | 4     | 1              | 4  | 6*   | -3   | 1    | 9***           | 12*** | 13*** | 12*** | 12*** | 13***          | 20*** | 40*** | 44*** | 47*** |
| 1a1. New good (%)                 | 14             | -2    | 16***          | 22*** | 25*** | 30*** | 41*** | ..             | ..  | ..   | ..  | ..  | -19            | -2  | 7    | 4     | 6     | 0              | 4  | 8**  | 2    | 5    | 6*             | 9***  | 11*** | 13*** | 14*** | ..             | ..    | 13*** | 11**  | 7*    |
| 1a2. New service (%)              | 1              | 0     | 7              | 9**   | 6     | 10    | 21*   | ..             | ..  | ..   | ..  | ..  | 2              | 5   | 0    | 2     | -1    | 0              | 0  | -1   | -4   | -2   | 5**            | 3     | 4*    | 6*    | 2     | ..             | ..    | ..    | ..    | ..    |
| 1b. New process (%)               | 13             | 7     | 13***          | 26*** | 28*** | 33*** | 47*** | -8             | 9   | -10  | -1  | 1   | -8             | -2  | -1   | 0     | 2     | 5              | 5  | -1   | -4   | -1   | 5              | 9***  | 16*** | 19*** | 17*** | ..             | ..    | 7*    | 12**  | 11*** |
| 1c. New organisation (%)          | 27***          | 31*** | ..             | ..    | ..    | ..    | ..    | 0              | 1   | 43** | -8  | 13  | -5             | -8  | 0    | 5     | 10**  | -3             | 1  | 5*   | 0    | 5    | 14***          | 10*** | 12*** | 13*** | 13*** | ..             | ..    | ..    | ..    | ..    |
| 1d. New marketing (%)             | 10             | 3     | 16***          | 25*** | 24*** | 33*** | 36*** | -4             | 6   | 9    | 7   | 0   | -6             | -8  | -5   | 8**   | 9**   | -5             | 6  | 7**  | 12** | 11** | 7***           | 9***  | 11*** | 11*** | 10*** | ..             | ..    | ..    | ..    | ..    |
| <b>Innovation trajectories</b>    |                |       |                |       |       |       |       |                |     |      |     |     |                |     |      |       |       |                |    |      |      |      |                |       |       |       |       |                |       |       |       |       |
| 2. New-to-the-mkt (%)             | 12             | -6    | 3              | 14**  | 1     | 13**  | 12**  | -14            | -28 | -9   | 10  | -41 | 0              | 1   | 0    | 5     | 2     | 11             | -1 | 1    | 1    | 17** | -2             | -1    | 0     | 2     | 2     | ..             | ..    | ..    | ..    | ..    |
| 3. Prod. in-house/co-op. (%)      | n.a.           | n.a.  | 3              | 0     | 3     | 1     | 1     | ..             | ..  | ..   | ..  | ..  | 1              | -2  | 1    | 5     | 2     | 4              | 4  | 1    | 4    | 4    | 5              | 9     | 6     | 7     | 7*    | ..             | ..    | ..    | ..    | ..    |
| 4. Proc. in-house/co-op. (%)      | n.a.           | n.a.  | 1              | 1     | 2     | 2     | 0     | ..             | ..  | ..   | ..  | ..  | -5             | -1  | 8*** | 15*** | 6     | 1              | -7 | -2   | -5   | 0    | 2              | 4     | 5*    | 4     | 6*    | ..             | ..    | ..    | ..    | ..    |
| 5a. Org. or mktg (%)              | 7              | 20**  | -3             | 2     | 1     | 3     | 0     | ..             | ..  | ..   | ..  | ..  | -5             | -10 | -2   | 11**  | 11**  | -5             | 5  | 6**  | 10** | 12** | 8**            | 5**   | 5***  | 6***  | 5***  | ..             | ..    | ..    | ..    | ..    |
| 5b. Org. and mktg (%)             | 11             | 6     | 6              | 2     | 2     | 7     | 2     | 1              | 8   | 22   | 14  | 0   | -1             | -4  | -4   | 6**   | 7***  | -9             | 4  | 0    | 2    | 7    | 7              | 7     | 11    | 13    | 8     | ..             | ..    | ..    | ..    | ..    |
| 5c. Org. (%)                      | 14             | 26*** | -7             | 0     | 2     | 0     | -2    | -5             | -32 | 13   | -24 | -8  | -1             | -7  | -1   | 7     | 10**  | -6             | 1  | 2    | -1   | 7    | 7              | 3     | 5     | 6     | 4     | ..             | ..    | ..    | ..    | ..    |
| 5d. Mktg (%)                      | 4              | 1     | 9*             | 5     | 1     | 10*   | 4     | -6             | -5  | 0    | 0   | -9  | -4             | -7  | -6   | 9**   | 9**   | -9             | 9* | 4    | 14** | 14** | 7*             | 9***  | 11*** | 12*** | 9***  | ..             | ..    | ..    | ..    | ..    |
| 6a. Prod. and mktg (%)            | -9             | -6    | 10*            | 3     | 3     | 8     | 4     | 0              | 0   | 0    | 1   | 0   | -1             | -6  | -7   | 7     | 9*    | -11            | 3  | -1   | 1    | 8    | 8**            | 7*    | 10*** | 12*** | 5     | ..             | ..    | ..    | ..    | ..    |
| 6b. Proc. and org. (%)            | -4             | 7     | -1             | 2     | 2     | 11**  | 8**   | -41            | -29 | -22  | -33 | -25 | -2             | -1  | -3   | 7     | 7     | -4             | 5  | -1   | -5   | 14   | 12***          | 11*** | 19*** | 21*** | 14*** | 15**           | ..    | 24*** | 31*** | 35*** |
| 6c. Prod. and mktg/org.           | 0              | 4     | 7*             | 1     | 3     | 6*    | 3     | ..             | ..  | ..   | ..  | ..  | -2             | -13 | 1    | 5     | 10*   | -7             | 6  | 1    | 4    | 8    | 8*             | 7*    | 10**  | 11**  | 7*    | ..             | -9*   | ..    | ..    | ..    |
| 6d. Proc. and mktg/org.           | -7             | 4     | 5              | 0     | -1    | 9**   | 5*    | -46            | -71 | -65  | -81 | -78 | -2             | -1  | -4   | 9     | 7     | -4             | 8  | 0    | -7   | 5    | 11***          | 10*** | 19*** | 20*** | 12*** | 16**           | ..    | 26*** | 33*** | 39*** |
| <b>Co-operation in innovation</b> |                |       |                |       |       |       |       |                |     |      |     |     |                |     |      |       |       |                |    |      |      |      |                |       |       |       |       |                |       |       |       |       |
| 7. Co-op. (%)                     | n.a.           | n.a.  | -2             | -1    | -2    | -2    | 2     | ..             | ..  | ..   | ..  | ..  | -8             | 6   | 4    | 13*** | 20*** | 12*            | 4  | 6*   | 4    | 9    | 5**            | 9     | 6***  | 7***  | 7***  | ..             | 13**  | 29*** | 36*** | 45*** |
| Data                              | Cross-section  |       | Panel          |       |       |       |       | Cross-section  |     |      |     |     | Panel          |     |      |       |       | Panel          |    |      |      |      | Cross-section  |       |       |       |       | Panel          |       |       |       |       |
| Estimation                        | Random Effects |       | Random Effects |       |       |       |       | Random effects |     |      |     |     | Random Effects |     |      |       |       | Random Effects |    |      |      |      | Random Effects |       |       |       |       | Random Effects |       |       |       |       |
| No. of observations               | 488            |       | 2 479          |       |       |       |       | 134            |     |      |     |     | 278            |     |      |       |       | 1 697          |    |      |      |      | 1 993          |       |       |       |       | 1 446          |       |       |       |       |

\* Significant at 10%.

\*\* Significant at 5%

\*\*\* Significant at 1%.

..: Non significant.

n.a.: Not available.

Table 3. Increase in the probability to innovate associated to the intensity of ICT use (number of IT links) – Services (cont.)

|                                   | Italy          |       |       |       |       | Luxembourg     |      |      |     |      | Netherlands    |       |       |       |       | Norway         |      |       |       |       | Spain          |       |       |       |       | United Kingdom |       |       |       |      |
|-----------------------------------|----------------|-------|-------|-------|-------|----------------|------|------|-----|------|----------------|-------|-------|-------|-------|----------------|------|-------|-------|-------|----------------|-------|-------|-------|-------|----------------|-------|-------|-------|------|
| Number of IT links                | 1              | 2     | 3     | 4     | 5     | 1              | 2    | 3    | 4   | 5    | 1              | 2     | 3     | 4     | 5     | 1              | 2    | 3     | 4     | 5     | 1              | 2     | 3     | 4     | 5     | 1              | 2     | 3     | 4     | 5    |
| <b>Innovation capabilities</b>    |                |       |       |       |       |                |      |      |     |      |                |       |       |       |       |                |      |       |       |       |                |       |       |       |       |                |       |       |       |      |
| 1. Any innovation (%)             | 28***          | 62*** | 56*** | 64*** | 73*** | 3              | 8*   | 7    | 6   | 6    | 0              | 1     | 0     | -4    | 1     | 15**           | 13** | 11**  | 14**  | 22*** | 15***          | 23*** | 21*** | 18*** | 23*** | ..             | ..    | 6*    | ..    | ..   |
| 1a. New product (%)               | 7***           | 25*** | 21*** | 23*** | 32*** | 36**           | 45** | 40** | 25* | 42** | 2              | 3     | 3     | -5    | 1     | 11             | 7    | 17*** | 10**  | 18*** | 2              | 2     | 7**   | 1     | 6**   | 10***          | 11*** | 18*** | 22*** | 21** |
| 1a1. New good (%)                 | 6***           | 17*** | 9**   | 12*** | 20*** | 9              | 8    | 2    | 6   | 6    | 4              | 18*** | 39*** | 17*** | 26*** | 3              | 5**  | 13*** | 5     | 8**   | 0              | 1     | 5**   | 2     | 6***  | 4*             | 4*    | 6***  | 7***  | 7*** |
| 1a2. New service (%)              | 4              | 17*** | 17*** | 20*** | 23*** | 6              | 13   | 5    | -7  | 10   | 12***          | 5     | -2    | 0     | -1    | 6              | -1   | 2     | 8**   | 8**   | 3              | 2     | 7***  | 3     | 6***  | ..             | ..    | ..    | ..    | ..   |
| 1b. New process (%)               | 11***          | 28*** | 25*** | 37*** | 36**  | -6             | -2   | -3   | 17  | 23   | -9             | 5     | -6    | 2     | -5    | 3              | 4    | 8**   | 12**  | 24*** | 12***          | 19*** | 20*** | 18*** | 21*** | ..             | ..    | ..    | -6    | ..   |
| 1c. New organisation (%)          | 24***          | 43*** | 47*** | 52*** | 59*** | 2              | 6    | 8    | 8   | -7   | -5             | -1    | -3    | 2     | -9    | 11**           | 4    | 8**   | 7     | 15*** | 10***          | 14*** | 7**   | 13*** | 19*** | ..             | ..    | ..    | ..    | ..   |
| 1d. New marketing (%)             | 0***           | 10*** | 7**   | 7**   | 18**  | 3              | 12*  | 17** | 6   | 2    | 7              | 12*** | 21*** | 19*** | 19*** | 2              | 5    | 10*** | 17*** | 20*** | -1             | 4*    | 2     | 5*    | 11**  | 11**           | 18**  | 24**  | 29**  | 32** |
| <b>Innovation capabilities</b>    |                |       |       |       |       |                |      |      |     |      |                |       |       |       |       |                |      |       |       |       |                |       |       |       |       |                |       |       |       |      |
| 2. New-to-the-mkt (%)             | 1              | 9     | -12   | -12   | 0     | 18             | 9    | 2    | 10  | 12   | -7             | -2    | -1    | -4    | 1     | 13             | 17   | 8     | 15    | 1     | -1             | 14*   | 13*   | 2     | 22*** | ..             | ..    | ..    | ..    | ..   |
| 3. Prod. in-house/co-op. (%)      | -7             | 10    | 15    | 0     | 7     | ..             | ..   | ..   | ..  | ..   | 5              | -5    | 6     | 1     | 0     | 1              | -2   | -6    | -8    | -8    | 5              | -14   | -2    | -4    | 2     | ..             | ..    | ..    | ..    | ..   |
| 4. Proc. in-house/co-op. (%)      | 4              | 3     | 12*   | 10    | 5     | ..             | ..   | ..   | ..  | ..   | -2             | -2    | 2     | 1     | 9     | -4             | -12  | 3     | -1    | -5    | 1              | -1    | 9     | 13**  | 1     | ..             | ..    | ..    | ..    | ..   |
| 5a. Org. or mktg (%)              | 1              | -4    | 0     | -1    | 0     | 1              | -10  | 5    | -2  | -26  | -6             | -2    | 1     | 5     | -6    | -4             | -2   | 1     | 5     | 3     | -1             | -1    | -11   | -2    | 4*    | ..             | ..    | ..    | ..    | ..   |
| 5b. Org. and mktg (%)             | -1             | 3     | 15*** | 11**  | 21*** | -3             | 13   | 17   | -3  | 2    | 3              | 8*    | 12**  | 12*   | 11*   | 0              | -6   | 11**  | 8     | 14**  | -9             | -5    | -6    | 4     | 8     | ..             | ..    | ..    | ..    | ..   |
| 5c. Org. (%)                      | 2              | -7    | 6     | 3     | 1     | -11            | -14  | -7   | -15 | -33  | -6             | -1    | -3    | 5     | -10   | 5              | -5   | 4     | -3    | 3     | 0              | -3    | -12   | 0     | 4     | ..             | ..    | ..    | ..    | ..   |
| 5d. Mktg (%)                      | -2             | 4     | 8     | 5     | 17*** | 3              | 15   | 24*  | 5   | 3    | 6              | 11**  | 21*** | 20*** | 18*** | -9             | -2   | 7     | 16**  | 13*   | -10            | -4    | -7    | 0     | 7     | ..             | 25*   | 31*   | 41*   | 45*  |
| 6a. Prod. and mktg (%)            | -12            | 2     | -1    | 6     | 4     | -11            | 14   | 10   | -27 | -2   | -4             | -5    | 3     | 7     | 6     | -14            | -8   | 0     | 4     | 19    | -2             | -5    | -3    | -2    | 7     | ..             | ..    | ..    | ..    | -8*  |
| 6b. Proc. and org. (%)            | 3              | 3     | 9*    | 15*** | 11**  | -5             | 2    | -5   | 6   | 4    | -8             | 0     | -8    | 8     | -2    | 4              | 1    | 12**  | 9     | 26*** | 4              | 9     | -1    | 11**  | 14*** | ..             | ..    | ..    | ..    | ..   |
| 6c. Prod. and mktg/org. (%)       | -5             | 1     | 1     | 4     | 7**   | 9              | 2    | 6    | -4  | -7   | -3             | 4     | 4     | 1     | -3    | -1             | -1   | 20*** | 11    | 17**  | 6              | -5    | -1    | -4    | 6     | 15**           | 21**  | 27**  | 29**  | 31** |
| 6d. Proc. and mktg/org. (%)       | 0              | 3     | 10*** | 10*** | 13*** | -6             | 7    | -2   | 4   | 10   | -6             | 1     | -7    | 8     | -2    | -6             | -1   | 8     | 8     | 25*** | 4              | 10**  | 3     | 12**  | 18*** | ..             | ..    | ..    | -8**  | ..   |
| <b>Co-operation in innovation</b> |                |       |       |       |       |                |      |      |     |      |                |       |       |       |       |                |      |       |       |       |                |       |       |       |       |                |       |       |       |      |
| 7. Co-op. (%)                     | 2              | -2    | -2    | 3     | 1     | 3              | 3    | 9    | 8   | 5    | 1              | 4     | 3     | -2    | 7     | 1              | 1    | 5     | -2    | 1     | 4              | 12*** | 12*** | 16*** | 19*** | ..             | ..    | ..    | ..    | ..   |
| Data                              | Cross-section  |       |       |       |       | Cross-section  |      |      |     |      | Panel          |       |       |       |       | Panel          |      |       |       |       | Cross-section  |       |       |       |       | Panel          |       |       |       |      |
| Estimation                        | Random Effects |       |       |       |       | Random Effects |      |      |     |      | Random Effects |       |       |       |       | Random Effects |      |       |       |       | Random Effects |       |       |       |       | Random Effects |       |       |       |      |
| No. of observations               | 1 912          |       |       |       |       | 210            |      |      |     |      | 235            |       |       |       |       | 1 273          |      |       |       |       | 1 336          |       |       |       |       | 2 630          |       |       |       |      |

\* Significant at 10%.

\*\* Significant at 5%

\*\*\* Significant at 1%.

.. : Non significant.

n.a.: Not available.

#### **6.1.4. *ICT use increases the probability to introduce a new organisation***

The number of web facilities increases the probability to innovate in organisation for the manufacturing firms in five countries out of eight. The increase is the highest in Italy, where firms with three web facilities are 43% more likely to innovate in organisation than firms with no web facilities. In Canada, the United Kingdom, the Netherlands and Spain the increase is 24%, 19%, 16% and 13%, respectively. Firms with two web facilities in Luxembourg are 40% more likely to innovate, although the effect becomes non significant for a higher number of facilities.

These effects are confirmed for services in four countries out of seven. The increase is the highest in Spain and Italy, where firms with three web facilities are, respectively, 46% and 43% more likely to introduce a new organisation than firms with no web facilities. In Norway and the United Kingdom the increase is 19% and 23%, respectively.

#### **6.1.5. *ICT use increases the probability to innovate in marketing***

The number of web facilities increases the probability to innovate in marketing for the manufacturing firms in six countries out of eight. The increase is the highest in Italy and the Netherlands, where firms with three web facilities are 38% and 36%, respectively, more likely to innovate than firms with no web facilities. The increase is 29% in Canada, 18% in Norway and the United Kingdom, and 16% in Spain. Firms with two web facilities in Luxembourg are 23% more likely to innovate in marketing, although the effect becomes non significant for a higher number of web facilities.

The number of web facilities increases the probability to innovate in marketing for the service firms in five countries out of seven. The increase is the highest in the Netherlands, where firms with three web facilities are 38% more likely to innovate than firms with no web facilities. In the remaining countries this effect seems weaker than in manufacturing. The increase in the probability to innovate in marketing is 22% in Norway, 18% in the United Kingdom, 14% in Italy and 10% in Spain.

### **6.2. *Trajectories in innovation***

#### **6.2.1. *ICT use does not increase the probability to introduce a product new-to-the-market***

The introduction of a new product by a firm may result from the adoption of an existing product, i.e. new-to-the-firm, or by the invention of a truly new product, i.e. new-to-the-market. If ICT use increased the invention capabilities of a firm, one may expect new products by ICT-intensive users to be new-to-the-market more often than new-to-the-firm.

Against this expectation, we found that ICT use does not increase the probability to introduce a product new-to-the-market – as opposed to new-to-the-firm. Manufacturing firms in Switzerland are the only ones to show a higher probability (10%) although the statistical significance of this result is weak (10%).

#### **6.2.2. *ICT use does not increase the probability to develop a new product or process in-house***

The introduction of a new product or process by a firm may result from the adoption of an existing product/process developed by another firm or by the invention of a new product/process developed in-house. If ICT use increased the invention capabilities of a firm, one may expect new products/process by ICT intensive users to be mostly developed in-house (or in co-operation with other firms).

In general, we found little evidence that ICT use increases the probability to introduce a new product or a new process developed in-house. Service firms in the United Kingdom are the only ones to show a higher probability (up to 19%) to develop a new product in-house or in co-operation with other firms.

### **6.2.3. Among all innovative firms, ICT-intensive users are more likely to innovate in organisation or marketing**

The number of web facilities increases the probability to innovate in marketing for the innovative manufacturing firms in six countries out of seven. The increase is the highest in the Netherlands, where innovative firms with three web facilities are 37% more likely to innovate in marketing than innovative firms with no web facilities. The increase is over 20% in Canada, Italy and Norway and it is 17% and 15% in Spain and the United Kingdom, respectively. In this latter country, the probability to innovate both in process and marketing/organisation increases up to 40%.

In the service industries, the intensity of ICT use increases the probability to innovate in marketing among innovative firms in the Netherlands (40%) and Italy (18%). In the United Kingdom, ICT use increases the probability to innovate in process and marketing/organisation (38%) as well as in product and marketing/organisation (32%).

## **6.3. Co-operation in innovation**

### **6.3.1. ICT use does not increase probability to co-operate in innovation**

In general, we found little evidence for the hypothesis that ICT intensive users are more likely to co-operate in innovation with other firms or institutions. The only firms where ICT use is associated with a higher probability to co-operate in innovation are manufacturing firms in the United Kingdom (16%) and services firms in the Netherlands (22%).

## **6.4. Cross-country comparisons**

The above results point to significant effects of ICT use on the probability to innovate in a majority of countries. However, the size of these effects varies considerably among them. Although the information available does not permit a full explanation of the estimated differences, it is worth examining some potential causes.

First, differences in the sample size may lead to different precision of the estimates. Although the estimates tend to be large and significant in Italy and Spain, the largest samples, and small and non significant in Luxembourg, the smallest sample, countries with a relative small sample (Canada, Netherlands and the United Kingdom) tend to show significant estimates whereas Switzerland show few significant estimates despite its large sample.

Second, panel estimation permits a better control for unobserved differences in the firms' capability to innovate, so that the estimated effects of ICT may be larger in cross-country regressions. However, this does not seem the case. The panel estimates for the Netherlands are similar or even bigger than the cross-country estimates for Italy and Spain. Panel estimates for services in Norway are in line with cross-country estimates for services in the United Kingdom.

Third, different estimates may be due to the use of different instruments. Against this explanation, the Netherlands and Switzerland show very different estimates despite the

use of the same IV (lagged value of ICT use) and the same panel estimation; whereas Norway and the Netherlands show similar panel estimates in services although they use different IV.

Finally, the estimated effects of ICT are consistently larger in three countries: Italy, the Netherlands and Spain. In Italy and Spain, the diffusion and use of ICT by firms is lower than in the other countries considered in this study. This suggests that the effects of ICT on innovation are stronger when ICT adoption is low, a result consistent with the order-effect of the diffusion theory: the benefits from the use of a new technology are higher for earlier adopters and decrease as the number of adopters increases.

This interpretation, however, is not plausible for the Netherlands, where the rate of diffusion of ICT among business is among the highest in OECD countries.

Overall, cross-country differences in the estimated effects of ICT on innovation seem to be mainly due to the characteristics of the data rather than to the sample size, the estimation approach or some country-specific features. This interpretation appears consistent with the characteristics of innovation survey data highlighted in the econometric literature (Mairesse and Mohnen, 2010).

## 7. Conclusions and suggestions for further research

This study has tried to assess the effects of information and communications technologies (ICTs) as an enabler of innovation in eight OECD countries. Our findings support the hypothesis that ICTs act as an enabler of innovation, in particular for product and marketing innovation. Unlike previous studies, our results show that these effects are large both in manufacturing and services.

However, we did not find any evidence that ICT use increases the capability of a firm to co-operate with other firms/institutions nor that ICT intensive firms have higher capacity to develop innovation in-house or to introduce more “innovative” (new-to-the-market) products. These results suggest that ICTs enable firms to adopt innovation but they do not increase their “inventive” capabilities, i.e. the capability to develop new products and processes.

In interpreting these results, one should bear in mind that they are based on some “imperfect” measure of ICT use by firms. As discussed above, firms with the same automatic IT links or web facilities may use them differently and our indicators would not capture these differences. In addition, these indicators seem biased towards the use of ICTs for e-commerce and e-business but they may be a poorer proxy for other ICT-enabled activities relevant for innovation, e.g. communication.

One development of the present study, therefore, would be to test the above results against some alternative indicator of ICT use. For instance, the analysis could be repeated using ICT investments for the few countries where data are available at the firm level.

If the results were confirmed, another development of the present study would be to have researchers from additional countries join the network and apply the research model developed for this study.

Another direction for further research would be to link the present results to an analysis of productivity at the firm level. Do ICT-enabled innovations have a different impact on productivity as compared with other types of innovation? Do they act through different channels? This line of research requires linking ICT and innovation micro data to

business registers or business surveys and introducing ICT variables into a broader productivity model.

Most important, further research should try to fill the gap between econometric outputs and policy demand. Policy-makers can benefit from cross-country comparisons to the extent that the results can be related to differences in economic and institutional settings. Unfortunately, micro-data analysis is still a long way from this objective, particularly in the field of ICT and innovation. Co-ordinated research projects, like the ones carried out by the OECD and Eurostat, can significantly improve the policy relevance of this work.

## Notes

1. Sylvain Ouellet (Canada), Valeria Mastrostefano and Alessandra Nurra (Italy), Leila Ben-Aoun and Anne Dubrocard (Luxembourg), Thomas Kooten and George van Leeuwen (Netherlands), Marina Rybalka (Norway), Olga Ureña Fernandez and Maria Martinez (Spain), Hans-Olof Hagén (Sweden), Martin Woerter (Switzerland), Peter Stam and Mark Franklyn (United Kingdom). The project benefitted from comments by Andrea Panizza and Marc Bogdanowicz (EC-IPTS, Seville).
2. As ICT is a discrete variable, the OLS estimates of  $\hat{\nu}_i$  are not consistent. Nonetheless, they lead to consistent estimates of equation (6) because they are orthogonal to all exogenous variables – see, for instance, Heckmann (1978).
3. We did not test for fixed effects because this would lead to inconsistent estimates in the context of the “unobserved effects probit model” used in this study (Wooldridge, 2002, p. 484). This situation is known as the “incidental parameters problem”.
4. The results were not significant for Sweden. This is probably due to the combination of two factors: a smaller number of observations and a lower variability in the ICT indicators due to the higher sophistication of ICT use by Swedish firms. An earlier study, based on the same dataset but using a different model, found that ICT use increases both the probability to innovate and the innovation activities among innovators (“ICT use, Broadband and Productivity in Sweden”) [www.scb.se/statistik/publikationer/OV9999\\_2008A01\\_BR\\_X76BR0802.pdf](http://www.scb.se/statistik/publikationer/OV9999_2008A01_BR_X76BR0802.pdf).

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# Exploring the Relationship Between Education and Obesity

by

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*An epidemic of obesity has been developing in virtually all OECD countries over the last 30 years. Existing evidence provides a strong suggestion that such an epidemic has affected certain social groups more than others. In particular, a better education appears to be associated with a lower likelihood of obesity, especially among women. This paper sheds light on the nature and the strength of the correlation between education and obesity. Analyses of health survey data from Australia, Canada, England, and Korea were undertaken with the aim of exploring this relationship. Social gradients in obesity were assessed across the entire education spectrum, overall and in different population sub-groups. Furthermore, investigations testing for mediation effects and for the causal nature of the links observed were undertaken to better understand the underlying mechanisms of the relationship between education and obesity.*

*JEL classification: I12, I21*

*Keywords: obesity, education, social disparities, mediation effect*

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Overweight and obesity rates have been increasing sharply over recent decades in all industrialised countries, as well as in many lower-income countries. The rise in obesity has reached epidemic proportions, with over 1 billion adults worldwide estimated to be overweight and at least 300 million of those considered to be clinically obese (WHO, 2003). The circumstances in which people have been leading their lives over the past 20-30 years, including physical, social and economic environments, have exerted powerful influences on their overall calorie intake, on the composition of their diets and on the frequency and intensity of physical activity at work, at home and during leisure time. On the other hand, changing individual attitudes, reflecting the long-term influences of improved education and socio-economic status (SES) have countered to some extent environmental influences.

Many OECD countries have been concerned not only about the pace of the increase in overweight and obesity, but also about inequalities in their distribution across social groups, particularly by level of education, socio-economic status and ethnic background. Inequalities across social groups appear to be particularly large in women (Wardle *et al.*, 2002; Branca *et al.*, 2007). Acting on the mechanisms that make individuals who are poorly educated and in disadvantaged socio-economic circumstances so vulnerable to obesity, and those at the other end of the socio-economic spectrum much more able to handle obesogenic environments, is of great importance not just as a way of redressing existing inequalities, but also because of its potential effect on overall social welfare. The current distribution of obesity appears particularly undesirable, as it is likely to perpetuate the vicious circle linking obesity and disadvantage by intergenerational transmission.

Research has produced ample evidence of the individual labour market returns of education. Economists have shown much interest in the estimation of the causal effect of education on wages and economic growth (see Card 2001, for a comprehensive review of the literature) but only recently has work begun to investigate the non-monetary returns of schooling (see McMahon, 2004 for a review). Empirical studies, for example, suggest that education has a positive impact on health and well-being (Wolfe and Haveman 2002; Lleras-Muney 2005), particularly in poorer countries (Cutler and Lleras-Muney, 2006), reduces crime (Lochner and Moretti 2004) and water and air pollution (Appiah and McMahon 2002). The finding that education has positive externalities provides a rationale for government intervention.

However, the causal nature of the link between education and health is still subject to a certain degree of scrutiny, and the precise mechanisms through which education may affect health are not yet fully understood. Lifestyles may be one of the keys to understanding such a relationship, as they are often significantly influenced by education and, at the same time, they contribute to health and longevity by affecting the probability of developing a wide range of diseases. Obesity is a close marker of important aspects of individual lifestyles, such as diet and physical activity, and is also an important risk factor for major chronic diseases, such as diabetes, heart disease, stroke and certain cancers. Obesity is also associated with negative labour market outcomes, in term of both wages and employment, particularly for women (Cawley, 2004; Brunello *et al.*, 2006).

The aim of this paper is to provide new evidence concerning the relationship between education and obesity and contribute to understand the nature of such relationship and its implications for health and education policy. The empirical analyses on education and obesity undertaken by the OECD focus on four countries: Australia, Canada, England and Korea. Data from health surveys regularly undertaken in the four countries were used in a range of analyses, in pursuit of the following specific objectives:

1. To explore the correlation between body mass index, and obesity, on one hand, and formal education, expressed in terms of years spent in full-time education, on the other, controlling for possible confounding factors. The main goal of this analysis is to determine whether the intensity of the relationship between education and obesity is constant, or whether it shows increasing or decreasing strength at either end of the education spectrum.
2. To assess the extent to which the correlations identified may reflect the influences of factors associated with individual education, such as socio-economic status and the level of education of household members.
3. To assess the extent to which the correlations identified may reflect causal links between education and obesity.
4. To explore what conceptual model of the role of education as a determinant of health is most consistently supported by the findings concerning the correlation between obesity and aspects of individual and group education.

#### Box 1. Data description

The analyses reported in this paper are based on individual-level national health surveys covering four OECD countries: Australia, Canada, England and Korea. Data sources include the Australian National Health Survey (NHS) 1989-2005, the Canadian National Population Health Survey-cross-section (NPHS) and the Canadian Community Health Survey (CCHS) 1995-2005, the Health Survey for England (HSE) 1991-2005 and the Korean National Health and Nutrition Examination Survey (KNHANES) 1998-2005. All available survey waves were pooled for each survey. Since the focus of the analyses was the relationship between obesity and education, survey samples were restricted to individuals in the age range 25-64 who were supposed to have completed their full time education, and for whom the body mass index is a useful proxy for health risk. Body mass index (BMI) was calculated as weight in kilograms divided by square height in meters. Obesity and overweight status were then derived as BMI greater than 30 and 25.

The analyses were conducted by applying the same models to all countries' data, in order to facilitate comparisons across countries. However, differences in data and survey methods sometimes make it difficult to achieve complete consistency. For instance, data on height and weight were measured by examination in England and Korea while they were self-reported in the other two countries. The education variable was obviously a critical one, and the format of this variable varied across countries. We created a variable reflecting the numbers of years spent by each individual in full-time education using all the information available in each dataset on years of schooling and educational attainment. For consistency, we grouped together individuals with no education and those with the lowest level of education, as these two groups were not always separated in the available datasets. A certain degree of heterogeneity was also present in relation to the socio-economic status (SES) variable, as occupation-based social class was reported in the English data, while equivalised household income was available in Australia, Canada and Korea. Individuals were allocated to income quintiles in Australia and Korea, and to income groups based on fixed income ranges in Canada. Finally, an ethnicity variable was available in England, while proxies were used in Canada (minority status) and Australia (migrant status). No such variable was available in Korea. Tables of descriptive statistics are presented in Annex A1.

## 1. Existing evidence on the relationship between education and obesity

The existing evidence concerning the relationship between education and obesity is relatively limited, as the main focus of most research has been more broadly on the links between socio-economic factors and health status, or longevity, with a smaller number of studies focusing on lifestyles and on obesity in particular. The evidence available, covering a number of OECD countries, generally shows strong associations between education and obesity. However, there have been only few studies that have investigated the causal effects of education on obesity, and these studies have reported mixed results.

Cutler and Lleras-Muney (2006) found that those with more years of schooling are less likely to smoke, drink a lot, to be overweight or obese or to use illegal drugs. Similarly, the better educated are more likely to exercise and to obtain preventive care such as flu shots, vaccines, mammograms, pap smears and colonoscopies. They also found the relationship between education and health appears to be non-linear for obesity, with increasing effects of additional years of schooling. A review by Grossman and Kaestner concluded that years of formal schooling is the most important correlate of good health (Grossman *et al.*, 1997). Cross-sectional estimates from a study of twins conducted by Webbink *et al.* (2008), also confirms the negative relationship between education and the probability of being overweight. By looking at differences between the sexes within a study of socio-economic factors and obesity, Yoon *et al.* (2006) found that income, rather than education, had a greater effect on BMI and waist circumference in men, whereas higher levels of education for women resulted in lower BMI and waist circumference.

The correlation between education and health may reflect three possible types of relationships: a) a causal link running from increased education to improved health, b) a reverse causal link, indicating that better health leads to greater education; or c) an absence of a causal relationship between education and health, which appear to be correlated because of possible unobserved factors affecting both health (or obesity) and education in the same direction. The three pathways are not mutually exclusive, of course, and some combination of the three is likely to provide the most plausible explanation of the strong correlations consistently found across countries between education and health, or obesity. Cutler and Lleras-Muney (2006) argue that children in poor health obtain less schooling and because of this they are also more likely to be unhealthy adults. Similarly, evidence on longitudinal data shows that becoming overweight during the first four years in school is a significant risk factor for adverse school outcomes in girls (Datar and Sturm, 2006). Unobserved factors possibly contributing to the third pathway identified may include family background, genetic traits or other individual differences, such as ability to delay gratification. These factors may explain why the more educated are also healthier. Cutler and Lleras-Muney (2006) found that even controlling for some of these factors, the effect of education on health generally remains large and significant. Although there is evidence to support the hypothesis that the direction of causality is from more schooling to better health (Grossman, 2000), when overall health status or longevity are the outcomes of interest, there are few studies shedding light on the causal nature of the relationship between education and obesity specifically. Results from Lundborg (2008) suggest that a causal effect of education on health exists, but found no evidence that lifestyle factors such as smoking and obesity contribute to the health/education gradient. Natural experiments where policy changes are implemented that directly affect the number of years of mandatory schooling, can provide an indication of the causal nature of the link between education and obesity. Arendt (2005) used changes in compulsory education laws in

Denmark and found inconclusive results regarding the effect of education on BMI. However, Spasojevic, (2003) using a similar estimation strategy for Sweden found that additional years of education have a causal effect on maintaining a healthy body mass index. Clark and Royer (2008) focused on an educational reform implemented in England in 1947, which increased the minimum compulsory schooling age in the country, from 14 to 15. They found that cohorts affected by the law display only slightly improved long-run health outcomes and their findings did not support a causal link between education and obesity. Brunello *et al.* (2009) used compulsory school reforms implemented in European countries after the Second World War to investigate the causal effect of education on the BMI and the incidence of overweight and obesity among European females. They showed that years of schooling have a protective effect on BMI. On US data, Grabner (2009) used the variation caused by state-specific compulsory schooling laws between 1914 and 1978 as an instrument for education, and found a strong and statistically-significant negative effect of additional schooling on BMI, effect especially pronounced in females.

Michael Grossman's demand for a health model, developed in the 1980s, hypothesised that "schooling raises a person's knowledge about the production relationship and therefore increases his or her ability to select a healthy diet, avoid unhealthy habits and make efficient use of medical care" (Kemna, 1987). Educated individuals make better use of health-related information than those who are less educated. Education provides individuals with better access to information and improved critical thinking skills. Speakman *et al.* (2005) hypothesised that the lack of education about energy content of food may contribute to the effects of social class on obesity. Results from their study show that on average, non-obese individuals in the lower social class group have better food knowledge than those who are obese in the same group. However non-obese subjects in all groups overestimate food energy in alcoholic beverages and snack foods indicating poorer knowledge of the energy content of these foods. Lack of information could also affect one's own perception of their body mass. Research has shown that over time more overweight individuals are under-perceiving their body mass compared with people with normal weight (Haas, 2008). It is possible that more highly-educated people have the knowledge to develop healthy lifestyles and have more awareness of the health risks associated with being obese (Yoon, 2006). The more educated are more likely to choose healthy lifestyles; however, it has been shown that the highly educated choose healthier behaviours than individuals who are highly knowledgeable about the consequences of those behaviours (Kenkel, 1991). This could indicate that the effect of education on obesity is driven by different mechanisms, and not just by information and knowledge about healthy lifestyles.

Exploring the link between education and obesity is important, as this may lead to the development of appropriate education-based policies to counteract recent trends in obesity and related chronic diseases. For example, if the findings reported by Cutler and Lleras-Muney (2006) showing increased effects of additional years of schooling for those who are better educated were confirmed by further analyses, these would provide support for education policies aimed at promoting higher education, as these would produce greater health returns.

## 2. Policy and institutional environment

Policies aimed at counteracting the negative effects of obesity through the education system can be of two main types: policies focusing on the educational environment, aimed

at promoting healthier lifestyles by exposing children to healthier environments and by providing health education; and policies aimed at encouraging higher levels of general education. Although the relationship between years of schooling, or educational attainment, and health outcomes is well established, most of the policies encountered to improve health by promoting lifestyle changes have focused on educating the population about healthier lifestyles as opposed to providing more general education. Each of the four countries examined in this study have implemented policies to strengthen “healthy living” education within schools, with the aim of achieving better health outcomes.

Australia has developed National Goals for Schooling in the Twenty-First Century, to which authorities across governmental jurisdictions refer to provide young Australians with the best possible educational outcomes and improve the quality of schooling nationally. The Active School Curriculum/ Building a Healthy Active Australia through the Department of Health and Ageing aims to provide young people with the skills to embrace an active lifestyle by introducing them to a range of physical activities. All state and territory governments and non-government education authorities have committed to providing in their curriculum at least two hours of physical activity each school week for primary and junior secondary school children under the Schools Assistance Act 2004. Also, the Australian Social Inclusion Agenda of the Australian Labour Party recommended that more young people from disadvantaged backgrounds complete 12 years of schooling and go on to further education and training.

In Canada, due to the vast geographical dispersion of the population, many policies relating to health and education are conducted at the provincial/territorial level. Nova Scotia, for example, implemented the Annapolis Valley Health Promoting Schools programme in seven elementary schools, with preliminary results indicating that those schools which implemented the programme had significantly lower rates of overweight and obese students. The British Columbia Children’s Hospital and the University of British Columbia implemented a programme called “Healthy Buddies” to empower elementary school children to live healthier lives by providing them with knowledge about health and physical activity. Results from the programme have shown that students had an increase in their healthy-living knowledge and BMI and less weight gain than students who were not in the programme. In Quebec the “Take care of your health!” programme delivered by ACTI-MENU (a health promotion organisation) aimed to provide employees with information and support risk factor reduction. Evaluation of the programme revealed that participants were more likely to report more frequent physical activity and better nutritional practices and absenteeism declined by 28% and turnover by 54%.

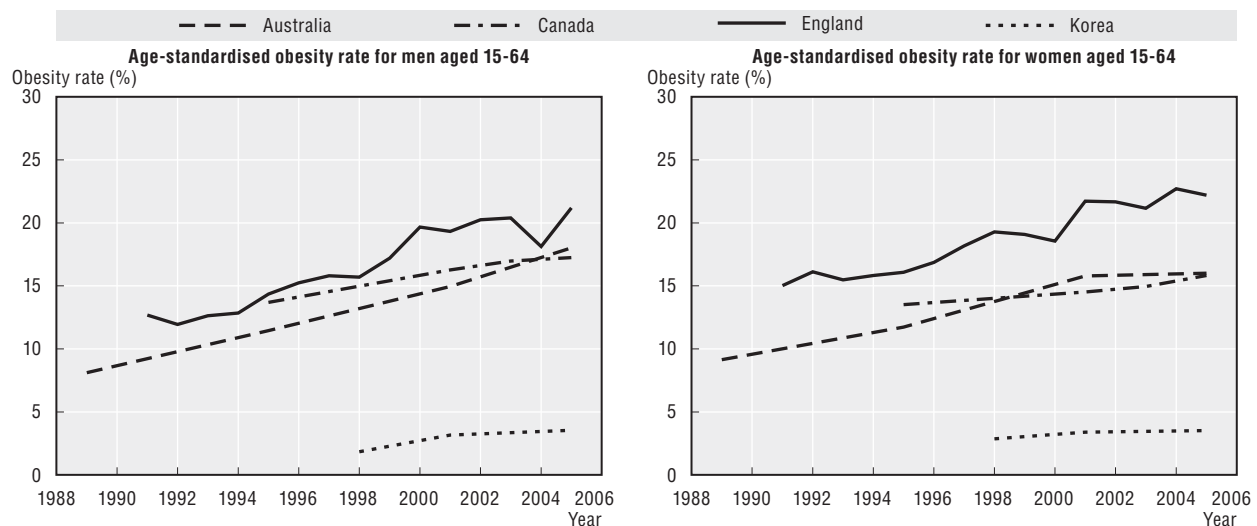
As part of the National Health Promotion Act, Korea established national policies aimed at enhancing people’s health through health education, disease prevention, nutrition improvement and the practice of healthy lifestyles. The Health Plan 2010 aims at improving the nutritional status of the population and a part of this was the revision and dissemination of dietary guidelines, enforcing mandatory nutrition labelling and providing information to groups deemed vulnerable such as the elderly and young children. Part of this strategy is to develop the plan in line with educational, political, economic and organisational means. The Health Plan 2010 includes activities focusing on the development of nutritious diets, development of obesity prevention and management programmes and physical activity campaigns.

“Healthy Weight, Healthy Lives: A Cross-Government Strategy for England” is a project which targets children for healthy growth and healthy weight. Funded through the Department of Health, this strategy aims to reduce the proportion of overweight and obese children back to the levels found in 2000 by 2020. The NHS (National Health Service) has strategies aimed at offering public advice and support to those who already have weight problems through weight management programmes, NHS websites, as well as by developing the ability of health-service staff to deal with issues of excess weight. Additionally, strategies exist in England to combat obesity through the promotion of healthier food choices, by limiting food advertising to children and working with the food industry to reduce salt, sugar and fat in foods; as well as strategies such as “Walking into Health” to build physical activity into the lives of the whole population and “Active England” aimed at promoting non-sport physical activity.

### 3. General trends in obesity in the four countries

The distribution of BMI in the four countries concerned has been shifting in a characteristic fashion over the past few decades, as illustrated in Sassi *et al.*, 2009. In particular, as in most OECD countries, a sizable share of the normal weight population has been progressively gaining weight, moving towards the pre-obese category first, then progressively towards obesity and, in some cases, morbid obesity ( $BMI > 40$ ). A visible increase in the percentage of the population that is obese was recorded for both men and women, across all four countries (Figure 1). However, a significant difference in trends between genders is observed in Korea, where the relative distribution of females over the BMI categories remained relatively stable between 1998 and 2005, while a 10% decrease in the normal weight category was observed in men, followed by a 9% increase in the pre-obese category and a 2% increase in the obese category. On the other hand, in 2005 Korea had only 4% of its population obese, on average, compared with 25% in England, 18% in Australia and 17% in Canada. In the latter three countries the percentage of overweight men is significantly higher than that of women. In Canada, the majority of men were overweight in all survey years, and the same has been true in England since 1995.

Figure 1. Trends in age-standardised obesity rates in Australia, Canada, England and Korea



Source: Authors' estimates using 2005 OECD standard population.

### Box 2. Methods

Differences in obesity rates among population groups with different levels of education were first analysed using logistic regression models controlling for a range of covariates, including gender, age, ethnicity, socio-economic status and survey year (Figure 2 and Annex A2). An interaction term between education and gender was also included in the regression model for the purpose of assessing differences between the two genders in the relationship between education and obesity (Figures 4 to 6, and Annex A3). The relationship between education and obesity in different ethnic groups was similarly explored through an interaction term between years of education and ethnicity (minority status in Canada, migrant status in Australia). The relationship between BMI and education was analysed using ordinary least squares regression models including the same covariates listed above (Figure 3 and Annex A2). All analyses were conducted using Stata 10.

Obesity rates, as well as BMI levels, by years of education were reported in separate graphs for different population groups. The linearity of the relationship between education and obesity and BMI was assessed visually, based on those graphs.

The effects of the clustering of individuals into households or geographical areas were studied using multilevel statistical models, also known as hierarchical linear models, random effects models or nested models (see Annex A4). Multilevel analyses concerned England and Korea, data which are based on household structure. Two-level random-intercept models, using households as higher-level units of aggregation, were tested on samples of people aged 25-64, living in a household comprising at least two members. It was not possible to perform this analysis on Australian and Canadian data, since the relevant surveys do not have a household structure.

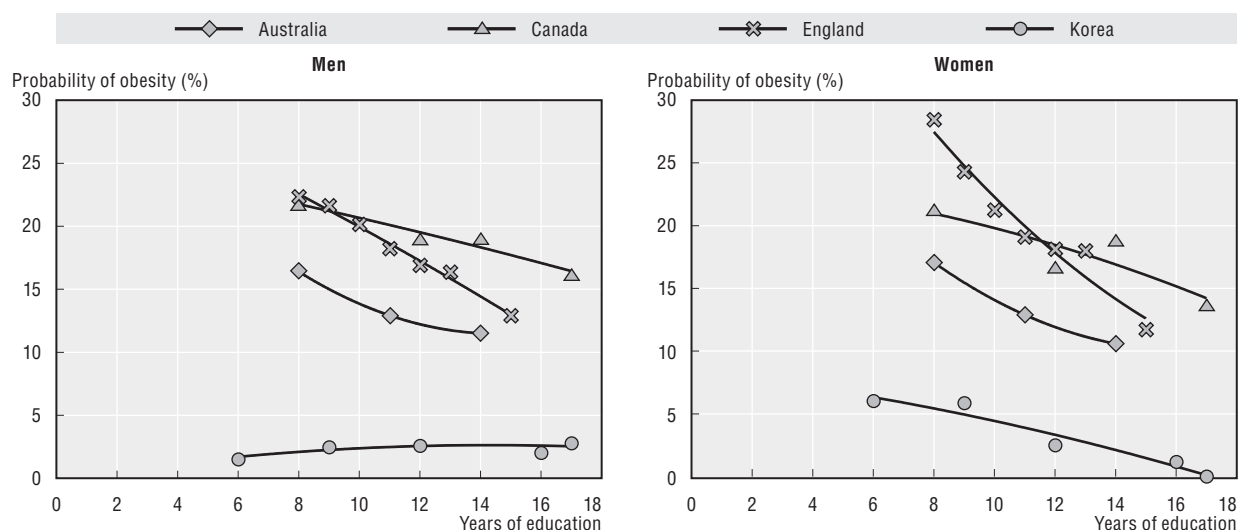
## 4. Is the strength of the correlation between education and obesity constant across the entire education spectrum, overall and in different population sub-groups?

Figure 2 shows the relationship between education and obesity for each gender in the four countries. Obesity rates in Figure 2 and BMI levels in Figure 3 are regression estimates adjusted for age, gender, and socio-economic status. Full results are presented in Annex A2. The relationship is negatively sloped in all cases except in Korean men, indicating that each additional year of education is consistently associated with a lower chance of being obese in Australia, Canada and England, as well as in Korean women. For Korean men, no conclusive results could be obtained as none of the coefficients for education were significant in the regression analysis, possibly due to the relatively small number of individuals who are obese in the country.

The patterns shown in Figure 2 suggest that the relationship between obesity and years of education may be considered broadly linear, i.e. of a constant strength across the entire education spectrum. However, results for England and Canada might suggest that the effect of further years of education tends to decrease progressively when approaching completion of upper secondary education (13-14 years of schooling), and then increase again sharply in individuals who complete tertiary education. A similar effect was also found for men in Australia, based on 2001 and 2005 data, which provided more detailed information on years of education relative to other editions of the same survey.

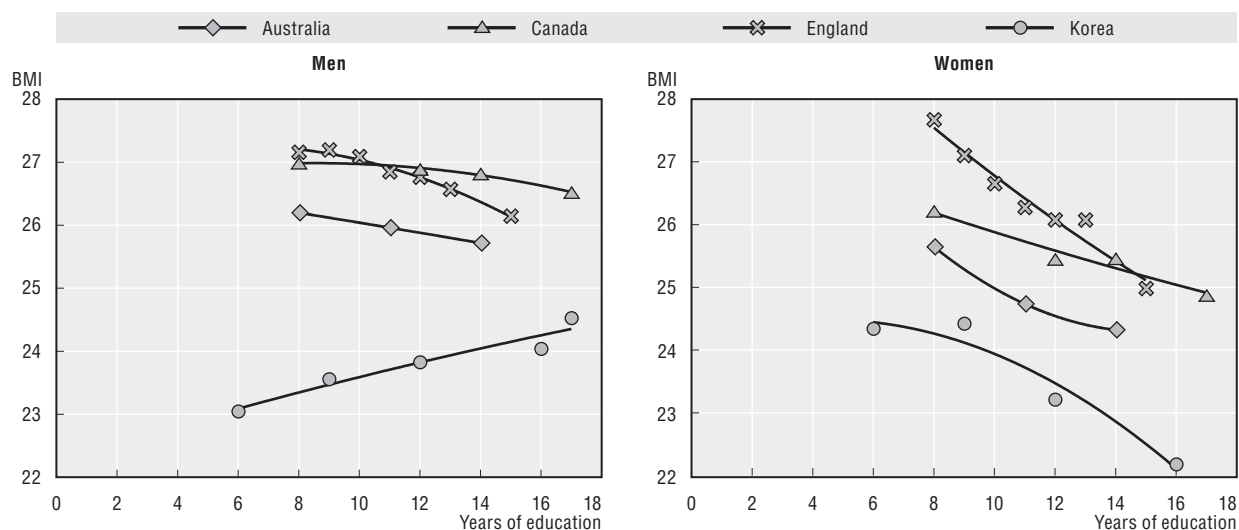
When the relationship between average BMI and education is observed, as in Figure 3, the conclusions are similar to what was previously discussed. No clear and consistent deviation is observed from a linear pattern in the four countries examined. Again Korean men represent an exception, as they display a positively sloped relationship, which seems substantially more marked than in Figure 2, where the link between education and obesity was examined.

