OECD Compendium of Productivity Indicators 2012

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BETTER POLICIES FOR BETTER LIVES

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FOREWORD

Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labour and capital, are being used in an economy to produce a given level of output. Productivity is considered a key source of economic growth and competitiveness and, as such, internationally comparable indicators of productivity are central for assessing economic performance.

In line with increasing demand from OECD countries for policy advice on international competitiveness and economic growth, productivity measurement and analysis have been an important focus of OECD work. This work has included both, efforts to improve the measurement of productivity growth, as well as efforts to enhance the understanding of the drivers of productivity performance. A central aim in this context has been international comparability which led to the development of the *OECD Productivity Databases* for the economy as a whole in 2004 and the extension to industry comparisons in 2011.

In the wake of the 2008 financial crisis and the current Euro area crisis, competitiveness has returned to the top of the policy agenda. Productivity and unit labour costs are widely recognised as being two of the most important drivers in this context. Against this background, this *Compendium of Productivity Indicators* presents a broad overview of recent and longer term trends in productivity levels and growth in OECD countries (Part I). It also highlights some of the key measurement issues faced when compiling cross-country comparable productivity indicators and describes the caveats needed in analyses (Part II). It analyses the role of productivity as the main driver of economic growth and convergence and the contributions of labour, capital and MFP in driving economic growth. It looks at the contribution of individual industries or sectors as well as the role of firm size and business dynamics for productivity growth. It analyses the link between productivity, unit labour costs and international competitiveness. And it asks what determines the cyclical patterns of labour and multifactor productivity growth.

This *Compendium of Productivity Indicators* is a joint initiative of the OECD Statistics Directorate and the OECD Directorate for Science, Technology and Industry. It has been prepared and authored by Anita Wölfl, with research assistance from Benoît Arnaud, Agnès Cimper, Julien Dupont, Frédéric Parrot and Bo Werth. Nadim Ahmad and Colin Webb acted as Editors. The previous *Compendium of Productivity Indicators* was issued in 2008.

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INTRODUCTION

Why Productivity matters

Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labour and capital, are being used in an economy to produce a given level of output. Productivity is considered a key source of economic growth and competitiveness and, as such, internationally comparable indicators of productivity are central for assessing economic performance.

There are different measures of productivity. The key distinguishing factor reflects the policy focus but data availability can also be a determining factor. One of the most widely used measures of productivity is Gross Domestic Product (GDP) per hour worked. This measure captures the use of labour inputs better than measures based on numbers of persons employed. Generally, the default source for total hours worked is the OECD *System of National Accounts* (SNA) database, though for a number of countries other sources have to be used. Despite the progress and efforts in this area, the measurement of hours worked still suffers from a number of statistical problems that can hinder international comparability.

To take account of the role of capital inputs, an appropriate measure is the flow of productive services that can be drawn from the cumulative stock of past investments (such as machinery and equipment). These services are estimated by the OECD using the rate of change of the 'productive capital stock', which takes into account wear and tear, retirements and other sources of reduction in the productive capacity of fixed capital assets. The price of capital services per asset is measured as their rental price. In principle, the latter could be directly observed if markets existed for all capital services. In practice, however, rental prices have to be imputed for most assets, using the implicit rent that capital goods' owners 'pay' to themselves (or the 'user costs of capital').

After computing the contributions of labour and capital to output, the so-called multifactor productivity (MFP) can be derived. It measures the residual growth that cannot be explained by the rate of change in the services of labour and capital. MFP is often perceived as a pure measure of technological change, but in reality it should be interpreted in a broader sense that partly reflects the way capital and labour inputs are measured. On top of disembodied technological change, in practice, as is the case in this publication, it also captures economies of scale, adjustment costs, pure efficiency change, variations in capacity utilisation, and measurement errors.

Gains in productivity also influence the development of Unit labour costs (ULCs), one of the most commonly used indicators to assess a country's international competitiveness. Despite their appeal, however, the ability of ULCs to inform policies targeting international competitiveness may be limited.

This relates to the increasing need to take into account growing global value chains and international fragmentation of production processes the effects of which may not be captured sufficiently by ULCs.

Against this background, this *OECD Compendium of Productivity Indicators* presents a broad overview of recent and longer terms trends in productivity levels and growth in OECD countries and highlights some of the key measurement issues faced when compiling cross-country comparable productivity indicators. The empirical evidence presented provides some insights on:

- the role of productivity as the main driver of economic growth and convergence (section 1);
- the role played by labour, capital and MFP in driving economic growth (section 2);
- the contribution of individual industries or sectors to aggregate labour productivity growth (section 3);
- the role of small, medium and large firms, as well as entry and exit of firms for productivity levels and growth (section 4);
- the link between productivity, unit labour costs and international competitiveness (section 5); and
- the cyclical patterns of labour and multifactor productivity growth (section 6).

Main results

In the wake of the 2008 financial crisis and the current Euro area crisis, competitiveness has returned to the top of the policy agenda. Productivity and unit labour costs are widely recognised as being two of the most important drivers in this context. The empirical evidence in this publication provides important insights in to how the crisis affected patterns of productivity growth and its components across countries. It does this by presenting the indicators over three distinctive time periods: *i)* 1995-2011; *ii)* 2001-2007; and *iii)* 2007-2010/11; with the latter period being specifically defined to capture the changes that occurred during and since the crisis.

Longer term trends of productivity

- Productivity growth is key to improving GDP per capita and hence living standards. Differences in GDP per capita growth across OECD countries in the last fifteen years can be mainly attributed to differences in growth in GDP per hour worked (labour productivity). In contrast, labour utilisation has shown little change.
- Very high growth rates in GDP per capita have meant that some countries with initially low GDP per capita levels have converged towards average income levels in the OECD. This process of convergence was typically driven by strong growth in labour productivity. But, in 2011, significant differences in per capita incomes remained across OECD countries, mainly reflecting differences in labour productivity levels and only marginally labour utilisation.
- From 1995 to 2010, GDP growth in most OECD countries was largely driven by growth in capital and MFP. As a corollary, MFP was the major driver of labour productivity, representing between one half and two thirds of aggregate labour productivity growth across countries.
- Productivity growth in the non-agricultural business sector was almost entirely driven by manufacturing and market services. In the case of manufacturing, this reflects relatively high

productivity growth rates. In the case of market services, where productivity growth was lower, it partly reflects a continuing shift in employment and value added towards specialised market services.

- Labour productivity growth in the manufacturing sector was almost entirely driven by MFP. MFP was also the main driver in the business services sector.
- Firm-size matters for productivity; although the link is more pronounced for levels than for growth. Larger firms are on average more productive than smaller ones - a conclusion that generally holds for all industries in all countries.
- There are some tentative indications of a positive correlation between entry and churning rates on the one hand and productivity growth on the other, but again, the relationship is far from being clear cut. Other factors not directly related to entry and exit of firms may play a significant role in determining overall productivity growth.
- Over the last 15 years, the G7 and most of the early members of the Euro area increased their competitiveness relative to other countries. Very low increases in ULC have typically been achieved by keeping labour costs low in both, Industry and Market services. Moreover, those countries with relatively low growth in ULC also displayed strong growth in labour productivity.
- Low labour costs and high export performance go hand in hand. The results show that those G7 countries that kept labour costs low also recorded increases in market shares and vice versa.
- Over the past almost three decades, labour productivity growth has followed very different trends across G7 countries. Interestingly, the data point to a decline in trend labour productivity growth since the second half of the 1990s up to 2007 for most G7 countries.
- In general, the empirical evidence confirms the pro-cyclical pattern of MFP. In fact, MFP follows GDP growth very closely, not only in terms of the direction but also the size of the change.

Impact of the crisis on productivity

In many respects, perhaps not surprisingly, the picture painted during the crisis differs from the long term picture:

- For most OECD countries for which data are available, labour productivity growth has fallen significantly and this decline is broadly spread across sectors.
- Labour input fell in many countries. Sometimes through reducing average hours worked per person engaged but also through job cuts. This means that head-counts are less reliable as a possible proxy for measuring hours worked.
- MFP also fell significantly, although, especially given the pro-cyclical pattern of MFP, it is too early to say whether this reflects a structural change and hence a lower long term trend.
- Within the Euro area, some peripheral countries recorded strong falls in unit labour costs. However, care is needed in interpreting these results as improved relative competiveness as the falls typically went hand in hand with significant falls in output and labour input.

PART I

PRODUCTIVITY INDICATORS

1. PRODUCTIVITY GROWTH AND CONVERGENCE

Growth in GDP per capita

GDP per capita levels

Labour productivity growth

Alternative income measures

GROWTH IN GDP PER CAPITA

Gross Domestic Product (GDP) per capita measures economic activity or income per person and is one of the core indicators of economic performance. Per capita GDP growth can be broken down into a part which is due to labour productivity growth and a part which is due to increased labour utilisation. A slowing or declining rate of labour utilisation combined with high labour productivity growth can be indicative of a greater use of capital and/or decreasing employment of lower-productivity workers.

Definition

GDP is measured as Gross Value Added in basic prices. Labour productivity is defined as GDP per hour worked. Labour utilisation is defined as hours worked per capita.

Converting nominal values of GDP to real values requires a set of detailed price indices, implicitly or directly collected. When applied to the nominal value of transactions, the corresponding volume changes can then be captured. Since the 1993 *System of National Accounts* it has been recommended that weights should be representative of the periods for which growth rates are calculated. This means that new weights should be introduced every year, giving rise to chain-linked (volume) indices.

Comparability

Although nominal values of GDP in all countries follow the 1993 SNA, except Australia which follows the 2008 SNA, there is some variability in how countries calculate their volume estimates of GDP. This concerns particularly the approaches used to measure price change in various activities, such as services. With the exception of Mexico and Chile, all OECD countries derive their annual estimates of real GDP using annually chain-linked volume indices. This means that the fixed prices or weights are updated every year. Mexico and Chile revise their fixed weights less frequently. Such practices tend to lead to biased growth rates, usually upward.

There is also some variability in the sources used to measure actual hours worked (see Annex B).

Overview

Differences in GDP per capita growth across OECD countries can be mainly attributed to differences in labour productivity growth. In contrast, over the past 15 years, labour utilisation has generally increased only marginally.

The picture has been slightly different since the onset of the financial crisis. In some countries, a decline in GDP per capita was coupled with substantial declines in labour utilisation. These mainly reflected falls in employment and hours worked per person, while labour force participation was broadly unchanged.

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- Pilat, D. and P. Schreyer (2004), The OECD Productivity Database – An Overview, *International Productivity Monitor*, No.8, Spring.
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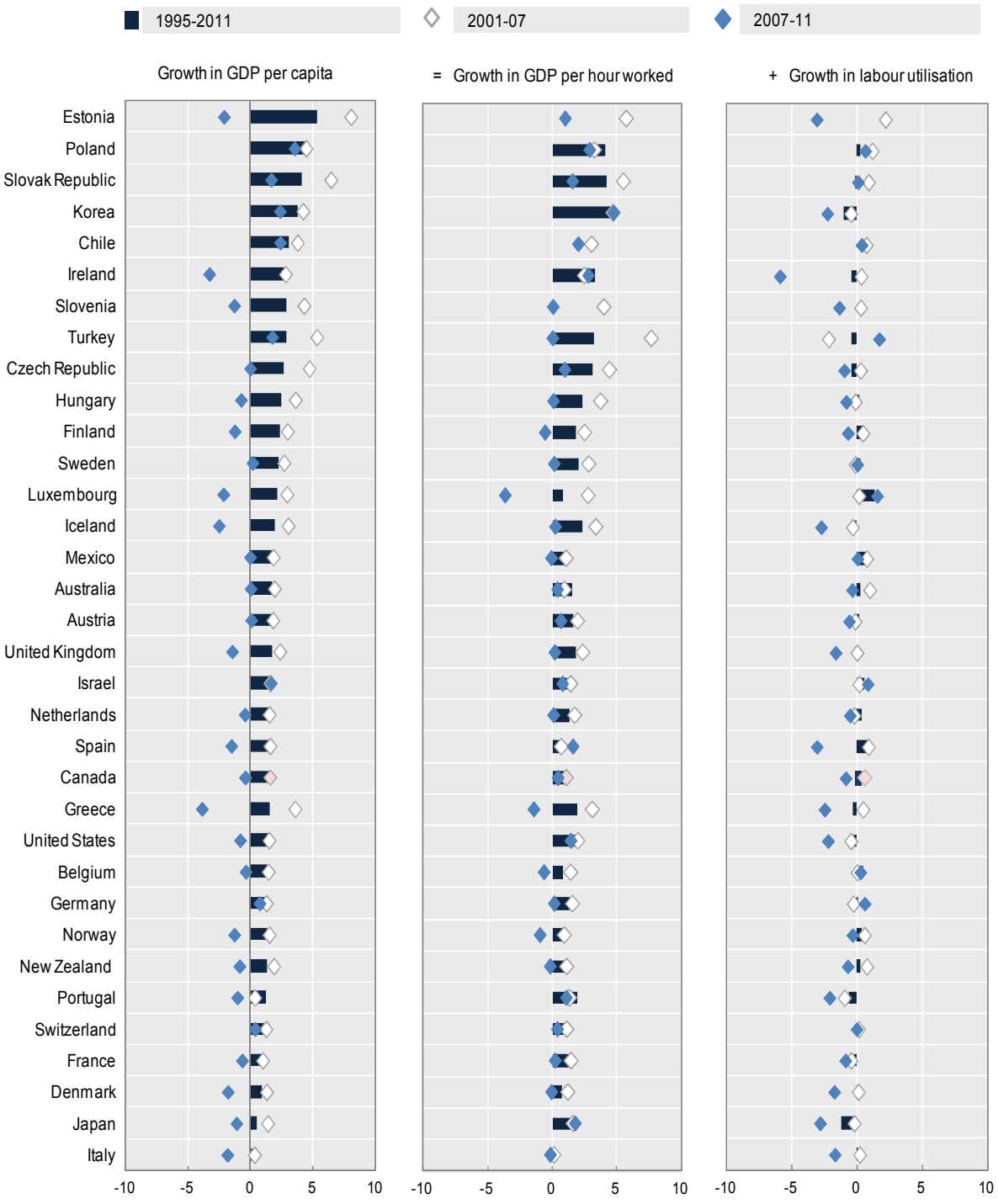
Figure 1.1. Growth in GDP per capita and its components

Total economy, percentage change at annual rate



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GDP PER CAPITA LEVELS

GDP per capita levels are typically used to compare living standards across countries. Differences in GDP per capita levels can be decomposed into differences in labour productivity levels and labour utilisation. The latter can represent differences in unemployment and participation rates of the working age population, on the one hand, and working hours per employed person, on the other.

Definition

The indicator hereafter shows labour productivity (GDP per hour worked), labour utilisation (hours worked per capita) and income levels (GDP per capita) in each country as percentage differences with respect to those of the OECD average. For international comparisons, data on current price GDP are converted to a common currency using the OECD *Purchasing Power Parities* (PPPs) for the year 2011.