Figure 2. Relationship between obesity and years of education



Source: Authors' estimates from logistic regression, see Annex A2.

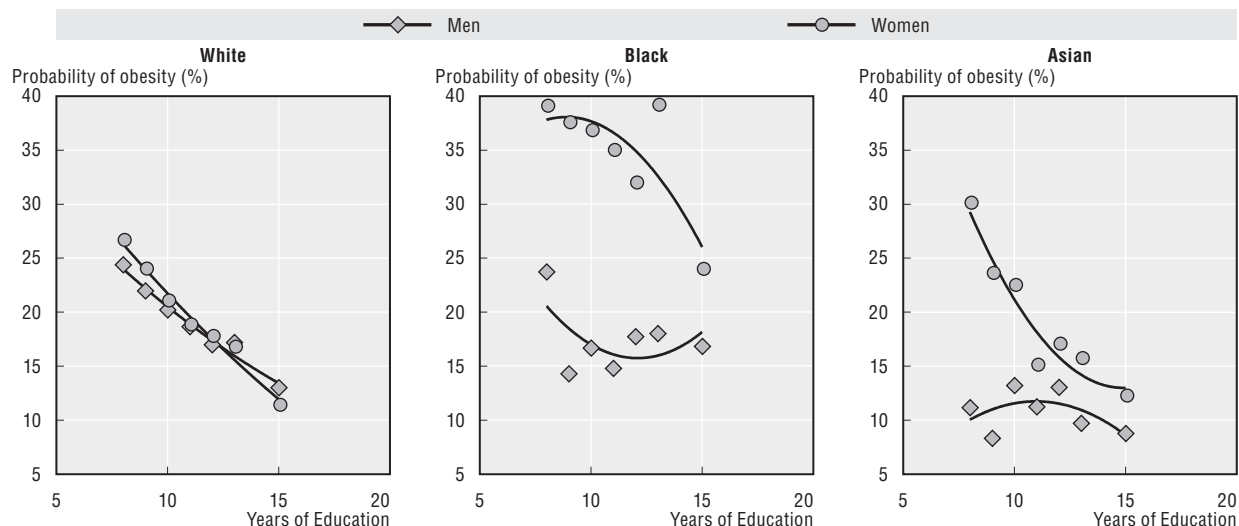
Figure 3. Relationship between BMI and years of education



Source: Authors' estimates from linear regression, see Annex A2.

The relationship between obesity and education was observed in different sub-groups along dimensions reflecting ethnicity or minority status (Figures 4 to 6). Obesity rates presented in Figures 4 to 6 are estimates adjusted for age, gender, and socio-economic status. Full results are presented in Annex A3. Three ethnic groups were identified in England (White, Black, Asian), while binary variables were used in Canada and Australia to denote, respectively, ethnic minority status and migrant status. The slope of the correlation between education and obesity is broadly similar in women, across all ethnic groups, although Black women display significantly higher obesity rates than others. It is difficult to assess whether the different patterns observed in Black and Asian women, suggesting a concave relationship between education and obesity in the former and a

Figure 4. Relationship between obesity and years of education by ethnicity groups in England

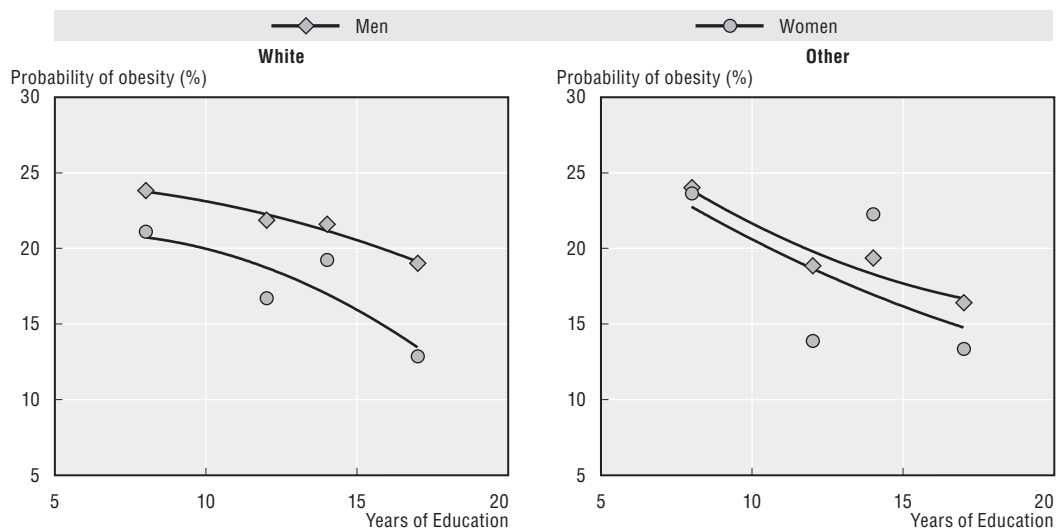


Source: Authors' estimates from logistic regression, see Annex A3.

convex relationship in the latter, reflects a true difference in the impact of education in the two groups. However, this interpretation of concavity and convexity on few data points should be taken with caution, as it is sensitive to outliers. This finding demands a larger and more detailed investigation. Education appears to be much more weakly correlated with obesity in Black and Asian men, although the least educated among Black men are substantially more likely to be obese than their more educated counterparts.

In Canada, individuals who belong to ethnic minority groups are less likely to be obese than White majority individuals. The relationship between obesity and education level is negatively sloped in both men and women, regardless of minority status, as illustrated in Figure 5.

Figure 5. Relationship between obesity and years of education by minority status in Canada



Source: Authors' estimates from logistic regression, see Annex A3.

The analysis of the correlation between obesity and education in Australia does not show significant differences by migrant status, as illustrated in Figure 6.

Figure 6. Relationship between obesity and years of education by migrant groups in Australia



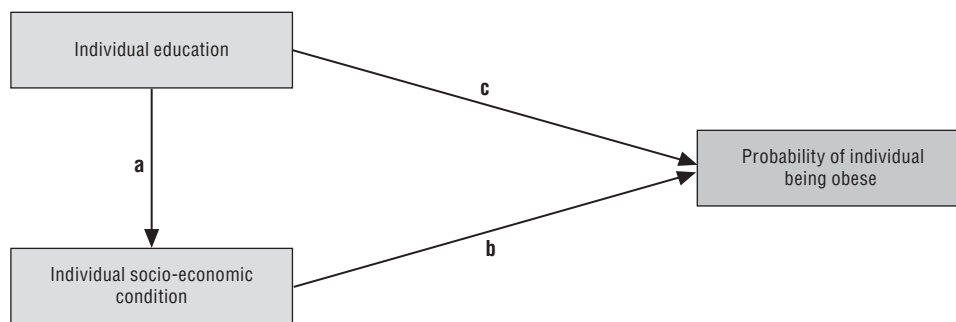
Source: Authors' estimates from logistic regression, see Annex A3.

In addition, regression analyses presented in Annexes A2 and A3 were adjusted for socio-economic status. Obesity tends to be more prevalent in disadvantaged socio-economic groups, and inequalities are consistently larger in women than in men. A more detailed analysis of social inequalities in obesity is presented in a separate study (Devaux and Sassi, 2011).

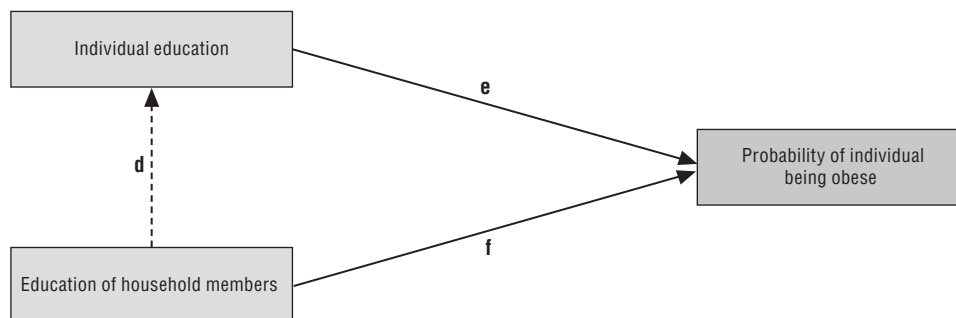
## 5. Does the relationship between education and obesity reflect the role of other factors associated with individual education?

Several factors associated with individual education may potentially have an influence on the correlation observed between education and BMI/obesity. In particular, we studied the influence of individual socio-economic status and of the education level of household members.

In addition to its direct effect on the likelihood of obesity, individual education may also have an indirect effect, mediated by individual socio-economic status. Figure 7 describes the hypothesised **mediation effect**. Individual education contributes to determining individual socio-economic status (a), which in turn has an influence on the likelihood of obesity (b). Such mediated effect adds to the direct effect of education on obesity<sup>1</sup> (c). In order to test for the existence of the hypothesised mediation effect, a series of logistic regression models were developed with and without controlling for the socio-economic status covariate, to assess possible variations in the coefficients of the individual education variable. Results are consistent with a slight mediation role played by socio-economic status in the relationship between education and obesity since odds ratios of obesity according to education level change slightly towards a unitary value, when the role of socio-economic status is accounted for (Sassi et al., 2009). However, it should be noted that this empirical strategy does not account for a potential reverse causality in the relationships outlined in Figure 7 (a, b and c).

Figure 7. **Indirect effect of individual education through individual socio-economic status**

A further analysis focused on the education of household members, which might have a direct influence on the likelihood of an individual being obese, i.e. it may have a **concurrent effect** to that of individual education (relationships e and f in Figure 8). In principle, individual education may also act as a mediator of the household education effect on obesity (d and e in Figure 8). However, the analysis focused on the former (concurrent) effect of the education of household members.

Figure 8. **Indirect effect of education of household members**

The concurrent effect of household education could bias estimates of the effect of individual education on obesity. The education of household members could be, indeed, viewed as an omitted variable that would bias the model's coefficients. So, to test for this concurrent effect, regression models with and without this covariable were computed. This analysis is limited to England and Korea, the two countries for which household-based surveys are available. Multilevel logistic models were used to account for household structure (see Annex A4 for details of methods used). The education of household members is defined as the years of education of the spouse of the head of household and, when the latter was not available, as the years of education of the head of household.<sup>2</sup>

Odds ratios for the probability of being obese in England are displayed in Table 1. Model 1 is a multilevel logistic model without controls for the level of education of household member, whereas model 2 accounts for the education of household members. Differences among households explain about one fifth of the total variance in the likelihood of obesity (see the intra-class correlation coefficient  $Rho$ , in Table 1). It is worth noting that household education is negatively correlated to obesity status (odds ratio < 1) with significant values when years of education are above 11. Comparison of model 2 with model 1 shows that there seems to be a small concurrent effect of household education on

obesity, which adds to the effect of individual education, since odds ratios of obesity according to individual education become smaller and closer to 1.

**Table 1. Odds ratios and significance for the probability of obesity in England**

| England                                | Model 1: without controls |              | Model 2: with controls for household education |              |
|----------------------------------------|---------------------------|--------------|------------------------------------------------|--------------|
|                                        | Odds Ratios               | Significance | Odds Ratios                                    | Significance |
| Age                                    | 1.070 ***                 |              | 1.073 ***                                      |              |
| Age squared                            | 0.999 ***                 |              | 0.999 ***                                      |              |
| Year of survey                         | 1.065 ***                 |              | 1.067 ***                                      |              |
| Women                                  | 1.441 ***                 |              | 1.381 ***                                      |              |
| <b>Years of education – Men</b>        |                           |              |                                                |              |
| 8                                      | ref.                      |              | ref.                                           |              |
| 9                                      | 0.937                     |              | 0.967                                          |              |
| 10                                     | 0.860 **                  |              | 0.916                                          |              |
| 11                                     | 0.767 ***                 |              | 0.859 *                                        |              |
| 12                                     | 0.703 ***                 |              | 0.798 **                                       |              |
| 13                                     | 0.671 ***                 |              | 0.796 ***                                      |              |
| 15                                     | 0.522 ***                 |              | 0.636 ***                                      |              |
| <b>Years of education – Women</b>      |                           |              |                                                |              |
| 8                                      | ref.                      |              | ref.                                           |              |
| 9                                      | 0.746 ***                 |              | 0.784 ***                                      |              |
| 10                                     | 0.630 ***                 |              | 0.697 ***                                      |              |
| 11                                     | 0.552 ***                 |              | 0.664 ***                                      |              |
| 12                                     | 0.514 ***                 |              | 0.615 ***                                      |              |
| 13                                     | 0.505 ***                 |              | 0.648 ***                                      |              |
| 15                                     | 0.304 ***                 |              | 0.390 ***                                      |              |
| <b>Ethnicity</b>                       |                           |              |                                                |              |
| White                                  | ref.                      |              | ref.                                           |              |
| Black                                  | 1.714 ***                 |              | 1.729 ***                                      |              |
| Asian                                  | 0.738 ***                 |              | 0.734 ***                                      |              |
| <b>Socio-economic status</b>           |                           |              |                                                |              |
| highest                                | ref.                      |              | ref.                                           |              |
| middle-high                            | 1.252 ***                 |              | 1.253 ***                                      |              |
| middle                                 | 1.199 ***                 |              | 1.192 ***                                      |              |
| middle-low                             | 1.347 ***                 |              | 1.337 ***                                      |              |
| lowest                                 | 1.481 ***                 |              | 1.466 ***                                      |              |
| <b>Years of education of household</b> |                           |              |                                                |              |
| 8                                      |                           |              | ref.                                           |              |
| 9                                      |                           |              | 0.951                                          |              |
| 10                                     |                           |              | 0.893                                          |              |
| 11                                     |                           |              | 0.812 **                                       |              |
| 12                                     |                           |              | 0.819 **                                       |              |
| 13                                     |                           |              | 0.752 ***                                      |              |
| 15                                     |                           |              | 0.749 ***                                      |              |
| Observations                           | 102 051                   |              | 100 202                                        |              |
| Log-likelihood                         | –49 860.1                 |              | –48 867.7                                      |              |
| Rho                                    | 0.195 ***                 |              | 0.196 ***                                      |              |

Note: \*\*\* means significant at 1%, \*\* at 5%, \* at 10%.

Source: Cross-sectional survey data from *Health Survey for England 1991-2005*. Authors' calculations.

Table 2 shows the results of the corresponding analysis for Korea. In this case, differences among households explain about 7% of the total variance in the likelihood of obesity (see intra-class correlation in Table 2). In both models, odds ratios for men are not significantly different from 1, although the strength of the correlation between obesity and

individual education is somewhat diminished in model 2, similarly to what was observed in England. On the other hand, the correlation between individual education and obesity appears marginally strengthened when accounting for household education in women, contrary to expectations. However, the absence of a statistically significant correlation between household education and obesity prevents from drawing any conclusions on the role of the latter in Korea.

**Table 2. Odds ratios and significance for the probability of obesity in Korea**

| Korea                                  | Model 1: without controls |              | Model 2: with controls for household education |              |
|----------------------------------------|---------------------------|--------------|------------------------------------------------|--------------|
|                                        | Odds Ratios               | Significance | Odds Ratios                                    | Significance |
| Age                                    | 0.961                     |              | 0.965                                          |              |
| Age squared                            | 1.000                     |              | 1.000                                          |              |
| Year of survey                         | 1.070 ***                 |              | 1.071 ***                                      |              |
| Women                                  | 3.871 ***                 |              | 3.759 ***                                      |              |
| <b>Years of education – Men</b>        |                           |              |                                                |              |
| 6                                      | ref.                      |              | ref.                                           |              |
| 9                                      | 1.551                     |              | 1.385                                          |              |
| 12                                     | 1.582                     |              | 1.439                                          |              |
| 16                                     | 1.438                     |              | 1.123                                          |              |
| 17                                     | 1.810                     |              | 1.209                                          |              |
| <b>Years of education – Women</b>      |                           |              |                                                |              |
| 6                                      | ref.                      |              | ref.                                           |              |
| 9                                      | 0.959                     |              | 0.795                                          |              |
| 12                                     | 0.408 ***                 |              | 0.394 ***                                      |              |
| 16                                     | 0.189 ***                 |              | 0.152 ***                                      |              |
| <b>Socio-economic status</b>           |                           |              |                                                |              |
| highest                                | ref.                      |              | ref.                                           |              |
| middle-high                            | 0.971                     |              | 0.940                                          |              |
| middle                                 | 1.006                     |              | 0.991                                          |              |
| middle-low                             | 1.040                     |              | 1.059                                          |              |
| lowest                                 | 1.203                     |              | 1.215                                          |              |
| <b>Years of education of household</b> |                           |              |                                                |              |
| 6                                      |                           |              | ref.                                           |              |
| 9                                      |                           |              | 1.181                                          |              |
| 12                                     |                           |              | 1.053                                          |              |
| 16                                     |                           |              | 1.320                                          |              |
| 17                                     |                           |              | 2.281                                          |              |
| Observations                           | 15 441                    |              | 15 199                                         |              |
| Log-likelihood                         | –2 039.7                  |              | –1 998.8                                       |              |
| Rho                                    | 0.077                     |              | 0.073                                          |              |

Note: \*\*\* means significant at 1%, \*\* at 5%, \* at 10%.

Source: Cross-sectional survey data from KNHANES 1998-2005. Authors' calculations.

## 6. Do the data provide evidence of the causal nature of the link between education and obesity?

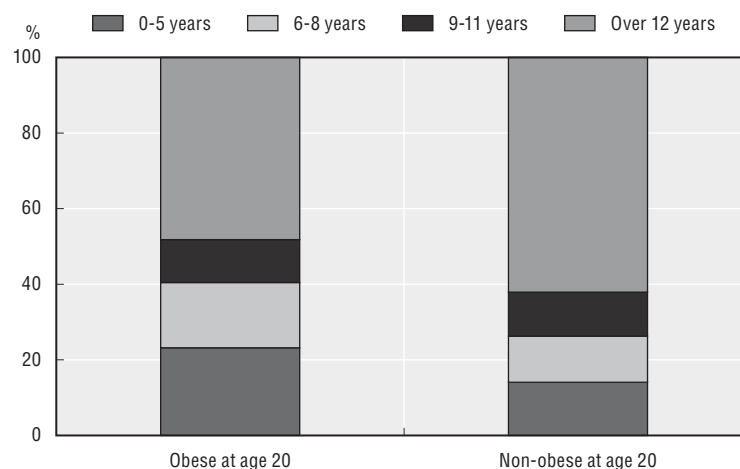
When exploring the cross-sectional relationship between obesity and education, it is difficult to interpret the direction of the causal link between the two variables. In addition, the correlations identified might be affected by the omission of relevant variables in the analysis.

The existence of a reverse causal effect (obesity in young age determines the level of educational achievement of an individual) is supported by the findings of several studies.

Sargent and Blanchflower (1994), using panel data, showed an inverse relationship between obesity at age 16 and earnings at 23 in young women. Gortmaker et al. (1993) found that women who were overweight in childhood completed fewer years of school. Crosnoe and Muller (2004) found that students at risk of obesity achieved worse outcomes in schools characterised by higher romantic activity, lower mean BMI or lower rate of athletic participation, than they did in schools lower in romantic activity, higher in mean BMI or higher in athletic participation.

Since no suitable instrument for education was identified in the available survey data, nor could be linked from external sources, it was not possible to address endogeneity issues satisfactorily in the analysis. However, an attempt to explore the direction of the causal link between education and obesity was made possible by data from an additional country, France.<sup>3</sup> The data from *Enquête Décennale Santé 2002-2003* provides information on body weight at age 20, which was taken to reflect **obesity status at school age**. The data shows that being “obese at age 20” is positively and significantly correlated with obesity in adulthood (correlation 0.177) and is negatively and significantly correlated with the number of years spent in education (correlation -0.035). Figure 9 shows that those who were obese at age 20 have significantly lower levels of educational attainment than those who were not obese, suggesting a potential for reverse causality in the relationship between education and obesity.

Figure 9. **Distribution of years of education according to obesity status at age 20**



Source: French data from *Enquête Décennale Santé 2002-03*; Authors' calculations.

In order to assess the influence of such potential reverse causal effect on the observed correlation between education and adult obesity, the results of two regression analyses assessing factors associated with adult obesity were compared, in one the “obesity at age 20” variable was included as an additional covariate (Table 3). Comparing Model 1 (without control) and Model 2 (with control) is a way of assessing whether the strength of the association between education and obesity is affected by a potential reverse causality. Odds ratios of obesity relative to education for women are virtually identical in both models, while small changes are observed in odds ratios for men. This comparison suggests that a reverse causal effect is unlikely to have a significant influence on the strength of the correlation observed between education and adult obesity. However, there

remains an issue of potential recall bias concerning body weight at age 20, as suggested by the fact that individuals tended to report round numbers (*e.g.* 60, or 65 kg).

**Table 3. Odds ratios for obesity in adulthood in France (age range 25-64)**

| France                            | Model 1: without control for obesity at age 20 |              | Model 2: with control for obesity at age 20 |              |
|-----------------------------------|------------------------------------------------|--------------|---------------------------------------------|--------------|
|                                   | Odds Ratios                                    | Significance | Odds Ratios                                 | Significance |
| Age                               | 1.13 ***                                       |              | 1.14 ***                                    |              |
| Age squared                       | 1.00 ***                                       |              | 1.00 ***                                    |              |
| Women                             | 1.26 **                                        |              | 1.31 **                                     |              |
| <b>Years of education – Men</b>   |                                                |              |                                             |              |
| 0-5 years                         | ref.                                           |              | ref.                                        |              |
| 6-8 years                         | 0.93                                           |              | 0.98                                        |              |
| 9-11 years                        | 0.75 **                                        |              | 0.79                                        |              |
| over 12 years                     | 0.85 *                                         |              | 0.90                                        |              |
| <b>Years of education – Women</b> |                                                |              |                                             |              |
| 0-5 years                         | ref.                                           |              | ref.                                        |              |
| 6-8 years                         | 0.84 *                                         |              | 0.83 *                                      |              |
| 9-11 years                        | 0.54 ***                                       |              | 0.54 ***                                    |              |
| over 12 years                     | 0.52 ***                                       |              | 0.53 ***                                    |              |
| <b>Obese at age 20</b>            |                                                |              | 15.53 ***                                   |              |
| <b>Occupation (SES)</b>           |                                                |              |                                             |              |
| Blue collar workers               | ref.                                           |              | ref.                                        |              |
| Craftsmen                         | 0.82 **                                        |              | 0.81 **                                     |              |
| Farmers                           | 0.88                                           |              | 0.84                                        |              |
| Clerks                            | 0.82 ***                                       |              | 0.82 ***                                    |              |
| Intermediate professions          | 0.65 ***                                       |              | 0.66 ***                                    |              |
| Managers, Professionals           | 0.42 ***                                       |              | 0.43 ***                                    |              |
| <b>Working status</b>             |                                                |              |                                             |              |
| Working                           | ref.                                           |              | ref.                                        |              |
| Not working                       | 1.29 ***                                       |              | 1.29 ***                                    |              |

Note: \*\*\* means significant at 1%, \*\* at 5%, \* at 10%.

Source: French data from *Enquête Décennale Santé 2002-03*. Authors' calculations.

## 7. What theoretical model of the influence of education on social outcomes is supported by the data?

As a final step in our empirical analysis, we assessed which of the absolute, relative and cumulative conceptual models of the outcomes of education proposed by Campbell (2006) is empirically supported by the data.

Table 4 indicates that better educated individuals are less likely to be obese than their less educated counterparts in all of the countries considered. This result can be viewed as evidence in support of the absolute effect of education model, mirroring evidence in the literature on the importance of individual level education for health status and health behaviours. However, after accounting for individual level education, those who are exposed to better educated environments in Australia, Canada and England are significantly more likely to be obese. This finding supports the relative model of the effects of education, which appears to play a larger role than the absolute model in explaining the distribution of obesity across social groups. The educational environment estimate is not significant in Korea which gives evidence for the absolute model.

The relative effect could operate through several pathways. One pathway that is consistent with both the absolute and the relative models is that linking social position to

### Box 3. The absolute, relative and cumulative models

The relationship between education and obesity may be interpreted according to various models/hypotheses, which involve alternative mechanisms. Three such models were conceptualised by Campbell (2006) as follows.

The **absolute model** implies that the probability that individuals will be obese depends on their level of education. According to this model, education may reduce the probability that an individual will be obese both by increasing the stock of information available to the individual concerning the health risks associated with unhealthy lifestyles, and by improving their ability to understand and handle such information. When the effects of education are in line with the predictions of the absolute model, policies which successfully promote education and learning and increase the average educational attainment of a population will have the effect of decreasing obesity rates. While our hypothesis is that the absolute model of education generally leads to lower rates of obesity through increased education, the absolute effect of education might also be negative. If education increases wages, and therefore increases the opportunity cost of leisure time, an educated individual's propensity to engage in leisure time physical activity or home meal preparation will likely be reduced.

The **relative model** implies that education serves as a marker of social status and an individuals' level of education relative to their peers, or relative to the prevailing level of education in the relevant social environment, is what affects the probability that they will be obese. This model implies that a generalised increase in the level of education of an entire community may not alter individual outcomes, unless the relative position of individuals within that community changes as a result.

The **cumulative model** rests on the idea that the impact of individual education on obesity is consistent with, and additive to, the impact of the level of education of other members of the same community. Therefore, the likelihood that an individual may become obese depends both on the individual's own level of education and on the level of education of other community members.

To test the above models, logistic regression analyses of the likelihood of obesity were run on the four countries' data using a similar approach to that proposed by Campbell (2006) in his analysis of civic and social engagement as an outcome of education. Regression models included, in addition to the control variables gender and age, two measures of education: the number of years of education completed by the individual respondent (education level) and the mean level of education completed by members of the same age cohort within the same country (educational environment). In order to calculate the educational environment variable, four 10-year birth cohort groups were devised: 1941-50, 1951-60, 1961-70, 1971-80. Mean education levels within each cohort were standardised using the 2005 national distributions of levels of education (lower secondary; upper secondary; tertiary education) by age group, available in *Education at a Glance 2007* (OECD, 2007). Findings of a statistically-significant and strong negative effect of individual level education on obesity would provide support for the absolute model. A correlation between educational environment and obesity could be interpreted as evidence of a relative effect of education, especially if the correlation is stronger than that between individual education and obesity. Findings indicating that individual education is correlated with obesity and the educational environment variable is inversely correlated with obesity would lend support to the cumulative model, especially if the latter correlation were stronger than the former (Campbell, 2006).

Table 4. **Odds ratios and significance for likelihood of obesity when controlling for cohort education level**

|                              | Australia | Canada   | England  | Korea    |
|------------------------------|-----------|----------|----------|----------|
| Age                          | 1.060***  | 1.026*** | 1.157*** | 0.992    |
| Age squared                  |           |          | 0.999*** | 1.000    |
| Women                        | 0.859***  | 0.808*** | 1.138*** | 1.179    |
| Individual education         | 0.912***  | 0.959*** | 0.913*** | 0.921*** |
| Educational environment      | 3.347***  | 1.184*** | 2.015*** | 0.989    |
| <b>Socio-economic status</b> |           |          |          |          |
| highest                      | ref.      | ref.     | ref.     | ref.     |
| middle-high                  | 1.179***  | 1.099*** | 1.232*** | 0.946    |
| middle                       | 1.158***  | 1.104*** | 1.221*** | 0.912    |
| middle-low                   | 1.531***  | 1.106**  | 1.397*** | 1.057    |
| lowest                       | 1.365***  | 1.189*** | 1.488*** | 1.200    |
| <b>Ethnicity</b>             |           |          |          |          |
| White                        |           |          | ref.     |          |
| Black                        |           |          | 1.675*** |          |
| Asian                        |           |          | 0.780*** |          |

In Australia and Canada age squared is not available as the age variable is categorical; we use mid-age of each category. \*\*\* means significant at 1%, \*\* at 5%, \* at 10%.

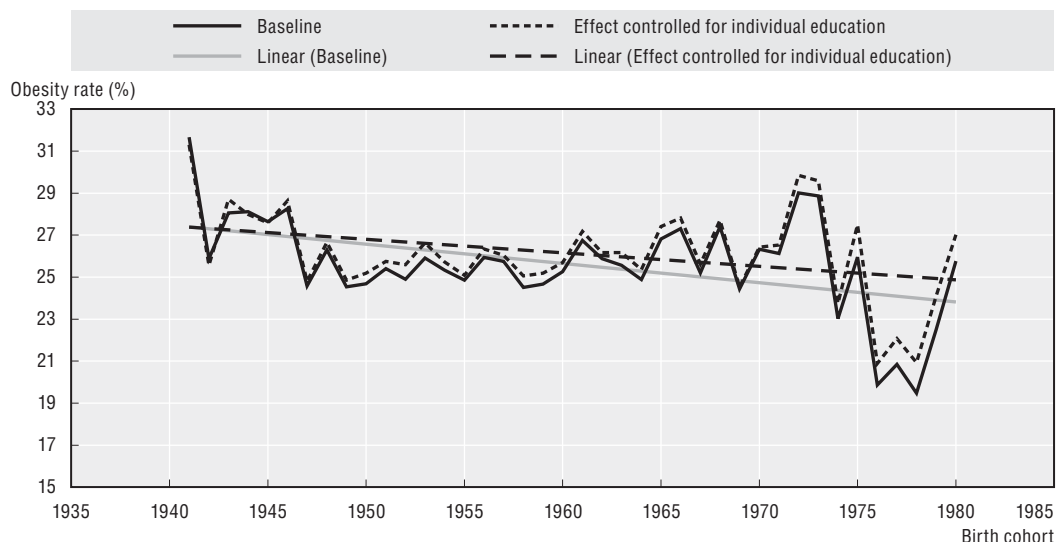
Source: Authors' calculations based on national survey data.

stress levels and eventually to health outcomes. Evidence has been gathered that individuals who have a lower social position are exposed to higher levels of perceived stress, because of a lower degree of control over their jobs and their life circumstances and because of a less satisfactory balance between efforts and rewards (Siegrist and Marmot, 2004). This is associated with a reduced ability to handle environmental pressures and often translates into less healthy lifestyles, obesity, chronic diseases and premature mortality (Brunner *et al*, 2007; Chandola *et al.*, 2008). A second pathway which typically reflects features of the relative model of the effects of education is linked to a higher demand for health inputs that are associated with a healthy weight, *e.g.* gym and health club memberships, by those who have higher levels of education and occupy higher social positions. In communities where the average level of education is higher, demand for such inputs, and consequently the price of those inputs, are also likely to be higher, hindering access to the same resources for the less educated and less well-off.

A further analysis was carried out to test for a possible effect of individual education on obesity, consistent with the *absolute* model discussed above. The analysis exploited age-period-cohort models of obesity developed by Sassi *et al* (2009) with the aim of disentangling the effects of the three time-related factors (individual age, period of observation and birth cohort) on the likelihood of obesity. The findings of the main analysis showed negatively sloped cohort effects, suggesting that individuals born in more recent cohorts, other things being equal (including age), have a lower probability of being obese than individuals born in earlier cohorts, with a possible flattening of the cohort effect curve for the most recent cohorts. Here, these models were completed by adding a control for individual education, for the purpose of testing whether improvements in education over time may account for at least part of the negatively sloped cohort effects observed in the main analysis, *i.e.* whether a higher level of education may partly explain why individuals born in more recent cohorts have a lower probability of being obese. The age-period-cohort model used in the analyses is the one proposed by Yang, Fu and Land (2004), based on a robust estimator (intrinsic estimator) which does not require the identification of

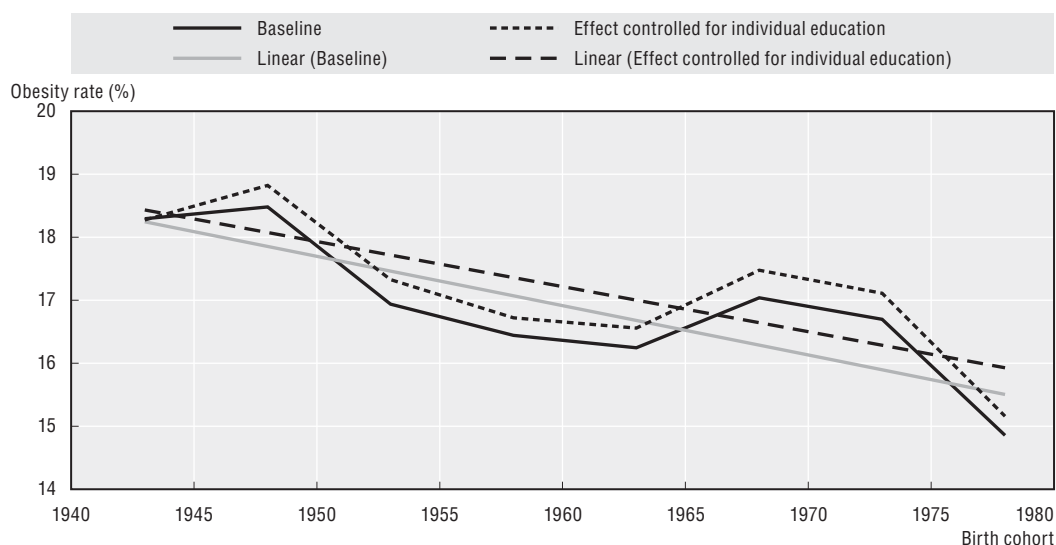
constraints on the parameter vector by using prior information. The intrinsic estimator method (Fu, 2000; Knight and Fu, 2000; Fu and Hall, 2004; Fu and Rohan, 2004) considers an orthogonal decomposition of the parameter space into a null space for the singular design matrix and a non-null space, where the intrinsic estimator is obtained by the Moore-Penrose generalised inverse. Analyses were carried out on data from Canada and England. Obesity rates in Korea are too low for this analysis to produce meaningful results, and Australian data were not directly accessible at the individual level.

Figure 10. **Negative cohort effect with/without controls for education level in England**



Source: Authors' calculation based on national survey data.

Figure 11. **Negative cohort effect with/without controls for education level in Canada**



Source: Authors' calculation based on national survey data.

An age-period-cohort analysis allowed to disentangle the impact of the three time-related effects on obesity. The findings of such analysis (reported in Sassi *et al.*, 2009) show

declining cohort effects in Canada, England and, to a lesser degree, in Korea (no APC analysis could be undertaken on Australian data). After inclusion of individual education as a covariate in the regression models for the two countries with more pronounced cohort effects, trends in cohort effects become more flat (Figures 10 and 11). This means that part of the reduction in the likelihood of obesity in younger birth cohorts is explained by their higher degrees of educational attainment achieved by individuals in the same cohorts, which is consistent with the absolute model of the effects of education on obesity.

## 8. Conclusions

A range of analyses of health survey data from Australia, Canada, England and Korea were undertaken with the aim of exploring the relationship between education and obesity. The findings of these analyses show a broadly linear relationship between the number of years spent in full-time education and the probability of obesity, with most educated individuals displaying lower rates of the condition (the only exception being men in Korea). This suggests that the strength of the correlation between education and obesity is approximately constant throughout the education spectrum. Increasing education at any point along that spectrum would be expected to reduce obesity to a similar degree, if the causal nature of the link between education and obesity had been established.

The education gradient in obesity is stronger in women than in men. Differences between genders are minor in Australia and Canada, more pronounced in England and major in Korea. The gradient has not meaningfully changed over the time periods covered by the health survey data available for our study. However, there is at least some evidence that over longer periods of time more educated individuals have been less likely to become obese than their less educated counterparts, suggesting that education produces its influence on obesity only in the long term.

The causal nature of the link between education and obesity has not yet been proven with certainty. Our own attempt to use a natural experiment, involving a school reform which increased the minimum compulsory schooling age in England by one year in 1973, failed to establish a causal link. However, using data from France we were able to ascertain that the direction of causality appears to run mostly from education to obesity, as the strength of the association is only minimally affected when accounting for reduced educational opportunities for those who are obese in young age. Most of the effect of education on obesity is direct. Small components of the overall effect of education on obesity are mediated by an improved socio-economic status linked to higher levels of education, and by a higher level of education of other family members, associated with an individual's own level of education.

The positive effect of education on obesity is likely to be determined by at least three factors: a) greater access to health-related information and improved ability to handle such information; b) clearer perception of the risks associated with lifestyle choices; and, c) improved self-control and consistency of preferences over time. However, it is not just the absolute level of education achieved by an individual that matters, but also how such a level of education compares with that of the individual's peers. The higher the individual's education relative to his or her peers, the lower is the probability of the individual being obese. The latter effect may be due to different levels of perceived stress experienced by individuals in different social positions, and by different coping mechanisms. Access to

resources required to maintain a healthy weight may also be driven by an individual's position in the social hierarchy.

The findings reported in this paper concerning the relationship between education and obesity are consistent with those reported in a number of other studies, notably Spasojevic (2003), Arendt (2005), Kenkel *et al.* (2006), Cutler and Lleras-Muney (2006), Sánchez-Vaznaugh *et al.* (2009). Several of the above studies showed a strong education gradient in BMI or obesity, with the better educated, especially if women, less likely to be overweight or obese. We found similar evidence in all of the four countries examined, with the largest differences between genders in Korea, the only country in which an inverse gradient (more education associated with higher obesity rates) was observed in men. This used to be a common pattern in many countries early in the 20<sup>th</sup> century, and it is possible that some countries which still display relatively low obesity rates, like Korea, still retain that feature as a sign of the slower transition they have been experiencing in the weight distribution across population groups. Cutler and Lleras-Muney (2006) also found that the gradient in obesity was steeper in whites than in ethnic minorities. In our study, a detailed analysis by ethnic group could be undertaken using data from England, which showed substantially milder education gradients in obesity for minority men, relative to white men, but similar gradients in women of different ethnic backgrounds.

It should be noted that BMI was measured in England and Korea, but self-reported in Canada and Australia. The use of self-reported data may potentially cause bias in the results, as a number of people tend to report incorrectly their height and weight. However, there is no clear evidence that self-report bias may vary among individuals with different levels of education. Therefore, the correlations reported in this paper may not be affected in a major way by this potential limitation. Also, BMI is not an accurate measure of body fat, or body composition. For instance, those with a substantial muscular mass because of intense physical activity may have a high BMI but a low risk for chronic diseases. However, BMI is a widely reported measure which has proven to be particularly useful in population-level analyses. There is evidence that the link between BMI and the associated health risks is different in Asian populations, suggesting that lower BMI thresholds should be used in the latter to identify individuals who are overweight or obese. In the present study we applied the same thresholds in all countries.

The analyses presented in this paper were based on cross-sectional health survey data, which provide a very detailed source of information on the health and health-related behaviour of the respective populations, but at the same time present a number of limitations, especially in the assessment of the causal nature of the link between education and obesity. Individual education was defined as the number of years spent in full-time education, although this was available in a discrete form and interpolations were required. No information was available on the quality and contents of the education received, which are also likely to influence health and health-related behaviour in adult life.

## 9. Policy Implications

Establishing the causal nature of links between obesity and policy levers that could potentially be used to curb the current epidemic is essential for effective policies to be designed and implemented. If changes in education could be expected to influence health-related behaviours and obesity rates in a population, this might strengthen the case for

educational policies aimed, for instance, at increasing compulsory schooling age or increasing enrolment in higher education. Our analysis in Table 4 provides an estimate of the size of such effect. Increasing education by one year in the whole population would decrease the overall obesity rate by 4% in Canada, and up to 9% in England. Cutler and Lleras-Muney (2006), with reference to the broader health effects of education, argued that if a causal link were proven, education subsidies might be desirable. These would promote higher levels of education for a larger share of the population and correspondingly improve population health. Grossman and Kaestner (1997) argued that education policies directed at disadvantaged groups might reduce some of the existing health disparities. Although the evidence currently available, including some of the findings of our study, provides strong suggestions that at least part of the correlation between education and obesity is of a causal nature, conclusive proof of this does not yet exist.

Health education programmes aimed at promoting healthy lifestyles might in principle generate similar effects to those associated with school education by providing relevant information. However, Speakman *et al.* (2005) argue that these campaigns are likely to be ineffective “if people in lower social strata already know what foods have high energy contents, but fail to act on this information”, suggesting that health promotion would mostly help those who have a higher level of education. However, very limited empirical evidence exists concerning the effects of health education programmes, and virtually none is available on differences in effectiveness between socio-economic groups. Haas (2008) suggested that more funding should not be spent on public health education campaigns while clear evidence of the effectiveness of such programmes does not exist.

Whether through formal schooling or health promotion campaigns, education may play a role in tackling overweight and obesity. Policy makers need to consider what levels of evidence should be deemed sufficient to prompt action, and how efficiency and equity objectives should be balanced in tackling obesity. Education policies aimed at increasing formal schooling include a flexible range of policies, which may be targeted at specific age and socio-economic groups. We showed that the strength of the link between education and obesity is approximately constant throughout the education spectrum, which means that similar gains could be achieved in terms of reduction of obesity rates by increasing educational attainment for early school leavers as well as for those who spend the longest in full time education. However, policies targeting early school leavers would likely improve equity by focusing on individuals who are more likely to belong to disadvantaged socio-economic groups. Similar results could be achieved by improving access to education, *e.g.* through financial incentives, for disadvantaged groups.

## Notes

1. The assumption on the direction of the causal link from the former to the latter is further discussed later in the paper.
2. We tested whether this distinction in the construction of the variable had an effect on obesity status by introducing a control dummy variable, but it was not significant.
3. A second test for the causal nature of the link between education and obesity was carried out using data from the Health Survey for England in a sort of natural experiment, assessing the impact of the educational reform introduced in England in 1973, which increased the minimum compulsory schooling age from 15 to 16 years. Clark and Royer (2008) used this approach with reference to an earlier educational reform implemented in England in 1947, which also increased the minimum compulsory schooling age in the country, from 14 to 15. They found that cohorts affected by the law display only slightly improved long-run health outcomes and their findings did not support a

causal link between education and obesity. Our results consistently indicated an absence of change in the likelihood of obesity in the cohorts affected by the educational reform, relative to previous cohorts. This finding does not necessarily indicate that the link between education and obesity is not of a causal nature. Rather, it may suggest that school reforms leading to small changes in minimum compulsory schooling age do not provide sufficiently strong means for implementing an instrumental variables approach.

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## ANNEX A1

*Data Description Tables*Table A1.1. **Australia – National Health Survey**

| Australia          |              | 1989   |        |        | 1995   |        |        | 2001  |       |       | 2005  |       |        |
|--------------------|--------------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|--------|
|                    |              | Men    | Women  | Total  | Men    | Women  | Total  | Men   | Women | Total | Men   | Women | Total  |
| Total frequency    |              | 12 499 | 12 490 | 24 989 | 10 932 | 10 904 | 21 836 | 4 744 | 5 164 | 9 908 | 5 348 | 5 590 | 10 938 |
| Age group          | 25-39        | 16.5%  | 16.7%  | 16.6%  | 15.3%  | 15.6%  | 15.4%  | 11.4% | 12.8% | 12.1% | 12.4% | 12.9% | 12.7%  |
|                    | 30-34        | 16.2%  | 16.5%  | 16.4%  | 15.9%  | 16.1%  | 16.0%  | 13.9% | 15.1% | 14.4% | 14.4% | 15.0% | 14.7%  |
|                    | 35-39        | 15.1%  | 15.4%  | 15.2%  | 15.2%  | 15.6%  | 15.4%  | 14.9% | 15.4% | 15.1% | 13.9% | 14.4% | 14.1%  |
|                    | 40-44        | 14.6%  | 14.5%  | 14.5%  | 14.0%  | 14.0%  | 14.0%  | 15.2% | 14.3% | 14.8% | 14.4% | 14.6% | 14.5%  |
|                    | 45-49        | 11.7%  | 11.1%  | 11.4%  | 12.9%  | 13.1%  | 13.0%  | 13.3% | 13.2% | 13.2% | 13.2% | 13.2% | 13.2%  |
|                    | 50-54        | 9.4%   | 9.2%   | 9.3%   | 10.7%  | 10.1%  | 10.4%  | 13.1% | 12.1% | 12.6% | 11.6% | 11.3% | 11.5%  |
|                    | 55-59        | 8.3%   | 8.2%   | 8.2%   | 8.7%   | 8.0%   | 8.4%   | 10.1% | 9.3%  | 9.7%  | 11.3% | 10.3% | 10.8%  |
|                    | 60-64        | 8.2%   | 8.5%   | 8.3%   | 7.4%   | 7.4%   | 7.4%   | 8.2%  | 7.8%  | 8.0%  | 8.8%  | 8.2%  | 8.5%   |
| Equivalized income | upper        | 31.6%  | 26.9%  | 29.3%  | 30.0%  | 26.0%  | 28.0%  | 31.3% | 25.7% | 28.6% | 30.4% | 24.4% | 27.5%  |
|                    | upper middle | 25.6%  | 23.6%  | 24.6%  | 23.6%  | 22.3%  | 23.0%  | 22.5% | 21.9% | 22.2% | 24.4% | 21.0% | 22.8%  |
|                    | middle       | 20.0%  | 19.5%  | 19.8%  | 18.8%  | 18.5%  | 18.7%  | 19.4% | 19.2% | 19.3% | 19.8% | 21.1% | 20.4%  |
|                    | lower middle | 13.9%  | 17.4%  | 15.6%  | 12.7%  | 16.5%  | 14.6%  | 12.9% | 16.0% | 14.4% | 14.5% | 17.1% | 15.8%  |
|                    | lower        | 8.9%   | 12.6%  | 10.7%  | 15.0%  | 16.6%  | 15.8%  | 13.9% | 17.1% | 15.5% | 10.9% | 16.4% | 13.6%  |
| Migrant            | yes          | 31.2%  | 29.2%  | 30.2%  | 29.8%  | 29.2%  | 29.5%  | 29.2% | 28.9% | 29.1% | 28.4% | 28.9% | 28.7%  |
|                    | no           | 68.8%  | 70.8%  | 69.8%  | 70.2%  | 70.8%  | 70.5%  | 70.8% | 71.1% | 70.9% | 71.6% | 71.1% | 71.3%  |
| Obese              | no           | 90.8%  | 89.6%  | 90.2%  | 86.4%  | 86.5%  | 86.4%  | 82.8% | 81.8% | 82.3% | 78.1% | 81.6% | 79.8%  |
|                    | yes          | 9.2%   | 10.4%  | 9.8%   | 13.6%  | 13.5%  | 13.6%  | 17.2% | 18.2% | 17.7% | 21.9% | 18.4% | 20.2%  |
| Overweight         | no           | 51.3%  | 67.0%  | 59.0%  | 43.8%  | 60.7%  | 52.0%  | 37.9% | 55.7% | 46.6% | 32.2% | 53.0% | 42.3%  |
|                    | yes          | 48.7%  | 33.0%  | 41.0%  | 56.2%  | 39.3%  | 48.0%  | 62.1% | 44.3% | 53.4% | 67.8% | 47.0% | 57.7%  |
| BMI classification | underweight  | 1.1%   | 5.1%   | 3.1%   | 0.9%   | 3.7%   | 2.3%   | 0.8%  | 3.4%  | 2.1%  | 0.5%  | 3.0%  | 1.7%   |
|                    | normal       | 50.1%  | 61.9%  | 55.9%  | 42.9%  | 57.0%  | 49.8%  | 37.2% | 52.2% | 44.5% | 31.7% | 50.0% | 40.6%  |
|                    | overweight   | 39.5%  | 22.6%  | 31.2%  | 42.6%  | 25.7%  | 34.4%  | 44.8% | 26.2% | 35.7% | 45.9% | 28.6% | 37.5%  |
|                    | obese        | 9.2%   | 10.4%  | 9.8%   | 13.6%  | 13.5%  | 13.6%  | 17.2% | 18.2% | 17.7% | 21.9% | 18.4% | 20.2%  |
| Years of education | 0-8          | 17.8%  | 17.9%  | 17.9%  | 13.8%  | 13.2%  | 13.5%  | 10.0% | 8.3%  | 9.2%  | 6.7%  | 5.4%  | 6.1%   |
|                    | 9-11         | 65.8%  | 70.2%  | 68.0%  | 67.1%  | 71.2%  | 69.1%  | 67.6% | 72.1% | 69.8% | 45.6% | 44.0% | 44.8%  |
|                    | over 12      | 16.4%  | 11.9%  | 14.2%  | 19.2%  | 15.6%  | 17.4%  | 22.4% | 19.6% | 21.0% | 47.7% | 50.6% | 49.1%  |

Table A1.2. **Canada – Canadian National Population Health Survey 1995 and Canadian Community Health Survey 2001-2005**

| Canada             |              | 1995  |       |        | 2001   |        |        | 2003   |        |        | 2005   |        |        |
|--------------------|--------------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                    |              | Men   | Women | Total  | Men    | Women  | Total  | Men    | Women  | Total  | Men    | Women  | Total  |
| Total frequency    |              | 5 009 | 5 560 | 10 569 | 35 044 | 36 852 | 71 896 | 33 154 | 34 911 | 68 065 | 33 471 | 35 495 | 68 966 |
| Age group          | 25-39        | 13.9% | 12.6% | 13.2%  | 12.0%  | 11.5%  | 11.8%  | 12.0%  | 11.4%  | 11.7%  | 11.8%  | 11.6%  | 11.7%  |
|                    | 30-34        | 16.3% | 17.5% | 16.9%  | 13.3%  | 12.5%  | 12.9%  | 11.9%  | 12.0%  | 12.0%  | 11.7%  | 11.8%  | 11.7%  |
|                    | 35-39        | 17.1% | 16.4% | 16.8%  | 15.6%  | 15.9%  | 15.7%  | 15.0%  | 14.8%  | 14.9%  | 13.3%  | 13.1%  | 13.2%  |
|                    | 40-44        | 14.8% | 14.7% | 14.7%  | 16.5%  | 16.5%  | 16.5%  | 16.6%  | 16.4%  | 16.5%  | 16.4%  | 16.0%  | 16.2%  |
|                    | 45-49        | 13.2% | 12.0% | 12.6%  | 14.0%  | 14.7%  | 14.4%  | 13.6%  | 14.2%  | 13.9%  | 14.3%  | 14.9%  | 14.6%  |
|                    | 50-54        | 10.2% | 9.9%  | 10.0%  | 12.2%  | 12.4%  | 12.3%  | 12.4%  | 12.8%  | 12.6%  | 12.5%  | 13.3%  | 12.9%  |
|                    | 55-59        | 7.7%  | 8.8%  | 8.2%   | 9.4%   | 9.2%   | 9.3%   | 10.6%  | 10.6%  | 10.6%  | 11.2%  | 10.9%  | 11.1%  |
|                    | 60-64        | 7.0%  | 8.1%  | 7.5%   | 7.0%   | 7.4%   | 7.2%   | 7.8%   | 7.8%   | 7.8%   | 8.8%   | 8.4%   | 8.6%   |
| Equivalized income | upper        | 19.9% | 16.5% | 18.2%  | 37.7%  | 31.8%  | 34.8%  | 45.0%  | 37.7%  | 41.5%  | 54.2%  | 47.6%  | 51.0%  |
|                    | upper middle | 41.1% | 37.9% | 39.5%  | 37.1%  | 36.6%  | 36.8%  | 34.2%  | 35.9%  | 35.0%  | 26.0%  | 27.1%  | 26.6%  |
|                    | middle       | 25.6% | 28.3% | 26.9%  | 17.1%  | 20.2%  | 18.6%  | 14.6%  | 17.7%  | 16.1%  | 12.9%  | 15.9%  | 14.4%  |
|                    | lower middle | 8.8%  | 11.4% | 10.1%  | 4.8%   | 7.3%   | 6.0%   | 3.8%   | 5.6%   | 4.7%   | 3.0%   | 4.1%   | 3.5%   |
|                    | lower        | 4.7%  | 5.9%  | 5.3%   | 3.3%   | 4.1%   | 3.7%   | 2.4%   | 3.0%   | 2.7%   | 3.9%   | 5.3%   | 4.5%   |
| Minority           | no           |       |       |        | 86.0%  | 85.9%  | 86.0%  | 84.3%  | 85.3%  | 84.8%  | 83.6%  | 84.0%  | 83.8%  |
|                    | yes          |       |       |        | 14.0%  | 14.1%  | 14.0%  | 15.7%  | 14.7%  | 15.2%  | 16.4%  | 16.0%  | 16.2%  |
| Obese              | no           | 85.9% | 86.1% | 86.0%  | 82.5%  | 84.8%  | 83.6%  | 82.1%  | 84.2%  | 83.1%  | 81.2%  | 83.8%  | 82.5%  |
|                    | yes          | 14.1% | 13.9% | 14.0%  | 17.5%  | 15.2%  | 16.4%  | 17.9%  | 15.8%  | 16.9%  | 18.8%  | 16.2%  | 17.5%  |
| Overweight         | no           | 39.0% | 59.2% | 49.0%  | 40.4%  | 57.4%  | 48.7%  | 38.5%  | 57.0%  | 47.5%  | 37.7%  | 56.4%  | 46.7%  |
|                    | yes          | 61.0% | 40.8% | 51.0%  | 59.6%  | 42.6%  | 51.3%  | 61.5%  | 43.0%  | 52.5%  | 62.3%  | 43.6%  | 53.3%  |
| BMI classification | underweight  | 0.5%  | 2.6%  | 1.5%   | 0.9%   | 3.4%   | 2.1%   | 0.7%   | 3.1%   | 1.9%   | 0.7%   | 3.5%   | 2.0%   |
|                    | normal       | 38.5% | 56.6% | 47.4%  | 39.5%  | 53.9%  | 46.6%  | 37.8%  | 54.0%  | 45.6%  | 37.1%  | 52.9%  | 44.7%  |
|                    | overweight   | 46.9% | 27.0% | 37.1%  | 42.1%  | 27.5%  | 34.9%  | 43.6%  | 27.1%  | 35.6%  | 43.5%  | 27.5%  | 35.7%  |
|                    | obese        | 14.1% | 13.9% | 14.0%  | 17.5%  | 15.2%  | 16.4%  | 17.9%  | 15.8%  | 16.9%  | 18.8%  | 16.2%  | 17.5%  |
| Years of education | 8            | 21.6% | 21.1% | 21.4%  | 18.1%  | 16.8%  | 17.4%  | 14.1%  | 13.3%  | 13.7%  | 12.4%  | 10.7%  | 11.6%  |
|                    | 12           | 14.9% | 18.4% | 16.6%  | 18.2%  | 21.3%  | 19.7%  | 18.0%  | 19.6%  | 18.7%  | 14.8%  | 15.8%  | 15.3%  |
|                    | 14           | 23.7% | 25.0% | 24.3%  | 6.9%   | 7.3%   | 7.1%   | 6.3%   | 6.6%   | 6.5%   | 7.1%   | 6.7%   | 6.9%   |
|                    | 17           | 39.8% | 35.5% | 37.7%  | 56.9%  | 54.6%  | 55.8%  | 61.6%  | 60.5%  | 61.1%  | 65.7%  | 66.8%  | 66.3%  |

Table A1.3. **Korea – Korean National Health and Examination Survey**

| Korea              | 1998  |       |       | 2001  |       |       | 2005  |       |       |
|--------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                    | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total |
| Total frequency    | 2 941 | 3 396 | 6 337 | 2 179 | 2 706 | 4 885 | 1 822 | 2 398 | 4 220 |
| Age group          |       |       |       |       |       |       |       |       |       |
| 25-39              | 13.6% | 14.4% | 14.0% | 11.7% | 12.7% | 12.3% | 8.3%  | 9.0%  | 8.7%  |
| 30-34              | 15.4% | 15.4% | 15.4% | 15.4% | 16.0% | 15.7% | 13.7% | 15.1% | 14.5% |
| 35-39              | 16.0% | 15.3% | 15.6% | 16.3% | 16.6% | 16.5% | 13.3% | 14.9% | 14.2% |
| 40-44              | 15.3% | 14.3% | 14.7% | 16.4% | 16.6% | 16.5% | 15.3% | 16.3% | 15.9% |
| 45-49              | 11.1% | 10.9% | 11.0% | 13.3% | 11.7% | 12.4% | 17.0% | 14.3% | 15.5% |
| 50-54              | 9.9%  | 9.6%  | 9.7%  | 8.6%  | 9.4%  | 9.0%  | 10.4% | 11.2% | 10.8% |
| 55-59              | 9.6%  | 10.6% | 10.1% | 10.1% | 8.4%  | 9.1%  | 11.9% | 9.7%  | 10.6% |
| 60-64              | 9.1%  | 9.6%  | 9.4%  | 8.2%  | 8.6%  | 8.4%  | 10.2% | 9.4%  | 9.7%  |
| Equivalized income |       |       |       |       |       |       |       |       |       |
| upper              | 20.5% | 25.6% | 23.3% | 22.7% | 28.7% | 26.0% | 22.7% | 27.4% | 25.4% |
| upper middle       | 21.8% | 21.6% | 21.7% | 19.4% | 18.7% | 19.0% | 21.5% | 19.9% | 20.6% |
| middle             | 21.9% | 19.1% | 20.4% | 22.9% | 19.7% | 21.1% | 20.9% | 18.6% | 19.6% |
| lower middle       | 20.4% | 18.6% | 19.4% | 20.3% | 18.7% | 19.4% | 20.4% | 18.7% | 19.5% |
| lower              | 15.4% | 15.0% | 15.2% | 14.7% | 14.3% | 14.5% | 14.4% | 15.4% | 15.0% |
| Obese              |       |       |       |       |       |       |       |       |       |
| no                 | 98.2% | 96.7% | 97.4% | 97.4% | 96.5% | 96.9% | 96.8% | 96.1% | 96.4% |
| yes                | 1.8%  | 3.3%  | 2.6%  | 2.6%  | 3.5%  | 3.1%  | 3.2%  | 3.9%  | 3.6%  |
| Overweight         |       |       |       |       |       |       |       |       |       |
| no                 | 72.2% | 70.8% | 71.4% | 65.5% | 70.9% | 68.5% | 61.6% | 70.4% | 66.6% |
| yes                | 27.8% | 29.2% | 28.6% | 34.5% | 29.1% | 31.5% | 38.4% | 29.6% | 33.4% |
| BMI classification |       |       |       |       |       |       |       |       |       |
| underweight        | 3.2%  | 3.8%  | 3.5%  | 2.2%  | 4.7%  | 3.6%  | 2.7%  | 4.1%  | 3.5%  |
| normal             | 68.9% | 67.0% | 67.9% | 63.3% | 66.1% | 64.9% | 58.9% | 66.2% | 63.1% |
| overweight         | 26.1% | 25.9% | 26.0% | 31.9% | 25.6% | 28.4% | 35.2% | 25.8% | 29.8% |
| obese              | 1.8%  | 3.3%  | 2.6%  | 2.6%  | 3.5%  | 3.1%  | 3.2%  | 3.9%  | 3.6%  |
| Years of education |       |       |       |       |       |       |       |       |       |
| 6                  | 16.8% | 31.5% | 24.7% | 10.5% | 21.0% | 16.3% | 9.9%  | 20.3% | 15.8% |
| 9                  | 15.5% | 17.5% | 16.6% | 14.0% | 15.4% | 14.8% | 12.6% | 14.1% | 13.4% |
| 12                 | 40.2% | 35.5% | 37.7% | 39.0% | 41.9% | 40.6% | 37.7% | 39.8% | 38.9% |
| 16                 | 24.2% | 14.7% | 19.1% | 31.3% | 20.7% | 25.4% | 35.0% | 24.1% | 28.8% |
| 17                 | 3.2%  | 0.8%  | 1.9%  | 5.2%  | 1.1%  | 2.9%  | 4.8%  | 1.8%  | 3.1%  |

Table A1.4. **England – Health Survey for England**

| England              |              | 1991  |       |       | 1992  |       |       | 1993  |       |        | 1994  |       |       | 1995  |       |       | 1996  |       |        | 1997  |       |       | 1998  |       |       |
|----------------------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|
|                      |              | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total  | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total  | Men   | Women | Total | Men   | Women | Total |
| Total Frequency      |              | 937   | 1 046 | 1983  | 1 162 | 1 242 | 2 404 | 5 000 | 5 364 | 10 364 | 4 557 | 5 073 | 9 630 | 4 536 | 5 108 | 9 644 | 4 734 | 5 303 | 10 037 | 2 514 | 2 867 | 5 381 | 4 484 | 5 221 | 9 705 |
| Age group            | 25-39        | 14.8% | 13.4% | 14.1% | 15.6% | 15.3% | 15.4% | 14.2% | 14.1% | 14.2%  | 14.0% | 14.3% | 14.1% | 12.1% | 13.6% | 12.9% | 12.1% | 12.7% | 12.5%  | 13.1% | 12.6% | 12.8% | 12.3% | 12.4% | 12.4% |
|                      | 30-34        | 14.6% | 15.5% | 15.1% | 12.0% | 12.9% | 12.5% | 14.3% | 14.6% | 14.4%  | 15.3% | 15.0% | 15.1% | 15.6% | 15.2% | 15.4% | 14.3% | 14.7% | 14.6%  | 13.9% | 14.9% | 14.4% | 14.6% | 14.4% | 14.5% |
|                      | 35-39        | 13.1% | 12.4% | 12.8% | 13.6% | 14.1% | 13.9% | 13.1% | 13.9% | 13.5%  | 15.1% | 14.7% | 14.9% | 15.1% | 13.6% | 14.3% | 13.9% | 14.7% | 14.3%  | 13.9% | 13.2% | 13.5% | 14.4% | 14.7% | 14.6% |
|                      | 40-44        | 14.3% | 15.2% | 14.8% | 14.3% | 14.2% | 14.2% | 12.9% | 13.2% | 13.0%  | 12.4% | 12.8% | 12.6% | 13.0% | 12.9% | 13.0% | 13.9% | 12.8% | 13.4%  | 13.6% | 13.5% | 13.5% | 12.3% | 12.4% | 12.4% |
|                      | 45-49        | 12.3% | 11.5% | 11.9% | 14.0% | 12.0% | 13.0% | 14.3% | 13.6% | 13.9%  | 12.7% | 13.5% | 13.1% | 12.4% | 12.9% | 12.7% | 14.1% | 13.7% | 13.9%  | 13.6% | 13.9% | 13.8% | 13.4% | 12.6% | 13.0% |
|                      | 50-54        | 10.0% | 10.5% | 10.3% | 10.8% | 10.8% | 10.8% | 10.6% | 10.8% | 10.7%  | 10.4% | 10.3% | 10.3% | 11.4% | 11.6% | 11.6% | 12.0% | 12.1% | 12.0%  | 12.1% | 12.6% | 12.4% | 12.8% | 13.4% | 13.1% |
|                      | 55-59        | 10.1% | 10.5% | 10.3% | 9.2%  | 9.4%  | 9.3%  | 10.7% | 9.9%  | 10.3%  | 9.8%  | 9.5%  | 9.7%  | 10.2% | 10.5% | 10.4% | 9.6%  | 9.4%  | 9.5%   | 10.1% | 9.8%  | 10.0% | 9.7%  | 9.8%  | 9.8%  |
|                      | 60-64        | 10.7% | 11.0% | 10.8% | 10.5% | 11.4% | 10.9% | 9.9%  | 10.0% | 9.9%   | 10.4% | 9.9%  | 10.1% | 10.1% | 9.6%  | 9.8%  | 10.1% | 9.8%  | 9.9%   | 9.7%  | 9.5%  | 9.6%  | 10.4% | 10.3% | 10.3% |
| Socioeconomic status | upper        | 7.6%  | 1.8%  | 4.5%  | 8.6%  | 1.8%  | 5.1%  | 10.0% | 2.4%  | 6.0%   | 8.3%  | 2.3%  | 5.1%  | 8.4%  | 1.9%  | 5.0%  | 7.5%  | 2.2%  | 4.7%   | 8.0%  | 2.3%  | 5.0%  | 7.2%  | 2.4%  | 4.7%  |
|                      | upper middle | 32.9% | 26.6% | 29.6% | 30.3% | 25.7% | 27.9% | 30.3% | 26.6% | 28.4%  | 29.6% | 26.3% | 27.9% | 31.1% | 25.6% | 28.2% | 32.3% | 25.9% | 29.0%  | 31.3% | 25.3% | 28.1% | 31.8% | 25.6% | 28.5% |
|                      | middle       | 40.8% | 42.9% | 41.9% | 43.3% | 47.8% | 45.6% | 43.9% | 44.1% | 44.0%  | 43.2% | 44.0% | 43.6% | 42.7% | 46.4% | 44.6% | 42.8% | 45.0% | 43.9%  | 42.4% | 45.3% | 43.9% | 42.6% | 44.3% | 43.5% |
|                      | lower middle | 14.3% | 18.5% | 16.5% | 13.3% | 15.8% | 14.6% | 11.7% | 18.8% | 15.4%  | 13.8% | 19.8% | 17.0% | 13.1% | 19.0% | 16.2% | 12.7% | 19.7% | 16.4%  | 14.7% | 19.9% | 17.5% | 13.6% | 19.7% | 16.9% |
|                      | lower        | 4.5%  | 10.2% | 7.5%  | 4.5%  | 8.9%  | 6.8%  | 4.1%  | 8.1%  | 6.2%   | 5.0%  | 7.6%  | 6.4%  | 4.7%  | 7.2%  | 6.0%  | 4.7%  | 7.2%  | 6.0%   | 3.6%  | 7.2%  | 5.5%  | 4.7%  | 7.9%  | 6.4%  |
| Ethnicity            | White        | 95.8% | 96.1% | 96.0% | 95.3% | 96.1% | 95.7% | 95.2% | 95.3% | 95.3%  | 95.2% | 95.4% | 95.3% | 95.4% | 95.6% | 95.5% | 94.6% | 94.8% | 94.7%  | 94.3% | 94.8% | 94.6% | 95.0% | 95.4% | 95.2% |
|                      | Black        | 2.0%  | 2.0%  | 2.0%  | 1.2%  | 1.7%  | 1.5%  | 1.8%  | 2.0%  | 1.9%   | 1.4%  | 2.1%  | 1.7%  | 1.3%  | 1.6%  | 1.5%  | 1.8%  | 2.2%  | 2.0%   | 1.7%  | 1.9%  | 1.8%  | 2.1%  | 1.9%  | 2.0%  |
|                      | Asian        | 2.1%  | 1.9%  | 2.0%  | 3.5%  | 2.2%  | 2.8%  | 3.0%  | 2.7%  | 2.9%   | 3.4%  | 2.5%  | 2.9%  | 3.3%  | 2.8%  | 3.0%  | 3.6%  | 3.0%  | 3.3%   | 4.1%  | 3.3%  | 3.6%  | 2.9%  | 2.7%  | 2.8%  |
| Obese                | no           | 85.5% | 82.6% | 84.0% | 86.0% | 82.0% | 83.9% | 85.3% | 82.7% | 83.9%  | 85.0% | 82.3% | 83.6% | 83.1% | 81.8% | 82.4% | 81.8% | 80.9% | 81.3%  | 81.0% | 79.3% | 80.1% | 81.2% | 78.3% | 79.6% |
|                      | yes          | 14.5% | 17.4% | 16.0% | 14.0% | 18.0% | 16.1% | 14.7% | 17.3% | 16.1%  | 15.0% | 17.7% | 16.4% | 16.9% | 18.2% | 17.6% | 18.2% | 19.1% | 18.7%  | 19.0% | 20.7% | 19.9% | 18.8% | 21.7% | 20.4% |
| Overweight           | no           | 42.7% | 54.2% | 48.8% | 39.9% | 53.5% | 47.0% | 38.3% | 50.9% | 44.8%  | 38.6% | 51.2% | 45.3% | 36.8% | 49.2% | 43.4% | 34.4% | 47.0% | 41.0%  | 33.4% | 46.9% | 40.6% | 33.0% | 45.5% | 39.7% |
|                      | yes          | 57.3% | 45.8% | 51.2% | 60.1% | 46.5% | 53.0% | 61.7% | 49.1% | 55.2%  | 61.4% | 48.8% | 54.7% | 63.2% | 50.8% | 56.6% | 65.6% | 53.0% | 59.0%  | 66.6% | 53.1% | 59.4% | 67.0% | 54.5% | 60.3% |
| BMI classification   | under-weight | 1.2%  | 2.0%  | 1.6%  | 0.9%  | 2.0%  | 1.5%  | 0.7%  | 1.4%  | 1.1%   | 0.6%  | 1.6%  | 1.1%  | 0.7%  | 1.4%  | 1.0%  | 0.6%  | 1.2%  | 0.9%   | 0.3%  | 1.5%  | 0.9%  | 0.6%  | 1.2%  | 0.9%  |
|                      | normal       | 41.5% | 52.2% | 47.2% | 39.1% | 51.5% | 45.5% | 37.5% | 49.5% | 43.7%  | 38.1% | 49.6% | 44.2% | 36.2% | 47.8% | 42.3% | 33.8% | 45.9% | 40.2%  | 33.1% | 45.4% | 39.6% | 32.4% | 44.3% | 38.8% |
|                      | overweight   | 42.8% | 28.4% | 35.2% | 46.0% | 28.5% | 37.0% | 47.0% | 31.8% | 39.1%  | 46.4% | 31.1% | 38.3% | 46.3% | 32.6% | 39.0% | 47.4% | 33.9% | 40.3%  | 47.6% | 32.4% | 39.5% | 48.2% | 32.8% | 39.9% |
|                      | obese        | 14.5% | 17.4% | 16.0% | 14.0% | 18.0% | 16.1% | 14.7% | 17.3% | 16.1%  | 15.0% | 17.7% | 16.4% | 16.9% | 18.2% | 17.6% | 18.2% | 19.1% | 18.7%  | 19.0% | 20.7% | 19.9% | 18.8% | 21.7% | 20.4% |
| Years of education   | 8            | 11.4% | 12.0% | 11.7% | 10.2% | 9.3%  | 9.7%  | 8.5%  | 8.2%  | 8.3%   | 7.5%  | 6.8%  | 7.1%  | 6.7%  | 5.5%  | 6.1%  | 5.0%  | 5.2%  | 5.1%   | 3.7%  | 4.4%  | 4.1%  | 2.8%  | 2.8%  | 2.8%  |
|                      | 9            | 30.6% | 29.3% | 29.9% | 28.4% | 29.9% | 29.2% | 27.7% | 29.2% | 28.5%  | 25.2% | 27.8% | 26.5% | 27.3% | 29.1% | 28.2% | 26.8% | 26.7% | 26.7%  | 26.0% | 29.1% | 27.6% | 27.8% | 27.1% | 27.4% |
|                      | 10           | 27.2% | 26.9% | 27.0% | 28.8% | 28.8% | 28.8% | 29.4% | 27.7% | 28.5%  | 31.6% | 28.4% | 29.9% | 30.6% | 29.3% | 29.9% | 31.8% | 31.4% | 31.6%  | 31.5% | 30.1% | 30.7% | 32.2% | 31.8% | 32.0% |
|                      | 11           | 7.7%  | 9.3%  | 8.5%  | 7.0%  | 9.2%  | 8.1%  | 7.5%  | 8.7%  | 8.1%   | 7.5%  | 10.0% | 8.8%  | 8.1%  | 10.0% | 9.1%  | 7.5%  | 10.1% | 8.8%   | 7.9%  | 9.4%  | 8.7%  | 7.5%  | 9.4%  | 8.5%  |
|                      | 12           | 5.1%  | 10.0% | 7.7%  | 6.7%  | 10.0% | 8.4%  | 7.2%  | 9.4%  | 8.3%   | 7.5%  | 10.2% | 8.9%  | 7.5%  | 10.0% | 8.8%  | 7.3%  | 9.3%  | 8.3%   | 8.5%  | 10.1% | 9.4%  | 7.1%  | 11.0% | 9.2%  |
|                      | 13           | 5.7%  | 6.8%  | 6.3%  | 7.7%  | 6.0%  | 6.8%  | 6.9%  | 8.9%  | 8.0%   | 8.3%  | 8.2%  | 8.2%  | 19.8% | 16.0% | 17.8% | 21.4% | 17.3% | 19.2%  | 8.5%  | 7.1%  | 7.7%  | 8.4%  | 8.0%  | 8.2%  |
|                      | 14           | 12.3% | 5.8%  | 8.9%  | 11.3% | 6.8%  | 8.9%  | 12.9% | 7.8%  | 10.3%  | 12.5% | 8.7%  | 10.5% | 0.1%  | 0.1%  | 0.1%  | 0.2%  | 0.1%  | 0.1%   | 14.0% | 9.8%  | 11.8% | 14.1% | 9.8%  | 11.8% |

Table A1.4. **England – Health Survey for England (cont.)**

| England              |              | 1999  |       |       | 2000  |       |       | 2001  |       |       | 2002  |       |       | 2003  |       |       | 2004  |       |       | 2005  |       |       |
|----------------------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                      |              | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total | Men   | Women | Total |
| Total Frequency      |              | 2 190 | 2 494 | 4 684 | 2 186 | 2 520 | 4 706 | 4 261 | 4 976 | 9 237 | 1971  | 2 531 | 4 502 | 4 025 | 4 745 | 8 770 | 3 027 | 3 689 | 6 716 | 1950  | 2 342 | 4 292 |
| Age group            | 25-39        | 11.4% | 10.2% | 10.7% | 11.0% | 11.5% | 11.3% | 10.4% | 10.7% | 10.6% | 10.2% | 11.7% | 11.0% | 9.6%  | 9.3%  | 9.4%  | 11.5% | 12.4% | 12.0% | 8.8%  | 10.0% | 9.5%  |
|                      | 30-34        | 13.8% | 14.8% | 14.3% | 15.2% | 14.4% | 14.7% | 13.4% | 12.7% | 13.0% | 12.3% | 14.0% | 13.3% | 12.8% | 12.3% | 12.6% | 15.8% | 13.6% | 14.6% | 13.5% | 11.3% | 12.3% |
|                      | 35-39        | 15.2% | 15.4% | 15.3% | 15.0% | 15.8% | 15.4% | 14.8% | 15.6% | 15.2% | 15.4% | 17.8% | 16.7% | 13.9% | 15.1% | 14.5% | 15.2% | 15.3% | 15.3% | 12.9% | 12.9% | 12.9% |
|                      | 40-44        | 12.4% | 13.8% | 13.2% | 13.8% | 14.1% | 14.0% | 13.3% | 13.8% | 13.6% | 15.6% | 13.4% | 14.4% | 14.3% | 14.7% | 14.5% | 14.9% | 15.7% | 15.3% | 11.9% | 14.9% | 13.6% |
|                      | 45-49        | 12.9% | 12.1% | 12.4% | 10.7% | 11.9% | 11.3% | 12.1% | 12.3% | 12.2% | 11.6% | 11.1% | 11.3% | 11.9% | 11.9% | 11.9% | 11.7% | 12.4% | 12.1% | 13.6% | 14.1% | 13.9% |
|                      | 50-54        | 13.2% | 15.2% | 14.2% | 12.9% | 12.7% | 12.8% | 13.8% | 13.9% | 13.8% | 12.2% | 11.8% | 12.0% | 12.6% | 11.7% | 12.1% | 11.3% | 10.8% | 11.0% | 13.4% | 11.9% | 12.6% |
|                      | 55-59        | 11.5% | 8.9%  | 10.1% | 11.6% | 10.7% | 11.1% | 12.1% | 11.6% | 11.8% | 12.1% | 11.6% | 11.8% | 13.9% | 14.2% | 14.1% | 9.8%  | 9.8%  | 9.8%  | 13.6% | 13.3% | 13.4% |
|                      | 60-64        | 9.7%  | 9.6%  | 9.7%  | 9.8%  | 9.0%  | 9.4%  | 10.1% | 9.4%  | 9.7%  | 10.5% | 8.7%  | 9.5%  | 10.9% | 10.9% | 10.9% | 9.8%  | 10.0% | 9.9%  | 12.2% | 11.6% | 11.8% |
| Socioeconomic status | upper        | 9.4%  | 2.1%  | 5.5%  | 7.8%  | 2.1%  | 4.8%  | 7.8%  | 2.7%  | 5.0%  | 9.1%  | 3.6%  | 6.0%  | 8.4%  | 3.3%  | 5.6%  | 7.4%  | 4.1%  | 5.6%  | 8.6%  | 3.5%  | 5.8%  |
|                      | upper middle | 31.6% | 26.9% | 29.1% | 32.4% | 30.1% | 31.2% | 33.2% | 29.8% | 31.4% | 32.1% | 30.6% | 31.3% | 33.6% | 32.5% | 33.0% | 32.0% | 31.6% | 31.8% | 35.5% | 33.7% | 34.6% |
|                      | middle       | 43.6% | 45.9% | 44.8% | 42.6% | 43.1% | 42.9% | 41.4% | 42.1% | 41.8% | 41.7% | 41.8% | 41.8% | 41.0% | 39.7% | 40.3% | 40.2% | 37.6% | 38.8% | 39.1% | 40.3% | 39.7% |
|                      | lower middle | 12.4% | 18.6% | 15.7% | 13.2% | 17.9% | 15.7% | 13.4% | 19.7% | 16.8% | 13.5% | 19.0% | 16.6% | 13.3% | 19.2% | 16.5% | 16.4% | 21.6% | 19.3% | 12.4% | 17.5% | 15.2% |
| Ethnicity            | lower        | 3.0%  | 6.5%  | 4.8%  | 4.0%  | 6.7%  | 5.5%  | 4.2%  | 5.7%  | 5.0%  | 3.5%  | 4.9%  | 4.3%  | 3.7%  | 5.2%  | 4.5%  | 4.0%  | 5.0%  | 4.5%  | 4.4%  | 5.0%  | 4.7%  |
|                      | White        | 94.2% | 94.9% | 94.6% | 94.2% | 94.4% | 94.3% | 94.8% | 95.0% | 94.9% | 94.1% | 94.1% | 94.1% | 93.6% | 94.0% | 93.8% | 58.3% | 60.9% | 59.8% | 93.6% | 93.9% | 93.8% |
|                      | Black        | 1.6%  | 1.7%  | 1.7%  | 1.4%  | 1.7%  | 1.6%  | 1.4%  | 1.8%  | 1.6%  | 1.4%  | 2.1%  | 1.8%  | 1.9%  | 2.0%  | 2.0%  | 13.2% | 14.3% | 13.8% | 1.1%  | 1.8%  | 1.5%  |
|                      | Asian        | 4.1%  | 3.4%  | 3.8%  | 4.4%  | 3.9%  | 4.1%  | 3.8%  | 3.2%  | 3.5%  | 4.5%  | 3.9%  | 4.1%  | 4.5%  | 4.0%  | 4.2%  | 28.4% | 24.8% | 26.4% | 5.2%  | 4.3%  | 4.7%  |
| Obese                | no           | 79.7% | 78.2% | 78.9% | 77.3% | 78.8% | 78.1% | 77.2% | 75.2% | 76.2% | 76.0% | 76.0% | 76.0% | 75.7% | 76.2% | 76.0% | 78.4% | 74.2% | 76.1% | 74.2% | 74.5% | 74.3% |
|                      | yes          | 20.3% | 21.8% | 21.1% | 22.7% | 21.2% | 21.9% | 22.8% | 24.8% | 23.8% | 24.0% | 24.0% | 24.0% | 24.3% | 23.8% | 24.0% | 21.6% | 25.8% | 23.9% | 25.8% | 25.5% | 25.7% |
| Overweight           | no           | 33.1% | 44.8% | 39.3% | 29.2% | 45.9% | 38.1% | 28.5% | 42.7% | 36.2% | 29.5% | 42.5% | 36.8% | 28.8% | 42.6% | 36.3% | 33.3% | 39.7% | 36.8% | 28.5% | 41.8% | 35.7% |
|                      | yes          | 66.9% | 55.2% | 60.7% | 70.8% | 54.1% | 61.9% | 71.5% | 57.3% | 63.8% | 70.5% | 57.5% | 63.2% | 71.2% | 57.4% | 63.7% | 66.7% | 60.3% | 63.2% | 71.5% | 58.2% | 64.3% |
| BMI classification   | under-weight | 0.7%  | 1.1%  | 0.9%  | 0.5%  | 1.3%  | 0.9%  | 0.6%  | 1.1%  | 0.9%  | 0.7%  | 1.1%  | 0.9%  | 0.6%  | 1.1%  | 0.9%  | 0.9%  | 1.2%  | 1.1%  | 0.3%  | 1.0%  | 0.7%  |
|                      | normal       | 32.4% | 43.7% | 38.4% | 28.6% | 44.6% | 37.2% | 28.0% | 41.6% | 35.3% | 28.8% | 41.4% | 35.9% | 28.3% | 41.5% | 35.4% | 32.4% | 38.4% | 35.7% | 28.3% | 40.7% | 35.1% |
|                      | overweight   | 46.6% | 33.4% | 39.6% | 48.1% | 33.0% | 40.0% | 48.7% | 32.5% | 40.0% | 46.5% | 33.5% | 39.2% | 46.8% | 33.6% | 39.7% | 45.1% | 34.5% | 39.3% | 45.6% | 32.7% | 38.6% |
|                      | obese        | 20.3% | 21.8% | 21.1% | 22.7% | 21.2% | 21.9% | 22.8% | 24.8% | 23.8% | 24.0% | 24.0% | 24.0% | 24.3% | 23.8% | 24.0% | 21.6% | 25.8% | 23.9% | 25.8% | 25.5% | 25.7% |
| Years of education   | 8            | 3.2%  | 2.8%  | 3.0%  | 3.2%  | 2.3%  | 2.8%  | 2.6%  | 2.2%  | 2.4%  | 2.4%  | 1.8%  | 2.0%  | 2.4%  | 1.9%  | 2.1%  | 3.9%  | 5.4%  | 4.7%  | 2.2%  | 1.6%  | 1.9%  |
|                      | 9            | 26.2% | 26.9% | 26.6% | 24.1% | 21.1% | 22.5% | 23.2% | 23.7% | 23.4% | 22.0% | 22.0% | 22.0% | 21.4% | 21.7% | 21.6% | 14.7% | 15.7% | 15.3% | 20.0% | 19.8% | 19.9% |
|                      | 10           | 32.3% | 31.2% | 31.7% | 30.6% | 32.4% | 31.6% | 31.9% | 32.1% | 32.0% | 32.8% | 29.7% | 31.1% | 32.4% | 30.9% | 31.6% | 25.4% | 25.0% | 25.2% | 30.6% | 30.8% | 30.7% |
|                      | 11           | 6.7%  | 10.1% | 8.5%  | 8.2%  | 9.4%  | 8.9%  | 7.8%  | 9.9%  | 9.0%  | 7.5%  | 9.7%  | 8.7%  | 7.2%  | 9.7%  | 8.5%  | 7.8%  | 9.8%  | 8.9%  | 7.6%  | 10.7% | 9.3%  |
|                      | 12           | 7.7%  | 10.0% | 8.9%  | 7.2%  | 11.7% | 9.6%  | 8.1%  | 11.3% | 9.8%  | 8.7%  | 11.8% | 10.4% | 8.8%  | 11.4% | 10.2% | 9.1%  | 11.6% | 10.5% | 8.9%  | 11.6% | 10.3% |
|                      | 13           | 8.6%  | 8.3%  | 8.5%  | 10.7% | 10.6% | 10.6% | 10.0% | 9.7%  | 9.8%  | 10.1% | 11.2% | 10.7% | 10.1% | 10.5% | 10.3% | 16.4% | 14.8% | 15.5% | 11.2% | 9.1%  | 10.0% |
|                      | 15           | 15.2% | 10.7% | 12.8% | 15.9% | 12.4% | 14.0% | 16.4% | 11.2% | 13.6% | 16.5% | 13.8% | 15.0% | 17.7% | 13.9% | 15.6% | 22.7% | 17.7% | 20.0% | 19.6% | 16.5% | 17.9% |

## ANNEX A2

## Regression Analysis Related to Estimates in Figures 2 and 3

Logistic regression was used to estimate the likelihood of obesity associated with different lengths of time in education for both genders.

| Australia                         | Dependant variable: obesity status |              | Canada                            | Dependant variable: obesity status |              |
|-----------------------------------|------------------------------------|--------------|-----------------------------------|------------------------------------|--------------|
|                                   | Odds ratios                        | Significance |                                   | Odds ratios                        | Significance |
| <b>Age</b>                        |                                    |              | <b>Age</b>                        |                                    |              |
| 25-29                             | ref.                               |              | 25-29                             | ref.                               |              |
| 30-34                             | 1.287 ***                          |              | 30-34                             | 1.091 *                            |              |
| 35-39                             | 1.325 ***                          |              | 35-39                             | 1.140 ***                          |              |
| 40-44                             | 1.450 ***                          |              | 40-44                             | 1.180 ***                          |              |
| 45-49                             | 1.717 ***                          |              | 45-49                             | 1.391 ***                          |              |
| 50-54                             | 1.752 ***                          |              | 50-54                             | 1.538 ***                          |              |
| 55-59                             | 1.604 ***                          |              | 55-59                             | 1.543 ***                          |              |
| 60-64                             | 1.536 ***                          |              | 60-64                             | 1.490 ***                          |              |
| Year of survey                    | 1.062 ***                          |              | Year of survey                    | 1.039 ***                          |              |
| Women                             | 1.027                              |              | Women                             | 0.956                              |              |
| <b>Years of education – Men</b>   |                                    |              | <b>Years of education – Men</b>   |                                    |              |
| 8                                 | ref.                               |              | 8                                 | ref.                               |              |
| 12                                | 0.738 ***                          |              | 12                                | 0.848 ***                          |              |
| 14                                | 0.568 ***                          |              | 14                                | 0.867 **                           |              |
| <b>Years of education – Women</b> |                                    |              | 17                                | 0.709 ***                          |              |
| 8                                 | ref.                               |              | <b>Years of education – Women</b> |                                    |              |
| 12                                | 0.700 ***                          |              | 8                                 | ref.                               |              |
| 14                                | 0.462 ***                          |              | 12                                | 0.754 ***                          |              |
| <b>Socio-economic status</b>      |                                    |              | 14                                | 0.896                              |              |
| highest                           | ref.                               |              | 17                                | 0.599 ***                          |              |
| middle-high                       | 1.157 ***                          |              | <b>Socio-economic status</b>      |                                    |              |
| middle                            | 1.132 ***                          |              | highest                           | ref.                               |              |
| middle-low                        | 1.517 ***                          |              | middle-high                       | 1.141 ***                          |              |
| lowest                            | 1.381 ***                          |              | middle                            | 1.136 ***                          |              |
| Obs.                              | 67 671                             |              | middle-low                        | 1.151 ***                          |              |
| Prob > chi2                       | 0.000                              |              | lowest                            | 1.207 ***                          |              |
| Pseudo R2                         | 0.032                              |              | Obs.                              | 219 496                            |              |
|                                   |                                    |              | Prob > chi2                       | 0.000                              |              |
|                                   |                                    |              | Pseudo R2                         | 0.0124                             |              |

| England                           | Dependant variable: obesity status |              |
|-----------------------------------|------------------------------------|--------------|
|                                   | Odds ratios                        | Significance |
| Age                               | 1.064***                           |              |
| Age squared                       | 0.999***                           |              |
| Year of survey                    | 1.058***                           |              |
| Women                             | 1.368***                           |              |
| <b>Years of education – Men</b>   |                                    |              |
| 8                                 | ref.                               |              |
| 9                                 | 0.956                              |              |
| 10                                | 0.882**                            |              |
| 11                                | 0.788***                           |              |
| 12                                | 0.726***                           |              |
| 13                                | 0.706***                           |              |
| 15                                | 0.558***                           |              |
| <b>Years of education – Women</b> |                                    |              |
| 8                                 | ref.                               |              |
| 9                                 | 0.792***                           |              |
| 10                                | 0.677***                           |              |
| 11                                | 0.599***                           |              |
| 12                                | 0.565***                           |              |
| 13                                | 0.558***                           |              |
| 15                                | 0.353***                           |              |
| <b>Socio-economic status</b>      |                                    |              |
| highest                           | ref.                               |              |
| middle-high                       | 1.235***                           |              |
| middle                            | 1.199***                           |              |
| middle-low                        | 1.347***                           |              |
| lowest                            | 1.440***                           |              |
| Obs.                              | 104 143                            |              |
| Prob > chi2                       | 0.000                              |              |
| Pseudo R2                         | 0.0266                             |              |

| Korea                             | Dependant variable: obesity status |              |
|-----------------------------------|------------------------------------|--------------|
|                                   | Odds ratios                        | Significance |
| Age                               | 0.973                              |              |
| Age square                        | 1.000                              |              |
| Year of survey                    | 1.066***                           |              |
| Women                             | 3.968***                           |              |
| <b>Years of education – Men</b>   |                                    |              |
| 6                                 | ref.                               |              |
| 9                                 | 1.601                              |              |
| 12                                | 1.649                              |              |
| 16                                | 1.509                              |              |
| 17                                | 1.909                              |              |
| <b>Years of education – Women</b> |                                    |              |
| 6                                 | ref.                               |              |
| 9                                 | 1.007                              |              |
| 12                                | 0.418***                           |              |
| 16                                | 0.195***                           |              |
| 17                                | 1.3E-07***                         |              |
| <b>Socio-economic status</b>      |                                    |              |
| highest                           | ref.                               |              |
| middle-high                       | 0.967                              |              |
| middle                            | 1.001                              |              |
| middle-low                        | 1.055                              |              |
| lowest                            | 1.217                              |              |
| Obs.                              | 15 242                             |              |
| Prob > chi2                       | 0.000                              |              |
| Pseudo R2                         | 0.026                              |              |

Linear regression was used to estimate BMI level associated with different lengths of time in education for both genders.

| Australia                         |            |              | Canada                            |            |              |
|-----------------------------------|------------|--------------|-----------------------------------|------------|--------------|
| Dependant variable: BMI           |            |              | Dependant variable: BMI           |            |              |
|                                   | Estimates  | Significance |                                   | Estimates  | Significance |
| <b>Age</b>                        |            |              | <b>Age</b>                        |            |              |
| 25-29                             | ref.       |              | 25-29                             | ref.       |              |
| 30-34                             | 0.523 ***  |              | 30-34                             | 0.496 ***  |              |
| 35-39                             | 0.695 ***  |              | 35-39                             | 0.651 ***  |              |
| 40-44                             | 1.006 ***  |              | 40-44                             | 0.847 ***  |              |
| 45-49                             | 1.422 ***  |              | 45-49                             | 1.303 ***  |              |
| 50-54                             | 1.575 ***  |              | 50-54                             | 1.638 ***  |              |
| 55-59                             | 1.575 ***  |              | 55-59                             | 1.733 ***  |              |
| 60-64                             | 1.454 ***  |              | 60-64                             | 1.552 ***  |              |
| Year of survey                    | 0.123 ***  |              | Year of survey                    | 0.078 ***  |              |
| Women                             | -0.554 *** |              | Women                             | -0.749 *** |              |
| <b>Years of education - Men</b>   |            |              | <b>Years of education - Men</b>   |            |              |
| 8                                 | ref.       |              | 8                                 | ref.       |              |
| 12                                | -0.351 *** |              | 12                                | -0.128     |              |
| 14                                | -0.883 *** |              | 14                                | -0.140     |              |
| <b>Years of education - Women</b> |            |              | <b>Years of education - Women</b> |            |              |
| 8                                 | ref.       |              | 8                                 | ref.       |              |
| 12                                | 0.239 ***  |              | 12                                | -0.801 *** |              |
| 14                                | 0.867 ***  |              | 14                                | -0.725 *** |              |
| <b>Socio-economic status</b>      |            |              | <b>Socio-economic status</b>      |            |              |
| highest                           | ref.       |              | highest                           | ref.       |              |
| middle-high                       | 0.184 ***  |              | middle-high                       | 0.148 ***  |              |
| middle                            | 0.143 **   |              | middle                            | 0.057      |              |
| middle-low                        | 0.538 ***  |              | middle-low                        | 0.036      |              |
| lowest                            | 0.254 ***  |              | lowest                            | -0.091     |              |
| Obs.                              | 67 671     |              | Obs.                              | 219 496    |              |
| Prob > F                          | 0.000      |              | Prob > F                          | 0.000      |              |
| Pseudo R2                         | 0.0709     |              | Pseudo R2                         | 0.0514     |              |

| England                           | Dependant variable: BMI |              |
|-----------------------------------|-------------------------|--------------|
|                                   | Estimates               | Significance |
| Age                               | 0.183***                |              |
| Age squared                       | -0.001***               |              |
| Year of survey                    | 0.120***                |              |
| Women                             | 0.503***                |              |
| <b>Years of education - Men</b>   |                         |              |
| 8                                 | ref.                    |              |
| 9                                 | 0.027                   |              |
| 10                                | -0.071                  |              |
| 11                                | -0.312**                |              |
| 12                                | -0.390***               |              |
| 13                                | -0.569***               |              |
| 15                                | -0.948***               |              |
| <b>Years of education - Women</b> |                         |              |
| 8                                 | ref.                    |              |
| 9                                 | -0.603***               |              |
| 10                                | -1.028***               |              |
| 11                                | -1.401***               |              |
| 12                                | -1.598***               |              |
| 13                                | -1.622***               |              |
| 15                                | -2.647***               |              |
| <b>Socio-economic status</b>      |                         |              |
| highest                           | ref.                    |              |
| middle-high                       | 0.332***                |              |
| middle                            | 0.196***                |              |
| middle-low                        | 0.434***                |              |
| lowest                            | 0.467***                |              |
| Obs.                              | 104 143                 |              |
| Prob > F                          | 0.000                   |              |
| Pseudo R2                         | 0.0503                  |              |

| Korea                             | Dependant variable: BMI |              |
|-----------------------------------|-------------------------|--------------|
|                                   | Estimates               | Significance |
| Age                               | 0.223***                |              |
| Age square                        | -0.002***               |              |
| Year of survey                    | 0.065***                |              |
| Women                             | 1.300***                |              |
| <b>Years of education - Men</b>   |                         |              |
| 6                                 | ref.                    |              |
| 9                                 | 0.487***                |              |
| 12                                | 0.739***                |              |
| 16                                | 0.922***                |              |
| 17                                | 1.379***                |              |
| <b>Years of education - Women</b> |                         |              |
| 6                                 | ref.                    |              |
| 9                                 | 0.042                   |              |
| 12                                | -1.167***               |              |
| 16                                | -2.223***               |              |
| 17                                | -2.584***               |              |
| <b>Socio-economic status</b>      |                         |              |
| highest                           | ref.                    |              |
| middle-high                       | -0.184**                |              |
| middle                            | -0.104                  |              |
| middle-low                        | -0.124                  |              |
| lowest                            | -0.294***               |              |
| Obs.                              | 15 704                  |              |
| Prob > F                          | 0.000                   |              |
| Pseudo R2                         | 0.0806                  |              |

## ANNEX A3

## Regression Analysis Related to Estimates in Figures 4 to 6

Logistic regression was used to estimate the likelihood of obesity associated with different lengths of time in education for both genders and by ethnicity/minority status.

Table A3.1. **Australia**

| Australia – men                         | Dependant variable: obesity status |              | Australia – women                       | Dependant variable: obesity status |              |
|-----------------------------------------|------------------------------------|--------------|-----------------------------------------|------------------------------------|--------------|
|                                         | Odds ratios                        | Significance |                                         | Odds ratios                        | Significance |
| <b>Age</b>                              |                                    |              | <b>Age</b>                              |                                    |              |
| 25-29                                   | ref.                               |              | 25-29                                   | ref.                               |              |
| 30-34                                   | 1.259 **                           |              | 30-34                                   | 1.369 ***                          |              |
| 35-39                                   | 1.396 ***                          |              | 35-39                                   | 1.347 ***                          |              |
| 40-44                                   | 1.559 ***                          |              | 40-44                                   | 1.479 ***                          |              |
| 45-49                                   | 1.715 ***                          |              | 45-49                                   | 1.927 ***                          |              |
| 50-54                                   | 1.735 ***                          |              | 50-54                                   | 1.998 ***                          |              |
| 55-59                                   | 1.475 ***                          |              | 55-59                                   | 1.969 ***                          |              |
| 60-64                                   | 1.435 ***                          |              | 60-64                                   | 1.841 ***                          |              |
| Year of survey                          | 1.070 ***                          |              | Year of survey                          | 1.050 ***                          |              |
| <b>Years of education – Migrant</b>     |                                    |              | <b>Years of education – Migrant</b>     |                                    |              |
| 8                                       | ref.                               |              | 8                                       | ref.                               |              |
| 12                                      | 0.580 ***                          |              | 12                                      | 0.675 ***                          |              |
| 14                                      | 0.373 ***                          |              | 14                                      | 0.408 ***                          |              |
| <b>Years of education – Non-migrant</b> |                                    |              | <b>Years of education – Non-migrant</b> |                                    |              |
| 8                                       | ref.                               |              | 8                                       | ref.                               |              |
| 12                                      | 0.693 *                            |              | 12                                      | 0.878                              |              |
| 14                                      | 0.576 ***                          |              | 14                                      | 0.729 ***                          |              |
| <b>Socio-economic status</b>            |                                    |              | <b>Socio-economic status</b>            |                                    |              |
| highest                                 | ref.                               |              | highest                                 | ref.                               |              |
| middle-high                             | 1.115 *                            |              | middle-high                             | 1.247 ***                          |              |
| middle                                  | 0.973                              |              | middle                                  | 1.409 ***                          |              |
| middle-low                              | 1.389 ***                          |              | middle-low                              | 1.784 ***                          |              |
| lowest                                  | 1.170 **                           |              | lowest                                  | 1.760 ***                          |              |
| Obs.                                    | 33 523                             |              | Obs.                                    | 34 148                             |              |
| Prob > chi2                             | 0.000                              |              | Prob > chi2                             | 0.000                              |              |
| Pseudo R2                               | 0.0357                             |              | Pseudo R2                               | 0.0367                             |              |

Table A3.2. **Canada**

| Canada – men                             | Dependant variable: obesity status |              | Canada – women                           | Dependant variable: obesity status |              |
|------------------------------------------|------------------------------------|--------------|------------------------------------------|------------------------------------|--------------|
|                                          | Odds ratios                        | Significance |                                          | Odds ratios                        | Significance |
| <b>Age</b>                               |                                    |              | <b>Age</b>                               |                                    |              |
| 25-29                                    | ref.                               |              | 25-29                                    | ref.                               |              |
| 30-34                                    | 1.222 ***                          |              | 30-34                                    | 1.193 ***                          |              |
| 35-39                                    | 1.203 ***                          |              | 35-39                                    | 1.160 ***                          |              |
| 40-44                                    | 1.197 ***                          |              | 40-44                                    | 1.210 ***                          |              |
| 45-49                                    | 1.366 ***                          |              | 45-49                                    | 1.441 ***                          |              |
| 50-54                                    | 1.471 ***                          |              | 50-54                                    | 1.689 ***                          |              |
| 55-59                                    | 1.475 ***                          |              | 55-59                                    | 1.646 ***                          |              |
| 60-64                                    | 1.323 ***                          |              | 60-64                                    | 1.474 ***                          |              |
| Year of survey                           | 1.030 ***                          |              | Year of survey                           | 1.053 ***                          |              |
| <b>Years of education – Non-minority</b> |                                    |              | <b>Years of education – Non-minority</b> |                                    |              |
| 8                                        | ref.                               |              | 8                                        | ref.                               |              |
| 12                                       | 0.880 ***                          |              | 12                                       | 0.823 ***                          |              |
| 14                                       | 0.869 ***                          |              | 14                                       | 0.843 ***                          |              |
| 17                                       | 0.735 ***                          |              | 17                                       | 0.739 ***                          |              |
| <b>Years of education – Minority</b>     |                                    |              | <b>Years of education – Minority</b>     |                                    |              |
| 8                                        | ref.                               |              | 8                                        | ref.                               |              |
| 12                                       | 0.639 ***                          |              | 12                                       | 0.529 ***                          |              |
| 14                                       | 0.761 ***                          |              | 14                                       | 0.926                              |              |
| 17                                       | 0.467 ***                          |              | 17                                       | 0.549 ***                          |              |
| <b>Socio-economic status</b>             |                                    |              | <b>Socio-economic status</b>             |                                    |              |
| highest                                  | ref.                               |              | highest                                  | ref.                               |              |
| middle-high                              | 0.988                              |              | middle-high                              | 1.323 ***                          |              |
| middle                                   | 0.941 **                           |              | middle                                   | 1.554 ***                          |              |
| middle-low                               | 0.944                              |              | middle-low                               | 1.825 ***                          |              |
| lowest                                   | 0.875 ***                          |              | lowest                                   | 1.821 ***                          |              |
| Obs.                                     | 101 113                            |              | Obs.                                     | 106 698                            |              |
| Prob > chi2                              | 0.000                              |              | Prob > chi2                              | 0.000                              |              |
| Pseudo R2                                | 0.0075                             |              | Pseudo R2                                | 0.0179                             |              |

Table A3.3. **England**

| England – men                     | Dependant variable: obesity status |              | England – women                   | Dependant variable: obesity status |              |
|-----------------------------------|------------------------------------|--------------|-----------------------------------|------------------------------------|--------------|
|                                   | Odds ratios                        | Significance |                                   | Odds ratios                        | Significance |
| Age                               | 1.089 ***                          |              | Age                               | 1.042 ***                          |              |
| Age squared                       | 0.999 ***                          |              | Age squared                       | 1.000 ***                          |              |
| Year of survey                    | 1.067 ***                          |              | Year of survey                    | 1.050 ***                          |              |
| <b>Years of education – White</b> |                                    |              | <b>Years of education – White</b> |                                    |              |
| 8                                 | ref.                               |              | 8                                 | ref.                               |              |
| 9                                 | 0.869 **                           |              | 9                                 | 0.886 **                           |              |
| 10                                | 0.781 ***                          |              | 10                                | 0.774 ***                          |              |
| 11                                | 0.701 ***                          |              | 11                                | 0.696 ***                          |              |
| 12                                | 0.626 ***                          |              | 12                                | 0.656 ***                          |              |
| 13                                | 0.640 ***                          |              | 13                                | 0.615 ***                          |              |
| 15                                | 0.471 ***                          |              | 15                                | 0.414 ***                          |              |
| <b>Years of education – Black</b> |                                    |              | <b>Years of education – Black</b> |                                    |              |
| 8                                 | ref.                               |              | 8                                 | ref.                               |              |
| 9                                 | 0.517 ***                          |              | 9                                 | 1.631 ***                          |              |
| 10                                | 0.618 ***                          |              | 10                                | 1.650 ***                          |              |
| 11                                | 0.537 **                           |              | 11                                | 1.582 ***                          |              |
| 12                                | 0.664                              |              | 12                                | 1.396 **                           |              |
| 13                                | 0.677 **                           |              | 13                                | 1.862 ***                          |              |
| 15                                | 0.634 **                           |              | 15                                | 0.984                              |              |
| <b>Years of education – Asian</b> |                                    |              | <b>Years of education – Asian</b> |                                    |              |
| 8                                 | ref.                               |              | 8                                 | ref.                               |              |
| 9                                 | 0.517 ***                          |              | 9                                 | 1.631                              |              |
| 10                                | 1.169 ***                          |              | 10                                | 1.142                              |              |
| 11                                | 0.970 ***                          |              | 11                                | 0.704 ***                          |              |
| 12                                | 1.153 ***                          |              | 12                                | 0.831 ***                          |              |
| 13                                | 0.826 ***                          |              | 13                                | 0.762 ***                          |              |
| 15                                | 0.762 ***                          |              | 15                                | 0.615 ***                          |              |
| <b>Socio-economic status</b>      |                                    |              | <b>Socio-economic status</b>      |                                    |              |
| highest                           | ref.                               |              | highest                           | ref.                               |              |
| middle-high                       | 1.220 ***                          |              | middle-high                       | 1.378 ***                          |              |
| middle                            | 1.185 ***                          |              | middle                            | 1.347 ***                          |              |
| middle-low                        | 1.135 **                           |              | middle-low                        | 1.682 ***                          |              |
| lowest                            | 1.022                              |              | lowest                            | 1.930 ***                          |              |
| Obs.                              | 48 558                             |              | Obs.                              | 55 585                             |              |
| Prob > chi2                       | 0.000                              |              | Prob > chi2                       | 0.000                              |              |
| Pseudo R2                         | 0.0261                             |              | Pseudo R2                         | 0.0312                             |              |

## ANNEX A4

## Multilevel models

This methodological annex gives a description of the multilevel model.