Comparability

All OECD countries follow the 1993 System of National Accounts, except Australia which follows the 2008 SNA. The 2008 SNA includes some items such as the capitalisation of research and development and some military weapons systems which increase GDP levels compared to the 1993 SNA (see also Annex C).

There is also some variability in the sources used to measure actual hours worked (see Annex B).

Overview

Very high growth rates in GDP per capita has meant that countries with initially lower GDP per capita levels have converged towards average income levels in the OECD. This has been particularly true for Korea, the Slovak Republic, Poland and Estonia. Nevertheless, in 2011, large differences in incomes remained across OECD countries. GDP per capita is up to 60% lower than the OECD average in Mexico, Chile and Turkey, while it is double the OECD average in Luxembourg, 80% higher in Norway and 45% higher in Switzerland.

Most of these differences in GDP per capita reflect differences in labour productivity levels. Among the countries presented, eleven (the majority being non-EU countries) had higher labour utilisation levels than the OECD average, narrowing their negative or reinforcing their positive gap in GDP per capita. This was notably the case for Australia, Canada, Iceland, Korea, Luxembourg, Mexico, New Zealand and Switzerland.

Sources and further reading

- OECD Annual National Accounts Database, www.oecd.org/statistics/national-accounts.
- OECD Productivity Database, www.oecd.org/statistics/productivity.
- OECD (2011), *National Accounts at a Glance,* OECD, Paris.
- OECD (2001), *Measuring Productivity – OECD Manual,* OECD, Paris.
- Pilat, D. and P. Schreyer (2004), The OECD Productivity Database – An Overview, *International Productivity Monitor*, No.8, Spring.
- Ahmad, N. and S. Koh (2011), Incorporating Estimates of Household Production of Non-Market Services into International Comparisons of Well-Being, *Statistics Directorate Working Paper 42*, OECD, Paris.

Figure 1.2. GDP per capita convergence

Percentage point differences, vis-à-vis the OECD average

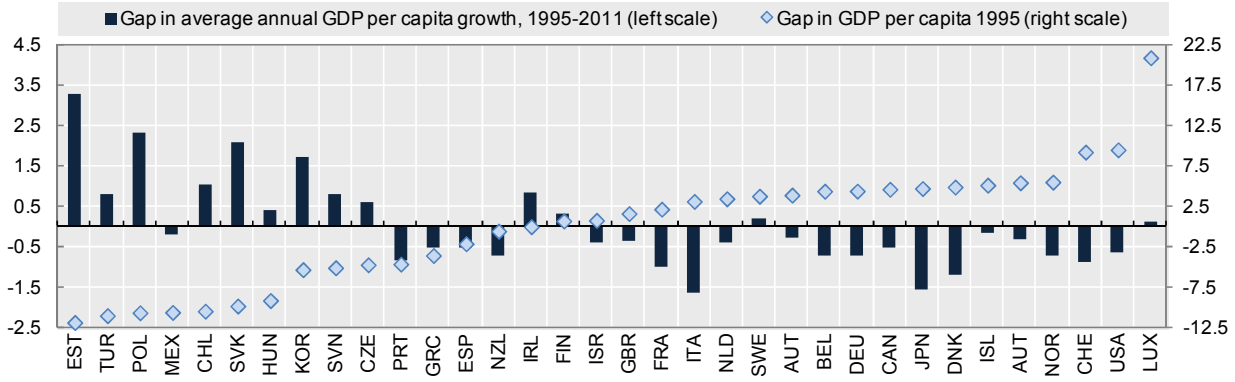

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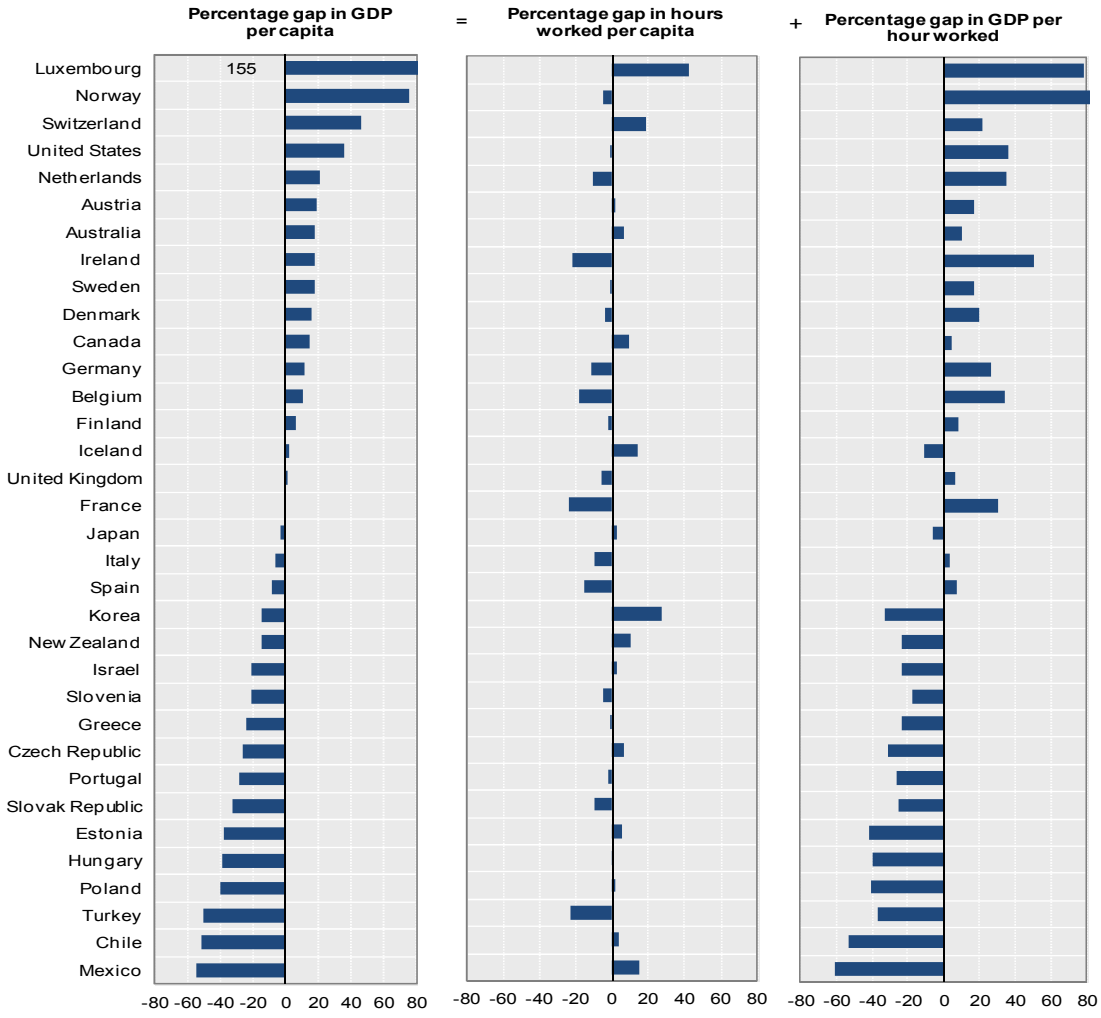
Figure 1.3. Differences in GDP per capita levels

Percentage differences vis-à-vis the OECD average, in current prices and current PPPs



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LABOUR PRODUCTIVITY GROWTH

Labour productivity growth is a key dimension of economic performance and an essential driver of changes in living standards.

Definition

Within the *OECD Productivity database*, labour productivity is defined as GDP per hour worked (see Annex A for more detail on the measurement of productivity growth).

The underlying concept for labour input is total actual hours worked. The concept includes all hours *actually* used in production, whether paid or not, and excludes those hours not used in production, even if some compensation is received (see Annex B).

Comparability

Estimates of GDP follow the 1993 System of National Accounts (SNA), except for Australia which follows the 2008 SNA.

Data on actual hours worked are based on a range of primary sources. In most countries, the main source for the data is labour force surveys, but several countries rely - only or in addition - on establishment surveys and administrative sources (see Annex B). These different sources may affect comparability of labour productivity levels but comparisons of labour productivity growth are likely to be less affected.

Overview

The process of convergence in GDP per capita as observed above was typically driven by strong growth in labour productivity. In Korea, the Slovak Republic, Poland and Estonia, productivity growth since 1995 was on average between 3 and 4% compared to less than 2% in most Euro area countries, Canada, the United Kingdom and the United States.

Since the onset of the financial crisis in 2007, labour productivity growth has fallen to close to zero in most OECD countries, characterised by almost equal declines in GDP and labour utilisation. In Greece, Norway and Belgium, labour utilisation fell less than GDP, leading to negative productivity growth. In contrast, significant cuts in employment in Spain saw labour productivity growth more than double over the 2007-2011 period compared to 2001-2007.

Countries have adjusted in different ways to the crisis. While some countries, *e.g.*, Ireland, Estonia and Germany, have adjusted by reducing average hours worked per employee, the opposite is true for Spain, Sweden, Luxembourg and Belgium. As a consequence employment based and hours worked based labour productivity growth estimates over the 2007-2011 period show larger differences compared to the 2001-2007 period, reinforcing the care that should be taken when using employment as a proxy for measuring hours worked.

Sources and further reading

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- OECD (2001), *Measuring Productivity – OECD Manual,* OECD, Paris.
- Pilat, D. and P. Schreyer (2004), The OECD Productivity Database – An Overview, *International Productivity Monitor*, No.8, Spring.
- OECD (2004), Clocking In (and Out): Several Facets of Working Time, *OECD Employment Outlook: 2004 Edition*, OECD, Paris.

Figure 1.4. Growth in GDP per hour worked

Total economy, percentage change at annual rate

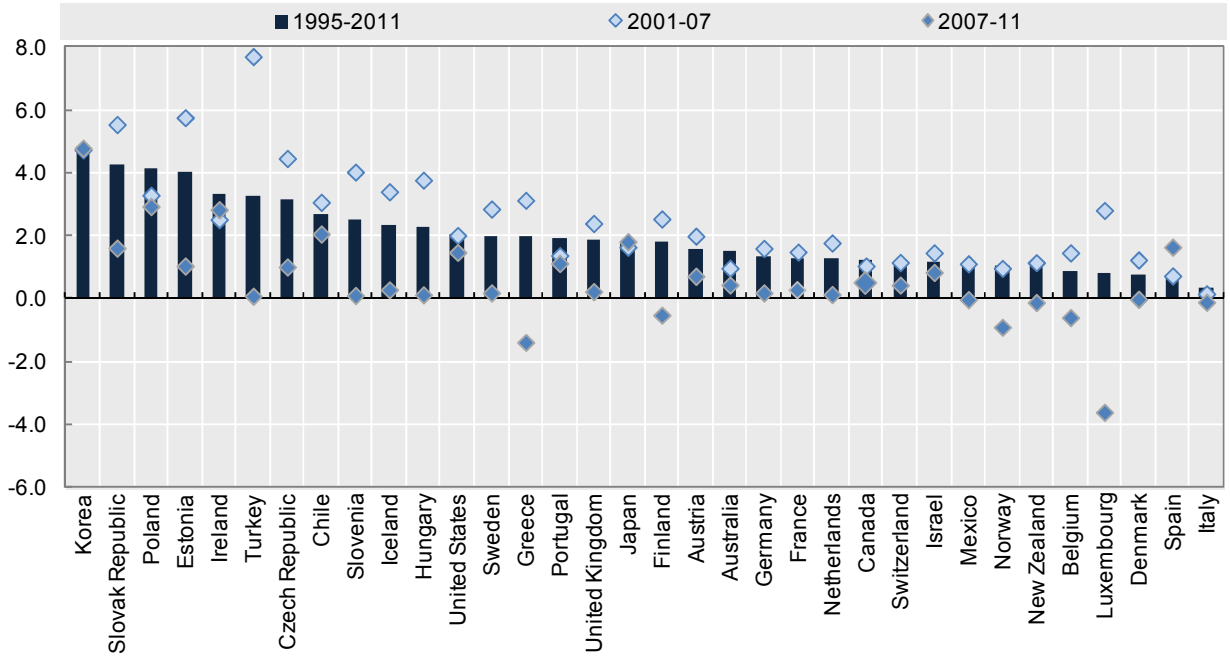

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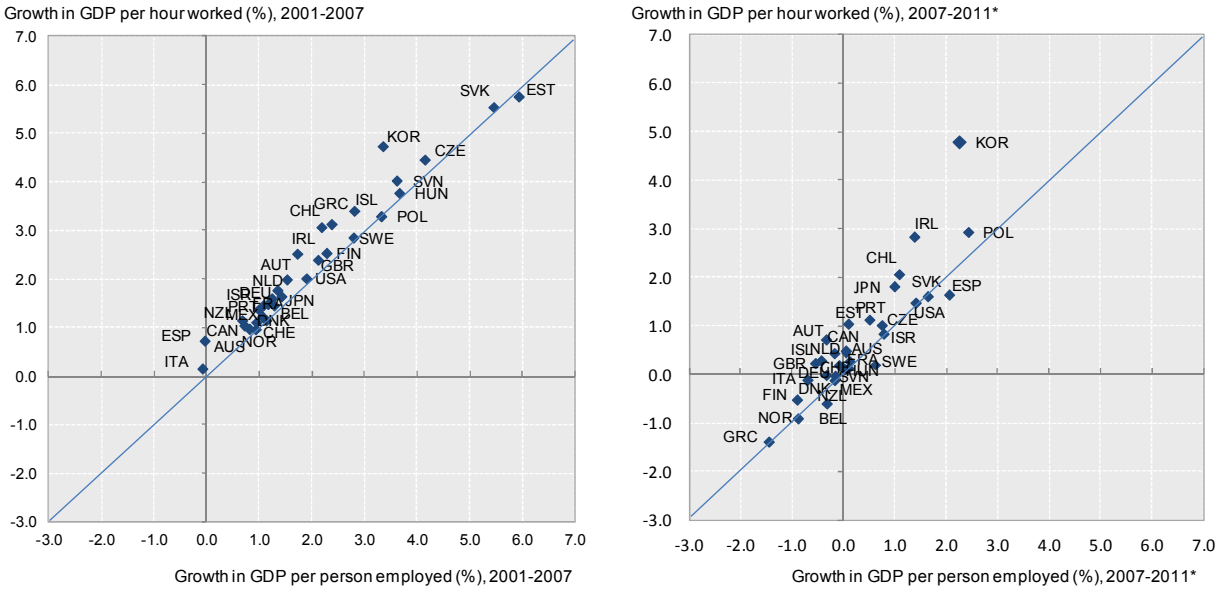
Figure 1.5. Growth in GDP per hour worked and GDP per person employed

Total economy, percentage change at annual rate



Note: * Or latest year available.

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ALTERNATIVE INCOME MEASURES

While GDP per capita is the most commonly used indicator to compare income levels, Gross National Income (GNI) is generally preferred in theory.

Definition

GNI is defined as GDP plus net receipts from abroad of wages and salaries and of property income plus net taxes and subsidies receivable from abroad. In most countries, net receipts of property income account for most of the difference between GDP and GNI. Property income from abroad includes interest, dividends and all or part of the retained earnings of foreign enterprises owned fully or in part by residents. Wages and salaries from abroad are those that are earned by residents who essentially live and consume inside the economic territory but work abroad. They also include wages and salaries earned by non resident persons that live and work abroad for only short periods (seasonal workers).