Let  $y_i$  be the value of the response variable  $Y$  for the individual  $i$ , and  $X_1$  an independent covariate in a simple univariate model, the single-level regression equation for the individual  $i$  is given by:

$$y_i = \beta_0 + \beta_1 x_{1i} + e_i \quad (1)$$

where  $\beta_0$  is the intercept,  $\beta_1$  the regression coefficient and the individual-level residuals  $e_i$  with  $e_i \sim N(0, \sigma_e^2)$ .

In order to evaluate the significance of a higher order aggregation of individuals in  $n$  groups on the single values  $y_i$ , the regression model in (1) can be written as:

$$y_{ij} = \beta_{0j} + \beta_{1j} x_{1ij} + e_{ij} \quad (2)$$

where  $j = 1, \dots, n$  refers to the level-2 units (groups) and  $i = 1, \dots, N$ , to the level-1 units (individuals).

The model in equation (2) is called *random intercept model* when the intercept  $\beta_0$  in (1) becomes a random variable depending on the group  $j$ , that is:

$$\beta_{0j} = \beta_0 + u_{0j} \quad (3)$$

with  $u_{0j} \sim N(0, \sigma_{u0}^2)$  as group-level residuals. When considering also the regression coefficient  $\beta_1$  as a random variable such as:

$$\beta_{1j} = \beta_1 + u_{1j} \quad (4)$$

with  $u_{1j} \sim N(0, \sigma_{u1}^2)$  and  $\text{cov}(u_{0j}, u_{1j}) = \sigma_{u01}$ , the model in equation (2) is called *random coefficient model* and can be written in the form:

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + (u_{0j} + u_{1j} x_{1ij} + e_{ij}) \quad (5)$$

In equation (5) the response variable  $y_{ij}$  has been expressed as the sum of a fixed part and a random part within the brackets, where the covariate  $x_{1ij}$  in the random part of the model is usually substituted by  $z_{1ij}$  to make the distinction with the covariates in the fixed part. In model (5) both intercept and regression coefficients vary from group to group, so as to explain the effect of the group's aggregation on the  $Y$  variable. The individual-level residuals  $e_{ij}$  are assumed to be independent from the group-level residuals  $u_{0j}$  and  $u_{1j}$ .

The intra level-2 unit correlation in random intercept models is given by:

$$\rho = \frac{\sigma_{u0}^2}{\sigma_{u0}^2 + \sigma_e^2} \quad (6)$$

and measures the proportion of the total variance which is between-groups. The same correlation index in case of random coefficient models equals:

$$\rho = \frac{\sigma_{u0}^2 + 2\sigma_{01}z_{1ij} + \sigma_{u1}^2 z_{1ij}^2}{\sigma_{u0}^2 + 2\sigma_{01}z_{1ij} + \sigma_{u1}^2 z_{1ij}^2 + \sigma_e^2} \quad (7)$$

The existence of a non-zero intra-group correlation indicates that traditional estimation procedures used in multiple regressions, such as ordinary least squares, are not correct. For this reason, estimation methods for multilevel models include generalised least square techniques (Goldstein, 1986), Fisher scoring algorithm (Longford, 1987) or the expectation-maximisation algorithm (Raudenbush and Bryk, 1986). The simple 2-level random coefficient model in (5) can be further extended by introducing more explanatory variables at either the individual or the group levels. Moreover, the number of nested levels can be increased when considering more aggregation stages.

In this case  $y_{ij}$  is a discrete response, the model is a hierarchical logistic model and the random intercept model is:

$$y_{ij} = \beta_0 + \beta_1 x_{1i} + (u_{0j} + e_{ij}) \quad (8)$$

with  $e_{ij}$  having logistic distribution and the individual-level variance  $\sigma_e^2$  is equal to  $\pi^2/3$ . So, the intra-class correlation is (with  $\sigma_{u0}^2$  the group-level variance):

$$\rho = \frac{\sigma_{u0}^2}{\sigma_{u0}^2 + \frac{\pi^2}{3}} \quad (9)$$



# Public Policies and Investment in Network Infrastructure

by

Douglas Sutherland, Sónia Araújo, Balázs Égert and Tomasz Koźluk\*

*How can public policy influence investment in infrastructure in network industries? Network industries rely mainly on fixed networks to deliver services, with investment being lumpy and largely irreversible. As a result, public policies – such as public provision, the introduction of competition and the regulatory environment – can potentially have an important impact on investment behaviour, with the net effect depending on the extent that policies boost socially-productive investment or reduce inefficient investment. Drawing on responses to a unique questionnaire assessing public policy in the network sectors, the information in this paper presents a systematic picture of relevant policies in place across OECD countries. Econometric analysis – both at the sectoral and firm level – finds that public policies can have significant quantitative effects. In particular, the introduction of competitive pressures through the reduction of barriers to entry and the combination of regulator independence and incentive regulation can promote investment in the sector.*

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How can public policy influence investment in infrastructure in network industries? Over the past few decades, the provision of infrastructure has undergone profound changes. The public sector was often responsible for provision, but over time, given the combination of privatisation, technological change and the development of new contracting techniques coupled with the establishment of independent regulatory authorities, private provision accounts for an increasingly large share of total investment. This raises questions about how the emerging institutional frameworks affect incentives to investment in infrastructure.

In order to address these questions, the analysis in this paper focuses on infrastructure in energy, water, transport and communications. These sectors are chosen not only because of their importance to the economy, but because they rely mainly on fixed networks to deliver their services, with investment in infrastructure assets being lumpy and largely irreversible. As there are elements of natural monopoly and market failure, public policies are often important. Addressing market failure has been a major motive for public intervention in infrastructure provision, intending to prevent the under-provision or non-provision of infrastructure, when externalities or public good features are predominant, or to limit the exercise of market power to the extent to which a natural monopoly is present.

Where supply entails a natural monopoly, as is typical in the network industries, the private sector will usually be willing to provide the service, though normally at a level that is below, and a price that is above, the social optimum. This will often result in some type of arm's length regulation. Investment will depend on standard investment determinants, such as the cost of capital, but due to the often extremely large fixed costs and the irreversibility of investment decisions, investment decisions are also particularly sensitive to the regulatory environment. As a result, direct public provision, the introduction of competition and the regulatory environment can potentially have an important impact on investment behaviour.

Despite the rationales for public provision to counter under-provision of infrastructure, the move towards greater private provision and more independent regulatory regimes does not necessarily imply lower investment levels. By better aligning incentives for investment and reducing uncertainty stemming from regulatory risk, the innovations seen in recent decades could provide a spur for investment.

The empirical literature assessing the impact of policies on investment has faced a number of difficulties. Data limitations on the diversity of policies in place make it difficult to measure the impact of a particular policy on investment for an individual sector yet alone across a number of sectors. Researchers are often better able to examine the impact of a change in policy through case study evidence or for policies (often a single regulatory policy) for an individual sector. For example, Edwards and Waverman (2006) find that greater regulatory independence is important for the telecommunications sector while Cambini and Rondi (2010) find that investment is higher in firms under incentive

regulation. More aggregate empirical studies have sometimes pooled the data for the sectors covered and thus say little about how the measured effects differ across sectors. For example, in time-series regressions using sectoral data, Alesina *et al.* (2005) noted that lowering barriers to entry was found to boost the investment rate. The empirical work in this paper addresses how general some of these types of findings are across different sectors and also considers interactions between policies.

The structure of the paper is as follows. Section 1 discusses the channels through which public policy affects infrastructure investment, drawing on responses to a unique questionnaire on infrastructure investment. Section 2 contains a discussion of the econometric approaches at sectoral and firm level to assess the impact of public policies on infrastructure investment, which is followed by a presentation of the results. Finally, Section 3 concludes.

## 1. Public policies in the infrastructure sectors

This section describes how public policies can influence investment behaviour in the infrastructure sectors and draws on two principal sources of information to describe actual public policies in OECD countries.<sup>1</sup> The first source of information is derived from responses to the OECD Regulatory Indicators Questionnaires (Wölfl *et al.*, 2009). This is a regular OECD questionnaire, issued every five years, which is much broader in scope than infrastructure but contains specific questions on policies for some network sectors. For example, the questionnaires contain responses on public ownerships, market structure, barriers to entry and regulator independence for energy, telecommunications and transportation.

A second source of information on public policies is an *ad hoc* questionnaire on infrastructure investment (<http://dx.doi.org/10.1787/888932482365>) submitted to the OECD member governments in December 2007. The aim of the questionnaire was to collect comparable cross-country information, complementing and extending the existing regulatory indicators. The questionnaire was divided into three sections concerning regulation (covering regulators and pricing policies), specific questions on concessions and franchises as well as questions on infrastructure planning and financing.<sup>2</sup> The questionnaire covered the energy (electricity and gas), water supply and sewerage, transport (railroad, road, water and air transport), and the telecommunication (fixed line, mobile and internet services) sectors. Respondents were requested to answer reflecting the regulatory settings at the time of response and not to anticipate changes. When appropriate, central governments were asked to respond basing their answers on institutions prevailing in the most representative sub-central governments or a subset of them that best characterised each country's institutional settings. As with the Regulatory Indicators Questionnaire, questions typically required a yes/no response.

The questionnaire was quite detailed and despite the burden it imposed, response rates were relatively good. In total, the questionnaire asked 38 sets of questions, which taking into account the sectoral coverage implied a possible 1 370 separate responses. Of the 30 OECD members at the time, 25 countries responded to the questionnaire (<http://dx.doi.org/10.1787/888932482384>).<sup>3</sup> The section on regulators and pricing policies had the highest response rate, with all respondents answering questions on the existence of sectoral regulators, their mandates and competencies. On average for this section, the response rate for specific questions was 83%. The response rate to the section on pricing

policies was 75%. Three-quarters of countries responded that they used concessions and franchises, though for the specific questions in this section the response rate sometimes dropped to 50%, often due to limited sectoral coverage. Finally, the response rate for the section on investment planning was around 60% while response rates to specific questions on public-private partnerships (PPPs) were around two-fifths, though conditional on the countries having noted experience of using PPPs the response rate rose to around one-half.

### 1.1. Public ownership and provision

There are a number of different delivery modes involving the public or private sector to a greater or lesser extent. These include public ownership and procurement, which has often characterised the water supply and road networks; concessions and public private partnerships, which are increasingly involving the private sector in the delivery of infrastructure; and fully privately-owned companies, which has often been the case in the energy sector. Until the late 1980s, public ownership was the dominant ownership form for many network industries. According to OECD indicators, public ownership only declined in importance in some of them quite recently (Figure 1). In the water sector, which is not covered by these indicators, public ownership characterised the ownership structure in two-thirds of OECD countries quite recently (OECD, 2004).

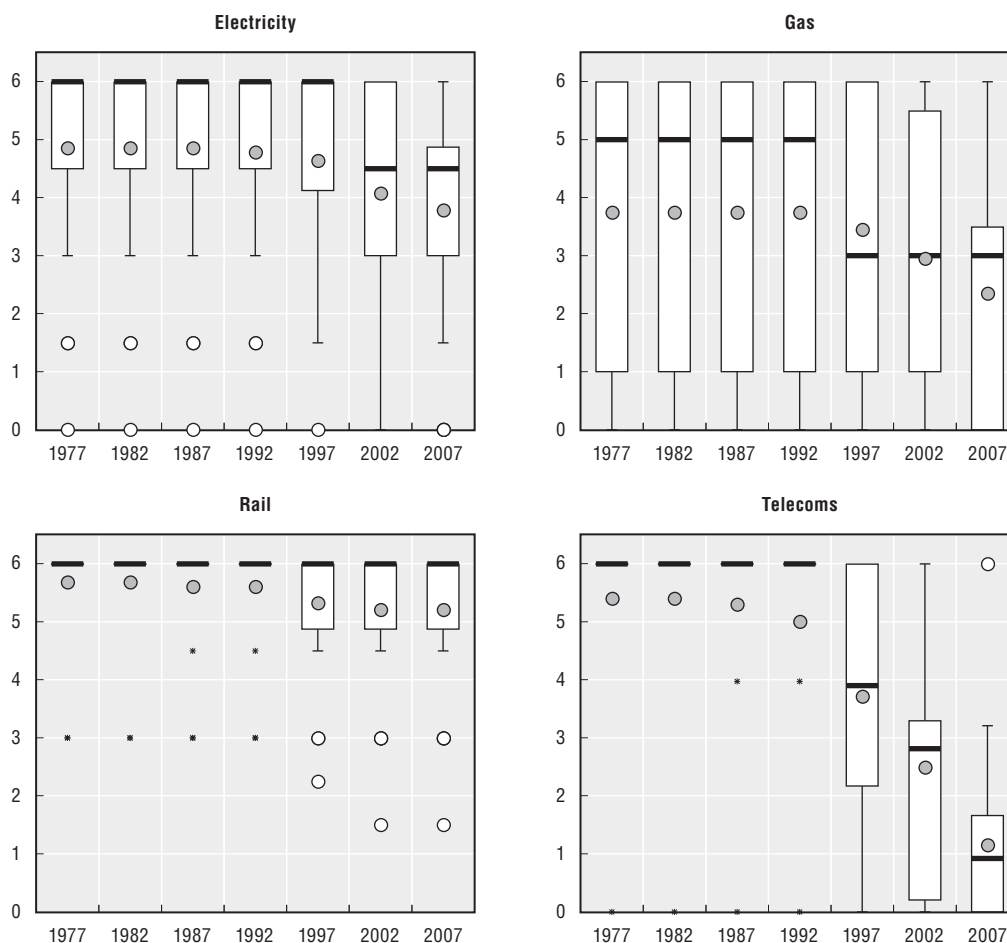
The decline of public ownership partly reflects recognition among OECD governments that it can contribute to inefficient investment in infrastructure. For instance, overinvestment may occur as public managers engage in “empire building” behaviour to strengthen their support with the politicians who appointed them (e.g. by expanding capacity and employment in public enterprises). Indeed, some telecom operators cut back ambitious plans to expand fibre-optic networks in the wake of privatisation. At the other extreme, underinvestment may occur, if public authorities pay insufficient attention to the long-term benefits of investment in a context of fiscal pressures. Public investment may also lead to the misallocation of resources across regions and sectors. For example, policymakers may allocate resources to a given region or project at the expense of other potentially higher return investments in more deserving regions or projects (Cadot et al., 2006; Castells and Solé-Ollé, 2005). Investment may also be allocated sub-optimally over time if it is allowed to be influenced by the electoral cycle.

Public ownership can also create disincentives for privately-operated firms to invest in network industries. First, the lack of a level playing field – often due to the state-owned company’s soft budget constraint – is a disincentive for private firms to invest. Second, there may be confusion between the role of the state as the regulator and owner, which serves to amplify regulatory discretion and risk (this is discussed below). Finally, state ownership can be a *de facto* barrier to foreign direct investment.

Against this background, private sector provision has become increasingly attractive. First, in some sectors – such as telecoms and electricity – the extent of the natural monopoly element has been redefined, in part as a result of technical progress or as a result of sunk costs having already been incurred, opening the door to competitive private provision. Second, refinements in regulatory techniques (see below) have made “arm’s length” regulation of private providers of infrastructure more desirable than direct public provision. Similarly, new contracting techniques were designed, which made contracting out of infrastructure provision more attractive than in the past. Finally, particularly in the presence of mature networks, specific distributional objectives were often found to be more efficiently achieved by other mechanisms, such as targeted social transfers.

Figure 1. **The declining importance of public ownership in network utilities**

Scale 0-6 from lowest to highest degree of public ownership



Note: These plots display the box that covers the observations between the 1<sup>st</sup> and 3<sup>rd</sup> quartiles, as well as the median (the horizontal bar) and the mean (the point). The whiskers extending from the box give the range that captures the observations which lie within 1.5 times the inter-quartile range from the 1<sup>st</sup> and 3<sup>rd</sup> quartiles. Points outside this range are considered outliers, which are marked by an asterisk.

The sample coverage is the same for each period. For electricity the countries included are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Mexico, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States. For gas, the country coverage is the same as electricity with the exception of the Slovak Republic. For rail the country coverage is the same as electricity with the exception of Iceland. For telecoms the country coverage is the same as electricity with the exception of Iceland and Luxembourg.

In the rail and telecommunication utilities, public ownership was predominant until the early 1990s in almost all countries.

Source: Regulatory indicators questionnaire.

## 1.2. Unbundling and market structure

Greater private provision and competitive pressures for efficient infrastructure investment can also be introduced through the unbundling of the natural monopoly elements of networks. The implications of vertical separation and of the ownership of the “core” network (the particular segment that is a natural monopoly also sometimes termed “essential facility”) are important for investment. An attraction of coupling entry liberalisation in competitive markets with vertical separation of the network industries is that the private sector will determine the appropriate level of investment in the competitive

segment of the industry. For example, while a vertically-integrated firm may innovate, particularly if there are first mover advantages and the market is contestable, more competition creates incentives to expand capacity and may give sharper incentives to invest in cost-saving technologies and organisational forms (as observed, for instance, in the development of low-cost air transport and innovations in mobile telephony after liberalisation). However, appropriate ownership and regulatory settings would still be needed to ensure an efficient level of investment in the core network.

The argument for retaining a vertically-integrated firm largely depends on the loss of economies of scale and scope and possible co-ordination problems and higher transaction costs in a vertically separated industry. In some sectors, such as mature electricity and gas networks, these factors are not crucial, supporting their unbundling, which was implemented especially in the electricity sector of OECD countries over the past decade. In the case of railroads a large range of options exist across the OECD, running from vertically-integrated public enterprises to vertically-separated private companies. In this sector, the problems created by vertical separation are arguably severe. Train operating companies are relatively unconcerned with lowering high marginal costs for the network operator, and the network operator – not benefitting from higher revenue from train operators – has little incentive to improve its services. Not only may this constellation of incentives lead to under provision of rail track services, some studies suggest that the resulting losses of economies of scope increase production costs by between 20% and 40% when the sector is fully separated (OECD, 2006).

In some parts of the network industries, there may be reasons for maintaining a vertically-integrated firm, such as allowing facilities-based competition to emerge in the long run while allowing service-based competition in the short run to create pressure to increase cost efficiency (in parts of telecommunication networks, for example). In this case, the network operator provides wholesale services to downstream competitors, which may blunt incentives to invest in quality (Auriol, 1998). The resulting regulatory problems are severe, and firms need careful monitoring to prevent the exercise of market power with care also needed in setting the appropriate access regime and price as this is complicated by the firm operating in both regulated and unregulated markets (see below).

When vertical separation is desirable, a central question concerns the ownership structure of the core network. Countries differ markedly with respect to different organisational forms. In the electricity sector, for example, the electricity transmission grid is privately owned and operated in the United Kingdom and Germany, privately owned and operated by an independent company in some parts of the United States, state-owned and run by an independent company in Italy and state owned and operated by a state-owned enterprise in the Netherlands. In some cases, the regulatory authorities have mandated that the “essential facility” be operated by a different entity than a user (to prevent foreclosure). The different types of organisational forms have potentially different consequences for investment (OECD, 2001).<sup>4</sup>

- *Accounting and legal separation:* Formal separation has generally been insufficient to change the behaviour of the incumbent, often amounting to *de facto* vertical integration, and does little to relieve the regulator's burden in determining the appropriate level of investment. For example, in the early 1990s, the UK competition authorities found that a greater degree of separation was desirable for British Gas, then a vertically integrated gas

company. Accounting and legal separation characterises industry structures in energy, rail and telecommunications in many EU countries that implemented the minimum requirements set by EU directives.

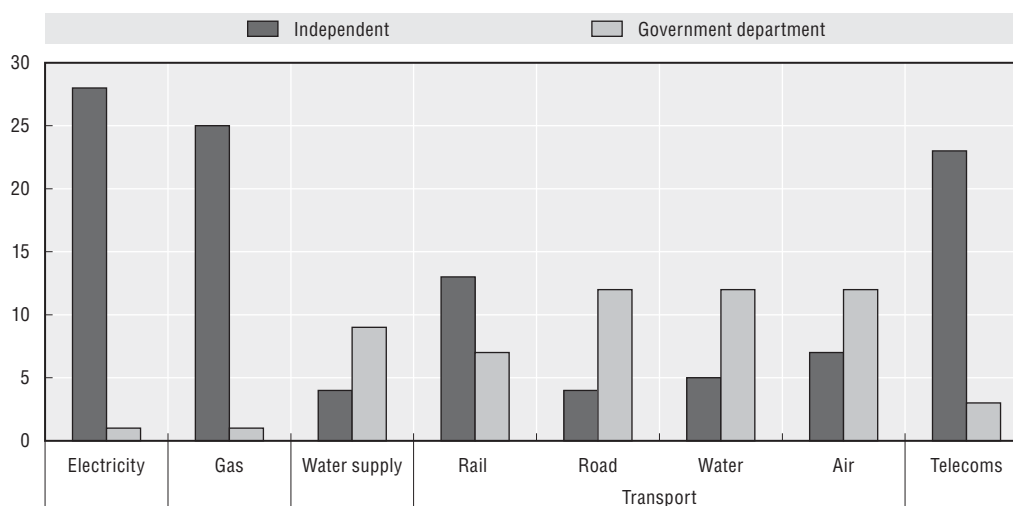
- *Operation separation*: This occurs when an independent entity controls the non-competitive component. A key element is whether this entity should be allowed to generate profits. If the governing entity has no interest in the profitability of the non-competitive component it may have little incentive for efficient and innovative investment in the non-competitive activity. Operational separation is a form used in the US electricity industry. But in the United States, electricity retailing companies have complained that (operationally-separate) transmission companies have not been responsive to changes in demands nor innovative (OECD, 2001).
- *Ownership separation*: In this case, the owner of the network will not discriminate among users and thus many of the competition problems that can arise in other organisational structures are mitigated. An example is the National Grid in the United Kingdom. In the absence of co-ordination problems, creating appropriate investment incentives depends on the regulatory framework and the setting of access prices, which are discussed below.
- *Club ownership*: Club ownership – when the core network is owned by a consortium of firms using the network – will help align incentives for network operators and downstream competitors. However, when the number of downstream competitors is small, collusion and foreclosure may result and when the number of competitors is large there may be principal-agent problems. Many EU countries have chosen club ownership between the major airlines and the slot allocation function at major airports or for electricity transmission in Italy.

### **1.3. Regulation and other framework conditions**

Regulation – which is prevalent in network industries – and other framework conditions will play an important role in investment decision making through their effect on determining the return on investment as well as ensuring efficient use and expansion of infrastructure through the effects of pricing. This section discusses how these policies can be designed to support such incentives, considering in turn institutional arrangements for the regulator, network access conditions and the pricing regime.

An important factor affecting investment in regulated network industries is the nature of the regulator. The regulator faces potential difficulties both in its relations with the government and the sector it is regulating – including political and private interest pressures – as well as problems related with lack of credibility and asymmetries of information (OECD, 2005). Ensuring the regulator's independence is central to preventing regulatory capture and enhances the stability and credibility of the regulatory framework, in a context where accountability to the government, the legislature and consumers should nonetheless be preserved. To facilitate independence, desirable features for the regulator's operation include providing a legal mandate (including criteria and procedures for overruling decisions), ensuring the regulator is separated and autonomous from the government, and defining how appointments and dismissals of regulators are to take place to minimise the possibility for pressure being applied to members. As can be seen in Figure 2, regulator independence across sectors varies substantially.

When it is appropriately designed, regulatory independence should help both improve the quality of regulation and, by holding the regulator accountable for

Figure 2. **Independence of the regulator**

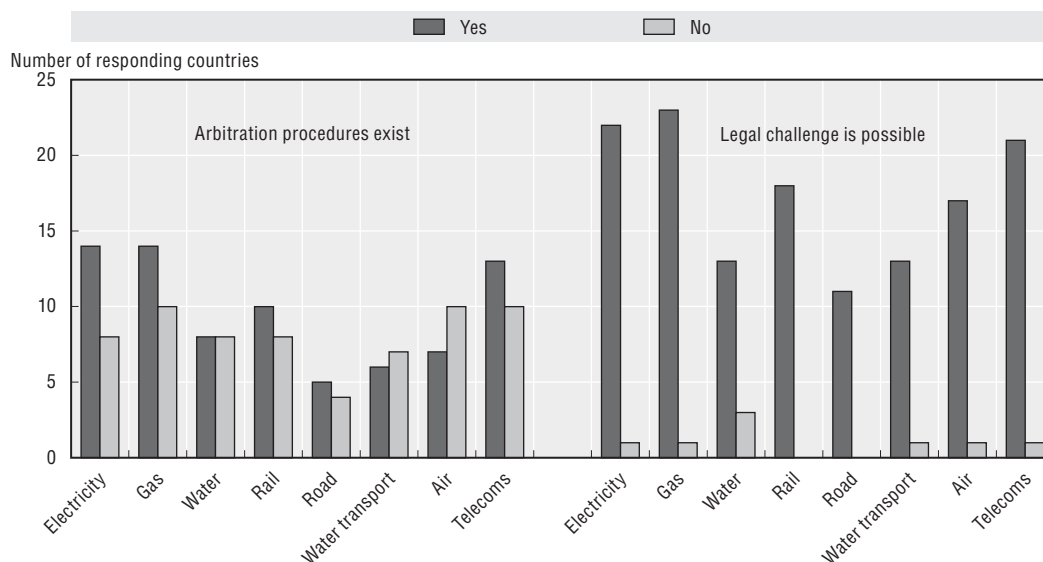
Source: Infrastructure investment and regulatory indicators questionnaires.

implementing its mandate, reduce the discretion that the regulator can exercise. In this framework, regulated firms will have greater certainty about regulatory outcomes over time (policy consistency) and may also be more willing to share information with the regulator than it would be the case with the government. Excessive use of discretionary powers by regulators can introduce uncertainty, with detrimental effects on investment incentives. Uncertainty may ultimately delay investments and skew them towards less capital intensive projects than is socially optimal (Couper et al. 2003).

Policymakers can try to overcome the potentially negative implications of regulatory uncertainty for investment in infrastructure in a number of ways. One approach is to determine the duties of the regulator in legislation, the requirements of the licence holders and procedures for dispute resolution, either through the courts or by appeal to the competition authorities. In other cases, such as the United States, well-defined administrative procedures govern how regulators act, make decision and can be challenged (Newbery, 2000). In both cases, one aspect of the mechanism to counter unexpected changes in regulation is the ability to appeal against the regulator's decisions. In Figure 3, it is apparent that legal challenge is generally more developed than arbitration procedures, although this can be more time consuming. In both cases, country responses report that these mechanisms are more prevalent in the energy and telecommunications sectors than transport and water. Another approach would be to embed regulatory reactions to changes in market conditions in a predictable framework. For example, revenue sharing rules for when firm profits rise above thresholds could mitigate the uncertainty arising due to the fear that high profits could provoke a change in the regulatory regime.

#### 1.4. Access conditions

Barriers to entry and anti-competitive behaviour by incumbents can create obstacles to efficient investment. These issues are in the purview of the competition authorities and sector regulators, which track abuses of dominance and determine access conditions and pricing to existing infrastructure, respectively.<sup>5</sup> Levelling the playing field requires, *inter*

Figure 3. **Dispute settlement with the regulator**

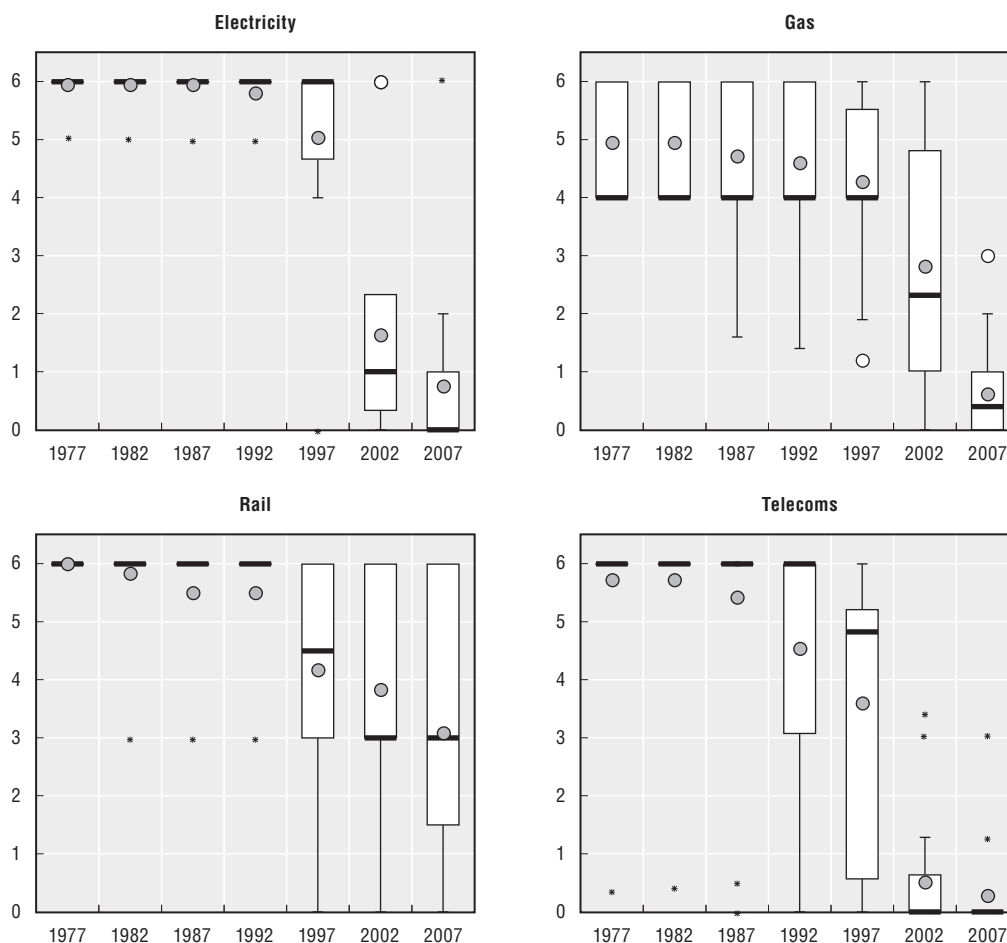
Source: Infrastructure investment questionnaire.

alia, liberalising entry through vertical separation, where appropriate, and introducing regulated third-party access. In OECD economies there has been substantial progress in implementing such policies and removing other barriers to entry (Figure 4).

- This is particularly the case in telecommunications during the 1990s, when most legal restrictions were lifted on both fixed and wholesale services. On average in 2007, the market share of new entrants in mobile telephony exceeded 50%, with only Mexico noticeably lower. For international calls, new entrants' market share was slightly less on average at around two-fifths with progress in opening up this market much slower in some countries, such as Turkey and the Slovak Republic.
- Substantial easing of entry barriers also occurred in the electricity sector, where in 2007 almost all countries had implemented regulated third-party access (TPA), with only Germany and Switzerland using negotiated TPA and Mexico without a TPA regime at all. Furthermore only a handful of countries – Japan, Korea, Mexico, Switzerland and the United States – permit vertically-integrated firms in the electricity sector. However, bottlenecks in interconnection capacity restrain new entry.
- Progress in the gas sector has been less dramatic, but barriers to entry have begun to fall. In the gas sector, both vertically-integrated firms and negotiated third-party access are more common than in the electricity sector. In many countries storage remains largely dominated by incumbents and bottlenecks in interconnection capacity restrains new entry.
- In rail, where reforms have tended to be more recent, few countries have implemented full vertical unbundling possibly recognising the severe co-ordination problems that can arise. Reforms when they have occurred have tended to be for freight rather than passenger transport. However, most countries have imposed legal or accounting separation.

Rules that determine the access conditions to the core network and its pricing have particularly important implications for infrastructure utilisation and investment. Regulated

Figure 4. **Barriers to entry**  
Scale 0-6 from lowest to highest degree of barriers to entry



Note: These plots display the box that covers the observations between the 1st and 3rd quartiles, as well as the median (the horizontal bar) and the mean (the point). The whiskers extending from the box give the range that captures the observations which lie within 1.5 times the inter-quartile range from the 1st and 3rd quartiles. Points outside this range are considered outliers, which are marked by an asterisk.

The sample coverage is the same for each period. For electricity and telecoms the countries included are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Mexico, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States. For gas and rail the country coverage is the same as for electricity and telecoms with the exception of Iceland.

Source: Regulatory indicators questionnaire.

or negotiated third-party access (TPA) regimes have been established in OECD countries, with regulated access being considered the most favourable to the development of competition in unregulated services. The effects of these regimes on infrastructure investment are intimately related to dispute resolution in the case of negotiated TPA and the terms of access conditions in the case of regulated TPA. In some cases, such regulations have been waived or adapted in energy markets where security-of-supply considerations are important.

Where facilities-based competition is viable, such as with airports and maritime ports and mobile telecommunications, ensuring a level playing field through appropriate competition policy enforcement is crucial to encouraging efficient infrastructure investment. Moreover, when the incumbent remains vertically integrated, but competition

in the unregulated sectors is possible, new entrants can face considerable difficulties with implications for investment:

- Strategic behaviour of a vertically-integrated incumbent can limit access to its regulated infrastructure for competitors in unregulated upstream or downstream markets by either foreclosing practices or insufficient expansion (or retention) of capacity.
- Even when the incumbent does not implement anti-competitive practices, new entrants wishing to invest in infrastructure may still be put at a competitive disadvantage relative to the incumbent, at least initially. This type of outcome has been a feature of telecom liberalisation where the incumbent often enjoyed economies of scale or scope.

### 1.5. Pricing regimes

The decisions of regulatory institutions concerning the desired market structure (reflecting the degree to which competition is possible), access regimes and pricing play important roles in determining infrastructure supply and use. In particular, the regulator often needs to set user costs, access prices or final prices, depending on whether the network provider is vertically integrated and competition is feasible. Under certain conditions, setting the price equal to the marginal social cost would be welfare maximising and when the networks are characterised by constant returns to scale this form of pricing would also cover investment costs. However, marginal cost pricing will not cover capital and operating costs if investment is characterised by increasing returns to scale. In this context, subsidisation or government provision may be warranted when the marginal social benefits arising from additional infrastructure outweigh the marginal social costs. Alternatively, the regulator may adopt an alternative pricing structure to cover investment costs. For example, multi-part tariffs can help preserve pricing that reflects short-run marginal costs while recouping investment costs (Gans, 2001). In other cases, so-called Ramsey pricing, which allows prices to vary in line with elasticities of demand for different services, will minimise the welfare losses arising from deviations from marginal cost pricing. Given the importance of pricing to investment decisions, the credibility and consistency of the regulatory framework are important determinants of infrastructure investment.

The regulator will need to set access prices when there is a vertically-separated firm (such as some electricity transmission grids) and also when service-based competition is feasible with the vertically-integrated firm (such as in telecommunications). In addition, when core network providers have monopoly power, the regulator will need to set the final price (such as in the water sector or operators of toll roads, bridges and tunnels) or a basket of prices (such as for rail). There are two broad approaches to pricing; either basing prices on costs (so that prices may change also to reflect the costs of investment) or using incentive-based pricing policies (where, at least for a period, prices do not vary in response to investment decisions).

Cost-based pricing – such as rate-of-return regulation – sets prices to cover production costs and allow a permissible margin, which should allow the firm to recover investment costs and can specifically relate to the return the firm is allowed to earn on its capital. In ensuring efficient investment a critical regulatory parameter is the so-called “rate base” on which the rate of return is calculated. However, measuring costs, particularly the common costs that are shared across products, is a difficult task. On the whole, the empirical evidence suggests that the outcome of cost-based regulation has tended to lead to inefficient investment and a slow rate of technological progress. Cost-based pricing provides limited incentives for the firm to

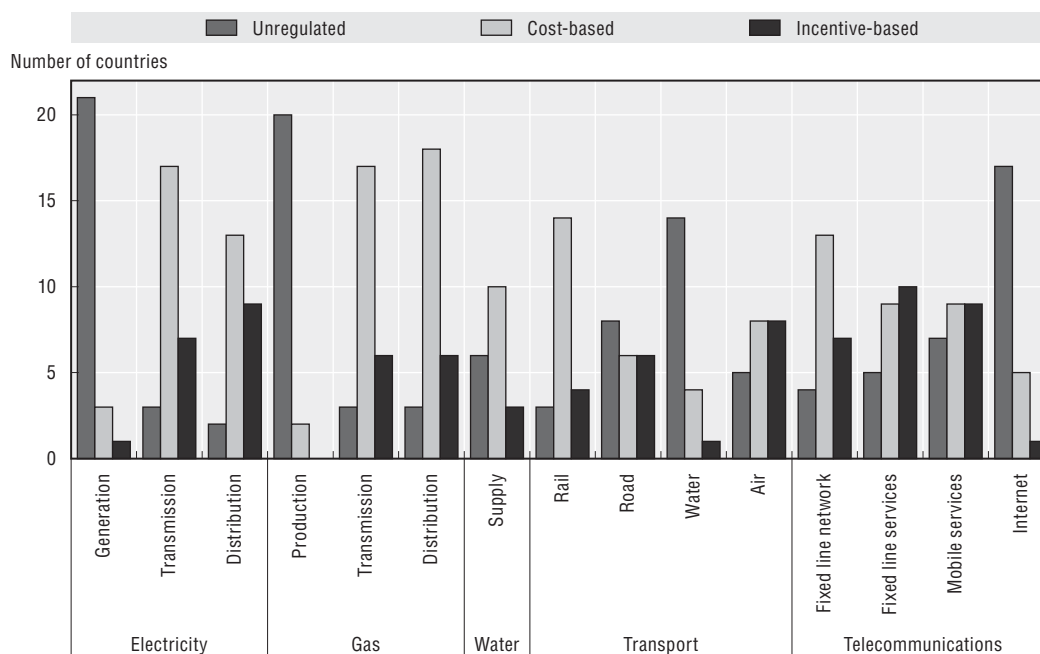
invest in cost-reducing technologies and encourages over-investment if the allowable rate of return exceeds the cost of capital (Averch and Johnson, 1962). Over-investment and the ensuing excess capacity may also be used as a strategic tool to deter potential entrants. Starkie (2006) reports evidence of this happening in the European gas industry and in the UK airport sector. Finally, firms have often continued to depend on government subsidies because of the poor incentives to eliminate inefficiencies.

Against the background of the difficulties in determining costs and the specific rate of return, incentive-based pricing regimes – such as price caps – have gained popularity and often accompanied deregulation and privatisation. In its most basic form of a price cap, prices are set with no explicit consideration of a specific rate of return. The underlying idea is to give firms “high-powered” incentives to invest in cost-saving technology and at the same time simulate competitive conditions which constrain firms’ monopoly profits in the long run. To this end, the regulator specifies a price basket that is allowed to increase in line with an exogenous measure of input costs minus a pre-determined factor reflecting expected efficiency gains, possibly allowing as well for expected increases in quality of service. Price cap reviews are made at regular intervals and, when they are not too frequent, this price regime creates incentives for firms to engage in long-term cost-reducing investment.

When prices are regulated, cost-based prices are generally predominant, particularly in the electricity and gas sectors, and to a lesser extent in fixed-line telecommunication networks and rail (Figure 5). Furthermore, in practice price reviews are held frequently in many OECD countries, both for incentive-based pricing and cost-based regimes (Figure 6). In most sectors, countries report that they normally review prices at an annual frequency. Only in the United Kingdom and Italy are prices reviewed less frequently – around 4-5 years – on a systematic basis across sectors.

Figure 5. **Pricing regimes**

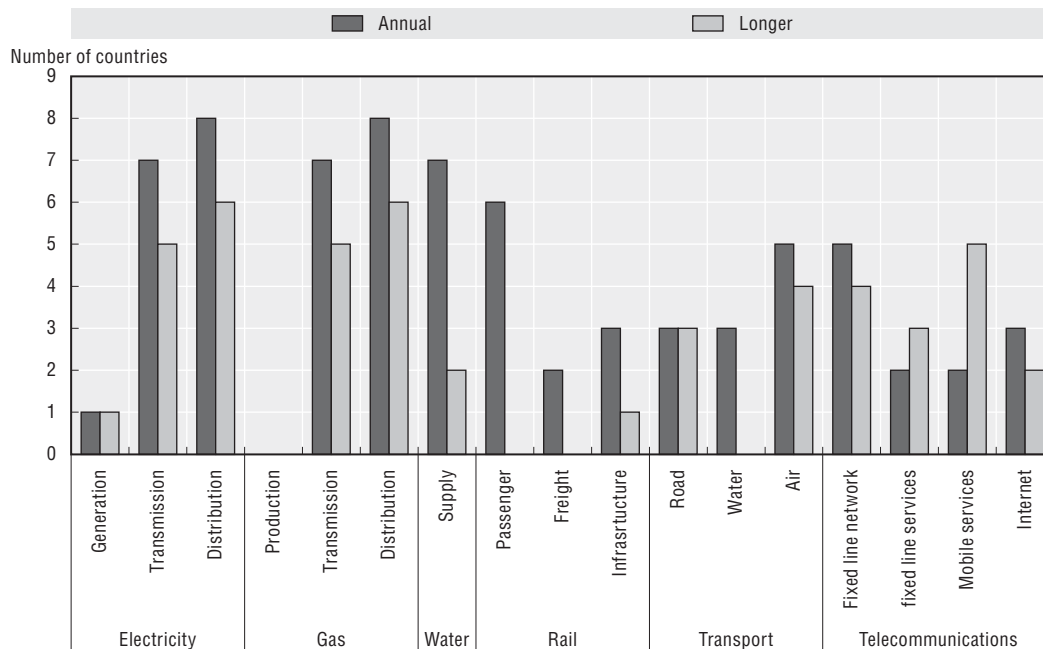
In late 2007, early 2008



Source: Infrastructure investment questionnaire.

Figure 6. **Frequency of price reviews**

In late 2007, early 2008



Source: Infrastructure investment questionnaire.

In comparison with cost-based regulation, incentive regulation shifts some risk from consumers to the shareholders and consequently raises the riskiness and the cost of capital of the regulated firm. The implications are that if the regulated firm is not allowed to earn a return on its capital that incorporates the higher risk the regulated firm faces, it may tend to under-invest relative to a cost-based regime. Alexander and Irwin (1996) show that a measure of volatility of a firm's returns is higher for firms subject to price caps and imply higher costs of capital of about 1 percentage point than a firm subjected to rate-of-return regulation. An additional problem with incentive-based pricing is that quality may be compromised. A price cap that does not account for quality changes can give incentives to reduce quality (Vogelsang, 2003). Generally, case studies suggest that incentive pricing can help the adoption of cost-saving technology. For example, a review of the effects of incentive regulation on investment reported that price-cap incentive regulation may have spurred investment in the telecommunications sector (Kridel *et al.* 1996; Guthrie, 2006). However, the overall impact on the investment rate is *a priori* uncertain.

With respect to prices set at the price reviews, the central challenge for investment is to ensure that it encourages efficient use of scarce network capacity while at the same time preserving incentives to maintain quality and expand capacity where appropriate. In practice, regulators can adopt a number of approaches to setting access prices. Setting the wrong price and access conditions can run the risk of inefficient utilisation, which in turn can generate either over or under-investment:

- Not only may excessively high access prices induce the incumbent to overspend to develop its own infrastructure, but they may also encourage new entrants to over-invest in alternative networks to bypass the existing infrastructure. While bypass is potentially a serious threat in telecommunications it is less so in other industries such as water and

sewerage and railroads where the sunk costs of duplicating the network are extremely high.

- Setting prices too low leads to underinvestment for opposite reasons and by preventing the incumbent from recovering investment costs, depresses its investment activity. Furthermore, if the access charge is determined without taking into account the option value of delaying investment by potential new entrants, the net present value of using the incumbent's network is higher than building a competing network (Crandall, Ingraham and Singer, 2004).
- Low access prices may also have spillover effects on investment in the upstream or downstream markets. For example, if the services provided by train operators depend on the quality of the railroad network, a lack of investment in the network will tend to depress train operators' investment. Strategic co-operation between the network operator and the train operators may provide a way out.

## 2. Econometric approach and results

This section first describes the econometric approach and the associated results at the sectoral level and then at the firm level (Egert, 2009; Araújo, 2011). In both cases, the data that complement the responses to the infrastructure questionnaire are also described. The sectoral level analysis concentrates on the importance of regulatory independence and the associated pricing regime, whereas the firm-level analysis looks at other aspects of the regulatory environment.

### 2.1. Sectoral level

As questionnaire responses only provide a snapshot of regulation in late 2007 and early 2008, the data on the type of regulatory and pricing regime do not have a time dimension. For this reason, only cross-sectional regressions are carried out in the analysis (with sectoral investment being the dependent variable). For the sectoral-level analysis, investment data for energy and water (electricity, gas and water), transportation (rail, road, and water and air transportation) and telecommunications were available for 13 countries (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, United Kingdom and the United States). Data were available for 1995-2006 and non-overlapping 6-year averages were computed. The investigation of investment determinants uses an investment equation with sectoral investment as a ratio to gross value added. The estimations use both country fixed effects and then industry fixed effects as well as the explanatory variables lagged one period. The structure of the estimated equation is:

$$I_t^{VA} = \beta_1 I_{t-1}^{VA} + \beta_2 OG_{t-1} + \beta_3 RIR_{t-1} + \sum_{i=1}^2 \sum_{j=1}^k \beta_{3+j} X_{j,t-i} + \sum_{l=1}^{country} \delta_l FE^C + \sum_{m=1}^I \phi_m FE^I + \varepsilon_t \quad (1)$$

where ( $I_t^{VA}$ ) is the ratio of investment to sectoral value added, (OG) the output gap to control for business cycle fluctuations, (RIR) the real interest rate to capture the impact of the cost of capital on investment and (X) variables capturing aspects of the regulatory environment, ( $FE^C$ ) and ( $FE^I$ ) denote country and industry fixed effects. The regulatory environment variables include a measure of barriers to entry and public ownership, a measure of regulatory independence and whether the sector had no price regulation as well as a variable that captured whether the sector was subject to incentive regulation. The last variable was also interacted with the regulatory independence variable to assess

whether the consistency in policy stance is important. The regulatory variables as well as the controls are lagged to address potential endogeneity arising between them and the investment ratio. An exception is the variable capturing incentive regulation because observations are only available for the most recent period.

As a robustness check of the simple OLS results, Bayesian model averaging was carried out. Bayesian averaging is a comprehensive analytical tool to check the extent to which any given explanatory variable improves the explanatory power of the estimated models when it is included. In other words, it investigates the probability with which any given variable would be included in the estimated models. This approach requires the estimation of all possible combinations of the candidate explanatory variables (of number  $K$ ) that is usually quantified as  $2^K$ .

Bayesian averaging of classical estimates (BACE) first determines the posterior probability attributed to each single model  $M_i$  that includes the given variable and conditioned on the underlying dataset  $y$  ( $P(M_i|y)$ ).

$$P(M_i|y) = \frac{P(M_i)T^{-k_i/2}SSE_i^{-T/2}}{\sum_{i=1}^{2^K} P(M_i)T^{-k_i/2}SSE_i^{-T/2}} \quad (2)$$

where  $SSE$  is the sum of squared residuals,  $T$  is the number of observations,  $k$  denotes the number of explanatory variables included in the specific model and  $K$  is the number of all explanatory variables considered. The expression above shows the extent to which any given model contributes to explaining the dependent variable as compared with the other models. These expressions are then summed up for the models that contain the variable of interest to obtain the posterior inclusion probability of this variable.

$$P(X_m|y) = \sum_{j=1}^n \frac{P(M_j)T^{-k_j/2}SSE_j^{-T/2}}{\sum_{i=1}^{2^K} P(M_i)T^{-k_i/2}SSE_i^{-T/2}} \quad (3)$$

where  $P(X_m|y)$  is the posterior inclusion probability of a given variable.  $j$  denotes the models that include variable  $X_m$  and  $n$  equals  $2k/2$ . If the posterior inclusion probability is higher than the prior inclusion probability, one can conclude that the specific variable should be included in estimated models. We estimate all possible combinations of the explanatory variables. In this case, the prior inclusion probability is 0.50.

The posterior mean conditional on inclusion ( $E(\beta|y)$ ) is the average of the individual OLS estimates weighted by  $P(M_i|y)$ . Note that the unconditional posterior mean considers all regressions, even those without the variable of interest. Hence, the unconditional posterior mean of any given variable can be derived as the product of the conditional posterior mean and the posterior inclusion probability. The posterior variance of ( $Var(\beta|y)$ ) can be calculated as follows:

$$Var(\beta|y) = \sum_{j=1}^{2^K} P(M_j|y)Var(\beta|y, M_j) + \sum_{j=1}^{2^K} P(M_j|y)(\hat{\beta}_j - E(\beta|y))^2 \quad (4)$$

The posterior mean and the square root of the variance (standard error) conditional on inclusion can be used to obtain t-statistics and to determine the significance of the individual variables upon inclusion.

Investment data are obtained from the OECD's STAN and SNA (Sectoral National Accounts) database. These two databases have two serious shortcomings. Firstly, the level of disaggregation is limited to three broad categories: first, electricity, gas and water

supply; second, transportation (road, rail, water, air and associated storage); and third, telecommunications (which also includes postal services). Secondly, the capital stock data needed to calculate the investment-to-capita stock ratio are available only for a limited number of OECD countries and are not fully comparable across countries. In principle, one could compute capital stock series using investment flows and the perpetual inventory method, but these estimates are extremely sensitive to the underlying assumptions. Given long asset lives, one often still needs an estimate of the value of the capital stock to anchor the series, which is not readily available. As a result, sectoral value added is used to construct the investment ratio at the sectoral level. Overall, the sectoral dataset covers 13 countries for the three sectors.

## 2.2. Sectoral level results

The main findings are presented in Table 1. A simple OLS regression shows that three variables are significantly correlated with investment: these are lagged investment, the measure of barriers to entry and the interaction term for regulatory independence and incentive regulation. Barriers to entry are found to influence investment negatively. The interaction term has a positive coefficient while, when taken separately, regulatory independence and incentive regulation appear to have no effect on investment. This suggests that a consistent policy mix is important in underpinning efficient investment incentives in network industries.

Using questionnaire responses, cross-country industry-level estimations looking at the effects of different types of price regulation on investment were estimated. The results suggest that incentive price regulation has a positive impact on investment in infrastructure only when it is accompanied by an independent regulator. Synergies between the regulator's independence and price regimes, for instance, could be enhanced in the electricity and (parts of) telecommunication sectors if France, Portugal, Spain and the United Kingdom moved to incentive regulation, while greater independence of the regulator in the Danish, Japanese and Norwegian telecom sectors could enhance the effects of the incentive price regulation that is in place.

As a robustness check of the simple OLS results, Bayesian model averaging was carried out. The measures of barriers to entry and the interaction term combining incentive regulation with regulatory independence consistently contribute to a better fit of the model. These results hold both when country and industry fixed effects are used. The results also reveal that the absence of price regulation is correlated with lower investment, however this result is sensitive to the inclusion of observations for the United States.

In terms of the economic significance of the results, the estimated coefficient for the interaction term suggests that reforms can have a large impact on investment. The size of the coefficient estimates for the different subsamples suggests that on average a one-step change in the interaction term (*e.g.* a change that would be slightly smaller than that of fixed-line telecommunications adopting incentive pricing when the regulator is independent) would induce an average increase of the investment ratio of 5.3 percentage points. Given that the observed investment ratios are between 18% and 74%, the impact of such a reform is potentially sizeable. Similarly, a one-step decrease in the measure of barriers to entry (which would be somewhat larger than the impact of introducing regulated third-party access) would be related to an average rise of 1.6 percentage points in the investment ratio. Given the expected influence of barriers to entry to specific sectors, these figures likely masks differences across sectors.

Table 1. **Sector-level results: Investment equations using OLS and Bayesian model averaging**  
With country and industry fixed effects

| Dependent variable: Investment                         | OLS                  | Bayesian model averaging        |                                                            |
|--------------------------------------------------------|----------------------|---------------------------------|------------------------------------------------------------|
|                                                        |                      | Posterior inclusion probability | Posterior mean and standard error conditional on inclusion |
| Lagged investment                                      | 0.865***<br>(0.161)  | <b>1</b>                        | <b>0.880</b><br>(0.166)                                    |
| Real interest rate                                     | 0.009<br>(0.006)     | <b>0.654</b>                    | <b>0.006</b><br>(0.003)                                    |
| Barriers to entry                                      | -0.046***<br>(0.164) | <b>0.998</b>                    | <b>-0.043</b><br>(0.012)                                   |
| Public ownership                                       | 0.004<br>(0.010)     | 0.151                           | 0.000<br>(0.002)                                           |
| Regulatory independence                                | -0.026<br>(0.040)    | 0.184                           | -0.004<br>(0.006)                                          |
| Incentive regulation                                   | -0.003<br>(0.019)    | 0.141                           | 0.000<br>(0.002)                                           |
| No price regulation                                    | -0.016<br>(0.010)    | <b>0.975</b>                    | <b>-0.015</b><br>(0.008)                                   |
| Independence and incentive regulation interaction term | 0.060***<br>(0.017)  | <b>0.996</b>                    | <b>0.053</b><br>(0.014)                                    |
| Adjusted R-squared                                     | 0.741                |                                 |                                                            |
| Regressions run                                        |                      | 256                             |                                                            |
| Prior Inclusion probability                            |                      | 0.5                             |                                                            |

Note: Posterior inclusion probability measures the extent to which any given model contributes to explaining the dependent variable as compared with the other models. Bold figures for the posterior inclusion probability indicate that it is higher than the prior inclusion probability of 0.5. The posterior mean conditional on inclusion is the mean of the individual OLS estimates weighted by the posterior inclusion probability of the individual models including a given variable.

\* denotes significance at the 10% level, \*\* at the 5% level and \*\*\* at the 1% level.

### 2.3. Firm level

For the firm-level analysis, in order to exploit data which varies over time, the concentration is on the importance of the independence of the sector regulator and regulatory indicators (described above). The approach adopted is to estimate the Euler equation. The estimated equation relates yearly firm investment rates (defined as investment-to-capital ratios) to one-year-lagged levels of the linear and quadratic investment rate, cash flow-to-capital ratios, and the user cost of capital. Similarly to Bond *et al.* (2003), we introduce the output-to-capital ratio term to account for either non-constant returns to scale or by monopolistic competition in the product market. The user cost of capital term in the Euler equation is replaced in the empirical specification by time effects and firm-specific effects in the estimated regression similarly to Bond *et al.* (2003). The Euler equation is then augmented to include variables that attempt to capture specific features of the regulatory environment faced by firms:

$$\left(\frac{I}{K}\right)_{icst} = \beta_1 \left(\frac{I}{K}\right)_{ics, t-1} + \beta_2 \left(\frac{I}{K}\right)_{ics, t-1}^2 + \beta_3 \left(\frac{Y}{K}\right)_{ics, t-1} + \beta_4 \left(\frac{CF}{K}\right)_{ics, t-1} + \beta_5 REG_{cs, t-1} + \gamma_{ct} + \eta_i + \varepsilon_{icst} \quad (5)$$

where  $I$  denotes gross investment,  $K$  the previous year's capital stock,  $Y$  output,  $CF$  cash-flow,  $REG$  is the set of sector specific regulatory indicators,  $\gamma$  unobserved year fixed effects and  $\eta$  firm-specific fixed effects. All variables were lagged once. The analysis does not

evaluate operating cost or service provision. The equation is estimated using the difference GMM estimator to control for biases due to unobserved firm-specific effects and endogenous explanatory variables and is appropriate for dynamic models with many cross-sections and few time periods.

To allow for firm-level analysis, a panel was constructed of companies operating in 18 OECD economies over the period 1983-2005 in the electricity, gas, rail and telecoms sectors. Firm-level variables come from the Worldscope (Thomson Financial) database. The main variables used from the Worldscope database are investment flows, capital stocks, cash flow and output. Investment flows are obtained from uses of funds accounts, which contain primary information on additions to fixed capital stocks. Output is proxied by firm sales and cash-flow by operating profits. The capital stock uses the book value of capital stock which may be flawed, but given the short history available for firms this measure is likely to be preferable to a measure derived from the perpetual inventory method.<sup>6</sup> The final dataset is obtained by merging data from the regulatory indicators with the data on firm-level investment. It results in an unbalanced panel, covering 565 firms operating in the electricity, gas, railways and telecoms sector in 28 OECD countries over the period 1980-2006. Summary statistics are presented in Table 2.

Table 2. **Firm-level summary statistics**

| Variable                    | N     | min    | p25  | p50  | mean | p75  | p90  | max    | sd   |
|-----------------------------|-------|--------|------|------|------|------|------|--------|------|
| <b>ELECTRICITY</b>          |       |        |      |      |      |      |      |        |      |
| Investment-to-capital ratio | 2 054 | 0      | 0.03 | 0.05 | 0.08 | 0.08 | 0.12 | 3.8    | 0.15 |
| Output-to-capital ratio     | 2 054 | 0      | 0.24 | 0.33 | 0.6  | 0.48 | 0.77 | 144.9  | 4.17 |
| Cashflow-to-capital ratio   | 1 557 | -23.97 | 0.05 | 0.09 | 0.08 | 0.14 | 0.21 | 15.09  | 0.89 |
| IRA                         | 2 160 | 0      | 0    | 0    | 0.32 | 1    | 1    | 1      | 0.47 |
| BE                          | 2 160 | 0      | 1    | 5    | 3.98 | 6    | 6    | 6      | 2.35 |
| PO                          | 2 160 | 0      | 1.5  | 1.5  | 2.6  | 4.5  | 6    | 6      | 1.81 |
| VI                          | 2 160 | 0      | 4.5  | 4.5  | 4.59 | 6    | 6    | 6      | 1.82 |
| <b>GAS</b>                  |       |        |      |      |      |      |      |        |      |
| Investment-to-capital ratio | 1 510 | 0      | 0.05 | 0.08 | 0.11 | 0.11 | 0.19 | 3.24   | 0.15 |
| Output-to-capital ratio     | 1 509 | 0      | 0.35 | 0.56 | 0.71 | 0.84 | 1.25 | 17.81  | 0.84 |
| Cashflow-to-capital ratio   | 1 178 | -0.28  | 0.09 | 0.14 | 0.16 | 0.21 | 0.28 | 1.33   | 0.11 |
| IRA                         | 1 550 | 0      | 0    | 0    | 0.36 | 1    | 1    | 1      | 0.48 |
| BE                          | 1 550 | 0      | 1.4  | 2    | 2.44 | 4    | 5    | 6      | 1.49 |
| PO                          | 1 550 | 0      | 0    | 0    | 0.43 | 0    | 2    | 6      | 1.26 |
| VI                          | 1 550 | 0      | 0    | 2.4  | 2.13 | 3.3  | 6    | 6      | 2.28 |
| <b>TELECOMS</b>             |       |        |      |      |      |      |      |        |      |
| Investment-to-capital ratio | 1 350 | 0      | 0.07 | 0.11 | 0.19 | 0.18 | 0.37 | 11.61  | 0.42 |
| Output-to-capital ratio     | 1 350 | 0.02   | 0.37 | 0.5  | 1.76 | 0.95 | 2.73 | 203.84 | 7.78 |
| Cashflow-to-capital ratio   | 1 204 | -10.55 | 0.09 | 0.19 | 0.56 | 0.37 | 0.84 | 37.09  | 2.25 |
| IRA                         | 1 375 | 0      | 0    | 0    | 0.33 | 1    | 1    | 1      | 0.47 |
| BE                          | 1 375 | 0      | 0    | 0    | 0.8  | 0.34 | 3.75 | 6      | 1.76 |
| PO                          | 1 375 | 0      | 0    | 0    | 1.1  | 2.57 | 3.72 | 6      | 1.77 |

## 2.4. Firm-level results

The results from the first-difference GMM estimations reveal that barriers to entry have a negative effect on investment when all the sectors are pooled (Table 3), consistent with the sector-level analysis and also found by Alesina *et al.* (2005). There is no evidence of other regulatory framework affecting investment rates in the firm-level pooled-sector regressions. The sector-specific regressions show a different picture: legal barriers to entry

act as a deterrent of investment in the electricity sector. In the gas sector, higher levels of public ownership seem to be associated with higher investment rates. The coefficient on the level of public ownership is significant at the 10% level when all the instruments available are used but restricting the number of instruments renders the coefficient insignificant. In telecommunications, the existence of an independent regulator has a positive effect on investment: the coefficient is stable and always significant at the 1% level throughout the regressions making use of different sets of instruments.

**Table 3. Firm-level results: Euler equations using first difference GMM**

| Dependent variable: Investment-to-capital ratio | Whole sample        | Electricity        | Gas                  | Telecoms            |
|-------------------------------------------------|---------------------|--------------------|----------------------|---------------------|
| Investment-to-capital ratio (t-1)               | 0.816***<br>(0.164) | 1.383**<br>(0.579) | 1.242***<br>(0.249)  | 0.263***<br>(0.100) |
| Squared investment-to-capital ratio (t-1)       | -0.311**<br>(0.144) | -0.887*<br>(0.468) | -0.499***<br>(0.161) | -0.022<br>(0.041)   |
| Output-to-capital ratio (t-1)                   | 0.033**<br>(0.016)  | 0.062<br>(0.045)   | 0.015<br>(0.010)     | 0.008**<br>(0.003)* |
| Cashflow-to-capital ratio (t-1)                 | -0.036<br>(0.088)   | -0.284<br>(0.282)  | 0.188<br>(0.259)     | 0.034<br>(0.021)    |
| Barriers to entry (t-1)                         | -0.005**<br>(0.002) | -0.007*<br>(0.004) | -0.002<br>(0.004)    | 0.001<br>(0.008)    |
| Public ownership (t-1)                          | -0.001<br>(0.006)   | -0.007<br>(0.010)  | 0.007*<br>(0.004)    | 0.004<br>(0.008)    |
| Vertical integration (t-1)                      | 0.001<br>(0.003)    | 0.004<br>(0.006)   | 0.001<br>(0.003)     |                     |
| Independent regulator (t-1)                     | -0.008<br>(0.009)   | -0.013<br>(0.015)  | -0.001<br>(0.014)    | 0.07***<br>(0.026)  |
| Observations                                    | 2 274               | 1 210              | 926                  | 847                 |
| Number of firms                                 | 323                 | 173                | 134                  | 160                 |
| Arellano-Bond test for AR(1) (p-value)          | 0.073               | 0.024              | 0.105                | 0.016               |
| Arellano-Bond test for AR(2) (p-value)          | 0.483               | 0.300              | 0.340                | 0.311               |
| Hansen test for overidentifying restrictions    | 0.663               | 0.472              | 0.187                | 0.549               |

Note: All regressions include year-fixed effects. Standard errors in parentheses are robust to heteroskedasticity and within serial correlation.

\* denotes significance at the 10% level, \*\* at the 5% level and \*\*\* at the 1% level.

The results from the firm-level analysis reveal differences in the importance of regulatory variables across the sectors that are masked when the sectors are pooled. To some extent this may reflect differences in samples, but is also likely to reflect the interaction of different market structures with regulation. For example, the telecommunication sector has undergone the largest switch to private ownership and the regulatory environment has moved furthest towards an incentive regulation framework. In this context and consistent with the sectoral results, the independence of the regulator becomes an important factor in reducing uncertainty for potential investors. The differences between the energy sectors may arise due to the greater difficulties in introducing competition in the gas market, where many countries are typically dependent on imported supplies (Newbery, 2000). In the electricity sector, on the other hand, competition can be introduced relatively easily in generation, which may account for the importance of barriers to entry in this sector.

### 3. Conclusions

The private sector has become increasingly involved in the provision of infrastructure across the OECD. This development has been accompanied by the development of new regulatory and policy environments. Past experience has shown that exclusive public sector ownership and provision can lead to inefficient investment decisions while rate of return regulation could induce firms to overinvest. Against this backdrop, harnessing greater private sector involvement in the provision of infrastructure could be feared to lead to a drop in investment, albeit more investment would be better targeted. However, changes in pricing mechanisms could encourage more investment (especially when sectors are particularly inefficient) and the move towards independent regulators could reduce uncertainty stemming from regulatory risk. In this light, the overall effect on investment is ambiguous.

The findings presented in this article suggest that greater private sector participation in the provision of infrastructure when accompanied by a supporting regulatory environment can boost investment. A number of policies appear to be more conducive to investment, though this can depend on the characteristics of the particular sector. Overall, a competitive environment appears generally supportive of more efficient use of resources. For example, there is evidence that removing barriers to entry – such as requiring vertical unbundling and establishing regulated third-party access regimes – can foster higher rates of investment in the network industries. Such barriers appear to be harmful for investment, especially in the electricity sector. Incentive regulation, such as setting price caps for infrastructure services, can help ensure that investment is cost reducing and mimics a competitive environment. Independence and accountability of the sectoral regulators can help establish a stable and credible framework for investment. Empirically, the evidence presented in this article suggests that price-cap regulation when combined with regulatory independence boosts investment. The importance of an independent regulator is particularly apparent in telecommunications. Policy settings vary considerably across OECD countries, suggesting in some cases scope to improve policy by drawing on the experience of others. The results also suggest that policy interactions are important and as more time series information becomes available further investigation of this aspect of the regulatory regime would be warranted.

#### Notes

1. Other factors influencing investment decisions are described in the appendix.
2. A copy of the questionnaire and a table giving the responses can be found by clicking on the links in the text.
3. The non-respondents were Greece, Iceland, Luxembourg, Sweden and Poland.
4. There are also organisational forms where the network is separated into reciprocal or smaller parts, which can be introduced with cellular telephony. While this choice can have implications for competition, the direct influence on investment is less clear cut.
5. There are a number of options available to the regulators to restrain *ex ante* such incumbents from abusing their monopoly power on the wholesale market. These include setting quality standards and introducing rewards and penalties or implementing parity standards.
6. Firms needed to have at least 80% of their revenues coming from a single sector. Firms with unusually high investment rates were also dropped from the dataset.

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## APPENDIX I

### *Factors influencing investment in infrastructure*

Addressing market failure has been a major motive for public intervention in infrastructural sectors. Governments have intervened to prevent the under-provision or non-provision of infrastructure, when externalities or public-good features are predominant or to limit the exercise of market power to the extent to which a natural monopoly is present. The resulting decisions about ownership and regulation are important factors affecting the supply and demand of infrastructure (these are summarised in the Appendix Figure).

The structure of infrastructure supply depends on the nature of the market failure. Where supply entails a natural monopoly, the private sector will usually be willing to provide the service, though normally at a level that is below, and a price that is above, the social optimum. This will often result in some type of arm's length regulation. Investment will depend on standard investment determinants, such as the cost of capital, but due to the often extremely large fixed costs and the irreversibility of investment decisions, investment decisions are also particularly sensitive to the regulatory environment.

When the government is involved in infrastructure provision, investment decision-making should use the standard criterion of setting the level of provision that equates the marginal social benefit to the marginal social cost, which is related to the marginal costs of public funds and production costs. However, due to the characteristics of networks, the marginal benefits of additional investments are often low and declining, but not always, particularly in well-developed networks.

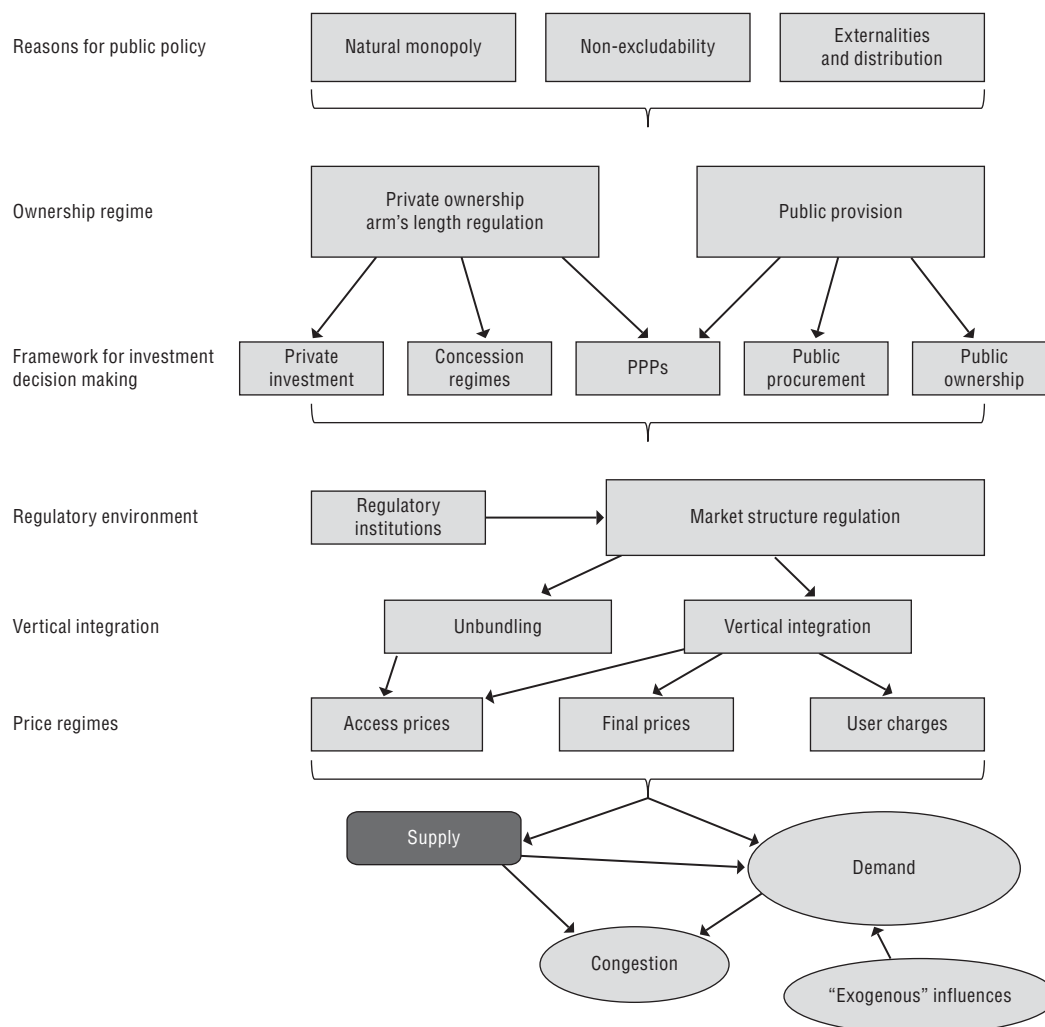
There are a number of different delivery modes involving the public or private sector to a greater or lesser extent. These include public ownership and procurement, which has often characterised the water supply and road networks; concessions and public private partnerships, which are increasingly involving the private sector in the delivery of infrastructure; and fully privately-owned companies, which has often been the case in the energy sector.

The decisions of regulatory institutions concerning the desired market structure (reflecting the degree to which competition is possible), access regimes and pricing play important roles in determining infrastructure supply and use. In particular, the regulator often needs to set user costs, access prices or final prices, depending on whether the network provider is vertically integrated and competition is feasible. Under certain conditions, setting the price equal to the marginal social cost would be welfare maximising and when the networks are characterised by constant returns to scale this form of pricing would also cover investment costs. Alternatively, the regulator may adopt a different

pricing structure to cover investment costs. Given the importance of pricing to investment decisions, the credibility and consistency of the regulatory framework are important determinants of infrastructure investment.

Infrastructure in the network sectors is also often a congestible public good with congestion-raising production costs and reducing individuals' utility. When pricing is introduced, the optimal toll – determined by the difference between the marginal social cost (reflecting congestion costs and wear and tear of the infrastructure) and private costs – will reduce demand and, by enhancing the efficient use of existing infrastructure, will damp the need for investment in additional capacity. Efficient investment decisions would then equate marginal costs to the marginal benefits of infrastructure capacity and quality, which the revenues from the congestion toll would indicate when additional investment is warranted.

Appendix Figure. **Factors influencing investment in infrastructure**





# Residential Mobility and Public Policy in OECD Countries

by

Aida Caldera Sánchez and Dan Andrews\*

*Residential mobility is closely tied to the functioning of housing markets and has important implications for labour mobility and the efficient allocation of resources across the economy. This paper analyses patterns of residential mobility across OECD countries and the role of housing policies in enhancing or hampering residential mobility. Based on cross-sectional household data for 25 countries, the results suggest that differences in residential mobility across countries are partially related to differences in public policies. After controlling for household and country-specific characteristics, residential mobility is higher in countries with lower transaction costs, more responsive housing supply, lower rent controls and tenant protection. Residential mobility tends also to be higher in environments with greater access to credit, suggesting that financial deregulation – by lowering borrowing costs and facilitating access to mortgage finance – facilitates mobility. This cross-country evidence is supported by city and state-level evidence for the United States.*

*JEL classification: R23, R31, R21, R38, H20.*

*Keywords: Housing markets, residential mobility, transaction costs, rental market regulations*

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This paper analyses patterns of residential mobility across OECD countries and the role of housing policies in enhancing or hampering residential mobility. Residential mobility is closely tied to the functioning of housing markets and has important implications for labour mobility and the efficient allocation of resources across the economy. When institutional constraints or other barriers impede residential mobility, the allocating role of housing markets is disrupted. Countries with low rates of residential mobility may suffer from higher housing-price volatility (Englund and Ioannides, 1993) if, due to high transaction costs, households cannot immediately react to price changes by changing their residence. Low rates of residential mobility can be an obstacle to labour adjustment, making labour markets less efficient and, therefore, can adversely affect overall economic performance (Hardman and Ioannides, 1999; Oswald, 1996). A low degree of residential mobility also has other economic costs since it reduces the speed of an economy's adjustment to shocks (Blanchard and Katz, 1992). On the other hand, excessive residential mobility may have adverse implications for social stability by depreciating local social capital, such as for instance relationships and social networks (David *et al.* 2011) or for the educational performance of children if forced to change schools too often (Ersing *et al.*, 2009).

Nearly all governments intervene in housing markets, primarily for social and redistribution reasons (Andrews *et al.* 2011). Policy interventions include fiscal measures such as taxes and direct provision of social housing, as well as various regulations aimed at influencing housing market outcomes in terms of prices, rents, quantity, quality and allocation of dwellings. Despite housing policy interventions being widespread in most OECD countries, little cross-country, comparable information exists measuring the extent of such policies. This paper exploits newly-constructed, cross-country comparable indicators on key structural features of OECD housing markets, including transaction costs, rental regulations, tenant protection arrangements and the responsiveness of housing supply, to investigate to what extent such features affect residential mobility across OECD countries.<sup>1</sup>

Results suggest that residential mobility tends to be relatively high in the Nordic countries, Australia and the United States, while it is much lower in eastern and southern European countries. These differences in residential mobility across countries are associated with differences in government intervention. After controlling for household and country-specific characteristics, residential mobility is higher in countries with lower transaction costs in buying and selling a property, particularly for younger households. It is also higher in countries with a more responsive housing supply. Higher rent controls and greater security of tenure are associated with lower residential mobility. This suggests that loosening rental market regulations may increase residential mobility, particularly in countries where rent controls are high and cover a large segment of the rental market, such as the Netherlands and Sweden. A transition towards a system that strikes a balance between tenants' and landlords' bargaining power and regularly updates rents in line with market developments is likely to encourage mobility.

Residential mobility is also higher in countries with greater access to credit. Evidence suggests that higher volumes of private credit to GDP in the economy and lower down-payment constraints are associated with higher residential mobility. This implies that financial deregulation can ease credit constraints by lowering borrowing costs and promoting access to housing finance to a wider set of the population, thereby increasing residential mobility. The evidence further suggests that younger households benefit more from greater access to credit in terms of mobility. City-level evidence for the United States complements the cross-country findings suggesting that mobility is higher in cities with less restrictive land-use regulation and rent controls and where there is more competition in banking and, thus, possibly greater access to credit. The recent experience in the United States, however, highlights the potential risks that very high leverage poses to mobility. To the extent that the city-level approach is not affected by unobserved cross-country differences which may be correlated with both mobility patterns and housing policies and it controls for regional differences using region fixed effects, it further strengthens the conclusions drawn from the cross-country analysis.

The remainder of the article is organised as follows. Section 1 presents a conceptual framework for understanding which factors weigh on households' residential mobility decisions, while Section 2 presents the empirical framework that will be used in the analysis. Section 3 describes the data used in the empirical analysis, paying particular attention to the description of the novel indicators measuring structural features of housing markets in the OECD. Finally, Sections 4 and 5 present the empirical results and assess the improvements in residential mobility associated with different policy reforms.

## 1. A framework for understanding the factors influencing residential mobility

There is a combination of microeconomic and macroeconomic reasons why people move that vary depending on the time period and household characteristics. Household attributes, households' course of life and job career patterns determine the propensity to move and the choice of dwelling (Dieleman, 2001). In addition, household mobility is strongly related to housing-market conditions and economic circumstances at the local and national level.

Economic theory predicts that the decision to move will depend on the fixed costs of moving, compared with the net present value of the gains in the alternative location (e.g. Sjaastad, 1962; Mincer, 1978; Bartel, 1979). Following Bartel (1979), in a discrete choice model, the household decision to move is determined by the discounted net return from moving at time  $t$ . If this return is positive, then the household will move:

$$Pr_t = f(G_t) \quad (1)$$

where  $Pr_t$  is the probability that the individual moves at time  $t$  and  $G_t$  are the discounted net returns from moving:

$$G_t = Y_t^* - Y_t - C_t \quad (2)$$

with  $Y_t^*$  the present value of the expected real income stream if the individual moves at  $t$ ,  $Y_t$  is the present value of the expected real income stream in the current location at time  $t$ , and  $C_t$  are the costs of moving. The costs of moving can be thought of being composed of pecuniary and non-pecuniary costs (Sjaastad, 1962). Pecuniary costs include the out-of-pocket expenditure involved in moving, such as searching for a new dwelling and a job in the new location and the transaction costs involved in the process of moving. Non-pecuniary costs include foregone earnings and the costs of changing one's environment,

such as the costs of uprooting school-age children or of giving up the returns on location-specific investments. If  $G_t > 0$ , the individual will migrate.

Mobility studies condition the decision to move on a household's characteristics influencing the gains/costs of moving. The decision to move has been shown to be closely tied to events in a person's life, such as family formation, dissolution and, in particular, job changes (*e.g.* Dieleman, 2001). Earlier research has shown that changing jobs over a long distance naturally requires a residential move (*e.g.* Clark and Withers, 1999) and that the decision to change jobs is closely tied to moving decisions (*e.g.* Bartel, 1979). In this sense, household characteristics influencing potential earnings in a different location, such as education, influence the (discounted net) returns from moving ( $G_t$ ). For instance, education is likely to have a positive effect on the probability of moving since more highly-educated individuals tend to have better information about non-local job opportunities and, thus, may be more adaptable to change (Bartel, 1979).

Other household characteristics, such as family size, marital status and age, also influence the decision to move. For example, households with more than one member in the labour force should have higher costs of moving than independent households comprising a single person (*e.g.* Bartel, 1979; Mincer, 1978). Similarly, households with school-age children should have lower net returns from migration because of the costs of uprooting school-age children. In the same vein, younger households are most likely to move because they have fewer location-specific investments that tie them down to a location and have longer time horizons in which to amortise the costs of moving; therefore, relatively small gains in earnings may make them move.

Major elements of the housing bundle, such as its price, type of tenure or location, are also critical to the mobility decision (*e.g.* Dieleman, 2001). House prices and rents, as long as they affect the cost of living, will influence the household's decision to move. Homeowners tend to have longer residential spells than renters and much lower mobility rates (*e.g.* Tatsimaras, 2009). One explanation is that homeowners face higher search and transaction costs. This means that they will tend to spend relatively longer spells in their residence to spread such costs over a longer time period (*e.g.* Coulson and Fisher, 2009). The distance from work of the dwelling place or the quality of services close to the dwelling may further influence mobility decisions. For instance, parents may move to live closer to a good school (Fack and Green, 2010).

The matching of households and dwellings is not only determined by households' attributes or the bundle of housing services that each dwelling represents. Household reallocation is also strongly linked to housing-market developments and influenced therefore by government policies that shape housing market outcomes. Housing policy interventions, such as taxation, can influence directly the opportunity costs of moving. For instance, stamp duties and registration taxes are typical transaction costs in buying and selling a property, together with real estate agent fees and legal fees, which are also influenced by government regulations, and can thus weigh on mobility rates. Many countries tax favourably owner occupancy relative to renting or buy-to-let, influencing the opportunity cost of housing investment. This favourable treatment of owner occupation may reduce residential mobility by tilting housing consumption towards owner occupancy away from renting and reducing turnover in the rental market. Many countries also have a range of controls and regulations in rental markets to address potential market failures, such as asymmetry of information between landlords and tenants. Rental regulations

include rent controls, rules concerning the duration and termination of contracts and the reasons to evict a tenant. Although these regulations are typically a good policy option to address market failures and provide security of tenure, too strict regulations can decrease residential mobility if, for instance, regulated rents are much lower than market rents or tenants are overprotected.

## 2. Empirical approach

In order to assess the role of housing policy settings in explaining cross-country differences in residential mobility the following model of the household decision to move is estimated:

$$\text{Pr}_{ic} = \Phi(\alpha + H_{ic}\phi + \beta P_c + C_c\Gamma + e_{ic}) \quad (3)$$

where  $\Phi$  is the normal distribution and  $\text{Pr}_{ic}$  is the probability to change residence for household head  $i$  in country  $c$ .

$H_{ic}$  is a vector of household characteristics which are likely to influence the household decision to move as discussed in Section 1. These include tenure status (categorical variable measuring if the head of household is an owner or a tenant in the private sector or a social/subsidised tenant); age (1 if the head of the household is older than 44 years and 0 otherwise); education (categorical variable measuring if the head of household has low, middle, or high levels of education); employment status (1 if unemployed and 0 if employed); marital status (1 if the head of household is married, 0 otherwise); household income and its square control for non-linear effects.

$P_c$  denotes country-specific housing policies or policy-related factors that may influence the decision to move. These include housing market policies that influence the amount of transaction costs in moving, rental regulations capping rents, and rental rules determining the degree of tenant protection. An additional important factor considered is the responsiveness of housing supply to price signals, which is partially policy-driven by land use and planning regulations (Caldera Sánchez and Johansson, 2011). In addition, the effect of broader policies influencing housing affordability, such as access to credit and unemployment benefits is also assessed. Vector  $C_c$  further controls for other factors that may influence residential mobility, including aggregate household income, which is meant to capture the overall development of a country, and the degree of urbanisation in the region where the household lives (NUTS 1 or 2 depending on the available data), which is meant to capture differences in local housing markets. Evidence by Van der Vlist *et al.* (2003) suggests this is a good proxy for local housing market conditions in the case of the Netherlands, and the degree of urbanisation can also pick up geographic differences between regions, such as for instance differences in building costs between mountains and plains. Finally,  $e$  is an error term capturing shocks affecting the household decision to move.

A number of potential sources of bias should be mentioned. First, despite the wide set of covariates included in the estimation equation, the results in Table 1 may fail to account for unobserved household characteristics that may influence the decision to move. For instance, households' unobserved characteristics could be correlated with households' observed characteristics included in the vector  $H_{ic}$  leading to spurious correlation and biased estimates. A possible solution for this problem would be to include household fixed effects in the model to control for household invariant unobserved characteristics. However, given the lack of time series data, this approach is not possible. Secondly,

selection bias may be of some concern in the estimation of equation (3) if, for instance, unobserved factors affecting tenure choice are correlated with unobserved factors affecting the probability of moving, so there is a non-random sample of movers. To account for this selection bias, a solution would be to estimate a Heckman selection model, which would involve estimating the probability of moving conditional on tenure choice. However, obtaining credible estimates would require an exclusion restriction: there must be at least one variable that appears in the selection equation and not in the equation of interest. Unfortunately, such variable, that would influence the tenure decision but not the decision to move, is not easy to find based on economic theory.<sup>2</sup>

The estimation of equation (3) treats policies as exogenous factors influencing mobility abstracting from some possible endogeneity concerns. However, institutions cannot be taken as exogenous. For instance, low residential mobility may prompt governments to design policies to address it. Or citizens may vote for governments that implement policies discouraging mobility in order to satisfy their preferences. However, the lack of plausible instruments and time series data on some of the policies make it difficult to control for omitted variables that may influence both residential mobility and policies and could potentially lead to a spurious relationship between policies and residential mobility. A possible solution would be to use country-fixed effects to wash out time-invariant, country-specific factors. The drawback from that approach is that in the cross-section approach used here the effect of the policy variables of interest,  $P$ , would no longer be identified. Given this, the robustness of the policy conclusions drawn from the cross-country analysis are tested within the single-country context, by using household data for the United States to model residential mobility and exploiting regional variation in policies.

### 3. Data

Two types of data are employed to estimate equation (3). First, household survey data from each OECD country for which such data are available. The advantage of these household surveys is that they are based on representative random samplings of the countries' populations and include information on residential moves, i.e. change of dwellings, as well as on household socio-economic characteristics. And second, data on policies mainly drawn from OECD cross-country comparable indicators on housing policies, completed with other publicly-available data.

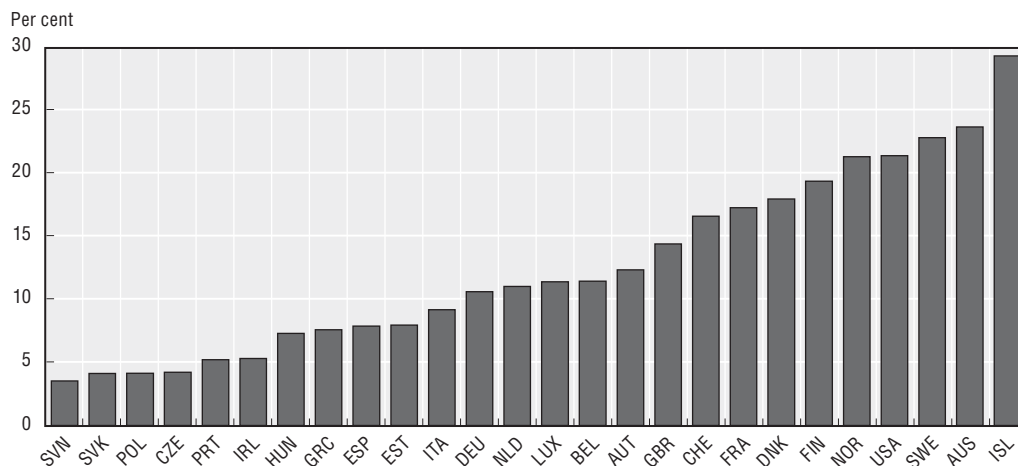
#### 3.1. Household data

Household data for 25 OECD countries were collected from different sources. Data for 22 European countries come from the European Union Statistics on Income and Living Conditions (EU-SILC) household database.<sup>3</sup> The analysis focuses on the 2007 cross-section because only that year contains a specific module on household housing conditions, including information on change of dwelling and the reasons for moving. These data are complemented with 2007 household data for Australia, Switzerland and the United States from different sources. The Australian data come from the Household, Income and Labour Dynamics in Australia (HILDA) survey, a household panel survey collecting information about economic and subjective wellbeing, labour market dynamics and family dynamics of Australian households. The American data are collected from the American Housing Survey (AHS), which contains data on US housing and household characteristics, as well as recent movers. And the Swiss data come from the Swiss Household Panel (SHP). The

sample used in the analysis covers individuals aged 24 to 66 in order to exclude atypical moving choices and excludes those for whom accommodation is provided free of cost to avoid the empirical results being influenced by atypical tenure status.<sup>4</sup>

As shown by Figure 1 residential mobility varies widely across countries. Mobility is highest in the Nordic countries (e.g. 29% in Iceland, 23% in Sweden or 21% in Norway), Australia (24%) and the United States (21%). By contrast, mobility is low in eastern European countries (e.g. 4% in Slovenia, the Slovak Republic, Poland, 5% in the Czech Republic and Portugal) and southern European countries (8% in Greece and Spain, and 9% in Italy). Looking at the breakdown of residential mobility by reasons for moving (Figure 2) in most countries the majority of moves are driven by housing-related reasons (37% on average) or family-related reasons (32% on average). Employment-related reasons account for a much smaller share (9.5% on average). As expected, the proportion of moves due to job-related reasons is greater in large countries such as the United States, Australia, Italy or the United Kingdom, while tending to be lesser in smaller countries like the Netherlands, Switzerland and Belgium. In small countries, commuting may be a preferred option when changing jobs than residential reallocation, which is relatively more costly.

**Figure 1. Residential mobility in OECD countries<sup>1</sup>**  
Percentage of households that changed residence within the last 2 years



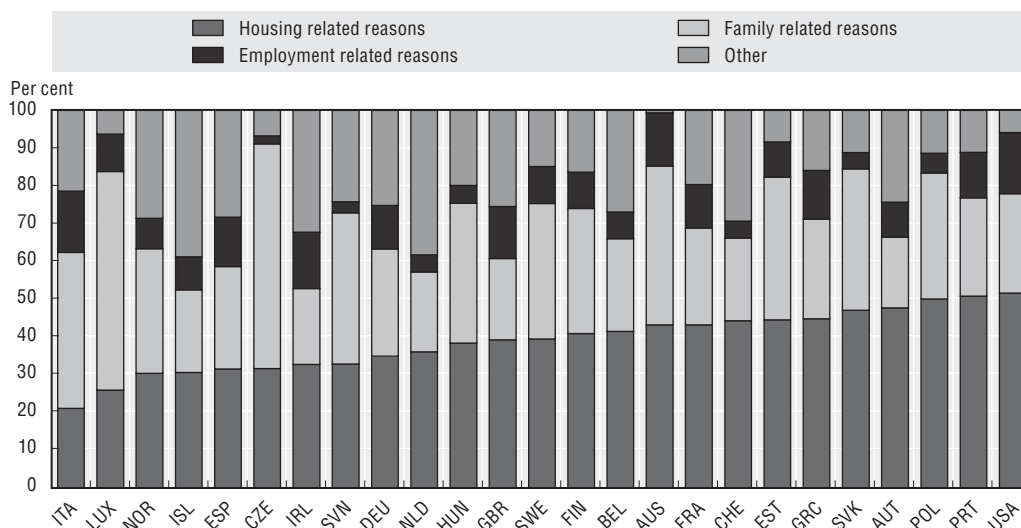
1. The low mobility rate in some eastern European countries (e.g. 4% in Slovenia implying a move every 50 years) does not seem reasonable and may reflect problems with the underlying data. However, this is difficult to verify as there is no alternative data source.

Source: OECD calculations based on 2007 EU-SILC Database, on HILDA for Australia, AHS for the United States, SHP for Switzerland.

### 3.2. Policy indicators

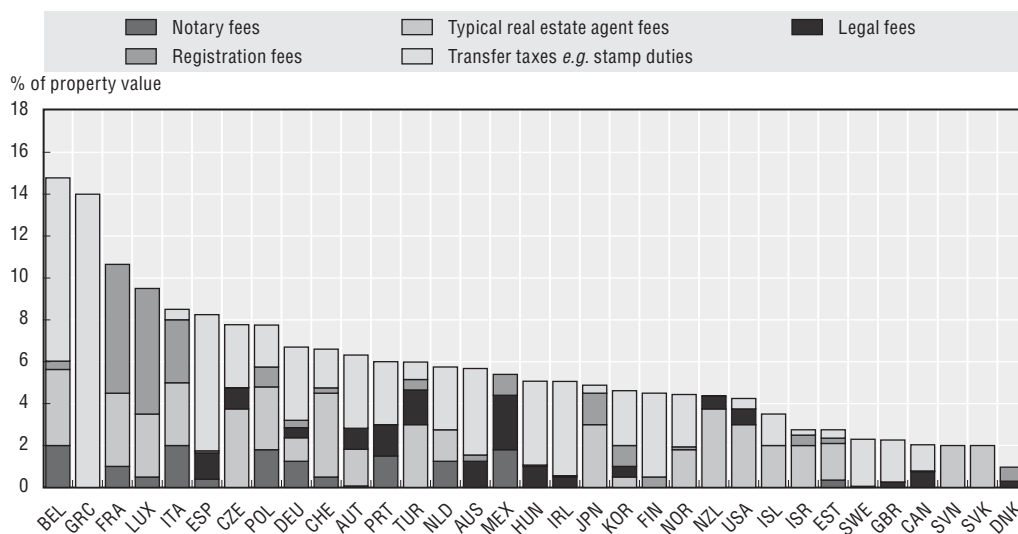
The household data are complemented with comparable cross-country indicators in three key housing policy areas: transaction costs, rental regulations and tenant protection arrangements in the private rental sector. These indicators are based on information provided to the OECD by its member countries through the OECD Housing Market Questionnaire at the end of 2009 and beginning of 2010. The construction of the indicators is described in detail by Johansson (2011).

The transaction costs indicator covers a number of different types of monetary costs and fees incurred when buying and selling a property. These include transfer taxes, such

Figure 2. **Breakdown of residential mobility rates by reasons to move**

Source: OECD calculations based on 2007 EU-SILC Database, on HILDA for Australia, AHS and Rupert and Wasmer (2009) for the United States, SHP for Switzerland.

as stamp duties, registration fees incurred when registering the property in the land registry, notarial or other legal fees and typical real estate agency fees. The bulk of these costs falls, in general, on the buyer, and differs considerably across countries (Figure 3). Transaction costs are particularly large in some continental (Belgium and France) and southern European countries (Greece and Spain), while tend to be lower in Nordic countries (Denmark and Sweden) and the United Kingdom. Transfer taxes and registration fees account for, on average, approximately half of overall costs.

Figure 3. **Transaction costs on buyer by type, 2009<sup>1</sup>**

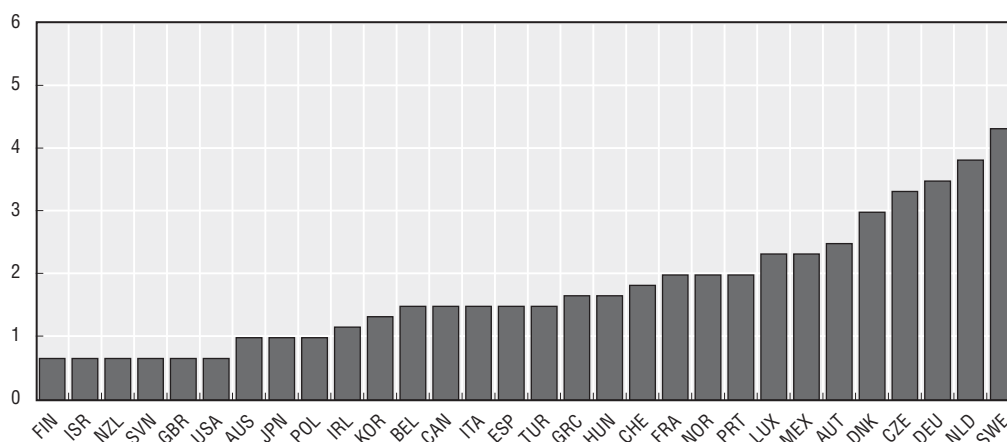
1. Transaction costs refer to average costs. See Johansson (2011) for details.

Source: Calculations based on the OECD Housing Market questionnaire.

The rent regulation indicator measures the importance of rent controls in the private rental market. These cover two broad areas. Regulations setting limits on rents, such as whether initial rent levels can be freely negotiated between the landlord and the tenant, or the coverage of rent controls on rent levels, for instance in terms of percentage of the rental market covered. And, second, regulations on rent increases, which take into account, for instance, if rent increases within a tenancy contract can be freely agreed upon or not, and if rent increases are regularly indexed to some cost/price index or determined through some other administrative procedure. It also includes information on whether landlords are allowed to pass on increases in costs onto rents and the types of cost that can be passed on. Rent regulations appear to be comparatively strict in countries with a relatively large rental sector (*e.g.* Sweden, the Netherlands, Germany and the Czech Republic). On the other hand, these are lax in New Zealand, Finland, Slovenia, the United Kingdom and the United States (Figure 4).

Figure 4. **Rent control in the private rental market, 2009<sup>1</sup>**

Scale 0-6: Increasing in degree of control



1. This indicator is a composite indicator of the extent of controls of rents, how increases in rents are determined and the permitted cost pass-through onto rents in each country. See Johansson (2011) for details.