Comparability

There are practical difficulties in the measurement both of international flows of wages and salaries and property income. Many flows related to the use of intellectual property assets are often recorded in practice as property income flows between affiliates. This has a direct impact on GDP levels but it also creates possible inconsistencies for productivity analysis as the underlying intellectual property being used in production in one country may be recorded on the balance sheets of another.

Some care is also needed when interpreting productivity in countries with high numbers of cross-border workers as the labour compensation earned by these workers will not be included in GNI but their hours worked will be included in calculating the labour contribution.

Overview

In general the ranking of countries in labour productivity levels is broadly the same whether measured on a GDP or GNI basis. The positions of Iceland, Ireland and Luxembourg fall when measured on a GNI basis, reflecting outflows of property income and the high number of cross-border workers in Luxembourg. Conversely, Switzerland's position moves up on a GNI basis, reflecting higher property income inflows offsetting the outflows driven by cross-border workers.

Productivity growth is also relatively similar for most countries when measured on a GNI or GDP basis, but there are some noticeable differences. In both periods shown below, for example Chile experienced higher growth in GNI per hour worked compared to GDP per hour worked, possibly reflecting increasingly smaller outflows of property income. On the other hand, Ireland recorded consistently higher rates of GDP per hour worked compared to GNI, reflecting increasing outflows of property income.

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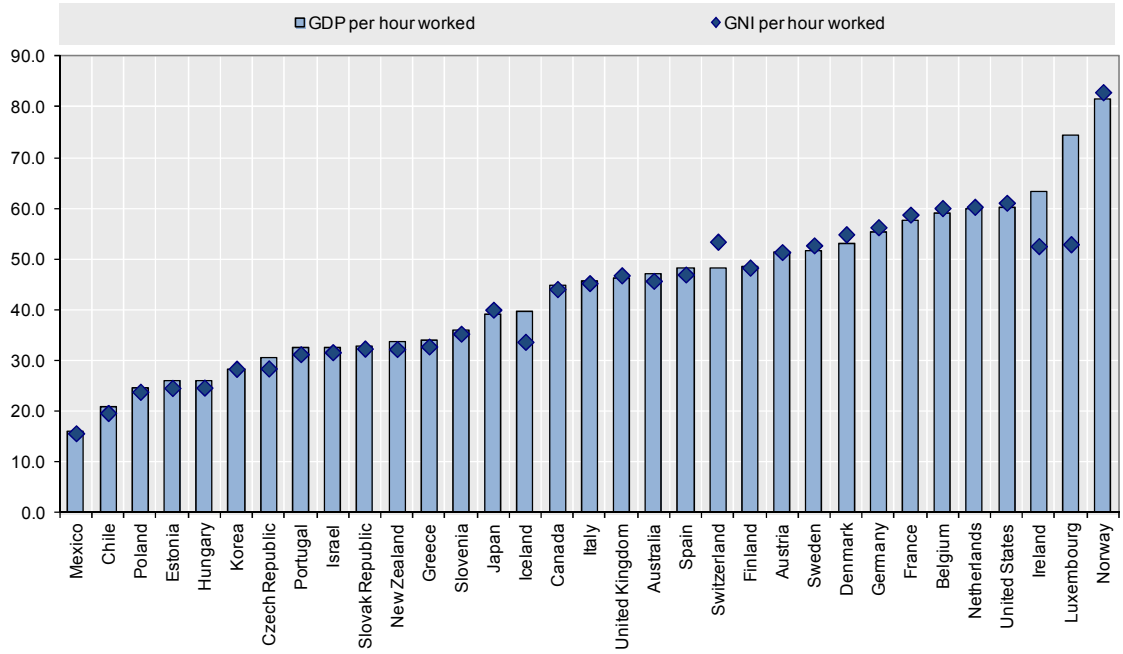
- Pilat, D. and P. Schreyer (2004), The OECD Productivity Database – An Overview, *International Productivity Monitor*, No.8, Spring.

Figure 1.6. GDP and GNI per hour worked, 2011*

Total economy levels, current prices, USD, current PPPs



Note: * Or latest year available.

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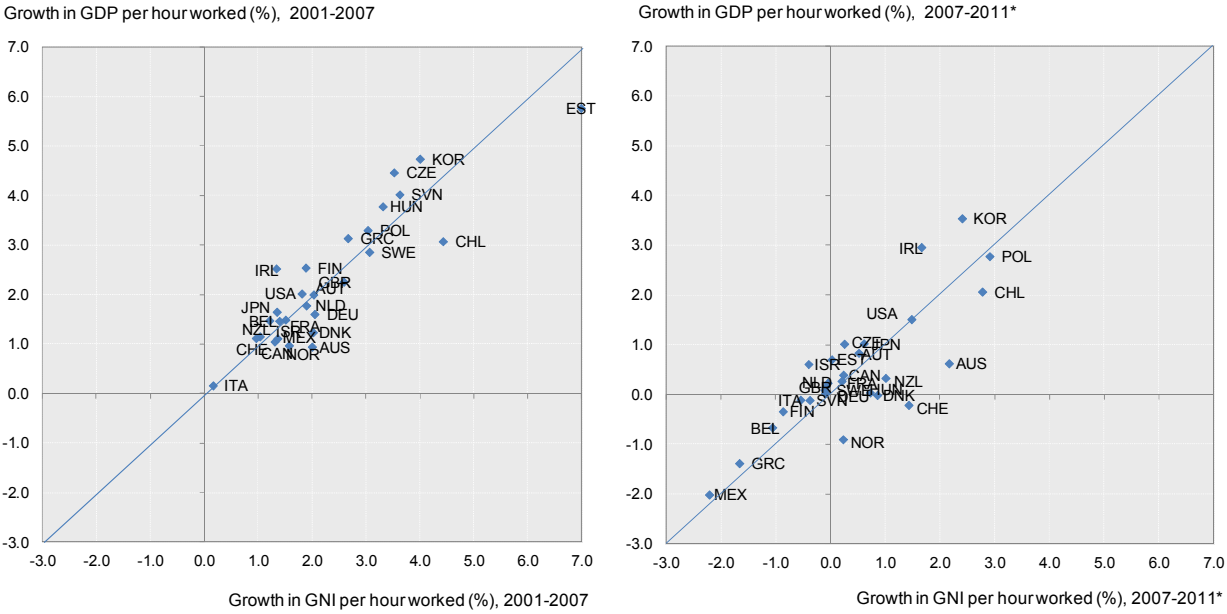
Figure 1.7. Growth in GDP per hour worked and GNI per hour worked

Total economy, percentage change at annual rate



Note: * Or latest year available.

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2. LABOUR, CAPITAL AND MFP

Growth accounts

The role of MFP for labour productivity

Capital productivity and the role of ICT

GROWTH ACCOUNTS

Economic growth can be increased either by raising the labour and capital inputs used in production, or by improving the overall efficiency in how these inputs are used together, *i.e.* higher multi-factor productivity (MFP). Growth accounting involves decomposing GDP growth into these three components, providing an essential tool for policy makers to identify the underlying drivers of growth.

Definition

Total output growth can be decomposed into a labour input component, a capital input component and MFP growth, computed as a residual (see also Annex A). In these calculations, the contribution of labour (capital) to GDP growth is measured as the growth in labour (capital) input, multiplied by the share of labour (capital) in total costs. In the figures below, the contribution of capital to GDP growth is further broken down into the contribution made by Information and Communication Technologies (ICT).

Comparability

The appropriate measure for capital input is the flow of productive services that can be drawn from the cumulative stock of past investments in capital assets. These services are estimated by the OECD using the rate of change of the productive capital stock (see Annex C).

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 those due to higher educational attainment and work experience. 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, rather than being attributed to labour.

Overview

From 1995 to 2010, GDP growth in most OECD countries was largely driven by growth in capital and MFP. In many countries, growth in capital accounted for around one third of GDP growth. ICT capital services represented between 0.2 and 0.6 percentage points of growth in GDP, with the largest contributions recorded in Sweden, Denmark, the United Kingdom, Australia and the United States, and the smallest in Ireland and Finland. Growth in labour input was important for a few countries over 1995-2010, notably Australia, Spain, and Canada, but Japan, Korea and Germany experienced negative labour contributions. Over the same period, MFP growth was a significant source of GDP growth in Korea, Ireland and Finland, while it was weak in Italy, Canada and Spain.

The data shown for the period 1995-2010 does not tell the full story, however. For example, the contribution of ICT capital slowed in the 2000s compared to the 1990s in all countries for which data are available. MFP growth also slowed in most countries, except Austria, Japan, the Netherlands, Sweden and the USA.

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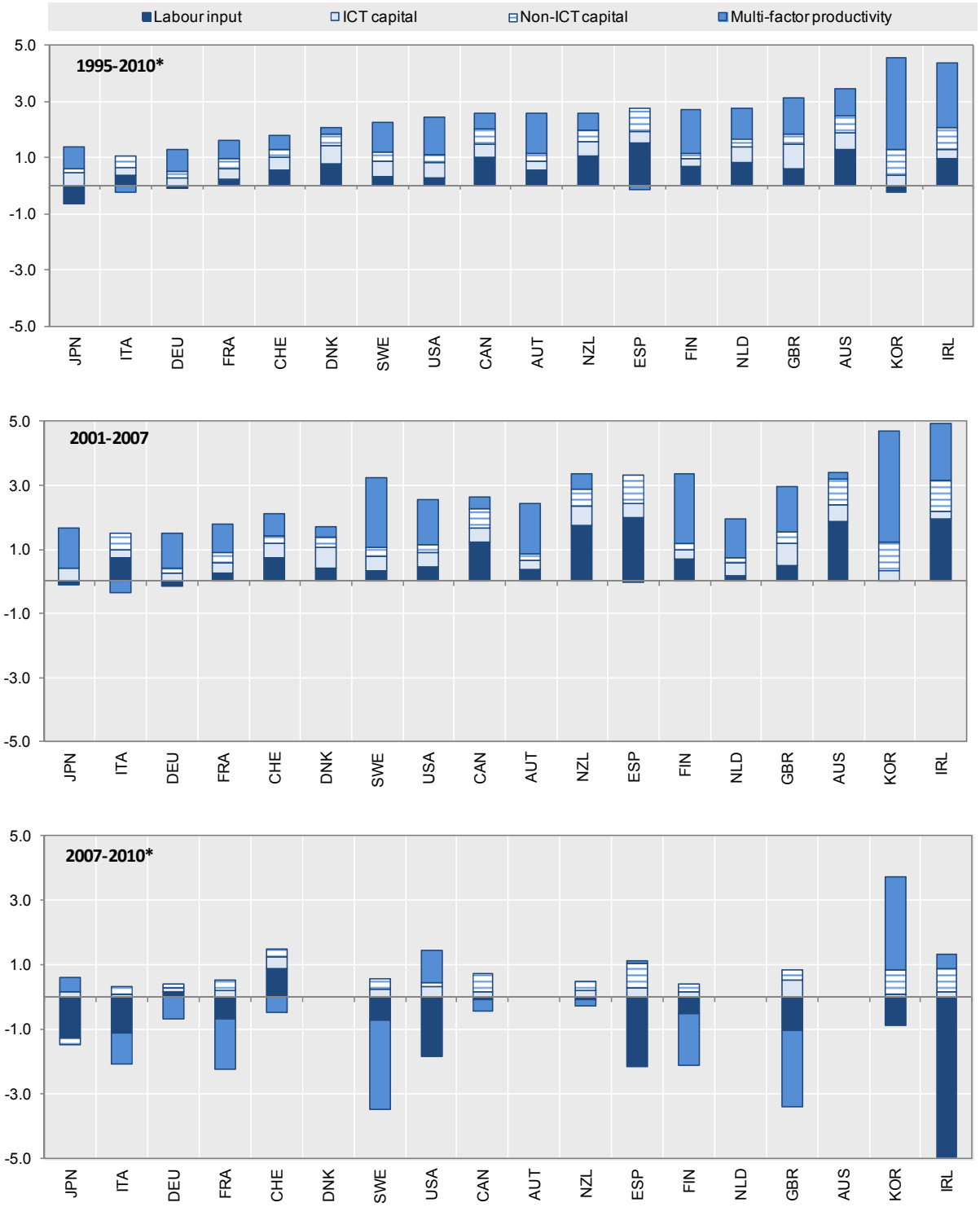
Figure 2.1. Decomposition of GDP growth in labour, capital and MFP

Total economy, percentage point contribution, annual average percentage change



Note: * Or most recent available. Countries are ranked according to the period 1995-2010.

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THE ROLE OF MFP FOR LABOUR PRODUCTIVITY

Labour productivity can be increased either through stronger use of capital relative to labour (capital deepening) or through increased technological change and overall efficiency of the production process, measured as multifactor productivity growth (MFP).

Definition

By reformulating the growth accounting framework, labour productivity growth can be decomposed into the contribution of capital deepening and MFP. Capital deepening is defined as the ratio between the total volume of capital services and total hours worked. Its contribution to labour productivity growth is calculated by weighting it with the share of capital costs in total costs.

Comparability

Within the standard production function approach, growth in MFP represents the exogenous shift of the production function over time, and this shift parameter is often treated as technological change. But some care is needed in interpretation.

First, some part of technological change, including improvements in the design and quality of new vintages of capital, is *embodied* in the measures of capital input. The capital services measure used in the *OECD Productivity Database* takes explicit account of different productivities across assets, and price indices of ICT assets typically adjust for quality changes (Annex A and C). MFP does pick up, however, *disembodied technical change*, *e.g.,* the result of research and development, general knowledge or spillovers from other factors.

Second, data and resource constraints hamper a precise differentiation and coverage of labour and capital input, affecting MFP. Moreover, the standard (neoclassical) approach is based on rigid assumptions, notably of constant returns to scale and perfectly competitive markets, which are not met in reality. The MFP measure in the *OECD Productivity Database* (Annex A and C) allows for non-constant returns to scale and imperfect competition, and has to be interpreted in a broader sense. It reflects disembodied technological change, economies of scale, adjustment costs, pure efficiency change, variations in capacity utilisation, and measurement errors.

Overview

MFP is a major driver of labour productivity, representing between one half and two thirds of aggregate labour productivity growth across countries over the period 1995 to 2010. In most countries, MFP appears to have moved in a pro-cyclical way, as reflected in substantial falls in MFP since the financial crisis. However, as described above, some care is needed in interpretation. MFP is computed as a residual and so will reflect the different ways and speeds with which capital (utilisation) and labour input adjust in a downturn. As such it is too early to say to what extent this decline reflects a trend decline in overall efficiency of the production process (See also Section 6).

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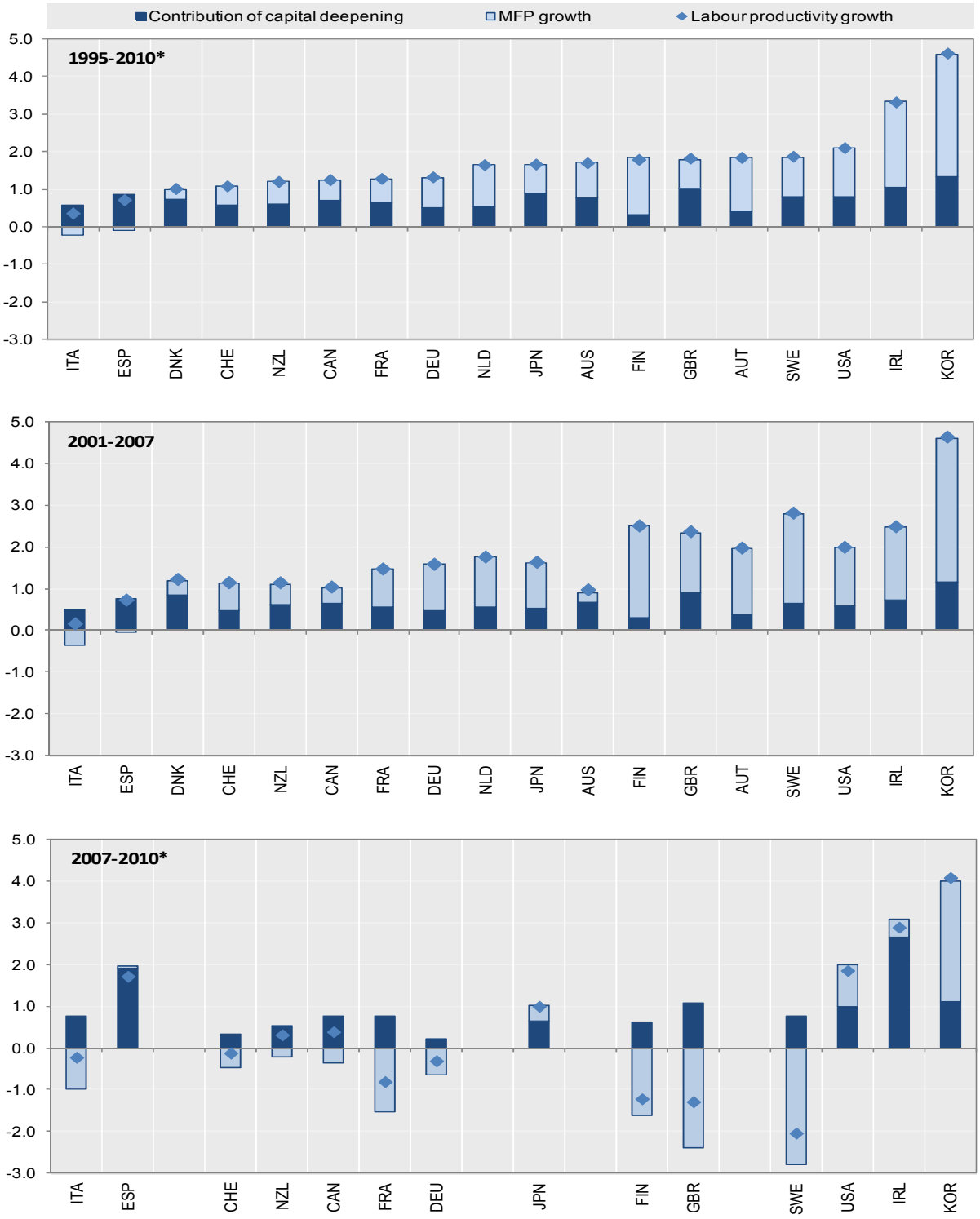
Figure 2.2. Labour and Multifactor Productivity growth (MFP)

Total economy, percentage point contribution, annual average percentage change



Note: * Or most recent available. Countries are ranked according to the period 1995-2010.

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CAPITAL PRODUCTIVITY AND THE ROLE OF ICT

Capital productivity shows how efficiently capital is used to generate output. It reflects the joint influence of labour input per unit of capital used and multifactor productivity growth (MFP), the latter reflecting technical change and the general efficiency of production. Investment in Information and Communication Technologies (ICT) helps expand and renew the capital stock and enables new technologies to enter the production process and is seen as an important driver of productivity growth.

Definition

Capital productivity is measured as the ratio between output and capital input, the latter being defined as the flow of productive services that capital delivers in production (see also Annex A and C).

Measures of investment (gross fixed capital formation) used to estimate productive capital stock and capital services follow the definitions described in the 1993 *System of National Accounts (*1993 *SNA*). ICT products include *i)* information technology equipment (computers and related hardware); *ii)* communications equipment; and *iii)* computer software (including purchased software and software developed in-house). The estimates do not include investment in R&D (Research and Development), which was included in the asset boundary in the 2008 SNA.

Comparability

While all countries follow the SNA, some differences may arise when considering specific capital assets. For example, software embodied in a computer will be recorded as investment in computers whereas software sold separately and then installed on a computer by an end-user will be recorded as investment in software.

Countries use different approaches to deflate ICT investment, where constant quality price changes are particularly important but difficult to measure. These differences can impact on comparability. Countries also use different depreciation rates and service life assumptions for specific assets, which often differ purely because of the convention used. To counteract for these differences, the OECD uses a set of 'harmonised' ICT investment deflators, depreciation rates and service lives for all assets.

Overview

Declining costs of using capital relative to labour and the resulting fall in the use of labour input per unit of capital services have led to a fall in capital productivity in most OECD countries over the past 15 years. This fall was particularly pronounced in Ireland, the United Kingdom, Sweden and Spain between 2007 and 2010, but a relative improvement was observed in Denmark, Australia and the Netherlands.

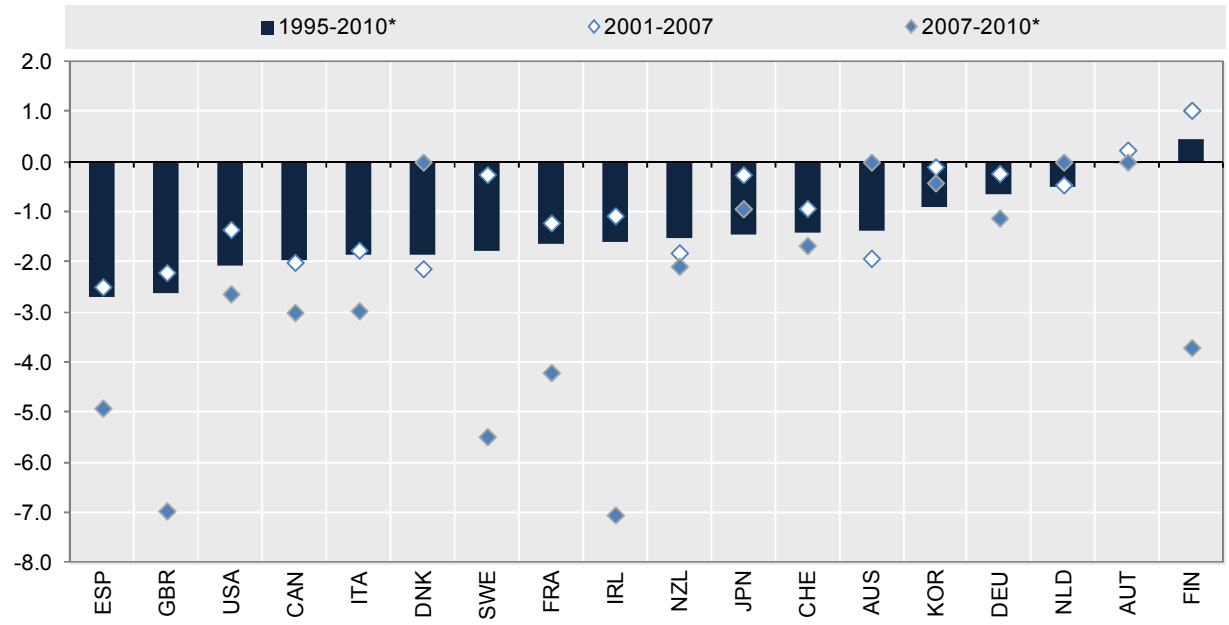
Some of the decline in overall costs of capital may relate to ICT. In technologically dynamic industries, such as ICT producers, new products' prices typically fell very rapidly, which may have spurred the increased use of ICT in production. In fact, the share of ICT assets in total investment increased significantly in nearly all OECD countries in the second half of the 1990s, although they have fallen again since then. In 2010, the share of ICT ranged from 10% of overall investment in Korea and Italy, to around one quarter in Sweden and the United Kingdom and one third in the United States.

Sources and further reading

- OECD Productivity Database, www.oecd.org/statistics/productivity.
- OECD (2010), *OECD Handbook on Deriving Capital Measures of Intellectual Property Products,* OECD, Paris.
- Schreyer, P. (2004), Capital Stocks, Capital Services and Multifactor Productivity Measures, *OECD Economic Studies*, Vol. 2003/2, OECD, Paris.
- OECD (2009), *Measuring Capital – OECD Manual*, OECD, Paris

Figure 2.3. Growth in capital productivity

Total economy, percentage change at annual rate



Note: * Or most recent available.

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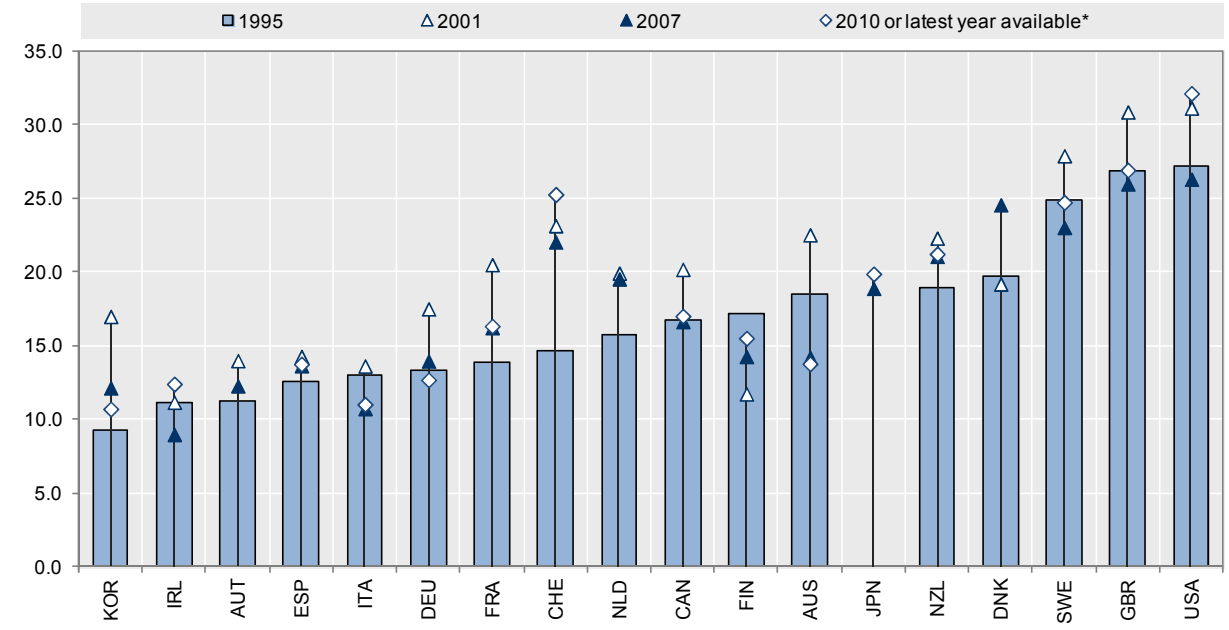
Figure 2.4. Share of ICT in total investment

Total economy, percentage of non-residential gross fixed capital formation



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3. SECTOR PRODUCTIVITY

Labour productivity growth by sector

Sector composition of labour productivity growth

The role of MFP by sector

LABOUR PRODUCTIVITY GROWTH BY SECTOR

Industries or sectors differ from each other with respect to their productivity growth. Such differences may relate for instance to the intensity to which sectors use capital and skilled labour in their production, the scope for product and process innovation, the absorption of external knowledge, the degree of product standardisation, the scope for economies of scale, and the involvement in international competition.

Definition

Labour productivity growth by industry or sector is defined as the rate of growth in real value added per hour worked per industry (Annex A).

Comparability

The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added. This is of particular relevance for services where it is difficult to isolate price effects that are due to changes in the quality or the mix of services from pure price changes. Despite substantial progress made over the past ten years in compiling service producer price indices (SPPIs) the methods used to compute real value added still vary across OECD countries.

In many countries estimates of real value-added in some industries are based on a sum of costs approach, where compensation of employees is deflated using a priori assumptions on labour productivity growth. For example, most countries assume no change in labour productivity for public administration activities, which is why this sector is not included here. Also excluded from the below are the real estate services which mainly reflect the imputation made for the dwelling services provided and consumed by home-owners.

In addition, certain sectors (*e.g.* construction and several services sectors), are characterised by a high degree of part-time work and self-employment, which can affect the quality of estimates of actual hours worked.

Overview

Productivity growth rates differ strongly across industries. High growth rates can be found in particular in the manufacturing sector but also in some business sector services. Despite these different productivity performances across sectors however, they do not appear to explain all of the differences in productivity growth across countries. For instance, within manufacturing, productivity growth rates ranged from less than 1% in Italy to 8% in the Czech Republic, between 1995 and 2011.