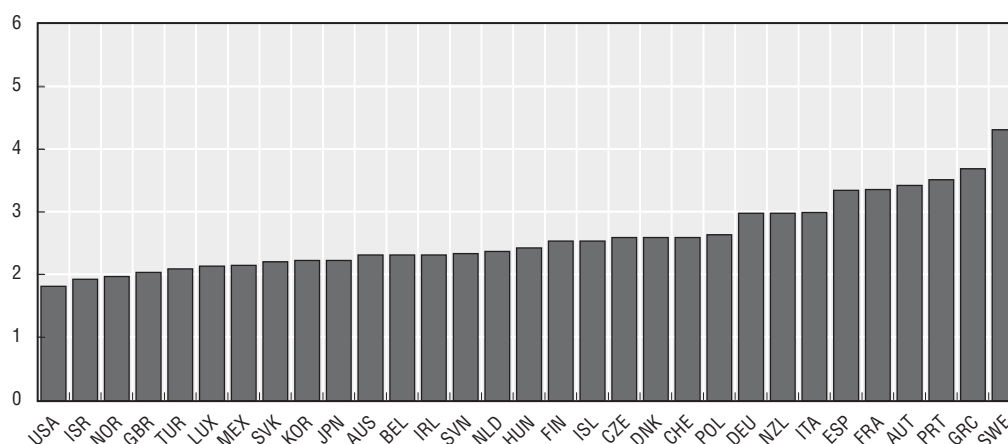
Source: Calculations based on the OECD Housing Market questionnaire.

The tenant protection indicator covers regulations governing tenant-landlord relations. These include three broad areas. Tenant eviction procedures regarding issues such as the valid reasons for evicting a tenant or how tenant-landlord eviction dispute can be settled, either through a regular court system or a specialised court. Deposit requirements such as whether the landlord can collect a security deposit as part of the rental agreement and if so the amount allowed. And tenure security issues such as whether contract duration is freely agreed upon between parties or average contract length. Tenant-protection regulations vary markedly across countries and are comparatively strict in many southern continental European countries (Figure 5).

In addition to these newly-built indicators the analysis uses recent, comparable country-level estimates of the long-run price responsiveness of new housing supply sourced from Caldera Sánchez and Johansson (2011). As shown in Figure 6, housing supply responsiveness varies substantially across countries. It tends to be comparatively high in North America and some Nordic countries (Sweden and Denmark), while it is lower in continental European countries and in the United Kingdom. Caldera Sánchez and

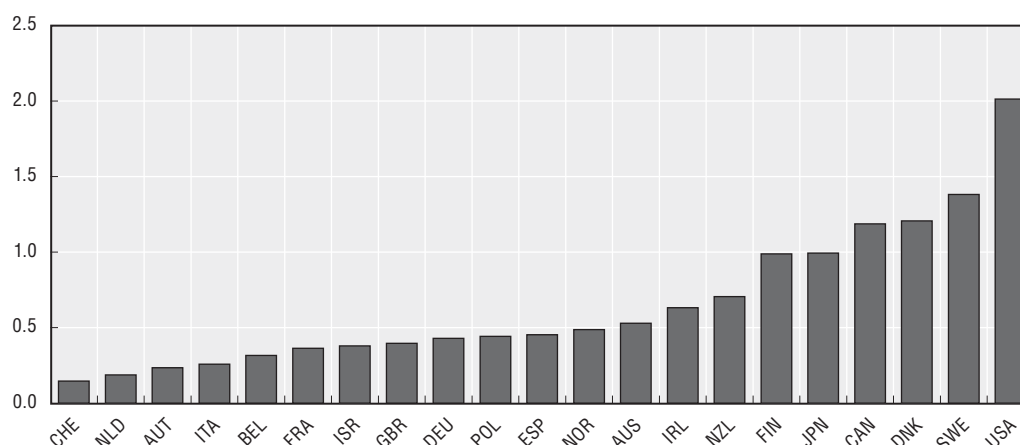
Figure 5. **Tenant-landlord regulations in the private rental market, 2009<sup>1</sup>**

Scale 0-6: Increasing in protection for tenants



1. The indicator measures the extent of tenant-landlord regulations within a tenancy. It includes the ease of evicting a tenant, degree of tenure security and deposit requirements. See Johansson (2011) for details.

Source: Calculations based on the OECD Housing Market Questionnaire.

Figure 6. **Price responsiveness of housing supply: selected OECD countries**Estimates of the long-run price elasticity of new housing supply<sup>1</sup>

1. Estimates of the long-run elasticity of new housing supply where new supply is measured by residential investment. All elasticities are significant at least at the 10% level. In the case of Spain, restricting the sample to the period 1995-2007, which would reflect recent developments in housing markets (such as the large stock of unsold houses resulting from the construction boom starting in 2000 and peaking in 2007-09), only slightly increases the estimate of the elasticity of housing supply from 0.45 to 0.58. The estimation period is the 1980s to early 2000s. For more details see Caldera Sánchez and Johansson (2011).

Source: OECD estimates.

Johansson (2011) show suggestive evidence that cumbersome land use and planning regulations are associated with a less responsive housing supply in the long run across OECD countries.

To complement the information on housing market policies, data on credit market institutions and labour market policies are also used. First, the share of private credit to GDP, sourced from the IMF, measures how much private credit the financial system lends to firms and individuals. Second, the loan-to-value ratio (LTV), sourced from the ECB (2009), measures the ability of mortgage markets to ensure households access to financing and

captures the extent of the down-payment constraint, which is particularly relevant for the marginal buyer. Finally, the income-supporting features of the unemployment system are measured by the long-term average unemployment net benefit replacement rate for a single person with social assistance and having been unemployed for 5 years (OECD, Benefits and Wages Database).<sup>5</sup>

## 4. Empirical results

### 4.1. Basic results

Table 1 reports the cross-country results on the effects of different policy-related factors on residential mobility obtained from the estimation of equation (3). Each column of Table 1 reports alternative specifications of equation (3) where the policy-related variables enter sequentially. To the extent that some of the policy-related variables are correlated among themselves (Table 2), these variables are included one at a time to avoid multicollinearity problems. The results are, however, robust to including several uncorrelated variables at a time (Table 1, columns 13-16).<sup>6</sup>

Considering the effect of buyer transaction costs on residential mobility, the third column of Table 1 shows that higher transaction costs in buying a property are associated with lower residential mobility. Transaction costs incurred by the buyer are considered because most of the transaction costs involved in a property transaction fall on the buyer rather than the seller (Johansson, 2011).<sup>7</sup> Theoretical studies suggest that transaction costs may create lock-in effects in the housing market and have negative effects on residential mobility (Oswald, 1996, 1999; Van Ommeren and Van Leuvensteijn, 2005). Decomposing transaction costs into its components shows that transaction taxes, notarial and legal fees have a negative and significant effect on mobility (columns 4, 5 and 6), while real estate and registration fees do not, and for that reason are not reported in the table.<sup>8</sup> This evidence is in line with the findings of Van Ommeren and Van Leuvensteijn (2005) for the Netherlands, which suggest that high transaction costs restrict residential mobility, potentially leading to lower labour mobility and higher unemployment.

Stricter rent regulations are associated with lower residential mobility. This is in line with a large body of research suggesting that too strict regulations can reduce both the size and the variety of services in the rental sector by discouraging new construction and delaying maintenance (Sims, 2007; Arnott, 2003). Other studies, mostly for the United States, also show that renters in rent-controlled housing markets move less frequently and consume less than optimal quantities of housing (*e.g.* Clark *et al.* 1982; Linneman, 1983; Lind, 2001). A possible reason is that if rents in rent-regulated dwellings are set, or vary differently from non-regulated dwellings, sitting tenants in rent-controlled dwellings will be reluctant to move and give up their below-market rents (*e.g.* European Housing Review, 2009). As expected, given the high correlation between rent control and tenant protection (0.62), higher tenant protection is also associated with lower residential mobility. Similarly, strict tenant-landlord regulation resulting in high tenure security can lower the expected returns from residential rental supply and reduce investment. It can also encourage owners not to rent out their apartments leaving them empty. Overall, these factors can hinder entry into and exit from the rent-regulated rental sector leading to lower residential mobility.

Table 1. The effect of policy-related factors on residential mobility<sup>1</sup>

|                                    | (1) <sup>2</sup>     | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  | (7)                  | (8)                  | (9) <sup>3</sup>     | (10)                 | (11)                 | (12)                 | (13)                 | (14)                 | (15)                 | (16)                 |
|------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Transaction costs buyer            |                      |                      | -0.002***<br>(0.000) |                      |                      |                      |                      |                      |                      |                      |                      |                      | -0.003***<br>(0.000) | -0.003***<br>(0.000) |                      |                      |
| Transaction taxes                  |                      |                      |                      | -0.009***<br>(0.001) |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Notary fees                        |                      |                      |                      |                      | -0.028***<br>(0.003) |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Legal fees                         |                      |                      |                      |                      |                      | -0.045***<br>(0.003) |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Rent control                       |                      |                      |                      |                      |                      |                      | -0.020***<br>(0.002) |                      |                      |                      |                      |                      | -0.015***<br>(0.002) |                      |                      | -0.020***<br>(0.002) |
| Security of tenure                 |                      |                      |                      |                      |                      |                      |                      | -0.016***<br>(0.003) |                      |                      |                      |                      |                      | -0.017***<br>(0.003) |                      |                      |
| Elasticity of supply               |                      |                      |                      |                      |                      |                      |                      |                      | 0.087***<br>(0.004)  |                      |                      |                      |                      |                      |                      | 0.060***<br>(0.005)  |
| Private credit to GDP <sup>4</sup> |                      |                      |                      |                      |                      |                      |                      |                      |                      | 0.031***<br>(0.000)  |                      |                      |                      |                      |                      | 0.045***<br>(0.000)  |
| Loan to value                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      | 0.002***<br>(0.000)  |                      | 0.001***<br>(0.000)  | 0.001***<br>(0.000)  | 0.002***<br>(0.000)  |                      |
| Long-term net replacement rates    |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      | 0.001***<br>(0.000)  | 0.000**<br>(0.000)   | 0.001***<br>(0.000)  | 0.000*<br>(0.000)    | -0.000<br>(0.000)    |
| Old                                | -0.118***<br>(0.003) | -0.119***<br>(0.003) | -0.120***<br>(0.003) | -0.119***<br>(0.003) | -0.120***<br>(0.003) | -0.121***<br>(0.003) | -0.119***<br>(0.003) | -0.120***<br>(0.003) | -0.124***<br>(0.003) | -0.119***<br>(0.003) | -0.118***<br>(0.003) | -0.119***<br>(0.003) | -0.118***<br>(0.003) | -0.118***<br>(0.003) | -0.122***<br>(0.003) | -0.118***<br>(0.003) |
| Owner                              | -0.200***<br>(0.004) | -0.194***<br>(0.004) | -0.194***<br>(0.004) | -0.194***<br>(0.004) | -0.199***<br>(0.004) | -0.190***<br>(0.004) | -0.203***<br>(0.004) | -0.195***<br>(0.004) | -0.198***<br>(0.004) | -0.197***<br>(0.004) | -0.192***<br>(0.004) | -0.197***<br>(0.004) | -0.201***<br>(0.004) | -0.198***<br>(0.004) | -0.205***<br>(0.004) | -0.203***<br>(0.004) |
| Social/subsidised tenant           | -0.074***<br>(0.004) | -0.061***<br>(0.004) | -0.061***<br>(0.004) | -0.066***<br>(0.004) | -0.064***<br>(0.004) | -0.065***<br>(0.004) | -0.066***<br>(0.004) | -0.061***<br>(0.004) | -0.062***<br>(0.005) | -0.061***<br>(0.004) | -0.064***<br>(0.004) | -0.062***<br>(0.004) | -0.068***<br>(0.004) | -0.066***<br>(0.004) | -0.069***<br>(0.005) | -0.066***<br>(0.004) |
| Low education attainment           | -0.034***<br>(0.004) | -0.038***<br>(0.004) | -0.036***<br>(0.004) | -0.034***<br>(0.004) | -0.036***<br>(0.004) | -0.029***<br>(0.004) | -0.042***<br>(0.004) | -0.037***<br>(0.004) | -0.036***<br>(0.004) | -0.039***<br>(0.004) | -0.037***<br>(0.004) | -0.039***<br>(0.004) | -0.038***<br>(0.004) | -0.036***<br>(0.004) | -0.036***<br>(0.004) | -0.042***<br>(0.004) |
| Middle education attainment        | -0.012***<br>(0.003) | -0.012***<br>(0.003) | -0.012***<br>(0.003) | -0.012***<br>(0.003) | -0.012***<br>(0.003) | -0.011***<br>(0.003) | -0.012***<br>(0.003) | -0.013***<br>(0.003) | -0.008**<br>(0.003)  | -0.011***<br>(0.003) | -0.010***<br>(0.003) | -0.011***<br>(0.003) | -0.011***<br>(0.003) | -0.011***<br>(0.003) | -0.007**<br>(0.003)  | -0.012***<br>(0.003) |
| Unemployed                         | 0.001<br>(0.004)     | -0.000<br>(0.004)    | -0.001<br>(0.004)    | -0.000<br>(0.004)    | -0.001<br>(0.004)    | -0.002<br>(0.004)    | 0.000<br>(0.004)     | -0.001<br>(0.004)    | -0.001<br>(0.005)    | -0.001<br>(0.004)    | -0.000<br>(0.004)    | 0.000<br>(0.004)     | -0.000<br>(0.004)    | -0.001<br>(0.004)    | -0.001<br>(0.005)    | 0.000<br>(0.004)     |
| Disposable income                  | 0.022**<br>(0.011)   | 0.026**<br>(0.011)   | 0.028**<br>(0.012)   | 0.027**<br>(0.011)   | 0.031**<br>(0.012)   | 0.024**<br>(0.011)   | 0.027**<br>(0.012)   | 0.030**<br>(0.012)   | 0.015<br>(0.012)     | 0.028**<br>(0.012)   | 0.018*<br>(0.011)    | 0.025**<br>(0.011)   | 0.023**<br>(0.011)   | 0.023**<br>(0.011)   | 0.016<br>(0.011)     | 0.028**<br>(0.012)   |
| Squared disposable income          | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001<br>(0.001)    | -0.001**<br>(0.001)  | -0.001*<br>(0.001)   | -0.001*<br>(0.001)   | -0.001**<br>(0.001)  | -0.001**<br>(0.001)  | -0.001<br>(0.001)    | -0.001**<br>(0.001)  |
| Household living in cohabitation   | -0.030***<br>(0.003) | -0.037***<br>(0.003) | -0.037***<br>(0.003) | -0.036***<br>(0.003) | -0.037***<br>(0.003) | -0.034***<br>(0.003) | -0.036***<br>(0.003) | -0.037***<br>(0.003) | -0.038***<br>(0.003) | -0.035***<br>(0.003) | -0.035***<br>(0.003) | -0.037***<br>(0.003) | -0.034***<br>(0.003) | -0.034***<br>(0.003) | -0.037***<br>(0.003) | -0.035***<br>(0.003) |
| Aggregate household income         |                      | 0.021***<br>(0.001)  | 0.020***<br>(0.001)  | 0.009***<br>(0.002)  | 0.017***<br>(0.001)  | 0.023***<br>(0.001)  | 0.011***<br>(0.002)  | 0.014***<br>(0.002)  | -0.032***<br>(0.003) | 0.011***<br>(0.002)  | 0.011***<br>(0.002)  | 0.020***<br>(0.001)  | 0.002<br>(0.002)     | -0.002<br>(0.002)    | -0.024***<br>(0.004) | 0.009***<br>(0.002)  |
| Degree of urbanisation             |                      | -0.028***<br>(0.001) | -0.027***<br>(0.001) | -0.029***<br>(0.001) | -0.020***<br>(0.002) | -0.033***<br>(0.001) | -0.023***<br>(0.001) | -0.028***<br>(0.001) |                      | -0.028***<br>(0.001) | -0.028***<br>(0.001) | -0.027***<br>(0.001) | -0.021***<br>(0.001) | -0.024***<br>(0.001) |                      | -0.022***<br>(0.001) |
| Number of observations             | 142 162              | 142 162              | 142 162              | 142 162              | 133 178              | 139 025              | 133 153              | 138 803              | 108 394              | 138 063              | 139 961              | 142 162              | 133 153              | 136 602              | 108 394              | 129 054              |

1. Estimates from probit regression. Values are marginal effects. The coefficients correspond to the impact of a change in the explanatory variable on the probability to move estimated at the mean of the independent variables. The sample is restricted to individuals who are the head of the household to avoid the results being influenced by atypical tenureship. The estimates are weighted by the individual sampling probability. Robust standard errors, clustered by country, are reported in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1.

2. The specification in Column (1) includes country dummies.

3. Urbanisation rate excluded from (9) and (15) because highly correlated with elasticity of supply.

4. The coefficient on private credit to GDP has been scaled by multiplying it by 100.

Source: OECD calculations based on 2007 EU-SILC for European countries, 2007 HILDA for Australia, 2007 SHP for Switzerland, 2007 AHS for the United States.

Table 2. **Correlation between different policies and policy-related factors**

| Policies                        | (1)<br>Transaction<br>costs buyer | (2)<br>Rent control | (3)<br>Security<br>of tenure | (4)<br>Elasticity<br>of supply | (5)<br>Private credit<br>to GDP (2006) | (6)<br>Loan to value | (7)<br>Long-term net<br>replacement rates |
|---------------------------------|-----------------------------------|---------------------|------------------------------|--------------------------------|----------------------------------------|----------------------|-------------------------------------------|
| Transaction costs buyer         | 1.00                              |                     |                              |                                |                                        |                      |                                           |
| Rent control                    | -0.03                             | 1.00                |                              |                                |                                        |                      |                                           |
| Security of tenure              | 0.31                              | 0.62                | 1.00                         |                                |                                        |                      |                                           |
| Elasticity of supply            | -0.54                             | -0.40               | -0.51                        | 1.00                           |                                        |                      |                                           |
| Private credit to GDP (2006)    | -0.58                             | -0.23               | -0.59                        | 0.59                           | 1.00                                   |                      |                                           |
| Loan to value                   | -0.05                             | -0.37               | -0.23                        | 0.39                           | 0.17                                   | 1.00                 |                                           |
| Long-term net replacement rates | 0.29                              | -0.35               | -0.14                        | 0.02                           | 0.07                                   | 0.09                 | 1.00                                      |

Source: OECD calculations based on 2007 EU-SILC for European countries, 2007 HILDA for Australia, 2007 SHP for Switzerland and 2007 AHS for the United States.

Turning to the role of housing supply, a more responsive supply has a positive and significant effect on residential mobility. Differences in supply response between areas can drive a wedge in prices and have a negative impact on household location decisions. The responsiveness of housing supply determines to what extent demand shocks, such as financial deregulation or population growth, lead to an adjustment in housing construction as opposed to adjustments in prices. Not only geographical and urban characteristics influence how responsive housing supply is, but also other policies, such as land-use regulations, building codes or rental regulations, which influence the allocation of land and housing between different uses (Caldera Sánchez and Johansson, 2011). Excessively strict regulations or a slow allocation of building permits can impede housing markets in reaching a competitive equilibrium and constrain housing supply. This implies that restrictive regulations, to the extent that they reduce the responsiveness of housing supply to price changes, can hinder household mobility (Mayo and Stein, 1995). For instance, if differences in supply responsiveness give rise to large price differentials across regions, households in lower-priced areas seeking to move to higher-priced regions—possibly to take advantage of better employment prospects – will need to clear a larger credit hurdle than otherwise (Saks, 2008; Barker, 2004; Cameron and Muellbauer, 1998). This can also contribute to perpetuate differences across regions in mobility if for instance a low responsiveness of housing supply contributes to the capitalisation of wages into house prices or rents.

Higher volumes of credit in the economy, as measured by the share of private credit to GDP, appear to enhance residential mobility (Column 10). A higher LTV ratio, that is the possibility to borrow a larger share of the housing value in order to purchase a home, is also associated with higher residential mobility (Column 11). These findings suggest that mortgage market features, through their effect on borrowing costs, can affect household mobility. Given that owner-occupied housing generally requires debt financing, liquidity constraints may force some households to remain in the rental market when they could optimally choose to be homeowners. During the period of adjustment to financial liberalisation, residential mobility can increase as easier access to credit can facilitate the transition from rental to owner occupation for previously credit-constrained households. But the resulting higher homeownership rates are likely to be associated with lower residential mobility, as argued before.

These average results may also conceal the heterogeneous effects greater availability of credit can have on residential mobility over the housing cycle. For instance, high LTV

ratios, coupled with decreasing house prices, can have negative effects on residential mobility. During a housing market bust, homeowners suffering severe house price declines and having mortgage balances higher than the value of their home will find it difficult to refinance their loan or raise sufficient capital to sell and move to another dwelling and may become locked-in (*e.g.* Chan, 2001; Ferreira *et al.* 2008). Financial deregulation may have therefore increased household vulnerability to shocks and the risks that households find themselves in negative equity positions hurting mobility (see Andrews *et al.* 2011).

Column 12 in Table 1 suggests that the generosity of unemployment benefits influences residential mobility. Higher long-term unemployment benefits, as measured by average net unemployment benefit replacement rates, are associated with higher residential mobility. Unemployment benefits can increase the degree of residential mobility by relaxing current financial constraints of those unemployed and help them to finance their labour search and moving costs. This finding, although it only reflects the effect of very long-term unemployment benefits on mobility, is in line with previous findings by Tatsiramos (2009). He finds that countries with relatively generous benefits, such as Denmark, France and, to some extent, Spain have higher residential mobility. Thus, by increasing the resources of those unemployed, unemployment benefits may increase residential mobility and help to finance jobseekers' labour moving and search costs. Indeed, evidence from OECD (2010) shows that unemployment benefit generosity is associated with higher employment reallocation, in terms of average gross worker flows, in OECD countries.

Focusing now on the average effects of household characteristics on mobility, the results in Table 1 suggest that older households are less mobile than younger ones. This evidence is in line with a large number of studies that find an inverse relationship between age and residential mobility due to life-cycle reasons for moving, such as household formation and increase in household size (*e.g.* Clark and Withers, 1998). Homeowners are less mobile than private renters. A common explanation for this finding is that homeowners face higher search and transaction costs than private tenants when considering moving to a new residence (*e.g.* Oswald, 1996). Residential mobility is also lower among households receiving a subsidy or paying below-market rents, compared with private tenants. Evidence suggests that compared with tenants in the private rental market, social housing tenants are typically more reluctant to move out so as not to give up their below-market rents (*e.g.* Flatau *et al.* 2003). The probability to move also increases with the level of education. More educated households are generally more mobile than less-educated ones. Households living in cohabitation are less mobile than single households and this is probably because they have to overcome higher costs to move to a new location. Current income has a positive effect on mobility, suggesting that more income helps facing mobility costs. Employment status, however, does not influence residential mobility.

#### **4.2. Sensitivity check: including several policies in the model**

To verify that the results are robust to considering the simultaneous effects of various policies, several policies are included in the regression equation. To avoid multicollinearity problems only those variables that are not significantly correlated are included.

Columns 13-16 in Table 1 report the results of different regressions, including several groupings of policies. The results are generally robust to this test and lead to similar conclusions as in the baseline results. Transaction costs, rent control and tenure security

regulations have a negative effect on residential mobility. The responsiveness of supply, loan-to-value ratios, private credit and long-term net replacement rates have a positive effect on mobility. But, the effect of long-term net replacement rates is sensitive to the considered specification. In column 16 of Table 1 the coefficient on this variable is not significant.

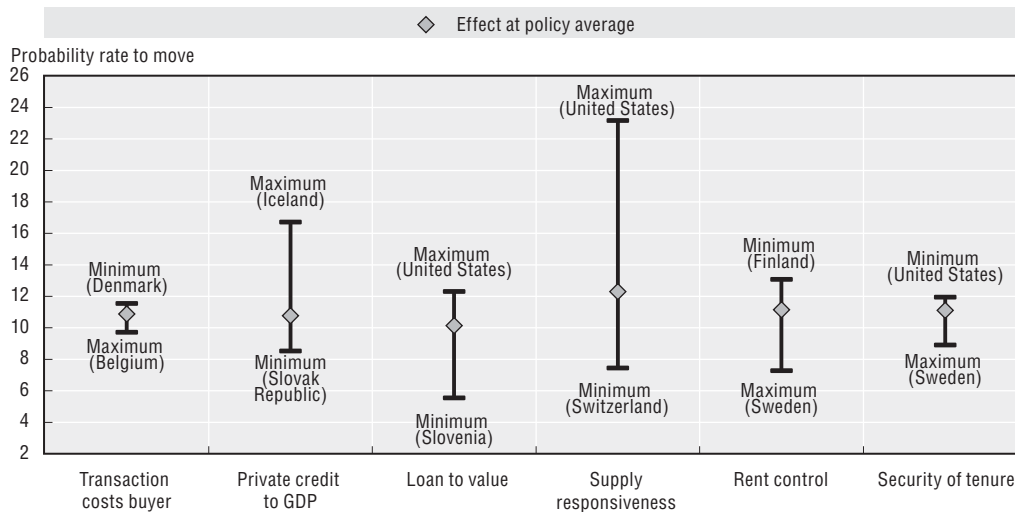
#### **4.3. Economic significance of the effect of policy-related factors on mobility**

To understand the economic significance of the effect of these different policy-related factors on residential mobility and shed some light on the improvements in residential mobility that could be associated with different policy reforms, Figure 7 shows illustrative examples of how different policy scenarios influence residential mobility. Each bar represents the change in the average probability to move, associated with a change from the least to the most mobile-friendly level of the policy. The probability rates are computed at the mean, max or min of the policies based on OECD countries' policies distribution, and at the mean of the rest of explanatory variables based on the estimates in Table 1. This provides a tentative way of quantifying the relative impact of policies on residential mobility, but it only quantifies the effects of one isolated policy on mobility. The overall effects of policy changes will also depend on the housing structure in a country.

*Reducing transaction costs could increase residential mobility:* The evidence in Figure 7 suggests that reducing overall transaction costs from the highest level observed in Belgium to the average level observed in Austria would bring an increase in residential mobility of about 1 percentage point. This simple exercise abstracts from the fact that if transactions costs, such as for instance, transfer taxes are reduced, other taxes may need to increase, which may in turn reduce mobility. Transaction taxes are inefficient for raising revenue as the same revenue could in principle be obtained at a lower economic cost by, for instance, taxing consumption instead (OECD, 2009). Policies can contribute to reducing these one-off costs by tax restructuring and/or lifting barriers to entry in the real estate or legal professions, particularly where costs are excessively high such as in Belgium or France (Figure 3).

*Reducing rent controls and changing the bargaining power balance between tenants and landlords could increase residential mobility:* reducing rent controls from the level in the most restrictive country (Sweden) to that of the average country (e.g. Norway) could increase residential mobility by about 4 percentage points. Making the rules governing tenant-landlord relations more landlord-friendly, by easing them from the level in the most restrictive country (Sweden) to the average (e.g. Denmark) could increase residential mobility by about 2 percentage points.

*An unresponsive housing supply tends to undermine residential mobility:* Regression estimates suggest that an increase in the responsiveness of supply in the country with the least responsive supply (Switzerland) to the average (e.g. Ireland) would be associated with almost double average residential mobility. In the longer term, a responsive supply is important to avoid bottlenecks in the housing market and excessive volatility in house prices. But in flexible-supply countries greater responsiveness can also translate into more volatile residential investment as housing investments adjust more rapidly to changes in demand. This can contribute over the short-term to more cyclical swings in economic activity and hurt mobility if households do not move because, for instance, they are in negative equity positions.

Figure 7. **Residential mobility and policy-related factors**<sup>1</sup>

1. The dot is the average probability to move evaluated at average policy and household characteristics. The distance between the Min/Max and the average is the change in the probability associated with a policy change. The reported probabilities for the elasticity of supply and loan to value have a different mean than the other specifications because they are estimated on a reduced sample of countries due to data constraints. Based on the estimates presented in Table 1.

Source: OECD calculations based on 2007 EU-SILC Database, on HILDA for Australia, SHP for Switzerland and AHS for the United States.

*Easier access to credit can ease financial constraints and increase residential mobility:* Finally, increasing the volume of private credit to GDP in the economy from the lowest level observed in the Slovak Republic, to the average level (Sweden), could increase residential mobility by 2 percentage points. Similarly, by lowering down-payment constraints (or increasing LTV ratios) from the lowest level in Slovenia (50% loan-to-value ratio) to the average (e.g. Estonia 90%) could increase average residential mobility by 5 percentage points.

#### 4.4. Do policy factors disproportionately affect the mobility of young households?

The influence of policy-related factors on residential mobility may vary depending on household characteristics. To obtain deeper insight into this issue, the next step analyses the differential effect of policy-related factors on younger compared with older households. For instance, older households may find it easier to finance the search and transaction costs involved in moving or have greater ability to raise capital in order to finance a new home because of their greater collateral assets than younger households.

To investigate these hypotheses the following model is estimated:

$$Pr_{ic} = \Phi(\alpha + \beta P_c + \gamma P_c * Old + \delta Old + Z_{ic}\phi + C_c\Gamma + e_{ic}) \quad (4)$$

where *Old* is a binary variable taking the value 1 if the head of the household is older than 44 years of age, and 0 when he/she is 44 years old or younger,  $Z_{ic}$  includes the same set of household characteristics as  $H_{ic}$  in equation (3) except that it does not include *Old*. The coefficient  $\gamma$  measures the differential effect of a given policy on old households compared with young ones, while the coefficient  $\beta$  measures the average effect of the policy.

Estimates of equation (4) suggest that most policy-related factors have a stronger effect on the mobility of younger households compared with older ones. Transaction costs,

Table 3. **The effect of policies and policy-related factors on residential mobility of old versus young households<sup>1</sup>**

| Policy-related factors                                                                              | (1)<br>Transaction costs<br>buyer | (2)<br>Rent control  | (3)<br>Security of tenure | (4)<br>Elasticity of<br>supply <sup>2</sup> | (5)<br>Private credit to<br>GDP (2006) | (6)<br>Loan to value | (7)<br>Long-term net<br>replacement rates |
|-----------------------------------------------------------------------------------------------------|-----------------------------------|----------------------|---------------------------|---------------------------------------------|----------------------------------------|----------------------|-------------------------------------------|
| Dependent variable: 1 if head of household changed residence within the past two years, 0 otherwise |                                   |                      |                           |                                             |                                        |                      |                                           |
| Policy-related factors <sup>3</sup>                                                                 | -0.003***<br>(0.001)              | -0.020***<br>(0.002) | -0.018***<br>(0.003)      | 0.035***<br>(0.005)                         | 0.036***<br>(0.000)                    | 0.001***<br>(0.000)  | 0.035***<br>(0.000)                       |
| Policy-related factors * Old                                                                        | 0.005***<br>(0.001)               | 0.010***<br>(0.002)  | 0.013**<br>(0.004)        | -0.020***<br>(0.004)                        | -0.027***<br>(0.000)                   | -0.061***<br>(0.000) | 0.000208<br>(0.000)                       |
| Old                                                                                                 | -0.152***<br>(0.006)              | -0.120***<br>(0.005) | -0.134***<br>(0.010)      | -0.119***<br>(0.006)                        | -0.094***<br>(0.009)                   | -0.101***<br>(0.011) | -0.143***<br>(0.010)                      |
| Observations                                                                                        | 142 162                           | 133 153              | 138 803                   | 108 394                                     | 138 063                                | 139 961              | 142 162                                   |

1. Estimates from probit regression. Values are marginal effects. The coefficients correspond to the impact of a change in the explanatory variable on the probability to move estimated at the mean of the independent variables. Regressions include similar controls as in Table 1, including age, tenureship, education, employment status, income and squared income, cohabitation status, total national income and urbanisation rate. The sample is restricted to individuals who are the head of the household to avoid the results being influenced by atypical tenureship. The estimates are weighted by the individual sampling probability. Robust standard errors, clustered at the country level, are reported in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .
2. Urbanisation rate excluded from (4) because highly correlated with elasticity of supply.
3. The coefficient on private credit to GDP has been scaled by multiplying it by 100.

Source: OECD calculations based on 2007 from EU-SILC for European countries, HILDA for Australia, SHP for Switzerland, AHS for the United States.

rent controls and security of tenure regulations have a negative effect on mobility and their effect is stronger on younger households. An elastic supply, greater access to credit and a relaxation of down-payment constraints is associated with higher residential mobility among younger households compared with older ones. The effect of long-term unemployment protection is, however, not significantly different among younger relative to older households as indicated by the non-significant effect of the interaction between long-term replacement rates and the age dummy.

## 5. Do policy-related factors affect within country mobility differently?

The effect of policies on residential mobility may differ within countries. Building on city-level and state-level information on policies from the United States, Table 4 reports the results from a probit model of the probability that a US household moves, as a function of a similar set of policies and controls as in the cross-country estimation. While the underlying household data continue to be drawn from the 2007 American Housing Survey, the policies are obtained from various sources.<sup>9</sup> City-level data on rent controls and land use regulations are based on Malpezzi (1996). A simple dummy variable is included to measure whether rent controls exist in each city while the land-use regulation index takes into account a number of factors, including approval times for zoning and subdivisions, share of zoning changes approved, amount of land zoned for single-family homes (relative to demand) and infrastructure quality. State real estate transaction tax rates are obtained from the Federal Tax Administrators Bulletin and the inter-state banking regulation index is based on Rice and Strahan (2009). The latter index captures various regulations that hamper interstate branching, such as limits on banks' size, interstate merger restrictions and restrictions on the amount of deposits a bank can hold. The analysis controls for regional differences using region-fixed effects. To the extent that this approach is not affected by unobserved cross-country differences which may be correlated with both

mobility patterns and housing policies, it further strengthens the conclusions drawn from the cross-country analysis.

Table 4. **The effect of policies on residential mobility in the United States**<sup>1</sup>

|                                                                                                         | (1)        | (2)        | (3)        | (4)        |
|---------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|
| Dependent variable: 1 if head of household has changed residence within the past two years, 0 otherwise |            |            |            |            |
| <b>Policies:</b>                                                                                        |            |            |            |            |
| Landuse regulation index (City-level)                                                                   | -0.00419*  |            |            |            |
|                                                                                                         | (0.002)    |            |            |            |
| Rent control dummy (City level)                                                                         |            | -0.0607*** |            |            |
|                                                                                                         |            | (0.017)    |            |            |
| Banking regulation index (State level)                                                                  |            |            | -0.00364** |            |
|                                                                                                         |            |            | (0.002)    |            |
| Transaction tax rate (State level)                                                                      |            |            |            | -0.0100    |
|                                                                                                         |            |            |            | -(0.010)   |
| <b>Household-level variables:</b>                                                                       |            |            |            |            |
| Age 35-44                                                                                               | -0.0842*** | -0.0847*** | -0.0850*** | -0.0847*** |
|                                                                                                         | (0.013)    | (0.013)    | (0.013)    | (0.013)    |
| Age 45-54                                                                                               | -0.142***  | -0.143***  | -0.142***  | -0.143***  |
|                                                                                                         | (0.012)    | (0.011)    | (0.011)    | (0.011)    |
| Age 55-64                                                                                               | -0.174***  | -0.175***  | -0.175***  | -0.175***  |
|                                                                                                         | (0.015)    | (0.015)    | (0.015)    | (0.015)    |
| Outright owner                                                                                          | -0.191***  | -0.191***  | -0.191***  | -0.191***  |
|                                                                                                         | (0.007)    | (0.007)    | (0.007)    | (0.007)    |
| Owner with mortgage                                                                                     | -0.213***  | -0.213***  | -0.212***  | -0.213***  |
|                                                                                                         | (0.020)    | (0.019)    | (0.020)    | (0.019)    |
| Social/subsidised tenant                                                                                | -0.0741*** | -0.0751*** | -0.0753*** | -0.0751*** |
|                                                                                                         | (0.001)    | (0.001)    | (0.002)    | (0.001)    |
| Low education attainment                                                                                | -0.0242**  | -0.0244*   | -0.0244*   | -0.0244*   |
|                                                                                                         | (0.012)    | (0.012)    | (0.012)    | (0.012)    |
| Unemployed                                                                                              | 0.0270***  | 0.0274***  | 0.0274***  | 0.0274***  |
|                                                                                                         | (0.010)    | (0.010)    | (0.010)    | (0.010)    |
| Disposable income                                                                                       | (0.000)    | (0.000)    | (0.000)    | (0.000)    |
|                                                                                                         | (0.000)    | (0.000)    | (0.000)    | (0.000)    |
| Household living in cohabitation                                                                        | -0.0506*** | -0.0506*** | -0.0507*** | -0.0506*** |
|                                                                                                         | (0.008)    | (0.008)    | (0.008)    | (0.008)    |
| Foreign born                                                                                            | 0.0250***  | 0.0255***  | 0.0238***  | 0.0255***  |
|                                                                                                         | (0.008)    | (0.007)    | (0.008)    | (0.007)    |
| <b>Other control variables:</b>                                                                         |            |            |            |            |
| Population Density (City Level)                                                                         | -0.001***  | -0.001***  | -0.001***  | -0.001***  |
|                                                                                                         | (0.000)    | (0.000)    | (0.000)    | (0.000)    |
| Trade Union Density (State level)                                                                       | (0.000)    | (0.000)    | (0.000)    | (0.000)    |
|                                                                                                         | (0.001)    | (0.002)    | (0.001)    | (0.002)    |
| Regional Dummies                                                                                        | Yes        | Yes        | Yes        | Yes        |
| Number of observations                                                                                  | 6 720      | 6 720      | 6 720      | 6 720      |

1. Estimates from probit regression. Values are marginal effects. The coefficients correspond to the impact of a change in the explanatory variable on the probability to move estimated at the mean of the independent variables. The sample is restricted to individuals who are the head of the household to avoid the results being influenced by atypical tenureship. The estimates are weighted by the individual sampling probability. Robust standard errors are reported in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Source: OECD calculations based on 2007 American Housing Survey.

The results broadly confirm the findings of the cross-country analysis with respect to the impact of policy variables:

- *Land-use regulations*: Residential mobility tends to be lower in cities with more stringent land-use regulations. The coefficients in Table 4 imply that a one standard deviation rise in the extent of land-use regulation, *e.g.* moving from the regulatory settings in Houston (the sample mean) to Los Angeles, reduces the probability of moving by about 10 percentage points, compared with a situation in which land-use regulation is at the sample mean.
- *Rent controls*: The probability that a household changes residence is substantially lower in cities with rent control than in those where rents are determined by market conditions.
- *Banking regulation*: Higher banking regulation tends to be associated with lower residential mobility, though this effect is considerably smaller than the impact of land-use regulations.

Finally, the last column in Table 4 investigates whether higher real estate transaction tax rates at state level tend to reduce residential mobility, but this effect is not significant.<sup>10</sup>

## Notes

1. Residential mobility refers in this paper to the change of dwelling. A distinction between different types of moves, such as regional or inter country moves, is not possible due to data limitations.
2. Credible estimates of a Heckman selection model require at least one variable to appear with a non-zero coefficient in the selection equation and not in the equation of interest. When instead the same covariates appear in the selection equation and the equation of interest, the Heckman selection model bases its identification on the normality assumption, and identification will be tenuous unless there are many observations in the tails where there is substantial non-linearity in the inverse Mills ratio.
3. The EU-SILC dataset includes the following 23 countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. Poland is not included in the empirical analysis because inspection of the dataset revealed a large number (35%) of households that were living in accommodation for free, which is not representative of the population.
4. Unfortunately the dataset does not allow for distinguishing between local residential moves and long-distance residential moves. Local residential moves typically involve a change in the residence but not in the working place, whereas regional or within-country moves are typically linked to job reasons (Clark *et al.* 1999). Ideally, one would also like to observe tenure and income before and after the move, but this is not possible given the cross-section nature of the dataset.
5. The choice of this indicator is motivated on the grounds that the benefit for this target group is the least generous, therefore providing a stricter test of the effect of unemployment insurance on mobility.
6. Caldera Sánchez and Andrews (2011) shows the results are robust to controlling for the potential bias resulting from pooling together country samples of different sizes by estimating the cross-country equation (4) on country samples of equal size.
7. This result is robust to considering as an alternative total transaction costs instead of buyer transaction costs.
8. The compound effect of the individual components of transaction costs on mobility should not be interpreted as the total sum of the components, because the underlying distribution of the transaction costs components varies greatly across countries. Studying the effect of different transaction costs for different types of households (*e.g.* some countries have zero stamp duties for low value owners) would help shed some light on these matter for different households. Unfortunately, the available data do not allow to go into such detail.

9. A caveat of this analysis is that it is based on answers at the city/state of destination. To the extent that the data does not distinguish between inter-city or inter-state moves, the policy settings at the city/state of destination may not be those influencing the decision to move.
10. About two-thirds of US states impose a tax on the transfer of real estate. Unfortunately, no data is available for California, Louisiana or Ohio since transfer taxes are imposed at the local level.

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# The Evolution of Homeownership Rates in Selected OECD Countries: Demographic and Public Policy Influences

by

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*Homeownership rates have increased significantly in many OECD countries over recent decades. Using micro-econometric decomposition techniques, this paper shows that part of this increase can be explained by changes in the characteristics of households, including age, household structure, income and education. Nevertheless, a significant portion of the change in homeownership rates remains unexplained by shifts in household characteristics, leaving a potential role for public policy in explaining developments in homeownership rates. Panel estimates suggest that the relaxation of down-payment constraints on mortgage loans has increased homeownership rates among credit-constrained households over recent decades, resulting in a rise in the aggregate homeownership rate that is comparable with the impact of population ageing. In countries where tax relief on mortgage debt financing is generous, however, the expansionary impact of mortgage market innovations on homeownership is smaller. This is consistent with the tendency for such housing tax relief to be capitalised into real house prices, which may crowd-out some financially constrained households from homeownership at the margin. The impact of housing policies regulating the functioning of the rental market, such as rent regulation and provisions for tenure security, on tenure choice is also explored.*

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Aggregate homeownership rates have increased significantly in many OECD countries over recent decades. A deeper understanding of the factors driving these trends is useful, given the potential consequences of homeownership for economic performance. On the one hand, homeownership has been linked to better educational outcomes – and, thus, future income prospects – for resident children (Haurin *et al.* 2002), as well as broader societal benefits. The latter includes the idea that homeownership provides the most stable tenure arrangement to satisfy basic household needs and promotes a more active and informed citizenry (Di Pasquale and Glaeser, 1999). On the other hand, rates of residential mobility tend to be lower among homeowners than renters – possibly reflecting the higher moving costs associated with owner-occupied housing – which may make homeowners more susceptible to spells of unemployment.

Even if the broader net effects of homeownership are unclear, it is still important to understand the factors driving homeownership rates to the extent that boosting homeownership has been a public policy goal in many OECD countries. For instance, a higher homeownership rate has been explicitly pursued by successive administrations in the United States. In 2002, President Bush outlined “a comprehensive agenda to help increase the number of minority homeowners by at least 5.5 million before the end of the decade” (see Bush, 2002), while in 1994, President Clinton requested an “... effort to dramatically increase homeownership in our nation over the next six years” (see Clinton, 1994). Moreover, homeownership developments have recently been at the forefront of policy discussion in Australia and New Zealand – two countries where the acquisition of the family home is likened to the attainment of the national dream (see Moran, 2006; Ferguson, 1994).

Consistent with these ideas, public policy in OECD countries is generally geared to enhancing homeownership, whether through the preferential tax treatment of housing investment or broader changes in financial markets that have alleviated credit constraints.<sup>1</sup> While it is tempting to conclude that such factors have underpinned a shift towards homeownership as the preferred mode of tenure in many OECD countries, part of the increase in homeownership rates over this period could simply reflect demographic and socio-economic influences. For example, the tendency for homeownership rates to rise with age implies that aggregate homeownership rates would have increased in OECD countries over recent decades – even if nothing else changed – due to population ageing.

Accordingly, this paper explores the extent to which trends in homeownership rates in a sub-set of OECD countries reflect changing household characteristics – including age, household structure, incomes and education – and policy influences such as mortgage market innovations and tax reliefs on mortgage debt financing.

Some new findings emerge:

- Overall, changes in household characteristics can account for around three-quarters of the increase in aggregate homeownership rates in Austria and the United Kingdom over the decade from the mid-1990s to mid-2000s, but only around one-third of the increase

in Canada, Germany, Spain, Switzerland and the United States. In Australia and especially Italy, other factors appear to have played a particularly important role in shaping homeownership patterns.

- On average, population ageing has boosted the aggregate homeownership rate by  $\frac{3}{4}$ -1 percentage point among the countries analysed, with the effect being particularly noticeable in Switzerland, Germany, Denmark and Canada. Changes in real household incomes have had more varied impacts, boosting aggregate homeownership rates by more than 1½ percentage point in Canada, Denmark, and Finland, while having negligible effects on the evolution of homeownership rates in Germany and other continental European countries. In comparison, shifts in household size and structure have – on average – exerted a modest downward influence on aggregate homeownership rates, although this effect varies somewhat across the countries studied. Finally, an increase in the share of immigrant (and ethnic minority) households has tempered the rise in aggregate homeownership rates in some countries.
- A significant proportion of the change in aggregate homeownership rates is, however, not explained by changes in the characteristics of the population, signalling a possible shift in the relative attractiveness of owner-occupied housing over recent decades and the possible influence of public policy settings:
  - The relaxation of down-payment constraints on mortgage loans has increased homeownership rates among credit-constrained, lower-income households. The estimated contribution of such mortgage market innovations to the change in aggregate homeownership rates is broadly comparable with the impact of population ageing.
  - Policies such as mortgage interest deductibility tend to be regressive since the probability of homeownership rises with income. The results indicate that such tax relief may distort the impact of other policies and potentially crowd-out financially constrained households from homeownership via house price capitalisation effects.
  - Rent regulations and provisions for tenure security implicitly impact homeownership by making renting more attractive. Nevertheless, rental market regulations may impose costs, to the extent that they are capitalised into housing costs, reduce the supply of rental housing and increase rigidity in the housing market, with possible adverse consequences for residential mobility.

The remainder of the paper is structured as follows. Section 1 discusses the link between homeownership and public policy in OECD countries, while Section 2 documents trends in homeownership rates in selected OECD countries and discusses some potential drivers of these trends. Section 3 outlines the empirical strategies used in the paper. It first describes the decomposition technique adopted to isolate the contribution of shifts in household characteristics to the change in aggregate homeownership rates. It then outlines the cross-country panel framework used to analyse the effect of mortgage market innovations and tax policies on homeownership rates. It finally specifies the cross-sectional model used to investigate the potential link between rental market regulations and tenure choice. Section 4 discusses the results of the effects of non-policy factors in homeownership rates, while Section 5 discusses the results on the influence of public policy on homeownership rates. The last section concludes.

## 1. Homeownership and public policy in OECD countries

Public policy in OECD countries tends to favour homeownership relative to renting and other investments, via the preferential tax treatment of owner-occupied housing. For example, while mortgage interest costs are tax deductible in many OECD countries, few countries tax imputed rent and those that do often substantially under-estimate the rental value.<sup>2</sup> Moreover, while property tax is often viewed as a substitute for taxation of imputed rent, the magnitude of the tax is rarely sufficient to offset the subsidy provided by mortgage interest deductibility.

The main economic argument for subsidising homeownership is that ownership may give rise to positive spillovers for society, although the case for subsidising homeownership is far from clear (see Box 1). In some instances, it is likely that homeownership is mistakenly attributed a causal influence for outcomes that are actually due to unobserved individual or household characteristics (Dietz and Haurin, 2003). For example, it is typically argued that children of homeowners perform better at school than those of renters. But this finding may simply reflect the impact of unobserved factors, such as the possibility that parents with a view to the longer term may be more likely to purchase a home and invest in their children. Nevertheless, focusing too closely on such identification issues may unduly divert attention from the broader idea that homeownership provides the most stable tenure arrangement to satisfy basic household needs – a plausible hypothesis that does not necessarily lend itself to econometric verification.

Whether it is due to the household needs hypothesis or a causal interpretation of the associations discussed in Box 1 the notion that public policy should favour homeownership over renting is active in many OECD countries. This economic rationale has sometimes been reinforced by a tendency to liken owner-occupation to the attainment of a “national dream”. Accordingly, many OECD governments pursue higher rates of homeownership – implicitly or explicitly – as a public policy goal. Therefore, understanding the drivers of aggregate homeownership rates is important from the perspective of public policy.

### Box 1. The Economic Benefits and Costs of Homeownership

The main economic argument for subsidising owner occupation is that homeownership may give rise to positive spillovers for society. While the literature has identified many possible spillovers, this box focuses on four key areas: wealth accumulation, child outcomes, social capital and mobility.<sup>1</sup> There is competing evidence for each hypothesis and a common problem is establishing causality since any correlation between homeownership and a variable of interest (*e.g.* wealth) may simply reflect the influence of a third omitted factor. The veracity of the arguments may also hinge on other policy settings and circumstances in a country.

**1. A Vehicle for Asset/Wealth Accumulation:** For myopic households, homeownership – to the extent that it creates an orientation towards the future (Sherraden 1991; OECD, 2003) – may result in a higher rate of wealth accumulation than otherwise. The act of taking out mortgage debt may also prompt a change in household spending behaviour, by making households pre-commit themselves to a scheme that is costly to break. However, the effectiveness of using one’s house as a means of forced savings has weakened considerably over recent decades, given the increased prominence of housing equity withdrawal and mortgage refinancing (Li and Yang, 2010).

With the move away from publicly-funded retirement systems, homeownership is playing an increasingly important role in maintaining the standard of living of households in retirement. In Australia, the incidence of poverty amongst older households is very high according to conventional measures, but

**Box 1. The Economic Benefits and Costs of Homeownership (cont.)**

falls dramatically once implicit rents are taken into account (Yates and Bradbury, 2009). Hirayama (2010) makes a similar argument with respect to Japan.

Against this, buying a house entails higher transaction costs than renting (Haurin and Gill, 2002) making it an illiquid investment. The timing of the purchase also tends to matter, especially given the volatility of housing prices. Indeed, recent experience in the United States highlights that policies that promote homeownership can have adverse consequences for mobility to the extent that they have been associated with a rise in negative equity (Ferreira et al. 2008; Caldera Sánchez and Andrews, 2011).