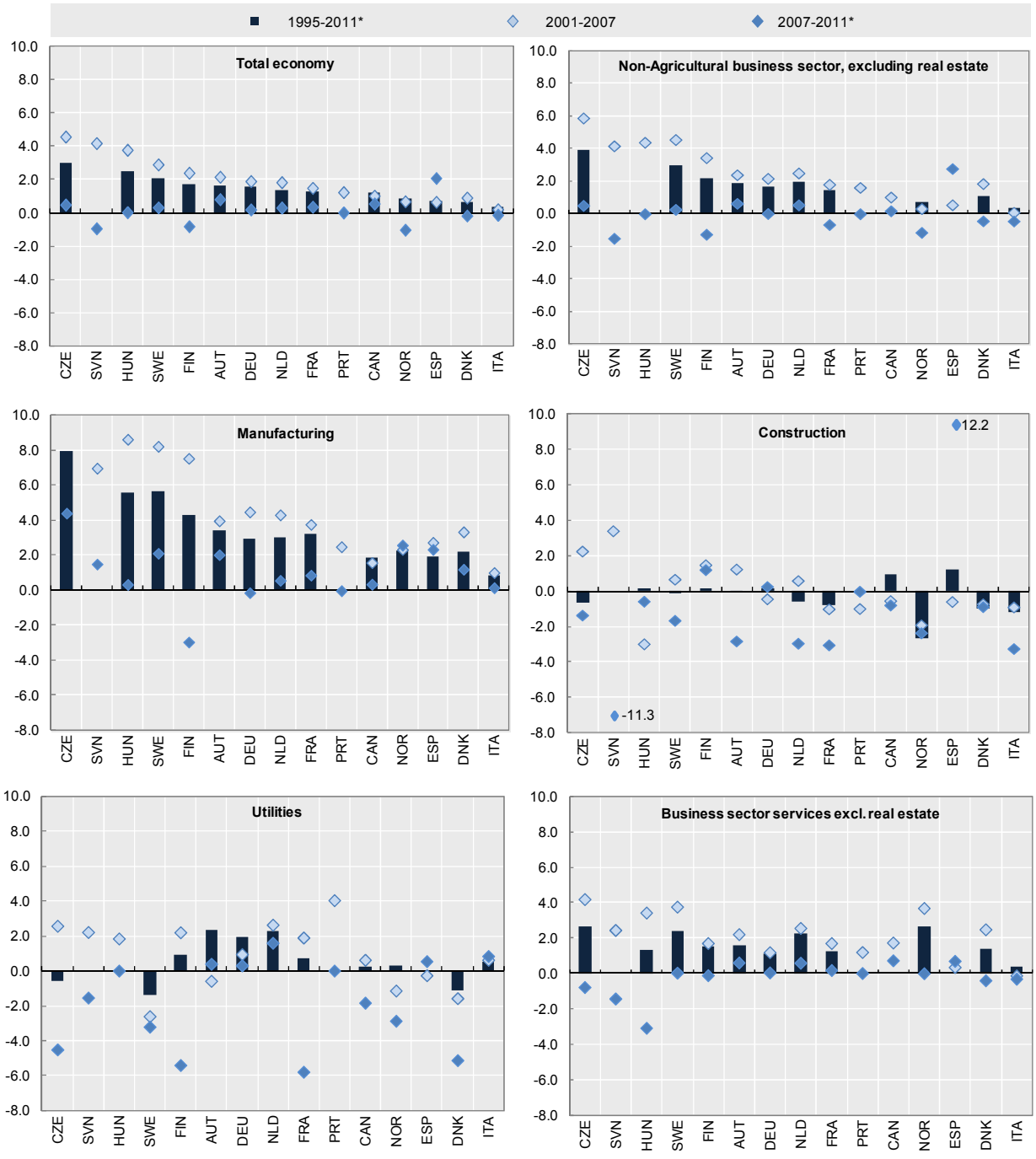
For most OECD countries for which data are available, labour productivity growth has declined since the onset of the financial crisis, and this decline is broadly spread across sectors. Spain is the notable exception, but some care is needed in interpretation as the labour productivity growth was linked to significantly stronger falls in employment compared to output.

Sources and further reading

- OECD Productivity Database, www.oecd.org/statistics/productivity.
- OECD STAN Structural Analysis Database, www.oecd.org/industry.
- Wölfl, A. (2003), Productivity Growth in Services Industries – an Assessment of Recent Patterns and the Role of Measurement, *OECD STI- Working Papers* 2003-7, OECD, Paris.
- Wölfl, A. (2005), The Service Economy in OECD Countries, *OECD STI Working Paper* 2005-3, OECD, Paris.
- OECD and Eurostat (2013), *Methodological Guide for Developing Producer Price Indices for Services*, OECD publishing, forthcoming.

Figure 3.1. Growth in labour productivity by sector

Percentage change at annual rate



Note: * or most recent available. The non-agricultural business sector excluding real estate covers mining and quarrying; manufacturing; utilities; construction; and business sector services. The latter covers distributive trade, repair, accommodation, food and transport services; information and telecommunication; financial and insurance services; professional, scientific and support activities; arts and entertainment and other repair services (Annex D).

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SECTOR COMPOSITION OF LABOUR PRODUCTIVITY GROWTH

Understanding the drivers of productivity growth at the whole economy level requires an understanding of the contribution each industry makes. The contribution of an individual sector depends not only on its productivity growth but also its share of value-added and employment.

Definition

Labour productivity growth per industry is defined as the rate of change of real value added per hour worked (Annex D). The contribution of each sector to aggregate labour productivity growth is computed as the difference between the growth rate of real value added and that of hours worked, with each weighted by the sector's share in total nominal value added and total hours worked respectively.

Comparability

The comparability of productivity growth across industries and countries may be affected by problems in measuring nominal and real value added, especially in services, as well as hours worked by sector (see above).

Under- or over estimation of output of a particular industry or sector, particularly for services, will be partially offset by intermediate consumption of this output by other production sectors, and hence their value added. Therefore, while this mis-measurement will impact on the comparability across sectors it will have a smaller impact on whole economy productivity growth.

Overview

Over the past 15 years, productivity growth was almost entirely driven by manufacturing and market services. In the case of manufacturing, this reflects the typically higher productivity growth rates. In the case of market services, the strong contribution also reflects its increasing share in overall activity. Business sector services make up between 50 and 70% of total employment and value added across OECD countries.

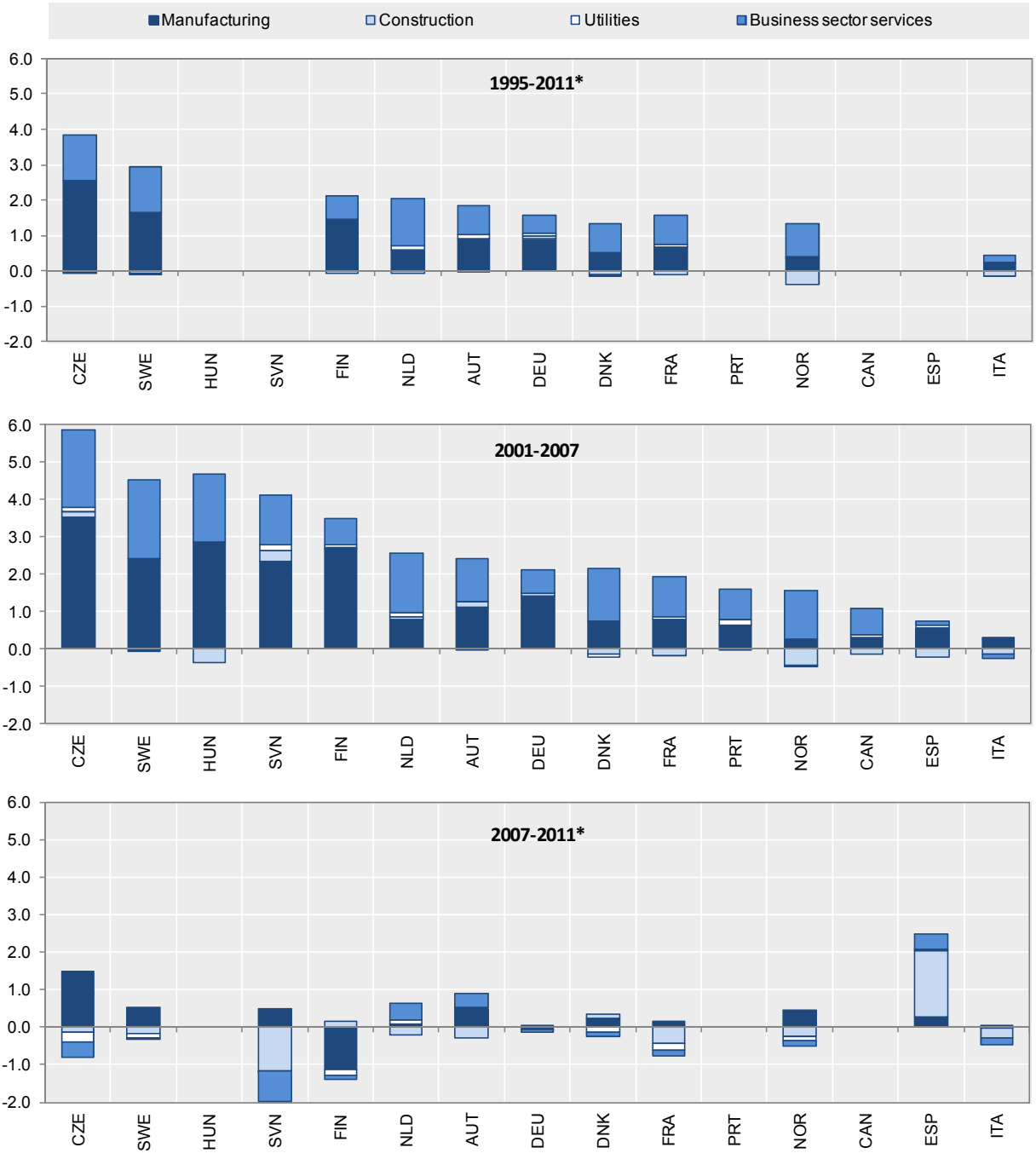
The evidence available so far suggests that reallocation effects have not been the primary drivers for overall labour productivity movements since the 2008 financial crisis. Rather, the changes in sector contributions reflect those in productivity growth per sector.

Sources and further reading

- OECD Productivity Database, www.oecd.org/statistics/productivity.
- Ahmad, N., F. Lequiller, P. Marianna, D. Pilat, P. Schreyer and A. Wölfl (2003), Comparing Labour Productivity Growth in the OECD Area: The Role of Measurement, *OECD Science, Technology and Industry Working Papers*, No. 2003/14.
- Wölfl, A. (2003), Productivity Growth in Services Industries – an Assessment of Recent Patterns and the Role of Measurement, *OECD Science, Technology and Industry Working Paper*, 2003-7, OECD, Paris.
- Wölfl, A. (2005), The Service Economy in OECD Countries, *OECD Science, Technology and Industry Working Paper* 2005/3, OECD, Paris.
- Pilat, D., A. Wölfl (2005), Measuring the Interaction between Manufacturing and Services, *OECD Science, Technology and Industry Working Paper* 2005/5, OECD, Paris.

Figure 3.2. Industry contribution to growth in real business sector value added per hour worked

Total economy, percentage change contribution at annual rate



Notes: *or most recent available. The business sector is measured as the non-agricultural business sector excluding mining and real estate. It covers manufacturing; utilities; construction; and business sector services. The latter covers distributive trade, repair, accommodation, food and transport services; information and telecommunication; financial and insurance; professional, scientific and support activities; arts and entertainment and other repair services (Annex D).

StatLink http://dx.doi.org/10.1787/888932750208

THE ROLE OF MFP BY SECTOR

Industries differ in their use of physical capital relative to labour on the one hand and factors driving MFP, such as innovative capacity or the openness to competition, on the other hand.

Definition

MFP for a given industry is defined as the difference between the growth rate of real value added and the weighted average of labour and capital inputs; with the weights reflecting the respective input shares in total costs (see Annex A). Output is measured as gross value added and capital input is based on a harmonised measure of net capital stocks (see Annex C). Capital deepening is measured as the ratio between capital input and labour input.

Comparability

Investment data by industry and by type of asset is not generally available and, as a consequence, it is not possible to take account of differences in the relative productivity of different assets. Hence, within the OECD *Productivity Database by industry* (PDBi), in practice, a measure of net capital stocks rather than capital services is used as capital input. This may affect comparability, particularly where the mix of assets used by an activity changes significantly over time.

Overview

In general, the results for different industries mirror the predetermining role of MFP for labour productivity growth observed at the whole economy level. This is particularly the case for the manufacturing sector where labour productivity growth was almost entirely driven by MFP. MFP also plays a dominant role in business sector services.

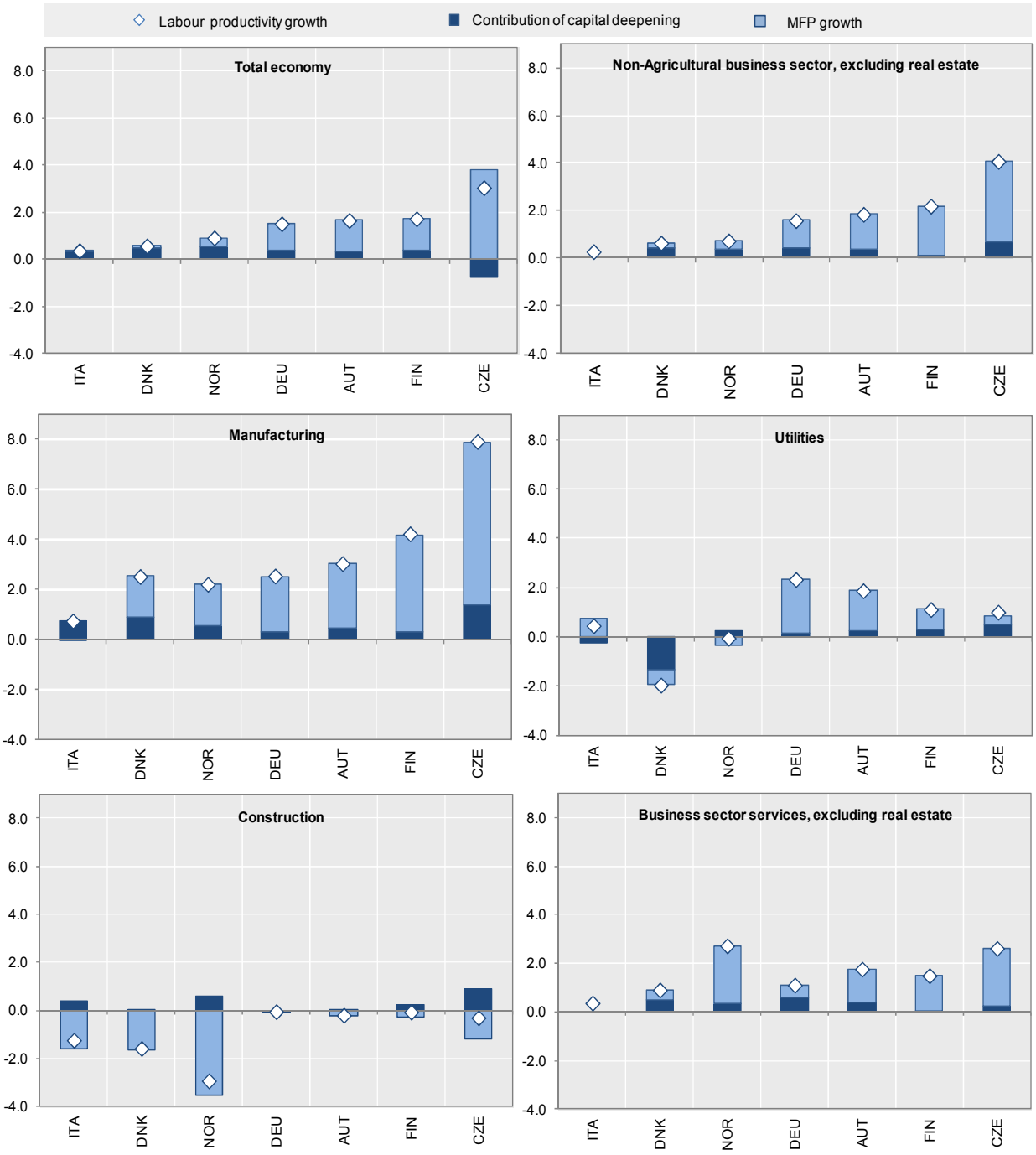
Overall, capital deepening contributed very little to labour productivity growth and this is true for all sectors. But some care is needed in interpretation. Evidence for the whole economy suggests that information and communication technologies (ICT) have taken an increasing share of overall investment. However, as noted above, the capital input measure used in the PDBi cannot take account of the higher productivity of these ICT assets. As such the contribution of capital to economic growth may be underestimated, and, by implication, MFP overestimated.

Sources and further reading

- OECD Productivity Database, www.oecd.org/statistics/productivity.
- OECD STAN Structural Analysis Database, www.oecd.org/industry .
- OECD (2009), *Measuring Capital – OECD Manual*, OECD, Paris.
- Arnaud,B., J. Dupont, S.-H. Koh, P. Schreyer (2011), Measuring Multifactor Productivity Growth by Industry – Methodology and First Results from the OECD Productivity Database, OECD, Paris.

Figure 3.3. Decomposition of labour productivity growth by industry

Annual average percentage point contribution, 1995-2010 or latest year available



Note: The business sector is measured as the non-agricultural business sector excluding mining and real estate. It covers manufacturing, utilities; construction; and business sector services. The latter covers distributive trade, repair, accommodation, food and transport services; information and telecommunication; financial and insurance services; professional, scientific and support activities; arts and entertainment and other repair services (Annex D).

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4. PRODUCTIVITY AND BUSINESS DYNAMICS

The role of firm size

Entry and exit of firms

THE ROLE OF FIRM SIZE

The relationship between firm size and productivity has many facets. On the one hand, to the extent that large firms can exploit increasing returns to scale, productivity should increase with firm size. On the other hand, new, typically small firms are often found to spur aggregate productivity growth as they enter with new technologies and stimulate productivity enhancing changes by incumbents.

Definition

The labour productivity distribution estimates shown in Figure 4.1 are based on value-added per employment, and not per hour worked as this data is not typically available by industry and size class.

In Figure 4.1, employment estimates are based on total head-counts, including the self-employed and employees.

Comparability

The value-added estimates presented for size classes are based on *Structural Business Statistics* and so will not typically align with estimates produced in the *National Accounts*. The latter includes a number of adjustments to reflect businesses and activities that may not be measured in structural business statistics, such as the inclusion of micro firms or self-employed. However, the impact of these differences on comparability is to some extent mitigated because labour productivity estimates per size class are presented relative to the underlying totals, and not as levels.

The size-class breakdown used here, based on persons employed (1-9, 10-19, 20-49, 50-249, 250+), provides for the best comparability given the varying data collection practices across countries. Some countries use different conventions. The size class "20-49" refers to "20-99" for the United States. The class "50-249" refers to "50-199" for Australia, and "100-499" for the United States. The size class "250+" refers to "200+" for Australia, and "500+" for the United States.

For productivity analysis the preferred measure for labour input is total hours worked (Annex B) rather than employment, as used in Figure 4.1. While over the medium term, employment can provide an indication for the trends in hours worked, in the short run, differences can arise, which could distort cross-country comparability.

Overview

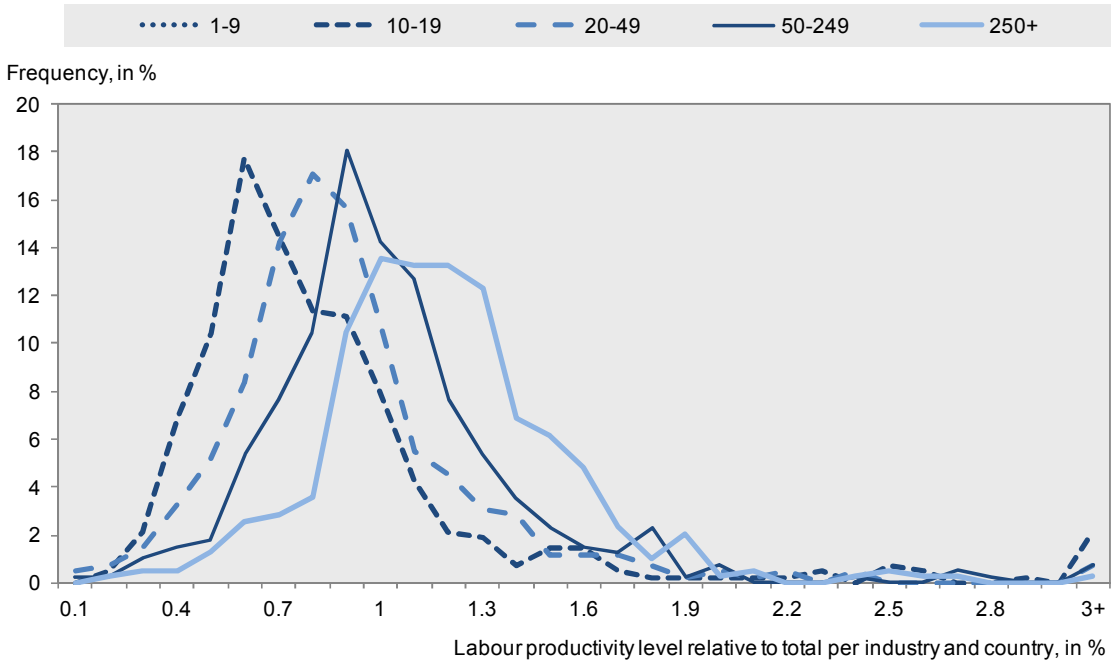
Firm-size matters for productivity. *First,* there is some evidence for the existence of increasing returns to scale. Larger firms are on average more productive than smaller ones - a conclusion that generally holds for all industries in all countries. However, productivity distributions shown in Fig.4.1 are fatter and in particular have a longer tail in the case of larger firm-size groups. This reflects that in some industries or countries, a number of larger firms are substantially more productive than the average.

Second, countries with a larger share of employment in firms with less than 20 persons employed typically show lower productivity growth rates. The relationship is, however, not clear cut, and this may suggest positive effects of the entry of some young and innovative firms for aggregate productivity growth as well as structural factors, such as cross-country differences in the contribution of sectors to overall GDP.

Sources and further reading

- OECD (2012) *Entrepreneurship at a Glance*, OECD Paris.
- OECD Structural and Demographic Business Statistics (SDBS) Database, http://www.oecd.org/std/industry-services.
- OECD Productivity Database, www.oecd.org/statistics/productivity.

Figure 4.1. Productivity level distributions by size class



Note: Data cover the market economy, excluding financial intermediation.

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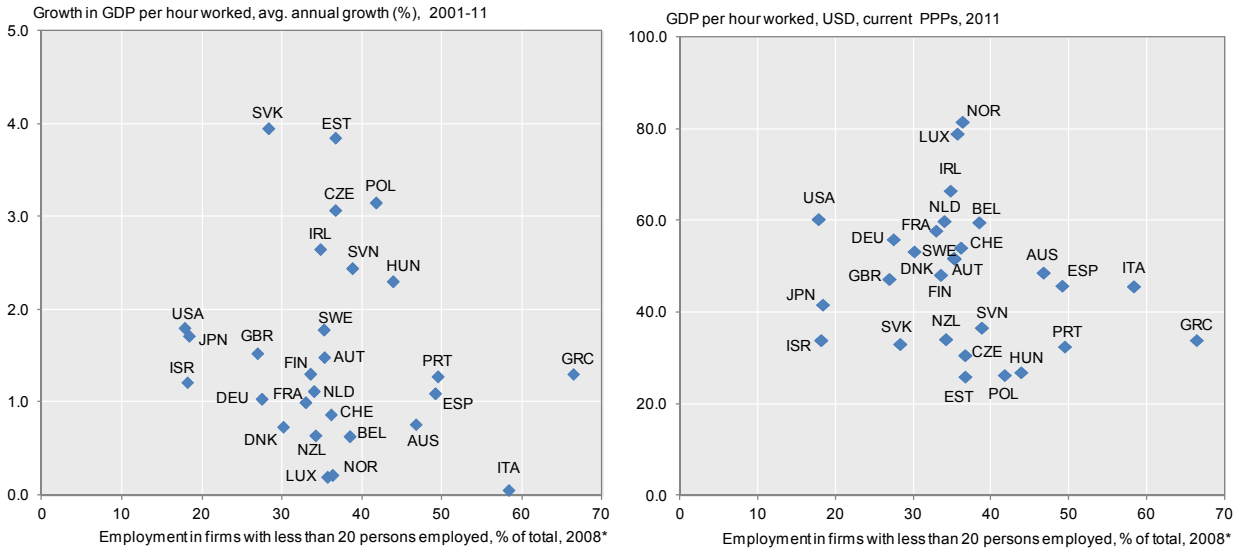
Figure 4.2. Firm size structure and level and growth of GDP per hour worked



Note: * Or latest year available. Data on employment in firms with less than 20 persons employed cover the market economy, excluding financial intermediation.

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ENTRY AND EXIT OF FIRMS

Productivity reflects the efficiency with which resources are allocated within an economy. Resource reallocation, in turn, is driven by firm dynamics, *i.e.,* the entry of new, especially innovative firms, and the exit of the least productive firms, a process typically referred to as (Schumpeterian) creative destruction. Hence, economies in which it is relatively easy for businesses to enter a market, but also for unsuccessful ones to go bankrupt, should exhibit higher productivity levels and growth.

Definition

Business entries and exits are measured by the *employer enterprise birth rate* and *employer enterprise death rate* respectively, as defined in the Eurostat-OECD Manual on Business Demography Statistics.

The extent of creative destruction is measured through the *employer enterprise churn rate* - the sum of the employer enterprise birth rate and the employer enterprise death rate.

Comparability

All countries measure entry (births) and exit (deaths) in line with the Eurostat-OECD Manual. The Manual uses the "Employer" based concept as this provides a better measure of international comparability than measures based on the total population of enterprises, which will reflect cross-country differences in the thresholds used to record enterprises. Moreover, the employer based concept provides a more meaningful threshold of economic relevance, as measures which include total enterprises may include enterprises with only marginal activity.

Some care is needed in interpretation. Large countries are, other things equal, likely to exhibit lower entry and exit rates than smaller countries within an economic zone as they are able to expand within the national economic territory via the creation of new *establishments*. For smaller countries similar expansions will be recorded as a birth if the parent enterprise in one country expands by the creation of an affiliate enterprise in a neighbouring country. Care is also needed if policies to create incentives or otherwise for sole-proprietors to become corporate entries are introduced.

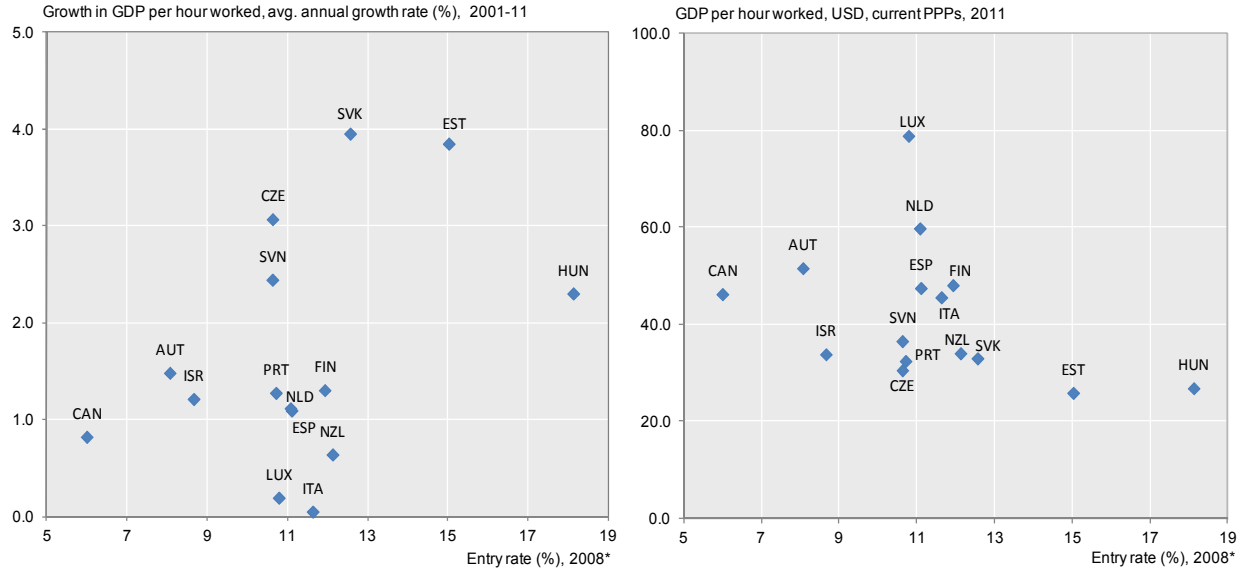
Overview

There are some tentative indications of a positive correlation between entry and churning rates, on the one hand, and productivity growth on the other. Some of those countries for which very high productivity growth can be observed also exhibit higher rates of firm entry and exit and vice versa. However, the relationship is far from clear as the number of countries for which data on business dynamics are available, is still limited. Moreover other factors may play a significant role in determining overall productivity growth, *e.g.*, productivity growth in existing businesses or industry composition effects, which may be hidden within this partial relationship.

Sources and further reading

- OECD *Entrepreneurship at a Glance,* OECD Paris.
- OECD Structural and Demographic Business Statistics (SDBS) Database, http://www.oecd.org/std/industry-services.
- OECD Productivity Database, www.oecd.org/statistics/productivity.
- Eurostat-OECD (2007), *Manual on Business Demography Statistics,* OECD Paris.
- Ahmad, Nadim (2006), A Proposed Framework for Measuring Business Demography Statistics, *Statistics Working Paper,* 2006(3) OECD, Paris.

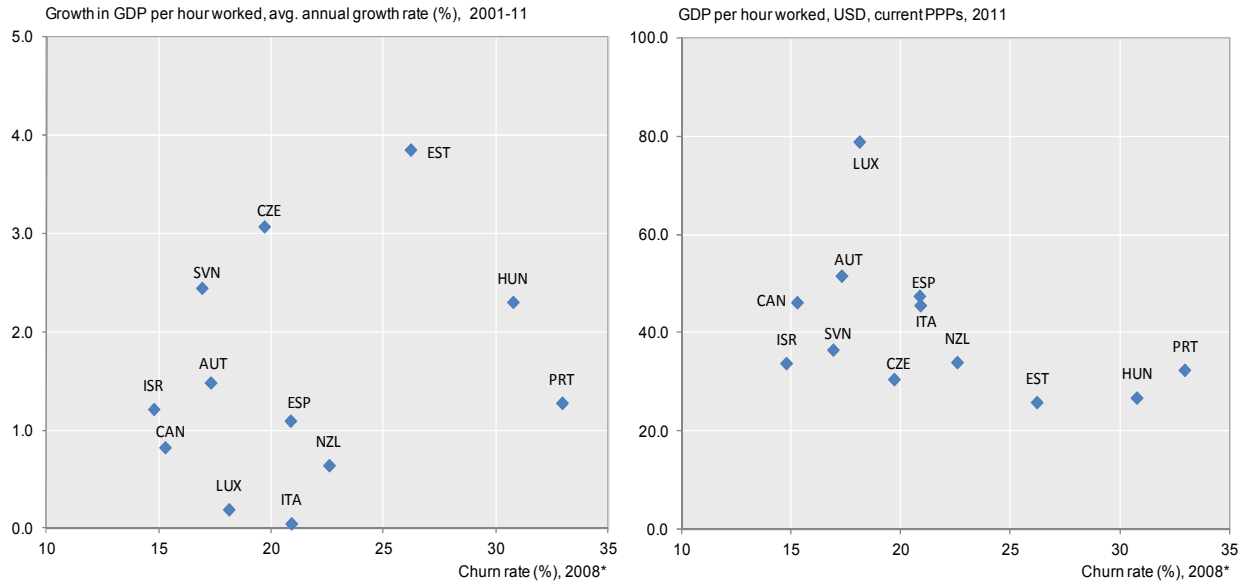
Figure 4.3. Firm entry and the level and growth of labour productivity



Note: * Or latest year available.