**2. Better Outcomes for Children:** Homeownership has been linked to better outcomes for children in terms of test scores and behaviour (Haurin et al. 2002). This may reflect the added geographic stability and improved home environment associated with homeownership compared with renting. It is unclear, however, whether the positive correlation between homeownership and child outcomes is causal. This may reflect the fact that in some datasets, family wealth is not measured. To the extent that family wealth affects both the likelihood of becoming a homeowner and child test scores, studies based on such datasets will overstate the impact of homeownership on child school performance (Dietz and Haurin, 2003). Even when family wealth is measured, however, unobserved parental characteristics are likely to confound the analysis. Green and White (1997) present an example where there are two types of parents – investors and non-investors. Since this characteristic of parents is unlikely to be observed, any estimate of the impact of homeownership on child test scores will be upwardly biased if investor-type parents are more likely to purchase a home and invest in their children.<sup>2</sup>

**3. Community Engagement and Voting Behaviour:** Homeownership tends to be associated with more active and informed citizens (Di Pasquale and Glaeser, 1999) and more residentially stable neighbourhoods. Homeowners might be more likely to make political choices that favour the long-run health of their community (such as more investment in green space, see Richer, 1996), while renters have an incentive to favour policies bringing immediate benefits relative to long-run gains. However, the positive impact of homeownership on political engagement may be over-stated due to endogeneity bias – people who are more likely to participate in community activities may also be more likely to be homeowners (Engelhardt et al. 2010).

Against this, homeowners have an incentive to restrict new supply – through support for zoning and land-use regulations – in order to raise house prices, which is likely to impose costs on outsiders (Glaeser and Shapiro, 2003; Hilber and Robert-Nicoud, 2010).

**4. Homeownership Adversely Affects Labour Mobility:** Labour mobility is lower and thus unemployment higher among owner-occupants than renters because of the high transaction cost of moving (Oswald 1996; Caldera Sánchez and Andrews, 2011). Of course, there are also costs associated with residential mobility. Hanusek et al. (2004) show that student turnover, particularly student entry during the school year, reduces achievement gain, and the effects are felt by everyone in the school, not just those who themselves move.

1. It has also been argued that homeowners take better care of their property (Di Pasquale and Glaeser, 1999), and are both happier (Rossi and Weber, 1996) and healthier (Benzeval and Judge, 1996). However, the extent to which this relationship is causal is unclear and the true relationship could, in fact, be negative if homeowners face greater anxiety due to their increased financial obligations (Nettleton and Burrows, 1998).
2. It should also be noted that the money spent on owner-occupied housing investment might crowd-out other family-specific investments that have a more direct payoff to children's outcomes (Aaronson, 2000). For example, Currie and Yelowitz (1998) argue that public housing has a positive effect on school retention because subsidised housing allows money to be directed to other family needs.

## 2. Evolution and potential drivers of homeownership rates in selected OECD countries

Table 1 shows how aggregate homeownership rates in selected OECD countries have evolved since the 1990s, based on household-level micro datasets (see Appendix A for a discussion of the data sources).<sup>3</sup> Homeownership rates have generally increased, particularly in Canada, Switzerland and Spain, while declines have been recorded in Australia and Luxembourg. The general increase in homeownership rates since the 1990s may partly reflect demographic trends, and in particular, the increase in the average age in OECD countries over recent decades. Population ageing affects the aggregate homeownership rate because older people have higher rates of homeownership than younger people. Across OECD countries, the probability of homeownership rises significantly between 25 and 44 years of age – the family formation years – and tends to peak in the 55-64 age bracket (see Figure 1). This implies that aggregate homeownership rates in OECD countries would have increased over recent decades because of ageing populations, even if nothing else changed.

Table 1. **Aggregate homeownership rates in selected OECD countries**

|                | Circa 1990s <sup>1</sup> | 2004 <sup>2</sup> |
|----------------|--------------------------|-------------------|
| Australia      | 71.4                     | 69.5              |
| Austria        | 46.3                     | 51.6              |
| Belgium        | 67.7                     | 71.7 <sup>3</sup> |
| Canada         | 61.3                     | 68.9              |
| Denmark        | 51.0                     | 51.6              |
| Finland        | 65.4                     | 66.0              |
| France         | 55.3                     | 54.8 <sup>3</sup> |
| Germany        | 36.3                     | 41.0              |
| Italy          | 64.2                     | 67.9              |
| Luxembourg     | 71.6                     | 69.3              |
| Netherlands    | 47.5                     | 55.4 <sup>3</sup> |
| Spain          | 77.8                     | 83.2              |
| Switzerland    | 33.1                     | 38.4              |
| United Kingdom | 67.5                     | 70.7              |
| United States  | 66.2                     | 68.69             |

1. 1987 for Austria, 1990 for Spain, 1991 for Italy, 1992 for Denmark and Switzerland, 1994 for Canada, France, Germany and the Netherlands, 1995 for Australia, Belgium and Finland, 1997 for Luxembourg and the United States.

2. 2003 for Australia, 2007 for Germany and the United States.

3. The data are particularly dated for Belgium (2000), France (2000) and the Netherlands (1999).

Sources: OECD, Luxembourg Income Study (LIS), GSOEP and the American Housing Survey.

The tendency for homeownership rates to change within age brackets over time, however, suggests that more is going on than just compositional effects (Figure 1). While homeownership rates within income quartiles have also changed over time (see Figure 2), homeownership rates may have also been affected by shifts in underlying household structure, such as the deferral of marriage and childbearing and the rise of single-parent households. Changes in education attainment, which may proxy for wealth and/or permanent income, may also matter.

Mortgage markets are also likely to be important since owner-occupied housing constitutes a household's single largest financial outlay, and generally requires debt financing. Housing finance markets have changed drastically over recent decades,

reflecting a wave of financial deregulation motivated by broader economic efficiency goals. There has been considerable cross-country variation in the timing of reform and the extent to which the financial sector was regulated in the earlier period (Abiad *et al.* 2008; Andrews, 2010). These changes in financial market regulation have significantly lowered borrowing costs for housing, resulting in a substantial expansion in the supply of mortgage loans in many countries (ECB, 2009a; Ellis, 2006), with potential implications for homeownership rates.

An important consequence of mortgage market deregulation was to significantly reduce deposit requirements, thereby easing the down-payment constraint for many households wishing to become homeowners.<sup>4</sup> The down-payment constraint tends to be particularly binding for financially-constrained households, especially younger households who have had less time to accumulate a deposit. Previous empirical research shows that from the late 1970s until the early 1990s, homeownership rates among younger households tended to increase more in those countries where the maximum loan-to-value (LTV) ratio rose, implying a reduction in the down-payment constraint (Chiuri and Jappelli, 2003).<sup>5</sup> While the maximum permissible LTV has risen in many OECD countries since the 1990s, important cross-country differences remain (see Andrews *et al.*, 2011).<sup>6</sup>

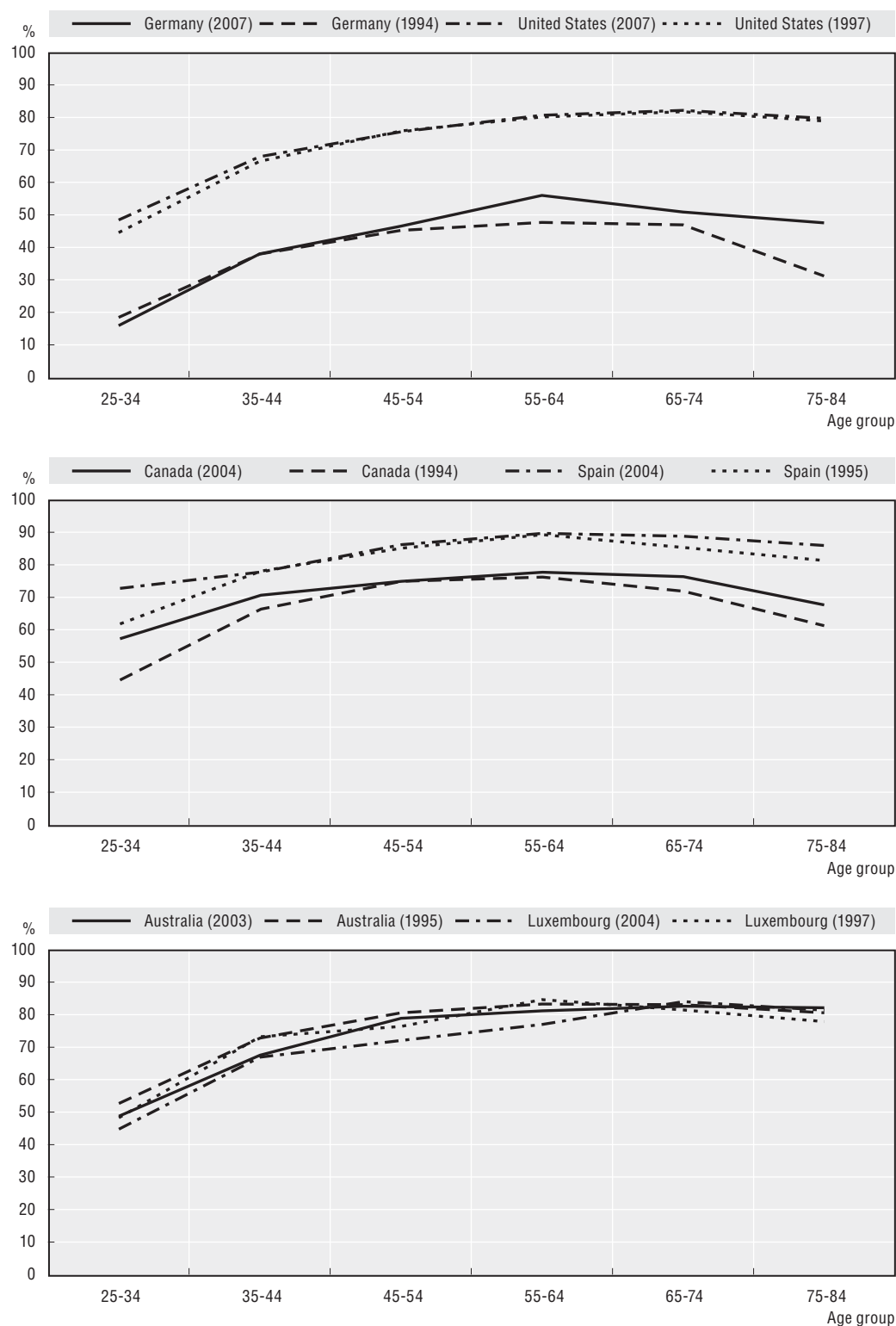
Cross-country differences in homeownership rates may also reflect differences in the tax treatment of housing. The wedge between the market interest rate and the debt financing cost of housing (the after-tax interest rate) provides one indicator of the extent to which the tax system favours owner-occupied housing with respect to debt financing (see Johansson, 2011). While this simplified measure is imperfect, it nevertheless serves as a useful indicator since households generally finance their house purchase with debt.<sup>7</sup> According to this indicator, tax relief is most generous in the Netherlands and effectively zero in countries where mortgage loans are not tax favoured (Figure 3).

The impact of tax relief on mortgage-debt-financing costs on homeownership, however, is unclear. One reason for this is that such tax relief generally takes the form of a deduction against earned income rather than a credit and, thus, are worth more to high-income earners (Andrews *et al.* 2011). To the extent that homeownership rates amongst high income earners in countries that do not allow mortgage interest deductibility (*e.g.* Australia) are still relatively high, it is likely that these households would still be homeowners in absence of the subsidy (Figure 2).<sup>8</sup> This suggests that such tax reliefs have little effect on aggregate homeownership rates and the effect may in fact be negative, if tax reliefs get capitalised into real house prices (Capozza *et al.* 1996; Andrews, 2010) and make homeownership less affordable for lower income households than otherwise (Bourassa and Yin, 2007; Hilber and Turner, 2010).

Finally, the paper analyses the impact of rental market regulations on homeownership, though the focus is on explaining cross sectional differences in homeownership – as opposed to changes over time – due to data constraints. Two specific measures of rental market regulations – rent control and security of tenure – based on a recent OECD Housing Questionnaire are adopted. The rent control variable captures regulations setting limits on rents and rent increases, including the pass-through of costs onto rents. Rent controls appear to be comparatively strict in countries with a relatively large rental sector (*e.g.* Sweden, the Netherlands, and Germany) while rent controls are lax in countries such as the United Kingdom and the United States. Meanwhile, security of tenure takes into account the length of the average rental contract, whether contract

Figure 1. Homeownership rates by age group<sup>1</sup>

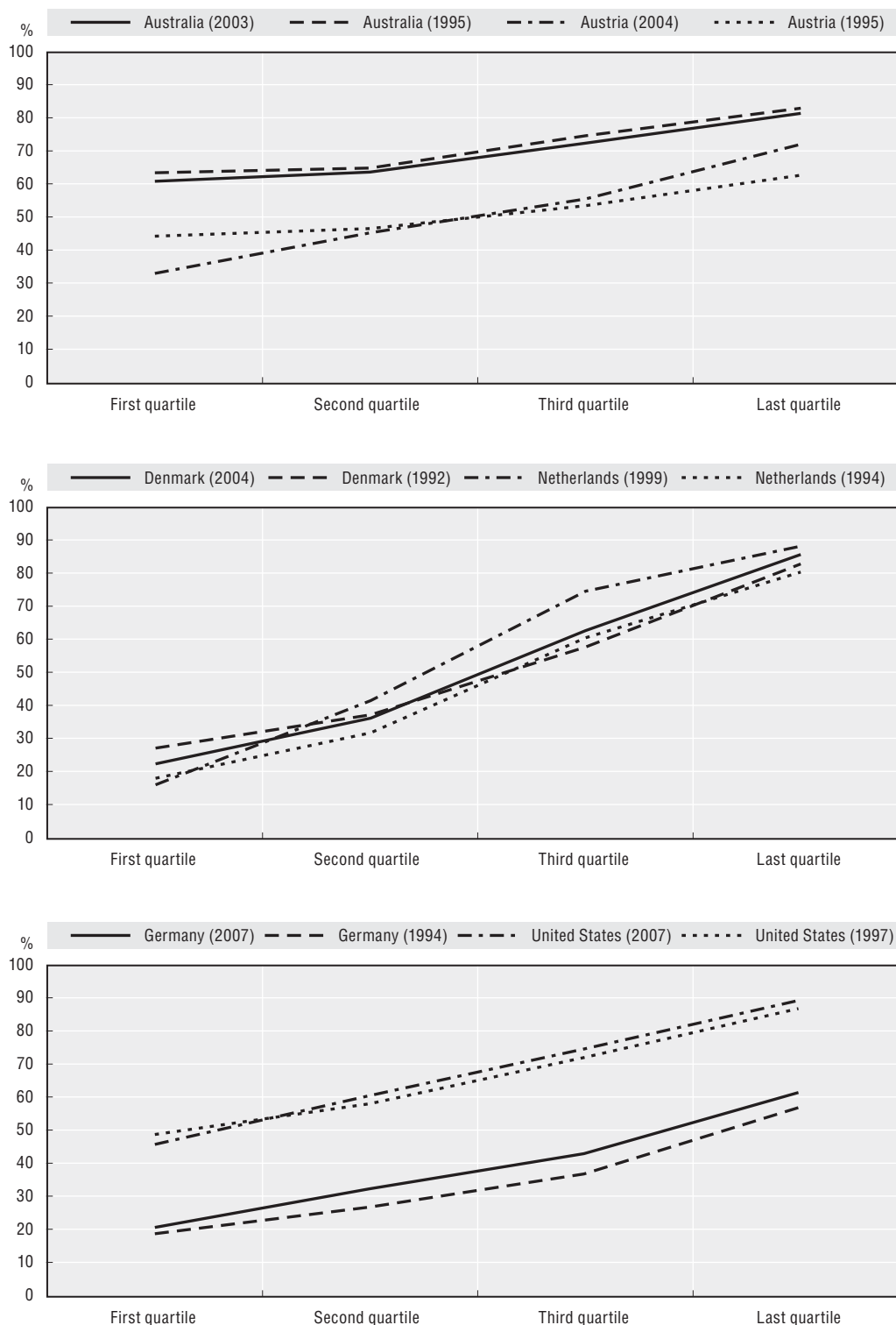
Selected OECD Countries



1. These six countries have been chosen for presentational purposes. The equivalent charts for the remaining countries in Table 1 are available in Andrews and Caldera Sánchez (2011).

Sources: OECD, Luxembourg Income Study (LIS), GSOEP and the American Housing Survey.

Figure 2. **Homeownership rates by household disposable income quartile**<sup>1</sup>  
Selected OECD Countries

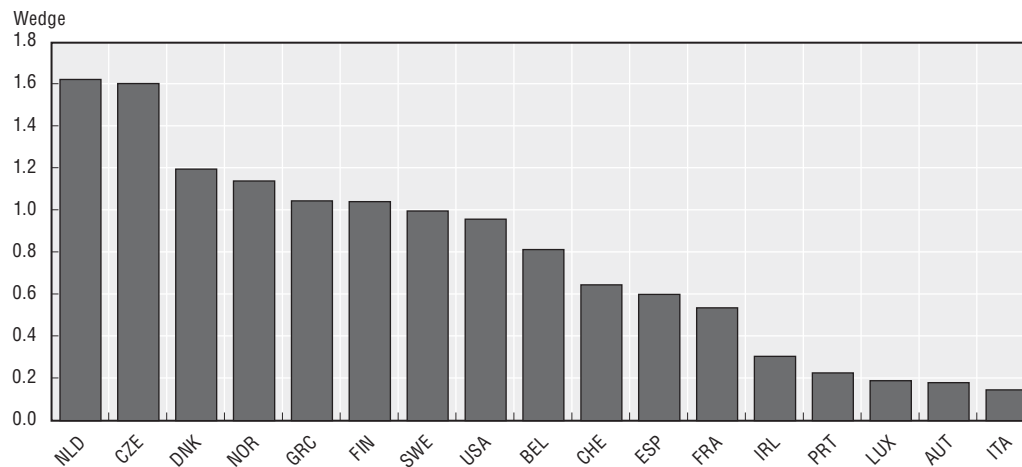


1. These six countries have been chosen for presentational purposes. The equivalent charts for the remaining countries in Table 1 are available in Andrews and Caldera Sánchez (2011).

Sources: OECD, Luxembourg Income Study (LIS), GSOEP and the American Housing Survey.

Figure 3. **Tax relief on debt financing cost of homeownership,<sup>1</sup> 2009**

Wedge increasing in the degree of tax relief



1. This indicator takes into account if interest payments on mortgage debt are deductible from taxable income and if there are any limits on the allowed period of deduction or the deductible amount, and if tax credits for loans are available (see Johansson, 2011 for details). For countries that have no tax relief on debt-financing costs, this indicator takes the value of zero. These countries include: Australia, Canada, Germany, the United Kingdom, Hungary, Japan, Korea, New Zealand, Poland, Slovenia, the Slovak Republic and Turkey. However, data limitations (related to tenure data) mean that not all of these countries are included in the subsequent econometric analysis (see Appendix A).

Sources: Calculations based on OECD Housing Market questionnaire. See Johansson, (2011) for details.

length is freely negotiable and the extent of notice required in the event that the rental contract is terminated. According to this measure, security of tenure tends to be relatively high in Portugal and Austria, while much lower in English-speaking countries. These measures are discussed at length in Johansson (2011), and are also utilised in Andrews *et al.* (2011) and Caldera Sánchez and Andrews (2011).

### 3. Empirical strategy

This section outlines the empirical frameworks used to analyse the extent to which changes in aggregate homeownership rates can be attributed to shifts in households' characteristics and public policy influences, including mortgage market innovations, tax arrangements and rental regulations. Panel estimation techniques are used to update and reassess earlier research highlighting the link between changes in down-payment constraints and homeownership rates (Chiuri and Jappelli, 2003). Unfortunately, it is not possible – due to data limitations – to estimate the direct impact of housing tax arrangements on homeownership rates over time. Instead, the paper investigates whether the impact of financial market deregulation on homeownership rates is affected by the extent to which housing is tax advantaged. This is a natural extension to recent empirical research, which shows that housing demand shocks – such as financial deregulation – are more likely to be capitalised into real house prices in countries where tax relief on mortgage debt financing is generous (Andrews, 2010). Finally, the paper uses the two newly constructed indicators of rent regulation and tenant protection discussed above to investigate the extent to which such policies increase the relative attractiveness of renting in a broader sample of countries (see Appendix A for details). The cross-sectional nature of this modelling, however, makes it difficult to identify the contribution of rental market regulations to changes in aggregate homeownership rates over time.

### 3.1. Non-policy influences on tenure choice

A variant of the Blinder-Oaxaca Decomposition (Blinder, 1973; Oaxaca, 1973) is utilised to decompose the change in the homeownership rate into the part that can be explained by changing household characteristics – including age, household size and structure – and changing propensities for homeownership given these characteristics. While this approach is somewhat partial as it assumes that trends in homeownership rates are demand-driven, it is nonetheless useful given the interest in estimating the contribution of changing household characteristics to aggregate homeownership rates over time. The decomposition technique involves two steps. As a first step, a binomial logit regression framework is employed to model the probability of homeownership for each OECD country:

$$\Pr(\text{Own} = 1) = \frac{\exp(X'b)}{1 + \exp(X'b)} \quad (1)$$

where  $\Pr(\text{Own} = 1)$ , or  $P$ , is the probability that a household will choose to be an owner, given the relevant household characteristics in the vector  $X$ . A transformation of equation (1) yields:

$$\ln\left(\frac{P}{1-P}\right) = Y = X'b = \sum b_i X_i \quad (2)$$

Implying that the dependent variable is the log of the odds that a particular tenure choice will be made.

In turn, to decompose the change in the homeownership rate over time (e.g. between 1994 and 2004) the following calculations are performed:

- The average probability of homeownership in 1994 ( $\bar{P}_{1994}$ ) and 2004 ( $\bar{P}_{2004}$ ) is calculated based on (1) setting each relevant independent variable equal to its sample mean and applying the estimated logistic coefficients.
- The decomposition of the change in the probability of homeownership ( $P$ ) can be then expressed as:<sup>9</sup>

$$\bar{P}_{2004} - \bar{P}_{1994} = (\bar{X}^{2004} - \bar{X}^{1994})\beta^{2004} + \bar{X}^{1994}(\beta^{2004} - \beta^{1994}) \quad (3)$$

“Explained effect”                      “Unexplained effect”

where  $\bar{X}^t$  is a row vector of average values of the independent variables and  $\beta^t$  is a vector of coefficient estimates for period  $t$  (where  $t$  equals 1994 or 2004). The change in the homeownership rate can be decomposed into two parts:

- *Explained effect*: captures the impact of shifts in household characteristics, such as age, household size and structure, household income and education.
- *Unexplained/residual effect*: captures changes in a household’s underlying propensity to become a homeowner, holding household characteristics constant. This effect may reflect both changes in behaviour and the impact of housing policies.

The vector  $X$  includes a number of variables relevant to the decision to become a homeowner:

- The head of household’s age is controlled for via a series of dummy variables covering seven age ranges (20-24, 25-29, 30-34, 35-44, 45-54, 55-64 and 65 and above).
- Household size and four different household structures: couples without dependents; couples with dependents; singles without dependents and singles with dependents. While changes in household structure will affect household size, there may also be

changes in household size independent of household structure if families chose to have fewer children over time.

- Real household disposable income is included to capture the financial capacity to afford a down-payment and service a mortgage.<sup>10</sup> Educational attainment is also included, since current income may be an imperfect proxy for permanent income or wealth (Goodman, 1988).
- Controls for health status, ethnicity, immigrant status and linguistic skills are also included, although these variables are not available for all countries.
- Dummy variables capturing the residential location of the household (*e.g.* state/province for large countries; city for small economies) are included, where possible, as a proxy for the relative prices of homeownership and renting.<sup>11</sup>

Since most of these variables are categorical, the specification has sufficient flexibility to control for non-linearities. In the case of the income variable, which is continuous, income-squared is included. Interactions between real income and each age bracket were also included to proxy for unobserved wealth effects, while interactions between real income and the household structure terms were included to proxy for an unobserved budget constraint (see Li, 1977). Finally, the potential simultaneity between tenure choice and household formation decisions is not addressed. Instead, it is assumed that the decision to form a household or change a household type is made prior to the tenure choice decision, which has been a common approach in the literature (see Yates, 2000). While this is a strong assumption, the data-intensive nature of this exercise (the modelling is repeated for 12 OECD countries) makes this potential simultaneity issue impractical to address.

### 3.2. Policy influences on tenure choice

After estimating the contribution of shifts in household characteristics to changes in aggregate homeownership rates, the role of selected public policies is assessed using panel and cross-section regression techniques.

#### 3.2.1. Mortgage market innovations and tax policy

To estimate the impact of mortgage market innovations – specifically, changes in the down-payment constraint – on homeownership rates over time, a cross country panel model is estimated:

$$HO_{i,t}^{Quartile2^j} = \alpha + \delta_1 LTV_{i,t} + \delta_2 LTV_{i,t} * Taxrelief_i + \delta_3 Z_{i,t-1} + \rho_i + \eta_t + \varepsilon_{i,t} \quad (4)$$

where *i* denotes country and *t* year. To the extent that the tenure decision of the “marginal homebuyer” will be most sensitive to changes in the down-payment constraint, the dependent variable in equation (4) is the homeownership rates of the marginal buyer. Two proxies are used to measure the marginal buyer: all households in the second income quartile and households aged 25-34 years in the second income quartile.<sup>12</sup> LTV is the maximum LTV ratio and Taxrelief is a time invariant variable capturing the extent of tax relief on mortgage debt financing (see Figure 3).

The vector *Z* further controls for real household income, real interest rates, price-to-rent ratio, real construction costs and the share of the total population aged 25-34. The homeownership rates of the remaining income/age groups (*i.e.* income quartiles 1, 3 and 4) are also included in *Z* to control for the influence of unobserved factors on homeownership and to make the implications for the aggregate homeownership rate clearer.<sup>13</sup> The

regressions also contain country-fixed effects ( $\rho$ ), which control for time invariant country-specific factors, such as cultural attitudes toward homeownership, and time fixed effects ( $\eta$ ) to capture common global shocks, such as the relatively benign macroeconomic environment that possibly increased the attractiveness of homeownership in the first half of the 2000s (see Li, 2005). The standard errors are clustered at the country level in order to allow for an arbitrary variance-covariance matrix within each country.

*A priori* and holding all else equal,  $\delta_1$  is expected to be positive while  $\delta_2$  will be negative if the expansionary impact of financial deregulation on homeownership amongst marginal buyers is smaller in environments with more generous tax relief. The latter may reflect the tendency for generous housing tax policies to be capitalised into real house prices (see Andrews, 2010), thereby making owner-occupation less affordable for the marginal buyer than otherwise. The inclusion of the interaction term relaxes the slope homogeneity assumption of the conventional fixed effects model, and allows the impact of changes in LTVs on homeownership to vary with the extent of tax relief. The overall impact of a change in the down-payment constraint on homeownership is given by  $(\delta_1 + \delta_2 * \text{Taxrelief}_i)$ . The direct effect of Taxrelief, however, cannot be identified since a fixed effects panel estimator is employed and this (time invariant) term would be subsumed in the country-fixed effects.

It is important to recognise that this estimation framework is quite partial, and cannot fully capture more complex dynamic feedback effects between changes in LTVs and other important variables, such as the house price to rent ratio. Moreover, the framework does not control for the influence of compositional changes in the dwelling stock, which have the potential to influence homeownership rates. For instance, in a sample of European countries over the period 1994-2001, Hilber (2007) finds that a greater proportion of apartments in the dwelling stock tends to raise the likelihood of renting. While both of these factors are likely to be important, data constraints make them difficult to address at present and the results should thus be interpreted with some caution.

### 3.2.2. Tenure choice and rental regulations

The effect of rental regulations on tenure choice is estimated using a cross-country probit model. Due to the absence of time series data on rental regulations, however, it is not possible to estimate the contribution of rental regulations to the change in aggregate homeownership rates over time. The following probit model is estimated:

$$\text{Pr}_{hi}(\text{Own} = 1) = \Phi(\alpha + \beta P_i + H_{hi} \phi + C_i \Gamma + e) \quad (5)$$

where  $\Phi$  denotes the normal distribution,  $h$  denotes household and  $i$  denotes country.  $\text{Pr}$  is the probability that a household will choose to be an owner, given the relevant household characteristics, such as income, education, employment status, summarised in the vector  $H$  and country-specific rental regulations, including rent control and security of tenure ( $P$ ). The vector  $C$  controls for other country-specific factors that may impact households' tenure decision, including national household income and urbanisation, while the error term  $e$  captures shocks and unobservable factors affecting the households tenure choice and errors are clustered at the country-level.<sup>14</sup>

Unfortunately, this estimation framework is unable to address the potential endogeneity between rental market policies and tenure choice, which may arise if existing policies are framed in response to a country's tenure structure. The lack of plausible instruments and time series data on rental regulations make this problem difficult to

address and the results should thus be treated with caution.<sup>15</sup> Moreover, it should be noted that rental regulations – if sufficiently strict – may reduce the supply of rental accommodation and give rise to spillover effects on the demand for homeownership. However, it is not possible to distinguish these unintended supply side effects from the more obvious demand side effects of rental regulations.

#### 4. Empirical results: non-policy influences on tenure choice

The estimated coefficients from the pooled logistic regression, equation (1), are reported in Table B.1 of Appendix B, while the marginal effects are shown in Table 2. The coefficients are generally of the expected sign and, across the 12 countries studied, the models – on average – predict individual tenure status correctly approximately 75% of the time, which is comparable with previous studies (see Yates, 2000; Gyourko and Linneman, 1997).

The probability of homeownership increases with age, as indicated by the age dummies which are positive and highly significant. Households aged 45-64 years tend to have the highest homeownership propensities, holding other characteristics constant, although this effect tends to vary across countries, as suggested by the different homeownership-age gradients in Figure 1. In the United States, a head of household aged 45-64 years is 37 percentage points more likely to be a homeowner than where the head is aged 20-24 years, holding all else equal. By contrast, in Germany, the same household type is 54 percentage points more likely to be a homeowner, than younger counterparts.

Relative to the benchmark household of a couple without children, the probability of homeownership tends to be significantly lower for single-headed households, particularly those with children, possibly reflecting unobserved financial resource constraints.<sup>16</sup> Consistent with this, household size tends to be positively related to the probability of homeownership in most of the countries analysed.

The probability of homeownership rises with real household disposable income, though at a diminishing rate, as implied by the negative coefficient on the income squared term. This is broadly consistent with the homeownership-income gradients presented in Figure 2. The impact of a 10% rise in household income on the probability of homeownership is particularly strong in Denmark, Finland and Germany (Figure 4), consistent with the relatively high degree of homeownership inequality between income groups in these countries (Figure 2).

Households with higher levels of education are more likely to be homeowners. While tertiary education tends to be positively associated with homeownership, this variable is not always statistically significant, possibly reflecting the relatively high correlation with household income. This is particularly the case in continental European economies, such as Austria, Spain and Switzerland. The impact of education on the probability of being a homeowner is particularly strong in the United Kingdom – household heads that are tertiary educated are 16 percentage points more likely to be a homeowner than those without post-secondary education (see Table 2).<sup>17</sup>

The probability of homeownership is generally lower for immigrant households – particularly in Italy and Luxembourg – and minority households and those not proficient in the official language of the country. In the United States, African Americans and Hispanic Americans are over 15 percentage points less likely to be homeowners than other Americans (Table 2), which is consistent with existing research (see Gabriel and Rosenthal,

Table 2. **Marginal-effects coefficients from the tenure choice equation<sup>1</sup>**

Dependent variable: Probability of being a homeowner

|                                                  | (1)<br>Austria |                | (2)<br>Finland |                | (3)<br>Italy |                | (4)<br>Spain |                | (5)<br>Switzerland |                |
|--------------------------------------------------|----------------|----------------|----------------|----------------|--------------|----------------|--------------|----------------|--------------------|----------------|
|                                                  | Coefficient    | Standard error | Coefficient    | Standard error | Coefficient  | Standard error | Coefficient  | Standard error | Coefficient        | Standard error |
| <b>Age of Household Head</b>                     |                |                |                |                |              |                |              |                |                    |                |
| 25-29 years                                      | -0.003         | (0.056)        | 0.117***       | (0.022)        | -0.272***    | (0.053)        | 0.055**      | (0.025)        | -0.268***          | (0.037)        |
| 30-34 years                                      | 0.112**        | (0.044)        | 0.194***       | (0.019)        | -0.234***    | (0.049)        | 0.084***     | (0.020)        | -0.131**           | (0.054)        |
| 35-44 years                                      | 0.170***       | (0.039)        | 0.258***       | (0.020)        | -0.078*      | (0.042)        | 0.102***     | (0.022)        | 0.061              | (0.061)        |
| 45-64 years                                      | 0.299***       | (0.034)        | 0.397***       | (0.023)        | 0.013        | (0.035)        | 0.176***     | (0.026)        | 0.239***           | (0.057)        |
| 65 years and over                                | 0.286***       | (0.033)        | 0.413***       | (0.016)        | 0.065*       | (0.034)        | 0.192***     | (0.021)        | 0.327***           | (0.059)        |
| <b>Household structure</b>                       |                |                |                |                |              |                |              |                |                    |                |
| Household Size                                   | 0.089***       | (0.013)        | 0.041***       | (0.014)        | 0.013*       | (0.008)        | ..           | ..             | 0.086***           | (0.019)        |
| H2: Couple with dependents                       | -0.016         | (0.032)        | -0.034         | (0.021)        | -0.125***    | (0.044)        | 0.000        | (0.011)        | -0.019             | (0.043)        |
| H3: Single without dependents                    | -0.046**       | (0.023)        | -0.017         | (0.026)        | -0.167***    | (0.035)        | -0.043***    | (0.012)        | -0.063*            | (0.034)        |
| H4: Single with dependents                       | -0.131***      | (0.039)        | -0.218***      | (0.041)        | -0.366***    | (0.098)        | -0.083***    | (0.026)        | -0.171***          | (0.042)        |
| Male household head                              | 0.029*         | (0.017)        | 0.010          | (0.013)        | -0.002       | (0.015)        | 0.011        | (0.009)        | 0.122***           | (0.025)        |
| <b>Real Household Disposable Income</b>          |                |                |                |                |              |                |              |                |                    |                |
| Income ('000s of national currency)              | 0.004***       | (0.001)        | 0.012***       | (0.002)        | 0.003***     | (0.000)        | 0.004***     | (0.000)        | 0.001***           | (0.000)        |
| <b>Education of household head</b>               |                |                |                |                |              |                |              |                |                    |                |
| Tertiary                                         | -0.014         | (0.029)        | 0.058***       | (0.016)        | 0.050**      | (0.023)        | -0.009       | (0.011)        | 0.027              | (0.033)        |
| <b>Indicators of socio-economic disadvantage</b> |                |                |                |                |              |                |              |                |                    |                |
| Disability (Household Head)                      | ..             | ..             | -0.016         | (0.016)        | -0.038       | (0.029)        | ..           | ..             | ..                 | ..             |
| Disability (Spouse of Household Head)            | ..             | ..             | 0.028          | (0.020)        | 0.001        | (0.040)        | ..           | ..             | ..                 | ..             |
| Ethnic minority                                  | -0.298***      | (0.031)        | -0.006         | (0.023)        | ..           | ..             | ..           | ..             | ..                 | ..             |
| Immigrant/Foreigner                              | ..             | ..             | ..             | ..             | -0.345***    | (0.034)        | ..           | ..             | -0.258***          | (0.021)        |
| Regional dummies                                 | No             |                | Yes            |                | Yes          |                | Yes          |                | No                 |                |
| Surveys                                          | 1987, 2004     |                | 1995, 2004     |                | 1991, 2004   |                | 1990, 2004   |                | 1992, 2004         |                |
| Number of observations                           | 16 294         |                | 20 488         |                | 16 171       |                | 33 986       |                | 9 547              |                |
| Classification rate                              | 64.78%         |                | 82.36%         |                | 68.72%       |                | 80.80%       |                | 69.64%             |                |

Note: Robust standard errors in parentheses. \* significant at 10%, \*\* significant at 5%; \*\*\* significant at 1%.

1. The regression results are based on a sample that pools data from the most recent household survey available, and data from an earlier period (generally the mid-1990s). The benchmark case against which the estimated coefficients and marginal probabilities are interpreted is a head of household aged 20-24, in a couple relationship with no children, with relatively low education and good health and not from an immigrant/ethnic background. See Appendix B for more details.

Source: OECD calculations based on household datasets sourced from LIS, the GSOEP and the American Housing Survey.

Table 2. **Marginal-effects coefficients from the tenure choice equation<sup>1</sup> (cont.)**

Dependent variable: Probability of being a homeowner

|                                                  | (1)<br>Canada |                | (2)<br>Denmark |                | (3)<br>Germany |                | (4)<br>United States |                | (5)<br>Australia |                | (6)<br>Luxembourg |                | (7)<br>United Kingdom |                |
|--------------------------------------------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------------|----------------|------------------|----------------|-------------------|----------------|-----------------------|----------------|
|                                                  | Coefficient   | Standard error | Coefficient    | Standard error | Coefficient    | Standard error | Coefficient          | Standard error | Coefficient      | Standard error | Coefficient       | Standard error | Coefficient           | Standard error |
| <b>Age of Household Head</b>                     |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| 25-29 years                                      | -0.002        | (0.028)        | 0.007          | (0.010)        | 0.146***       | (0.049)        | 0.111***             | (0.009)        | 0.086***         | (0.018)        | 0.055             | (0.046)        | 0.078***              | (0.011)        |
| 30-34 years                                      | 0.089***      | (0.024)        | 0.070***       | (0.010)        | 0.278***       | (0.043)        | 0.172***             | (0.007)        | 0.173***         | (0.013)        | 0.115***          | (0.037)        | 0.166***              | (0.008)        |
| 35-44 years                                      | 0.145***      | (0.022)        | 0.140***       | (0.009)        | 0.417***       | (0.037)        | 0.247***             | (0.007)        | 0.250***         | (0.012)        | 0.182***          | (0.035)        | 0.233***              | (0.008)        |
| 45-64 years                                      | 0.237***      | (0.020)        | 0.244***       | (0.008)        | 0.512***       | (0.034)        | 0.369***             | (0.008)        | 0.367***         | (0.014)        | 0.244***          | (0.038)        | 0.340***              | (0.009)        |
| 65 years and over                                | 0.228***      | (0.017)        | 0.301***       | (0.007)        | 0.588***       | (0.027)        | 0.365***             | (0.005)        | 0.365***         | (0.010)        | 0.274***          | (0.028)        | 0.340***              | (0.007)        |
| <b>Household structure</b>                       |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Household Size                                   | 0.015***      | (0.005)        |                |                | 0.013**        | (0.007)        | 0.014***             | (0.002)        | ..               | ..             | 0.056***          | (0.013)        |                       |                |
| Couple with dependents                           | -0.086**      | (0.034)        | 0.079***       | (0.009)        | 0.029*         | (0.016)        | ..                   | ..             | 0.021*           | (0.012)        | -0.031            | (0.034)        | 0.044***              | (0.010)        |
| Single without dependents                        | -0.187***     | (0.024)        | -0.161***      | (0.006)        | -0.143***      | (0.012)        | ..                   | ..             | -0.254***        | (0.014)        | -0.065**          | (0.028)        | -0.166***             | (0.009)        |
| Single with dependents                           | -0.340***     | (0.038)        | -0.211***      | (0.010)        | -0.167***      | (0.018)        | ..                   | ..             | -0.334***        | (0.025)        | -0.042            | (0.051)        | -0.277***             | (0.016)        |
| Male household head                              | 0.029***      | (0.007)        | 0.115***       | (0.005)        | -0.012         | (0.010)        | ..                   | ..             | -0.024**         | (0.011)        | -0.007            | (0.022)        | 0.013**               | (0.006)        |
| Married                                          | ..            | ..             | ..             | ..             | ..             | ..             | 0.223***             | (0.006)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Divorced, widowed, separated                     | ..            | ..             | ..             | ..             | ..             | ..             | 0.049***             | (0.005)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| <b>Real Household Disposable Income</b>          |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Income ('000s of national currency)              | 0.003***      | (0.001)        | 0.001***       | (0.000)        | 0.008***       | (0.000)        | 0.003***             | (0.000)        | 0.002***         | (0.000)        | 0.003***          | (0.000)        | 0.006***              | (0.001)        |
| <b>Education of household head</b>               |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Secondary                                        | 0.002         | (0.009)        | ..             | ..             | 0.087***       | (0.009)        | 0.054***             | (0.005)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Associate                                        | 0.046***      | (0.009)        | ..             | ..             | 0.060***       | (0.016)        | 0.061***             | (0.005)        | 0.070***         | (0.008)        | 0.101***          | (0.033)        | 0.162***              | (0.005)        |
| Tertiary                                         | 0.019         | (0.011)        | 0.064***       | (0.007)        | 0.046***       | (0.014)        | 0.067***             | (0.006)        | 0.041***         | (0.011)        | -0.037            | (0.025)        | 0.162***              | (0.007)        |
| <b>Indicators of socio-economic disadvantage</b> |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Disability (Household Head)                      | -0.041***     | (0.009)        | ..             | ..             | -0.027**       | (0.012)        | ..                   | ..             | ..               | ..             | ..                | ..             | -0.121***             | (0.005)        |
| Disability (Spouse of Household Head)            | -0.021        | (0.013)        | ..             | ..             | ..             | ..             | ..                   | ..             | ..               | ..             | ..                | ..             | -0.057***             | (0.007)        |
| Ethnic minority                                  | ..            | ..             | ..             | ..             | ..             | ..             | ..                   | ..             | ..               | ..             | ..                | ..             | -0.065***             | (0.011)        |
| Immigrant/Foreigner                              | ..            | ..             | -0.305***      | (0.007)        | ..             | ..             | ..                   | ..             | ..               | ..             | -0.353***         | (0.021)        | ..                    | ..             |
| Non-English Speaking Background                  | ..            | ..             | ..             | ..             | ..             | ..             | ..                   | ..             | -0.111***        | (0.015)        | ..                | ..             | ..                    | ..             |
| African American                                 | ..            | ..             | ..             | ..             | ..             | ..             | -0.180***            | (0.007)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Hispanic                                         | ..            | ..             | ..             | ..             | ..             | ..             | -0.164***            | (0.008)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Asian                                            | ..            | ..             | ..             | ..             | ..             | ..             | -0.202***            | (0.013)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| American Indian                                  | ..            | ..             | ..             | ..             | ..             | ..             | -0.074***            | (0.022)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Regional dummies                                 | Yes           |                | No             |                | Yes            |                | Yes                  |                | Yes              |                | No                |                | Yes                   |                |
| Surveys                                          | 1994, 2004    |                | 1992, 2004     |                | 1994, 2007     |                | 1997, 2007           |                | 1995, 2003       |                | 1997, 2004        |                | 1999, 2004            |                |
| Number of observations                           | 68 578        |                | 96 133         |                | 17 877         |                | 78 266               |                | 16 908           |                | 6 136             |                | 52 708                |                |
| Classification rate                              | 77.52%        |                | 75.31%         |                | 70.81%         |                | 77.52%               |                | 76.85%           |                | 77.95%            |                | 75.49%                |                |

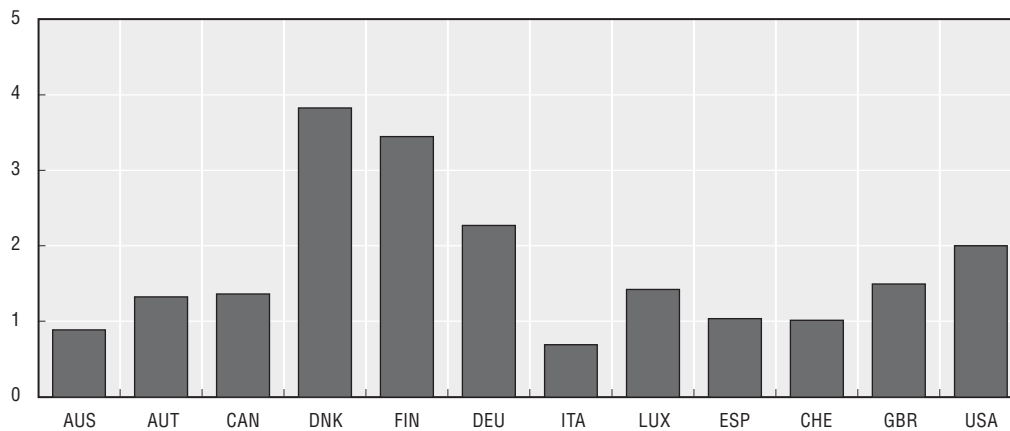
Note: Robust standard errors in parentheses. \* significant at 10%, \*\* significant at 5%; \*\*\* significant at 1%.

1. The regression results are based on a sample that pools data from the most recent household survey available, and data from an earlier period (generally the mid-1990s). The benchmark case against which the estimated coefficients and marginal probabilities are interpreted is a head of household aged 20-24, in a couple relationship with no children, with relatively low education and good health and not from an immigrant/ethnic background. See Appendix B for more details.

Source: OECD calculations based on household datasets sourced from LIS, the GSOEP and the American Housing Survey.

Figure 4. **Impact of a 10% increase in household disposable income on the probability of being a homeowner<sup>1</sup>**

Percentage change in the probability of being a homeowner, selected OECD countries



1. Calculations are based on the marginal effects estimation contained in Table 2, and show the impact on the probability of a 10% rise in household income from the sample mean level.

Source: OECD calculations based on household datasets sourced from LIS, the GSOEP and the American Housing Survey.

2005). The probability of homeownership also tends to be lower amongst households affected by health problems, possibly reflecting the financial strain associated with illness.

#### 4.1. Decomposing the change in aggregate homeownership rates

By combining the coefficient estimates with changes in the average characteristics over time (these changes are discussed in Appendix E of Andrews and Caldera Sánchez, 2011), it is possible to decompose the change in the aggregate homeownership rate as given by equation (3). Figure 5 decomposes the actual change in aggregate homeownership across the two survey years (expressed in percentage points) into three parts: the portion explained by changes in the age structure (the darker bar), the contribution of non-age factors (*e.g.* household structure, income *etc.*; the lighter bar) and a part unexplained by the model (shaded bar). The latter may reflect changes in economic behaviour and/or the impact of policy settings, which will be investigated in later sections. The 12 countries can be separated into two broad groups according to the observed changes in homeownership rates.

##### 4.1.1. Rising homeownership rates: Austria, Canada, Germany, Italy, Spain, Switzerland, the United Kingdom and the United States

- Changes in the characteristics of the population generally account for around three-quarters of the increase in aggregate homeownership rates in Austria and the United Kingdom.
- In Canada, Germany, Spain, Switzerland and the United States, changes in the characteristics of the population can only account for approximately one-third of the increase in aggregate homeownership rates, implying an important role for other factors.
- For Italy, the explained contribution to the change in the aggregate homeownership rate is negative, suggesting that other factors account for the rise in the aggregate homeownership rate.

#### 4.1.2. *Broadly flat or declining homeownership rates: Australia, Denmark, Finland, and Luxembourg*

- While the aggregate homeownership rate rose slightly in Denmark and Finland over the period studied, changes in the characteristics of the population implied a much larger increase in homeownership than what actually occurred. This implies that the aggregate homeownership rate in these countries would have declined considerably, had it not been for a shift in the characteristics of the population towards homeownership.
- In Australia and Luxembourg, the aggregate homeownership rate declined by around 2 percentage points over the decade to the mid-2000s. Australia's homeownership rate would have declined further had it not been for a shift in the characteristics of the population towards homeownership.<sup>18</sup> For both countries, the estimates point to a significant decline in the propensity for households to be homeowners, holding household characteristics constant.

The factors that account for the explained change in the aggregate homeownership rate are now briefly discussed. Appendix C contains the detailed decomposition estimates for each country.

#### 4.1.3. *Age structure*

Across the 12 OECD countries studied, changes in the age structure boosted the aggregate homeownership rate by  $\frac{3}{4}$ -1 percentage point on average, and the effect was somewhat larger in Switzerland, Germany, Denmark and Canada. Moreover, while the impact of population ageing was smaller in absolute terms in Australia and the United States, it nonetheless accounts for a significant proportion of the explained change in aggregate homeownership rates. Indeed, the estimates imply that the homeownership rate in Australia and Luxembourg would have declined even further over the period examined, had it not been for changes in age structure.<sup>19</sup>

#### 4.1.4. *Other explained factors*

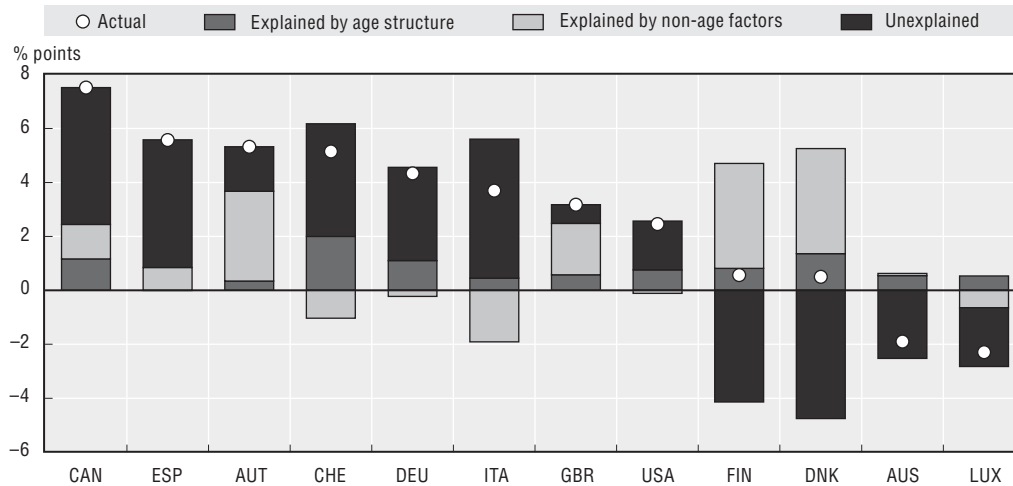
The decomposition estimates also suggest a role for changes in other household characteristics:

- Changes in household size and structure have generally exerted a downward influence on aggregate homeownership rates, particularly in Germany, Italy and Australia (Table 2). This generally reflects a rise in the share of single-headed households over the sample period, although in Italy a decline in average household size has also contributed. By contrast, changes in household size and structure have placed upward pressure on aggregate homeownership rates in Austria, Canada and Denmark.<sup>20</sup>
- Growth in real household disposable income generally has placed upward pressure on homeownership rates, particularly in Denmark and Finland, which is consistent with the large estimate effect of household income on homeownership probabilities. By contrast, relatively stagnant household incomes have exerted modest downward pressure on aggregate homeownership rates in Germany, Italy and Switzerland.
- With the exception of the United Kingdom, the impact of changes in education on aggregate homeownership rates is generally modest.
- An increase in the socio-economic disadvantaged – proxied by ethnic/immigrant and health status – has generally exerted downward influence on aggregate homeownership rates. This is particularly the case with respect to immigrant households in Italy and

Luxembourg. In Canada, an increase in the incidence of disability has exerted downward pressure on aggregate homeownership rates.