StatLink http://dx.doi.org/10.1787/888932750284

Figure 4.4. Firm churning and the level and growth of labour productivity



Note: * Or latest year available.

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5. PRODUCTIVITY AND COMPETITIVENESS

UNIT LABOUR COSTS

Unit labour costs (ULC) reflect total labour costs relative to a volume of output, and so the growth in unit labour costs is often viewed as a broad measure of international price competitiveness.

Definition

Unit Labour Costs (ULC) are defined as the average cost of labour per unit of output produced (Annex E). They can be expressed as the ratio of total labour compensation per hour worked to output per hour worked (labour productivity). Total labour compensation is for all *persons employed* and so includes *employees* and the *self-employed*.

Comparability

The data are presented for the economic activities 'Total economy', 'Industry' and 'Market services' according to the ISIC Rev. 4 classification (Annexes D and E). For some countries, time series of total hours worked are not available, so proxies such as employees or the numbers of persons employed are used to measure labour input. This may reduce comparability of ULC components across countries and time and also means that the underlying productivity measures used to compute ULC are not necessarily consistent with those used in the *OECD Productivity Database*.

Overview

Over the last 15 years, the G7 and most of the early members of the Euro area increased their competitiveness, as measured by ULCs, relative to other countries. Very low increases in ULC have typically been achieved by keeping labour costs low in both, Industry and Market services, as was the case, for instance, in Germany and Austria. The opposite was true for Turkey, Mexico, Estonia, Iceland, Hungary, and Norway.

Within the Euro area, Ireland, Spain, Portugal and Greece, have recorded strong falls in ULC since the onset of the financial crisis. However, care is needed in interpreting these results as improved relative competiveness needs to be balanced against the significant falls in output and labour input seen during that period. In Germany, improvements in competitiveness during the first half of the 2000s shows signs of being reversed in the second half of the 2000s.

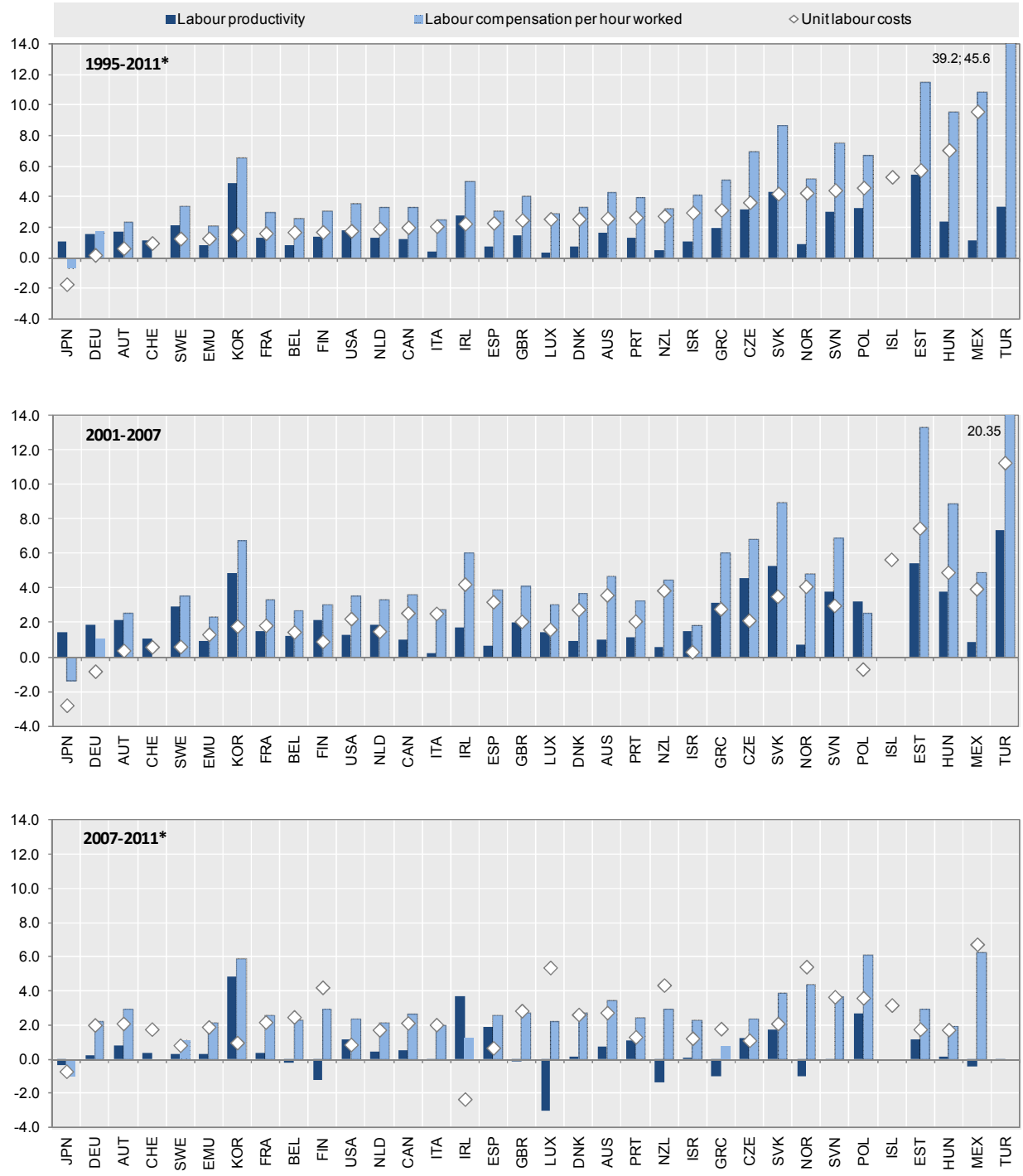
Comparing the data for ULC with those for labour productivity growth can provide some information on the possible sources for changes in ULC. For instance, over the past 15 years, some countries, notably those countries with relatively low growth in ULC, such as Germany, Israel, Korea, Poland, and Sweden, displayed stronger growth in labour productivity than in ULCs. In these countries, high productivity growth coincided with wage moderation. In contrast, most of those countries for which one can observe a relative deterioration in competitiveness displayed weak growth in labour productivity.

Sources and further reading

- OECD *Annual National Accounts Database*, www.oecd.org/std/nationalaccounts/.
- OECD *Main Economic Indicators Database,* www.oecd.org/std/oecdmaineconomicindicatorsmei.htm.

Figure 5.1. ULC, labour compensation per hour worked and labour productivity, Total economy

Total economy, percentage change at annual rate



Note: * Or most recent available. Countries are ranked according to the period 1995-2011.

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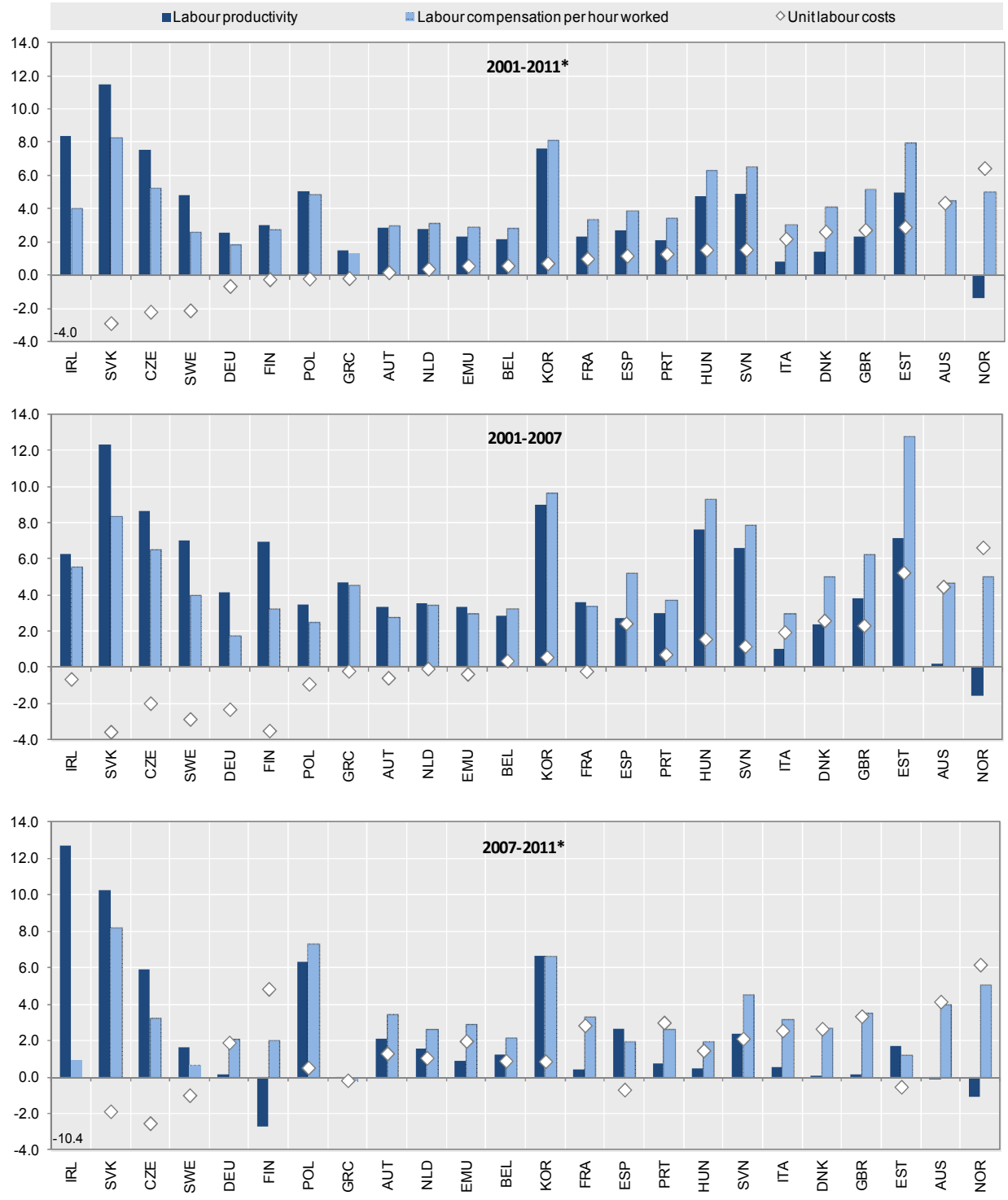
Figure 5.2. ULC, labour compensation per hour worked and labour productivity, Industry

Industry, percentage change at annual rate



Note: * Or most recent available. Countries are ranked according to the period 2001-2011.

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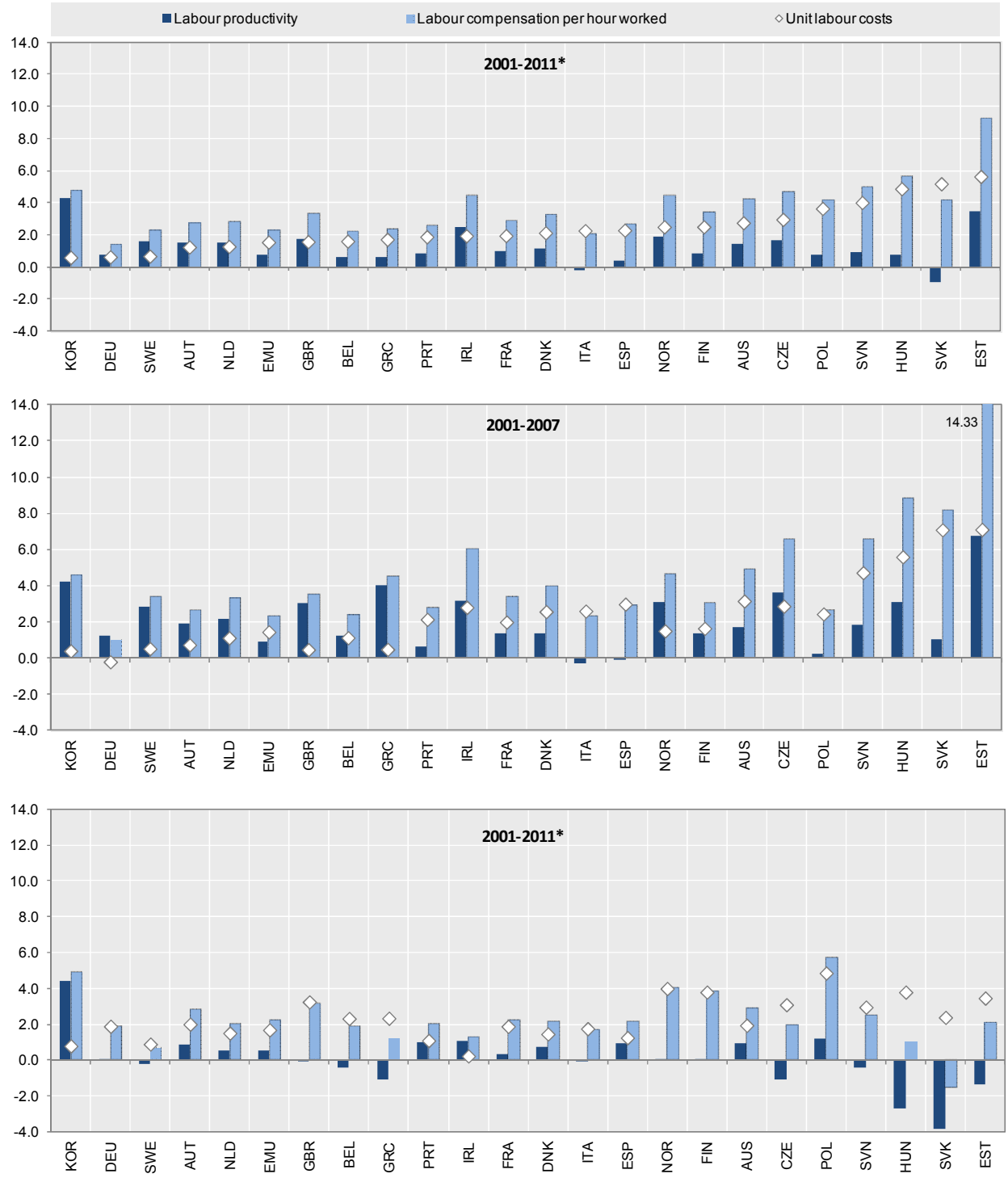
Figure 5.3. ULC, labour compensation per hour worked and labour productivity, Market services

Market services, percentage change at annual rate



Note: * Or most recent available. Countries are ranked according to the period 2001-2011.