Figure 5. **The contribution of ageing to the change in the aggregate homeownership rate<sup>1</sup>**

Circa 1995 to 2005, selected OECD countries



1. The dot refers to the actual change in the aggregate homeownership rate over the period studied. This can be decomposed into a part explained by changes in household characteristics – which include age structure and other non-age factors such as household structure, household income, and education – and a component which is unexplained by changes in household characteristics.

Source: OECD calculations based on household datasets sourced from LIS, the GSOEP and the American Housing Survey.

Table 3. **Contribution of household size and structure to the change in aggregate homeownership**

Percentage point contribution, ranked in order of combined effect

|                | Explained by household size<br>(1) | Explained by household structure<br>(2) | Combined effect<br>(3) = (1) + (2) |
|----------------|------------------------------------|-----------------------------------------|------------------------------------|
| Austria        | 1.1                                | 0.2                                     | 1.2                                |
| Canada         | 0.1                                | 0.3                                     | 0.4                                |
| Denmark        | ..                                 | 0.3                                     | 0.3                                |
| Luxembourg     | -0.1                               | 0.1                                     | -0.1                               |
| Finland        | -0.3                               | 0.2                                     | -0.1                               |
| United Kingdom | ..                                 | -0.1                                    | -0.1                               |
| Spain          | ..                                 | -0.4                                    | -0.4                               |
| Switzerland    | -0.6                               | 0.2                                     | -0.4                               |
| United States  | 0.0                                | -0.4                                    | -0.5                               |
| Australia      | ..                                 | -0.7                                    | -0.7                               |
| Italy          | -0.4                               | -0.4                                    | -0.8                               |
| Germany        | -0.2                               | -0.8                                    | -1.0                               |

Note: The combined effect corresponds to the household size and structure bar in Figure C.1 and and C.2. For Australia, Denmark, Spain and the United Kingdom, the decompositions are based on regressions that do not include household size.

Source: OECD calculations based on household datasets sourced from LIS, the GSOEP and the American Housing Survey.

## 5. Empirical results: policy influences on tenure choice

Given that shifts in household characteristics can only explain part of the change in aggregate homeownership rates (Figure 5), there may be a role for policy factors in explaining these developments. For instance, the increased propensity for homeownership amongst households in the United States, holding their characteristics constant, is consistent with the considerable relaxation of lending standards that made mortgage debt available to households who would not otherwise have been homeowners (Doms and Krainer, 2007). Accordingly, this section sheds light on the influence of innovations in mortgage markets, tax relief on mortgage debt financing and rental market regulations on homeownership rates. For purposes of continuity, it is important to note that this analysis is generally based on the 12 countries studied in Section 4 plus Belgium, France and the Netherlands (see Appendix A). However, the results are broadly similar if the latter three countries are excluded.

### 5.1. Mortgage market innovations

The results from the cross-country panel estimation of equation (4), which examines the link between changes in the down-payment constraint and homeownership rates amongst marginal buyers, are summarised in Table 4. Other control variables (including demographic and socio-economic influences on homeownership) are not shown in the table for sake of brevity. To aid interpretation, an estimate of the total impact of financial deregulation evaluated at the sample median value of housing tax relief is also provided. In addition, Figure 6 shows the impact of a 10 percentage point rise in the LTV on the homeownership rate of different groups – relative to the group-specific sample median

Table 4. **Panel estimation of homeownership rates**

Households in income quartile 2

|                                                                                                                                                | All households |            | Households 25-34 years |            |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------|------------------------|------------|
|                                                                                                                                                | (1)            | (2)        | (3)                    | (4)        |
| <b>Variables of interest</b>                                                                                                                   |                |            |                        |            |
| Loan to value ratio (LTV)                                                                                                                      | 0.255***       |            | 0.594***               |            |
|                                                                                                                                                | [0.054]        |            | [0.125]                |            |
| LTV x Tax relief                                                                                                                               | -0.189**       |            | -0.471*                |            |
|                                                                                                                                                | [0.086]        |            | [0.268]                |            |
| Financial reform index                                                                                                                         |                | 5.742      |                        | 11.215*    |
|                                                                                                                                                |                | [4.119]    |                        | [6.255]    |
| Financial reform index x Tax relief                                                                                                            |                | -12.307*** |                        | -26.102*** |
|                                                                                                                                                |                | [3.005]    |                        | [6.325]    |
| <b>Impact of financial deregulation terms on homeownership rates evaluated at the median of the structural features (p-values in brackets)</b> |                |            |                        |            |
| LTV                                                                                                                                            | 0.192***       |            | 0.437***               |            |
|                                                                                                                                                | [0.001]        |            | [0.000]                |            |
| Financial reform index                                                                                                                         |                | 1.636***   |                        | 2.509***   |
|                                                                                                                                                |                | [0.002]    |                        | [0.001]    |
| Observations                                                                                                                                   | 63             | 60         | 60                     | 57         |
| Number of Countries                                                                                                                            | 16             | 16         | 15                     | 15         |
| R-squared                                                                                                                                      | 0.93           | 0.93       | 0.82                   | 0.79       |

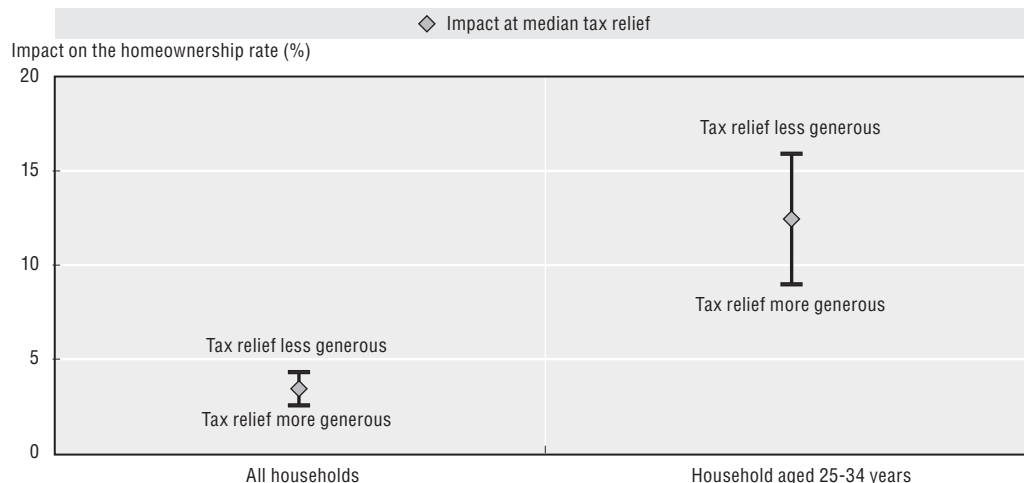
Note: Standard errors in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%. The regression includes country and time fixed effects and control variables, such as real household disposable income, real interest rates, real construction costs, house price-to-rent ratio, share of population aged 25-44 years and the homeownership rates of other income/age groups. The sample includes the following countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Luxembourg, the Netherlands, Spain, Switzerland, the United Kingdom and the United States.

homeownership rate – and how this impact varies with the extent of housing tax relief. Results are also presented using an index of financial reform (Abiad *et al.* 2008; see Figure 4 in Andrews, 2010), in place of the LTV, to demonstrate the robustness of the estimates (Columns 2 and 4). While additional analysis suggests the results are also broadly robust to controlling for evolution of the dwelling stock (as measured by the number of dwellings), changes in the composition of the dwelling stock may also matter for homeownership (Hilber, 2007). Unfortunately, data constraints make it difficult to test the importance of this hypothesis over the period of analysis.

With the above caveat in mind, financial deregulation has been associated with an increase in homeownership among households who are potentially financially constrained, via a reduction in the down-payment constraint. The estimates imply that a 10 percentage point increase in the LTV (i.e. a reduction in the down-payment constraint) could raise the homeownership rate of households in the second income quartile by 1.9 percentage points, holding all else equal (including the price-to-rent ratio). By comparison, a 10 percentage point increase in the LTV could raise the homeownership rate of households aged 25-34 years in the second income quartile by 4.4 percentage points,

**Figure 6. Homeownership, financial deregulation and housing tax relief**

Impact of a 10 percentage point increase in the maximum LTV ratio on the homeownership rate of households in the second income quartile relative to the sample median homeownership rate



*Note:* The figure shows the impact of a 10 percentage point – or one standard deviation – rise in the maximum LTV on the homeownership rate of each group. The impact on homeownership is expressed in percentage terms, relative to the sample median homeownership rate for each group, to control for differences in median level of homeownership between each group. The dot shows the estimated impact of an increase in the LTV on the group-specific homeownership rate when tax relief on mortgage debt financing is set equal to the sample median level. The upper (lower) bound shows the estimated impact when tax relief is set at 0.5 standard deviations below (above) the sample median level.

When Tax relief is set to the sample median, the overall impact coefficient on LTV is 0.19 for all households and 0.44 for those aged 25-34 years (see columns 1 and 3 of Table 3). In turn, these coefficients are used to construct the following policy experiments:

- i) *All households in the second income quartile:* a 10 percentage point rise in the LTV is associated with a 1.9 percentage point rise in the group-specific homeownership rate. This is equivalent to a 3.4% rise – as indicated by the dot – relative to the group-specific sample median homeownership rate of 55.6%.
- ii) *Households aged 25-34 years in the second income quartile:* a 10 percentage point rise in the LTV is associated with a 4.4 percentage point rise in the group-specific homeownership rate. This is equivalent to a 12.4% rise – as indicated by the dot – relative to the group-specific sample median homeownership rate of 35.1%.

*Sources:* LIS and OECD calculations. LTVs are plotted in Figure 14 of Andrews, Caldera Sánchez and Johansson (2011) and are sourced from Chiuri and Jappelli (2003), Catte *et al.* (2004) and ECB (2009).

holding all else equal. This is consistent with the idea that the down-payment constraint particularly affects younger households, who have had less time to accumulate a deposit.

Back of the envelope calculations suggest that the impact of a relaxation in the down-payment constraint on aggregate homeownership rates is in the same ballpark as the impact of population ageing on aggregate homeownership rates. Overall, the estimates imply that a 10 percentage point increase in the maximum LTV could be associated with a 0.5 percentage point increase in the aggregate homeownership from a sample median aggregate homeownership rate of 63.6%. In comparison, changes in the age structure boosted the aggregate homeownership rate by  $\frac{3}{4}$ -1 percentage point on average across the 12 OECD countries studied.

## 5.2. Tax relief on mortgage debt financing

The impact of mortgage market innovations on homeownership, however, is also influenced by the extent of tax relief for mortgage debt financing. The interaction between LTV and Taxrelief is negative and significant, which suggests that in countries with more generous tax relief on debt financing, the expansionary impact of an increase in the LTV ratio on the homeownership rate of financially-constrained households is smaller. In a typical OECD country, a 10 percentage point increase in the LTV is associated with a 4.4 percentage point rise in the homeownership rate of households aged 25-34 years in the second quartile. In a country where tax relief is half a standard deviation more generous, however, the impact is only 3.2 percentage points.

Thus, tax reliefs can distort the impact of other policies such as mortgage market innovations, and indirectly crowd-out financially constrained households from homeownership. This may reflect the greater tendency for house price capitalisation of demand shocks to occur in countries where housing tax relief is generous (see Andrews, 2010). In such environments, it is possible that the increase in the required deposit – due to higher real house prices – may have offset the easing of the down-payment constraint, thereby reducing housing affordability for the marginal buyer.<sup>21</sup> This interpretation is consistent with studies that show that higher real house prices can reduce homeownership rates amongst marginal buyers, by discouraging saving for a deposit and/or significantly increasing the period required to save for a deposit (Engelhardt, 1997; Engelhardt and Mayer, 1988).

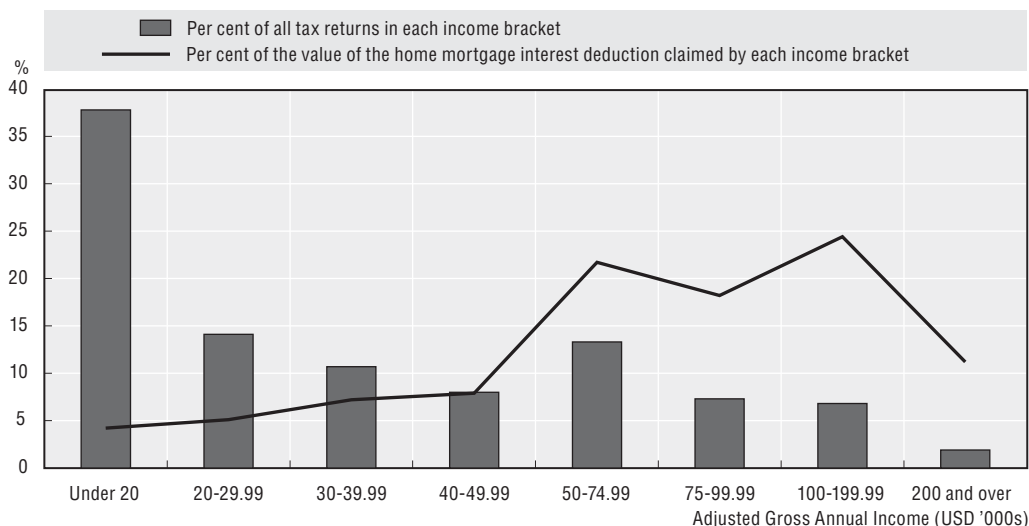
Of course, mortgage market innovations tend to have a direct effect on real house prices, irrespective of housing taxation arrangements, which may have offset the easing of the down-payment constraint on homeownership. For example, Andrews (2010) estimates that financial deregulation has boosted real prices by as much as 30% in the average OECD country over recent decades. The extent to which this reduces affordability for the marginal buyer, however, also depends on the extent to which housing supply responds, with the evidence suggesting that the impact of financial deregulation on house prices is smaller in environments where housing supply is more responsive to price developments (see Andrews, 2010; Favara and Imbs, 2009). Indeed, additional modelling (not presented here) suggests that the adverse affect of generous housing tax policies on homeownership is more acute in countries with more rigid housing supply, which is consistent with existing evidence from the United States (Toder et al. 2010). This hypothesis is tested by including a triple interaction term (Financial Reform\*Taxrelief\*Supplyelasticity) in the estimation framework outlined above (estimates of the elasticity of housing supply are sourced from Caldera-Sánchez and Johansson, 2011). However, this interaction term is not

always significant, especially in the specifications that include the LTV in place of the Financial Reform Index.

Since the direct effect of tax relief on the homeownership rate of households in the second income quartile (i.e. the marginal buyer) is not modelled, it is possible that this effect – to the extent it is positive – could offset the indirect effect identified above.<sup>22</sup> However, the direct effect is likely to be economically small since tax reliefs for debt financing costs generally take the form of a deduction against earned income, which is worth less to households in the second income quartile than to high-income earners. This is supported by data from the United States, which show that the bulk of the value of the mortgage interest deduction is claimed by a relatively small fraction of households with high incomes (Figure 7). For example, while over half of all filed tax returns in 2003 pertained to adjustable gross incomes of less than 30 000 USD, this income bracket accounted for just 9% of the value of mortgage interest deductions. By contrast, taxpayers with adjustable gross incomes over 75 000 USD claimed 54% of the value of home mortgage interest deductions, despite only accounting for 16% of tax filers.

Figure 7. **Who benefits from the home mortgage interest deduction?**

United States, 2003<sup>1</sup>



1. The columns show the share of tax filers in each income bracket, while the line shows the share of the value of mortgage interest deductions claimed by each income bracket. For instance, while 38% of all filed tax returns in 2003 pertained to adjustable gross incomes of less than 20 000 USD, this income bracket accounted for only 4% of the value of mortgage interest deductions. As noted in Prante (2006), while adjustable gross income differs somewhat from other measures of personal income, this distinction does not affect the distributional analysis shown above.

Source: Calculations from Prante (2006) based on Internal Revenue Service data.

### 5.3. Rental market regulations

Results also suggest a role for rental market regulations in influencing tenure choice, with stricter rent regulation and greater tenant protection associated with lower

probability to be a homeowner in the sample of countries studied. The results from the probit estimation of equation (5) reported in Table 4 show that<sup>23</sup>:

- Higher rent controls, measured by the rent control index (column 1) are associated with lower probability of homeownership. Similarly, higher security of tenure is also associated with lower homeownership (column 2).
- The estimates imply that decreasing rent control from the average observed in the sample of countries by  $\frac{1}{2}$  a standard deviation (or to the level in Ireland) would raise average homeownership by 4 percentage points. Lowering the security of tenure by  $\frac{1}{2}$  a standard deviation would, in turn, increase average homeownership by 2 percentage points.

Rental market regulations may impose costs, however, to the extent that they are capitalised into housing costs and undermine flexibility in the housing market. Across OECD countries, residential mobility tends to be lower – *all else equal* – in countries where rental market regulations are stricter, as measured by the degree of rent control and security of tenure (see Caldera Sánchez and Andrews, 2011). This may reflect the reluctance of sitting tenants in heavy regulated dwellings to move and give up their below-market rents.

Table 5. **The effect of policies on tenure choice**<sup>1</sup>

| Policies                                                                                  | (1)<br>Rent control  | (2)<br>Security of tenure |
|-------------------------------------------------------------------------------------------|----------------------|---------------------------|
| Dependent variable = 1 if homeowner; 0 if tenant (living in the private or social sector) |                      |                           |
| Policy                                                                                    | -0.083***<br>(0.002) | -0.071***<br>(0.003)      |
| Number of observations                                                                    | 224 359              | 235 953                   |
| Number of countries                                                                       | 22                   | 22                        |

1. This analysis covers the following countries: Australia, Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States. Regressions include control variables on household characteristics such as real household disposable income, age, education, employment status, household size, cohabitation status; as well as controls for the degree of urbanisation and total national income. Values are marginal effects. The coefficients correspond to the impact of one unit change in the probability to be a homeowner estimated at the mean of the independent variables. The sample is restricted to individuals who are the head of the household and aged 24-66 to avoid the results being influenced by atypical tenureship. The estimates are weighted by individual sampling probability. Robust standard errors clustered at the country level are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Sources: OECD calculations based on 2007 EU-SILC for European countries, 2007 HILDA for Australia, 2007 SHP for Switzerland, 2007 AHS for the United States and the OECD Housing Market questionnaire.

## 6. Conclusion

The results highlight the contribution of changes in demographic, socio-economic and selected policy variables to explaining patterns in aggregate homeownership rates across OECD countries over recent decades. Since the mid 1990s, part of the change in homeownership rates can be explained by changes in household characteristics. In some of the countries studied, population ageing and increases in real household incomes can each account for around 1 percentage point of the rise in aggregate homeownership rates, although the contribution of these factors can vary significantly across countries. Shifts in household characteristics, however, cannot account for all of the change, leaving a potential role for public policy in explaining developments in homeownership rates. Innovations in mortgage markets appear to have boosted aggregate homeownership rates,

and rough estimates suggest that this effect appears to be broadly comparable with the impact of population ageing. However, there is some evidence that the impact of mortgage market innovations has been distorted by generous housing tax relief, especially for lower income households due to the resulting increase in house prices. The evidence also suggests that rental market regulations impact homeownership by making renting more attractive, but these policies also carry costs.

To the extent that boosting homeownership is a public policy goal in some OECD countries, these results highlight some of the unintended consequences of current housing tax arrangements in many OECD countries. Of course, higher homeownership rates may not necessarily be desirable to the extent that they may constrain residential and labour mobility (see Caldera Sánchez and Andrews, 2011). Moreover, while alleviating credit constraints is generally desirable, it is important to acknowledge that the relaxation in lending standards can go too far, especially if this is associated with insufficient regulatory supervision as illustrated by recent developments in the United States (see Andrews, Caldera Sánchez and Johansson, 2011).

## Notes

1. See Andrews, Caldera Sánchez and Johansson (2011) for a discussion of the tax treatment of housing investment and mortgage market developments.
2. For a discussion on housing taxation, see Andrews, Caldera Sánchez and Johansson (2011).
3. The study uses various household-level micro datasets, such as the Luxembourg Income Study (LIS), American Housing Survey (AHS), German Socio-Economic Panel (GSOEP) and the European Union Statistics on Income and Living Conditions (EU-SILC). While a number of data sources are utilised to improve country coverage, coverage still varies significantly between the three main empirical strategies owing to the specific data requirements of each approach (see Appendix A).
4. Asymmetric information and other credit market friction mean that lenders often require equity contributions (i.e. a down-payment) from borrowers when granting a home mortgage loan.
5. Similarly, Duca and Rosenthal (1994) found that borrowing constraints lowered the United States homeownership rate by around 8 percentage points, disproportionately affecting younger households.
6. Regulatory ceilings on LTV ratios have tended to be particularly binding in Germany, while in other countries, LTVs are effectively capped by lengthy legal procedures in the event of default (Catte *et al.* 2004).
7. The specific focus on tax relief to debt financing is also appropriate, given the important changes that have taken place in mortgage markets in OECD countries over recent decades.
8. Tax relief on mortgage debt financing also encourages households (particularly those with high incomes) to hold more debt than otherwise (Hendershott *et al.* 2002).
9. This is the expression for the Blinder-Oaxaca decomposition based on a linear regression. To account for the binary dependent variable and the non-linear nature of equation (1), however, a more involved non-linear procedure proposed by Fairlie (1999) is adopted, although the intuition is essentially the same as in the linear case. See Appendix C of Andrews and Caldera Sánchez (2011) for more details.
10. This is obtained by deflating the nominal income measure contained in the survey by the consumer price index.
11. To the extent that housing costs tend to be higher in large cities, regional dummies may provide a reasonable proxy for relative house prices.
12. In the context of equation (4), this implies that  $j = 2$  and a separate model is estimated for both groups.
13. For example, if the homeownership rate of the other income quartiles is not held constant, then it is possible that a rise in the LTV could increase  $HO^{Quartile2}$  at the expense of another income

quartile, thereby making inferences about the impact on the aggregate homeownership rate difficult.

14. The model does not include regional-fixed effects because data on household location are not available for more than half of the countries in the sample.
15. A possible solution is to include country-fixed effects to control for time-invariant, country-specific factors. However, since the policy variables in equation (5) are only measured at a single point, their impact on tenure could no longer be identified since they would be subsumed in the country-fixed effects.
16. In half of the countries studied, there tends to be little difference between the probability of homeownership for couple-headed households with children compared with those without. While it is not possible to separate household structure into the same categories for the United States, the probability of homeownership tends to be higher amongst married households and households where the head has been previously married.
17. By contrast, the estimates from the tenure choice equation for Australia – which is most comparable with the United Kingdom – suggest a much smaller impact of education on the probability to be a homeowner. For example, households with tertiary and associate-level (i.e. trade) qualifications in Australia are only 4 percentage points and 7 percentage points more likely to be homeowners than those without post-secondary education.
18. Additional modelling (not shown) based on the Household, Income and Labour Dynamics in Australia Survey suggests a further unexplained decline in Australia's homeownership rate up until 2007.
19. The decomposition estimates suggest that changes in the age structure had little impact on the aggregate homeownership rate in Spain. This reflects the fact that while the average age increased by over one year in Spain over the period studied, the share of households in the 45-64 age bracket – the group with the highest propensity to be homeowners according to the tenure choice equation – declined somewhat. This result is robust to using different age brackets in the tenure choice estimation.
20. In Canada, the positive contribution from household structure reflects a decline in single-headed households coupled with a negative marginal impact of being a single-headed household on homeownership propensities (Table 2).
21. For instance, Battelino (2009) notes that a particular problem for first-home owners in Australia is that the rise in the ratio of house prices to income has substantially increased the deposit required to access the market.
22. The direct effect of tax relief for debt financing costs on homeownership is not modelled since the variable used to proxy tax relief is time invariant and is thus subsumed in the country-fixed effects.
23. The control variables, omitted from the table for the sake of brevity and listed at the bottom of Table 3 are generally of the expected sign and significance. The results are also robust to controlling for cross-country differences in the share of private rentals in the housing stock.

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## APPENDIX A

### *Data Sources*

The data sources and country coverage varies somewhat according to the empirical approach. This Appendix provides a further elaboration on these issues.

#### **Stylised facts and homeownership decomposition**

To assess the contribution of shifts in household characteristics to aggregate homeownership rates over time, country-level household surveys from multiple time periods are required. Suitable household surveys for 12 OECD countries were obtained, primarily from the *Luxembourg Income Study* (LIS). For many of these countries, LIS provides around four or five cross sections, repeated at roughly five-year intervals, beginning in the early- to mid-1980s. At the time the modelling was undertaken, wave 6 surveys (circa 2004) were available for 11 OECD member countries: Australia, Austria, Canada, Denmark, Finland, Italy, Luxembourg, Spain, Switzerland, the United Kingdom and the United States. While the LIS database contains survey data for the United States, a consistent measure of the household's ethnic status – which has been shown to be an important determinant of homeownership (see Gabriel and Rosenthal, 2005) – is not available across the various surveys. Accordingly, the data for the United States in this paper are drawn from the 1997 and 2007 editions of the *American Housing Survey*. Similarly, since the wave 6 LIS dataset for Germany was not available at the time the decomposition analysis was undertaken, data for Germany are sourced from the 1994 and 2007 editions of the *German Socio-Economic Panel Study* (GSOEP). Accordingly, empirical decompositions are conducted for these 12 countries.

Repeated cross-sectional surveys are also available for Belgium, France and the Netherlands, but decompositions were not conducted for these countries since the latest available data were somewhat dated (circa 2000). Data of sufficient quality were lacking for Korea, Japan, New Zealand, Norway and Sweden,<sup>1</sup> and finally estimates are not presented for eastern European countries such as Hungary, Poland and Slovenia.<sup>2</sup>

#### **Cross-country panel analysis**

The cross-country panel analysis – which estimates how changes in financial and tax policies influence homeownership rates of some population groups over time – also utilises data from LIS. Unlike the decomposition analysis which explicitly models tenure choice at the household level, this analysis aggregates the household data to two groups of interest: average homeownership rates of households in the second income quartile – a potential proxy for the marginal buyer – and the average homeownership rate of very

young households (aged 25-34 years) in the second income quartile. While the influence of financial and tax policies on the marginal buyer could also be tested by pooling the various surveys and estimating the impact at the household level, this is not possible due to restrictions on access to the LIS data.<sup>3</sup>

The sample consists of an unbalanced panel of 15 OECD countries, and homeownership rates are observed at 5-year intervals, generally beginning in the early-to-mid 1980s and concluding around 2004. More specifically, the sample includes the 12 countries mentioned above plus Belgium, France and the Netherlands, though for the latter three countries, the most recent (*circa* 2005) data are not available. Finally, unlike in the decomposition analysis, the data for both Germany and the United States are sourced from LIS to take advantage of the relatively long time series that the LIS database provides.

### Cross-sectional analysis

A cross-sectional modelling approach is adopted to estimate the impact of rental regulations on tenure choice at the household level. The cross-sectional – as opposed to panel – approach reflects the fact that the indicators of rental regulations are only available at a single point in time. To the extent that the data requirements are less demanding, however, data for a much broader sample of OECD countries – based on more timely data (from 2007) – are utilised. The sample is based on 22 OECD countries, sourced from the European Union Statistics on Income and Living Conditions (EU-SILC) household database, the Household, Income and Labour Dynamics in Australia Survey, Swiss Household Panel and the American Housing Survey.

### Notes

1. There are no time series data available for Korea, while Japan and New Zealand are not LIS members. The survey question referring to tenure status is missing for Norway and contains a large number of missing observations for Sweden.
2. While survey data for these countries are available, the tenure choice equations tend to perform poorly for Eastern European countries – possibly due to the very high rates of homeownership, which make it difficult to distinguish the impact of household characteristics on homeownership.
3. It is not possible to directly access the various LIS household surveys due to confidentiality restrictions. Instead, the data are accessed by sending a statistical code to a server, and estimation results are subsequently returned. This process effectively places computational limits on the estimation, which means that it is very cumbersome to estimate models that require the pooling of numerous households datasets.

## APPENDIX B

### *Empirical Results*

The regression results in Table B.1 are based on a sample that pools data from the most recent household survey available, and data from an earlier period (generally the mid-1990s). The benchmark case against which the estimated coefficients and marginal probabilities are interpreted is a head of household aged 20-24, in a couple relationship with no children, with relatively low education and good health and not from an immigrant/ethnic background.

In initial specifications for Australia, Denmark, Spain and the United Kingdom, the coefficient on household size was negative. This appears to reflect a multicollinearity problem between household size and household structure, so household size was excluded from the baseline tenure choice equation. For Austria, Denmark, Finland, Italy, Spain and Switzerland, data constraints mean that it is only possible to assess the relationship between education and homeownership using a dummy variable which takes the value 1 if the household head has tertiary education. For Australia, Canada, Germany, Luxembourg, the United Kingdom and the United States, more detailed data on the educational level of the household head are available. For approximately one-half of the countries modelled, the interaction terms between income and age/household structure were insignificant and, thus, excluded from the baseline regression, while regional dummies are included in two-thirds of the countries studied.

Table B.1. **Logistic regression coefficients from the tenure choice equation**

Dependent variable: Probability of being a homeowner

|                                                  | (1)<br>Austria |                | (2)<br>Finland |                | (3)<br>Italy |                | (4)<br>Spain |                | (5)<br>Switzerland |                |
|--------------------------------------------------|----------------|----------------|----------------|----------------|--------------|----------------|--------------|----------------|--------------------|----------------|
|                                                  | Coefficient    | Standard error | Coefficient    | Standard error | Coefficient  | Standard error | Coefficient  | Standard error | Coefficient        | Standard error |
| <b>Age of Household Head</b>                     |                |                |                |                |              |                |              |                |                    |                |
| 25-29 years                                      | -0.022         | (0.225)        | 0.488***       | (0.136)        | -1.126***    | (0.217)        | 0.544*       | (0.302)        | -1.680***          | (0.395)        |
| 30-34 years                                      | 0.444**        | (0.188)        | 1.160***       | (0.139)        | -0.978***    | (0.198)        | 0.895***     | (0.290)        | -0.694**           | (0.307)        |
| 35-44 years                                      | 0.679***       | (0.170)        | 1.593***       | (0.132)        | -0.350*      | (0.179)        | 1.028***     | (0.281)        | 0.241              | (0.262)        |
| 45-64 years                                      | 1.239***       | (0.157)        | 2.277***       | (0.131)        | 0.053        | (0.163)        | 1.663***     | (0.280)        | 1.020***           | (0.248)        |
| 65 years and over                                | 1.233***       | (0.162)        | 2.985***       | (0.139)        | 0.303*       | (0.164)        | 2.044***     | (0.283)        | 1.430***           | (0.255)        |
| <b>Household structure</b>                       |                |                |                |                |              |                |              |                |                    |                |
| Household Size                                   | 0.333***       | (0.050)        | 0.173***       | (0.044)        | 0.056        | (0.035)        | ..           | ..             | 0.367***           | (0.084)        |
| H2: Couple with dependents                       | -0.039         | (0.127)        | -0.112         | (0.091)        | -0.590***    | (0.178)        | 0.003        | (0.093)        | -0.057             | (0.197)        |
| H3: Single without dependents                    | -0.142         | (0.094)        | -0.084         | (0.108)        | -0.711***    | (0.141)        | -0.320***    | (0.091)        | -0.249             | (0.158)        |
| H4: Single with dependents                       | -0.485***      | (0.165)        | -0.936***      | (0.146)        | -1.496***    | (0.446)        | -0.560***    | (0.154)        | -0.877***          | (0.289)        |
| Male household head                              | 0.105          | (0.068)        | 0.044          | (0.061)        | -0.011       | (0.069)        | 0.092        | (0.076)        | 0.562***           | (0.125)        |
| <b>Real Household Disposable Income</b>          |                |                |                |                |              |                |              |                |                    |                |
| Income                                           | 0.029***       | (0.005)        | 0.062***       | (0.006)        | 0.000***     | (0.000)        | 0.040***     | (0.004)        | 0.011***           | (0.002)        |
| Income squared                                   | 0.000***       | (0.000)        | 0.000***       | (0.000)        | 0.000***     | (0.000)        | 0.000***     | (0.000)        | 0.000***           | (0.000)        |
| <b>Education of household head</b>               |                |                |                |                |              |                |              |                |                    |                |
| Tertiary                                         | -0.089         | (0.113)        | 0.295***       | (0.064)        | 0.222*       | (0.114)        | -0.080       | (0.087)        | 0.117              | (0.146)        |
| <b>Indicators of socio-economic disadvantage</b> |                |                |                |                |              |                |              |                |                    |                |
| Disability (Household Head)                      | ..             | ..             | -0.067         | (0.072)        | -0.166       | (0.127)        | ..           | ..             | ..                 | ..             |
| Disability (Spouse of Household Head)            | ..             | ..             | 0.126          | (0.095)        | 0.005        | (0.184)        | ..           | ..             | ..                 | ..             |
| Ethnic minority                                  | -1.269***      | (0.168)        | -0.023         | (0.113)        | ..           | ..             | ..           | ..             | ..                 | ..             |
| Immigrant/Foreigner                              | ..             | ..             | ..             | ..             | -1.436***    | (0.152)        | ..           | ..             | -1.382***          | (0.148)        |
| Constant                                         | -2.292***      | (0.220)        | -2.694***      | (0.165)        | 0.387*       | (0.221)        | -0.572*      | (0.315)        | -2.780***          | (0.355)        |
| <b>Interaction terms</b>                         |                |                |                |                |              |                |              |                |                    |                |
| Income * Age                                     | No             |                | No             |                | No           |                | No           |                | No                 |                |
| Income * Household structure                     | No             |                | No             |                | Yes          |                | No           |                | No                 |                |
| Regional dummies                                 | No             |                | Yes            |                | Yes          |                | Yes          |                | No                 |                |
| Surveys                                          | 1987, 2004     |                | 1995, 2004     |                | 1991, 2004   |                | 1990, 2004   |                | 1992, 2004         |                |
| Number of observations                           | 16 294         |                | 20 488         |                | 16 171       |                | 33 986       |                | 9 547              |                |
| Classification rate                              | 64.78%         |                | 82.36%         |                | 68.72%       |                | 80.80%       |                | 69.64%             |                |

Note: Robust standard errors in parentheses, \* significant at 10%, \*\* significant at 5%, \*\*\* significant at 1%.

Sources: OECD, LIS, German socioeconomic Panel and American Housing Survey.

Table B.1. **Logistic regression coefficients from the tenure choice equation (cont.)**

Dependent variable: Probability of being a homeowner

|                                                  | (1)<br>Canada |                | (2)<br>Denmark |                | (3)<br>Germany |                | (4)<br>United States |                | (5)<br>Australia |                | (6)<br>Luxembourg |                | (7)<br>United Kingdom |                |
|--------------------------------------------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------------|----------------|------------------|----------------|-------------------|----------------|-----------------------|----------------|
|                                                  | Coefficient   | Standard error | Coefficient    | Standard error | Coefficient    | Standard error | Coefficient          | Standard error | Coefficient      | Standard error | Coefficient       | Standard error | Coefficient           | Standard error |
| <b>Age of Household Head</b>                     |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| 25-29 years                                      | -0.032        | (0.100)        | 0.087          | (0.113)        | 0.568***       | (0.199)        | 0.548**              | (0.059)        | 0.220            | (0.246)        | 0.301             | (0.292)        | 0.454***              | (0.115)        |
| 30-34 years                                      | 0.498***      | (0.101)        | 0.377***       | (0.114)        | 1.118***       | (0.194)        | 1.098**              | (0.058)        | 0.795***         | (0.229)        | 0.709**           | (0.281)        | 1.076***              | (0.119)        |
| 35-44 years                                      | 0.967***      | (0.090)        | 0.844***       | (0.112)        | 1.757***       | (0.187)        | 1.627**              | (0.055)        | 1.381***         | (0.210)        | 1.148***          | (0.273)        | 1.278***              | (0.099)        |
| 45-64 years                                      | 1.580***      | (0.085)        | 1.355***       | (0.088)        | 2.241***       | (0.185)        | 2.313**              | (0.055)        | 1.857***         | (0.208)        | 1.453***          | (0.263)        | 1.687***              | (0.109)        |
| 65 years and over                                | 1.715***      | (0.101)        | 1.905***       | (0.083)        | 2.767***       | (0.186)        | 3.007**              | (0.058)        | 2.442***         | (0.218)        | 1.934***          | (0.266)        | 2.091***              | (0.097)        |
| <b>Household structure</b>                       |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Household Size                                   | 0.050***      | (0.015)        |                |                | 0.031          | (0.027)        | 0.067**              | (0.008)        | ..               | ..             | 0.284***          | (0.068)        |                       |                |
| Couple with dependents                           | -0.351***     | (0.085)        | 0.322**        | (0.139)        | 0.150**        | (0.067)        | ..                   | ..             | -0.250*          | (0.144)        | -0.138            | (0.180)        | -0.054                | (0.108)        |
| Single without dependents                        | -0.830***     | (0.060)        | -0.864***      | (0.069)        | -0.579***      | (0.053)        | ..                   | ..             | -1.423***        | (0.106)        | -0.319**          | (0.143)        | -0.886***             | (0.076)        |
| Single with dependents                           | ..            | ..             | ..             | ..             | -0.713***      | (0.094)        | ..                   | ..             | ..               | ..             | ..                | ..             | ..                    | ..             |
| Male household head                              | 0.151***      | (0.024)        | 0.483***       | (0.020)        | -0.054         | (0.040)        | 0.065**              | (0.020)        | -0.149**         | (0.063)        | -0.043            | (0.122)        | 0.052*                | (0.029)        |
| Married                                          | ..            | ..             | ..             | ..             | ..             | ..             | 1.124**              | (0.030)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Divorced, widowed, separated                     | ..            | ..             | ..             | ..             | ..             | ..             | 0.287**              | (0.029)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| <b>Real Household Disposable Income</b>          |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Income                                           | 0.021***      | (0.002)        | 0.007***       | (0.000)        | 0.001***       | (0.000)        | 0.000**              | (0.000)        | -0.004           | (0.005)        | 0.019***          | (0.003)        | 0.015***              | (0.004)        |
| Income squared                                   | 0.000***      | (0.000)        | 0.000***       | (0.000)        | -0.000***      | (0.000)        | -0.000**             | (0.000)        | 0.000            | (0.000)        | 0.000**           | (0.000)        | 0.000***              | (0.000)        |
| <b>Education of household head</b>               |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Secondary                                        | 0.013         | (0.032)        | ..             | ..             | 0.358***       | (0.040)        | 0.275**              | (0.027)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Associate                                        | 0.199***      | (0.033)        | ..             | ..             | 0.225***       | (0.063)        | 0.298**              | (0.029)        | 0.386***         | (0.048)        | 0.635**           | (0.259)        | 0.889***              | (0.029)        |
| Tertiary                                         | 0.036         | (0.042)        | 0.285***       | (0.027)        | 0.147***       | (0.055)        | 0.321**              | (0.032)        | 0.218***         | (0.066)        | -0.234*           | (0.129)        | 1.003***              | (0.045)        |
| <b>Indicators of socio-economic disadvantage</b> |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Disability (Household Head)                      | -0.193***     | (0.028)        | ..             | ..             | -0.106**       | (0.052)        | ..                   | ..             | ..               | ..             | ..                | ..             | -0.599***             | (0.025)        |
| Disability (Spouse of Household Head)            | -0.089**      | (0.045)        | ..             | ..             | ..             | ..             | ..                   | ..             | ..               | ..             | ..                | ..             | -0.320***             | (0.038)        |
| Ethnic minority                                  | ..            | ..             | ..             | ..             | ..             | ..             | ..                   | ..             | ..               | ..             | ..                | ..             | -0.318***             | (0.053)        |
| Immigrant/Foreigner                              | ..            | ..             | -1.298***      | (0.039)        | ..             | ..             | ..                   | ..             | ..               | ..             | -1.706***         | (0.097)        | ..                    | ..             |
| Non-English Speaking Background                  | ..            | ..             | ..             | ..             | ..             | ..             | ..                   | ..             | -0.545***        | (0.067)        | ..                | ..             | ..                    | ..             |
| African American                                 | ..            | ..             | ..             | ..             | ..             | ..             | -0.767**             | (0.027)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Hispanic                                         | ..            | ..             | ..             | ..             | ..             | ..             | -0.659**             | (0.031)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Asian                                            | ..            | ..             | ..             | ..             | ..             | ..             | -0.921**             | (0.051)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| American Indian                                  | ..            | ..             | ..             | ..             | ..             | ..             | -0.438**             | (0.086)        | ..               | ..             | ..                | ..             | ..                    | ..             |
| Constant                                         | -1.504***     | (0.104)        | -2.566***      | (0.101)        | -5.067***      | (0.249)        | -3.349**             | (0.064)        | -0.448**         | (0.220)        | -1.074***         | (0.321)        | -0.287**              | (0.118)        |
| <b>Interaction terms</b>                         |               |                |                |                |                |                |                      |                |                  |                |                   |                |                       |                |
| Income * Age                                     | Yes           |                | Yes            |                | No             |                | No                   |                | Yes              |                | No                |                | Yes                   |                |
| Income * Household structure                     | Yes           |                | Yes            |                | No             |                | No                   |                | Yes              |                | No                |                | Yes                   |                |
| Regional dummies                                 | Yes           |                | No             |                | Yes            |                | Yes                  |                | Yes              |                | No                |                | Yes                   |                |
| Surveys                                          | 1994, 2004    |                | 1992, 2004     |                | 1994, 2007     |                | 1997, 2007           |                | 1995, 2003       |                | 1997, 2004        |                | 1999, 2004            |                |
| Number of observations                           | 68 578        |                | 96 133         |                | 17 485         |                | 78 266               |                | 16 908           |                | 6 136             |                | 52 708                |                |
| Classification rate                              | 77.52%        |                | 75.31%         |                | 70.81%         |                | 77.52%               |                | 76.85%           |                | 77.95%            |                | 75.49%                |                |

Note: Robust standard errors in parentheses, \* significant at 10%, \*\* significant at 5%, \*\*\* significant at 1%.

Sources: OECD, LIS, German socioeconomic Panel and American Housing Survey.

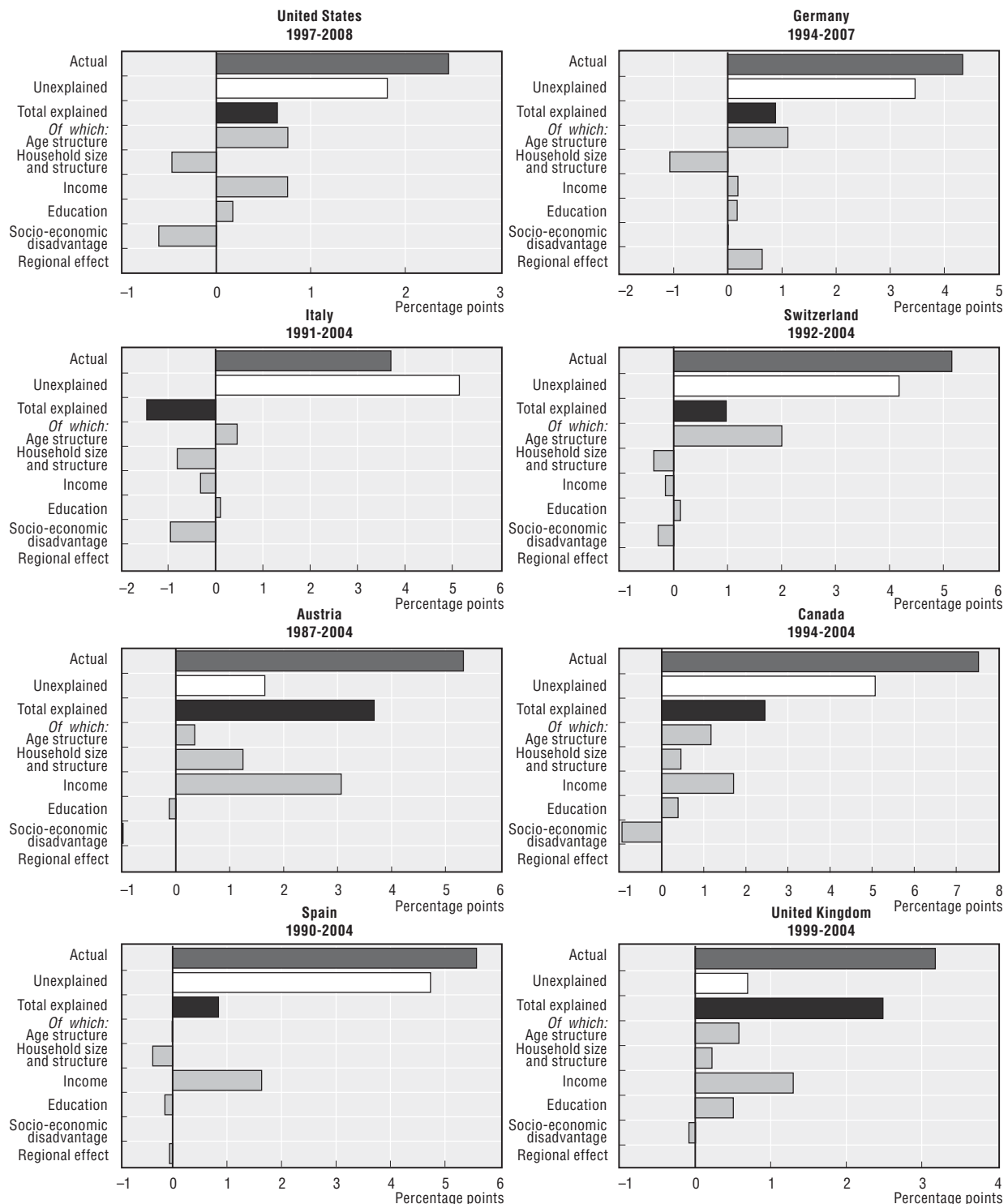
## APPENDIX C

### *Detailed Decomposition Results*

The following charts isolate the contribution of each explanatory variable included in the tenure choice equation to the change in the homeownership rate. Together, these characteristics sum to the total explained column. For some countries, the characteristics do not perfectly sum to the total explained bar, because variables that make a very small contribution (such as the regional dummies or the male household head dummy) are generally excluded for presentational purposes. Figure C.1 contains the detailed decomposition estimates for countries where the aggregate homeownership rate increased noticeably over recent times, while the estimates for countries where the aggregate homeownership rate has declined or changed little are shown in Figure C.2.

Figure C.1. **Detailed decompositions: countries with rising homeownership rates**

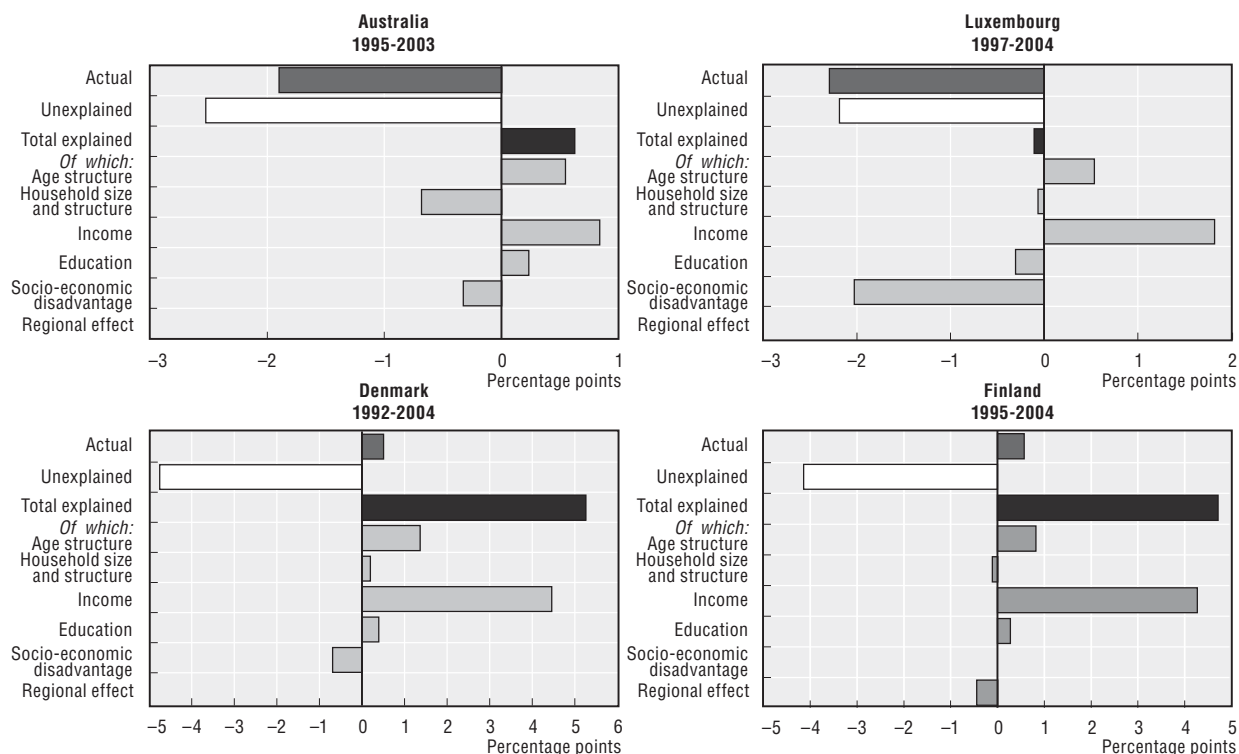
Fairlie non-linear decomposition



Source: OECD calculations based on Luxembourg Income Study (LIS), GSOEP and the American Housing Survey.

Figure C.2. **Detailed decompositions: countries with stable or declining homeownership rates**

Fairlie non-linear decomposition



Source: OECD calculations based on Luxembourg Income Study (LIS).

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