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INTERNATIONAL COMPETITIVENESS

Despite their frequent use, unit labour costs (ULC) are an incomplete indicator for international competitiveness. In an era of global value chains a measure based only on the costs of domestic labour may not be representative of overall cost competitiveness of a country. Moreover, ULC as a measure of price-competitiveness cannot capture the capacity of firms to serve international markets through high quality goods and services and where demand is relatively price inelastic.

Definition

Export performance is defined as the growth rate of the total exports of a particular OECD country and the growth rate of the imports from the rest of the world. The *export market share* for a single country measures the share of exports by firms in that country as a share of world exports. *Real effective exchange rates* take account of price level differences between trading partners and provide an indication of the evolution of a country's aggregate external price competitiveness.

Comparability

Measures of international cost competitiveness would ideally cover those sectors exposed to international competition and they should be constructed on data that are fully comparable across countries. However, data availability and other limitations may affect comparability:

Export performance and *export market shares* are based on trade data and hence relate to goods and services actually competing on international markets. However, they exclude potentially exportable goods and services. Moreover, they measure only competition in those OECD member and non-member economies for which data of adequate quality are available.

Industry ULC is often perceived as more representative for competition in tradable products, but they ignore increasing trade in services. Services prices are often not very reliable, which affects cross-country comparability of M*arket services ULC*. Looking at *Total economy ULCs* somewhat alleviates these concerns, but their coverage goes significantly beyond the tradable sector.

Further care is needed in interpretation. International trade statistics measure trade on a gross basis and, so, include the value of imports embodied in goods and services as well as domestic value-added created in other domestic sectors that returns embodied in imports. This 'double-counting' particularly affects those firms closely integrated into global value chains, such as processing firms. The OECD has launched an initiative with the WTO to measure trade in value-added terms that separately identifies these 'double-counted' flows.

Overview

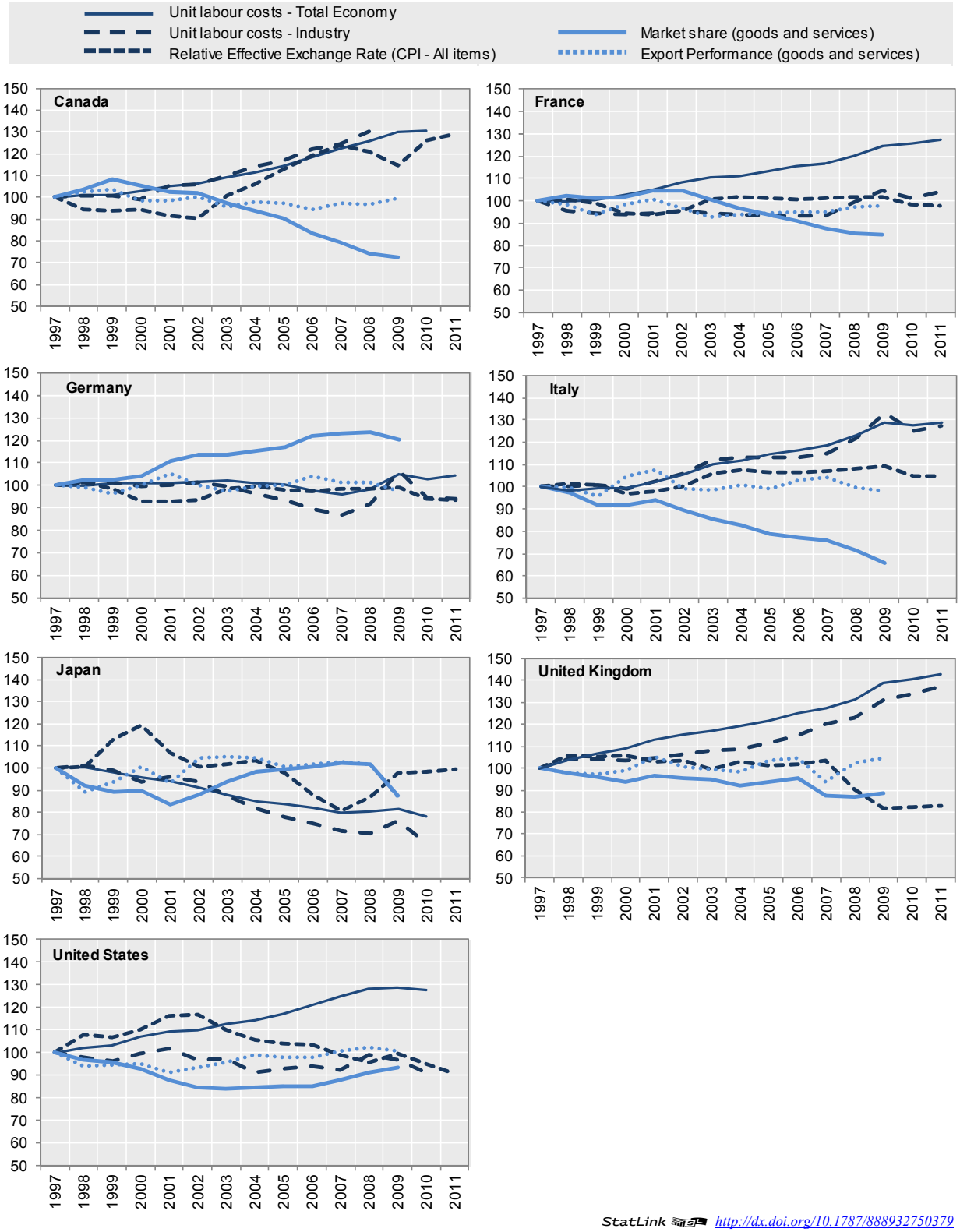
Over the past 15 years, those G7 countries that kept labour costs low increased export performance and vice versa and this link is more important for Euro area countries which do not have recourse to exchange rate adjustments. For instance, Germany reduced its ULCs and increased its world market shares, while the opposite was true for France and Italy. While in the United Kingdom market shares remained relatively constant over the same period despite increasing labour costs, due to a declining real effective exchange rate. The weight of services and the relative cost developments between manufacturing and services appear to matter, though. For instance, low Industry ULCs as compared to Total economy ULCs allowed the United States and France to moderate falls in global export market shares, while the opposite was true for Canada and Italy.

Sources and further reading

- OECD Trade Indicators, www.oecd.org/std/its/tradeindicators.
- Durand, M. and C. Giorno (1987), Indicators of international competitiveness: conceptual aspects and evaluation, *OECD Economic Studies*, No. 9, OECD, Paris.
- Measuring Trade in Value-Added, www.oecd.org/trade/valueadded.

Figure 5.4. Indicators of international competitiveness

Indexes, 1997=100



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6. PRODUCTIVITY OVER THE CYCLE

Labour productivity growth - trend versus cycle

MFP over the cycle

LABOUR PRODUCTIVITY GROWTH – TREND VERSUS CYCLE

Labour productivity is a key driver of economic growth and living standards. It is hence important for policy makers to analyse the structural factors determining productivity growth. One simple way of doing this is by decomposing the time series of labour productivity growth into a *trend* (or structural) component, on the one hand, and a *cyclical* component, on the other hand.

Definition

Labour productivity is defined here as real value added per hour worked (Annex A). Its decomposition into a trend and cyclical components is done in two steps. *First,* average annual growth is calculated for each cycle, where the economic cycle is defined using the chronology of turning points in the OECD's *Composite Leading Indicators*. *Second,* the individual average growth rates for a given cycle are linked so as to develop a time series of smoothed trends. The smoothing follows a geometric average, *i.e.,* assuming that annual labour productivity growth is constant between the mid-points of each cycle.

Comparability

Filter techniques, such as the Hodrick-Prescott (HP) filter are commonly used to compute trend series. However, applying an HP filter accurately necessarily makes assumptions about the future evolution of the time series of labour productivity growth and its components.

The method used here is similar to that used by the Australian Productivity Commission (see also Parham, 2003). Its main advantage is its simplicity. In contrast to the HP-Filter, it does not impose a priori assumptions about cycle lengths, but instead takes the actual lengths of cycles into account. Determining the cycle lengths and hence the trend may be somewhat arbitrary at the beginning and end of the time series, though. Care may hence be needed when interpreting these averages.

Overview

Over the past three decades, labour productivity growth followed very different trends across the G7 countries. In the second half of the 1980s and the first half of the 1990s some acceleration of productivity growth could be observed in Canada, the United Kingdom and the United States. In contrast, trend labour productivity growth showed a gradual decline almost throughout the period, from relatively high rates, in France, Germany, Italy and Japan. Interestingly, for almost all G7 countries, trend labour productivity growth has been declining since the second half of the 1990s up to 2007, the fall being particularly marked in Canada and Italy.

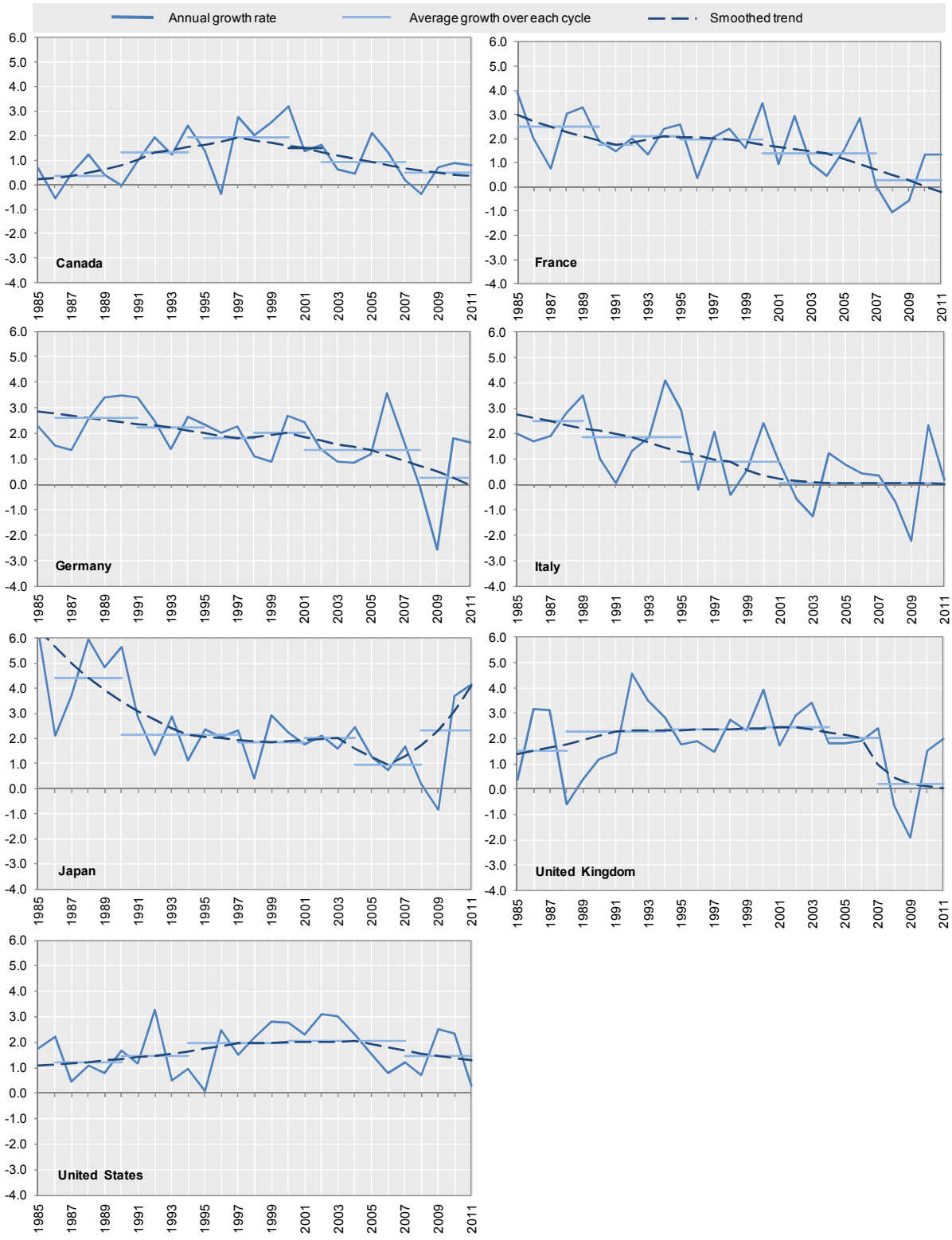
While one needs to be cautious in interpreting this as a post-crisis trend, average labour productivity growth over the 2007-2010 period declined significantly in Germany, France and the United Kingdom. Average productivity growth over the same period also fell in Canada and the United States but at a much more moderate rate.

Sources and further reading

- OECD Productivity Database, www.oecd.org/statistics/productivity.
- OECD Composite Leading Indicators, www.oecd.org/std/leadingindicatorsandtendencysurveys.
- Parham, D. (2003), Sources of Australia's Productivity Revival, Canberra, http://www.pc.gov.au/__data/assets/pdf_file/0018/9225/soapr.pdf.

Figure 6.1. Labour productivity growth and its trend

Total economy, percentage change at annual rate, G7 countries



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MFP OVER THE CYCLE

A number of studies have indicated that MFP behaves cyclically, *i.e.,* it increases in an upturn and declines in a downturn. This has sometimes been interpreted as a paradox, as MFP has traditionally been perceived as exogenous technological change, which should typically not behave cyclically.

Definitions

Four factors help to explain this cyclical movement. Each of them is related to the definition of MFP as the part of GDP growth that cannot be explained by the rates of change of labour and capital inputs (see also Annex A). *First,* cycles in productivity growth may relate to imperfect competition and the potential to capitalise on increasing returns to scale during upturns. *Second,* labour input typically adjusts with a lag in downturns, as firms seek to retain workers even if not needed for current production so as to keep the human capital. *Third,* adjustment costs prevent an immediate up- or downsizing of production and capital, resulting in lower utilisation of existing capital stock in downturns. *Fourth,* the reallocation of resources to production of goods and services with higher or lower marginal productivities may be pro or counter cyclical.

Comparability

The appropriate measure of capital input for productivity analysis and within the growth accounting framework is the productive capital stock and its derived capital services (see Annex C). While these take into account the productivity of the different capital assets, no account is taken of the extent to which the existing capital stock is actually used, *i.e.,* the rate of capital utilisation, which may affect comparability over time and space.

Theoretically, measuring labour input by the total actual hours worked of persons employed should capture the rate of labour utilisation and hence account for the cyclical effects of labour input. Continuous labour force surveys provide a basis for measuring this. However in practice, total hours worked are often measured based on hours typically worked, or actual hours worked during a reference week which are then extrapolated over the year using additional data sources. These may not sufficiently capture variations in actual hours worked over the cycle (Annex B).

Through the use of cost instead of income shares of labour and capital, the OECD measure of MFP allows for non-constant returns to scale and imperfect competition (Annex A and C).

Overview

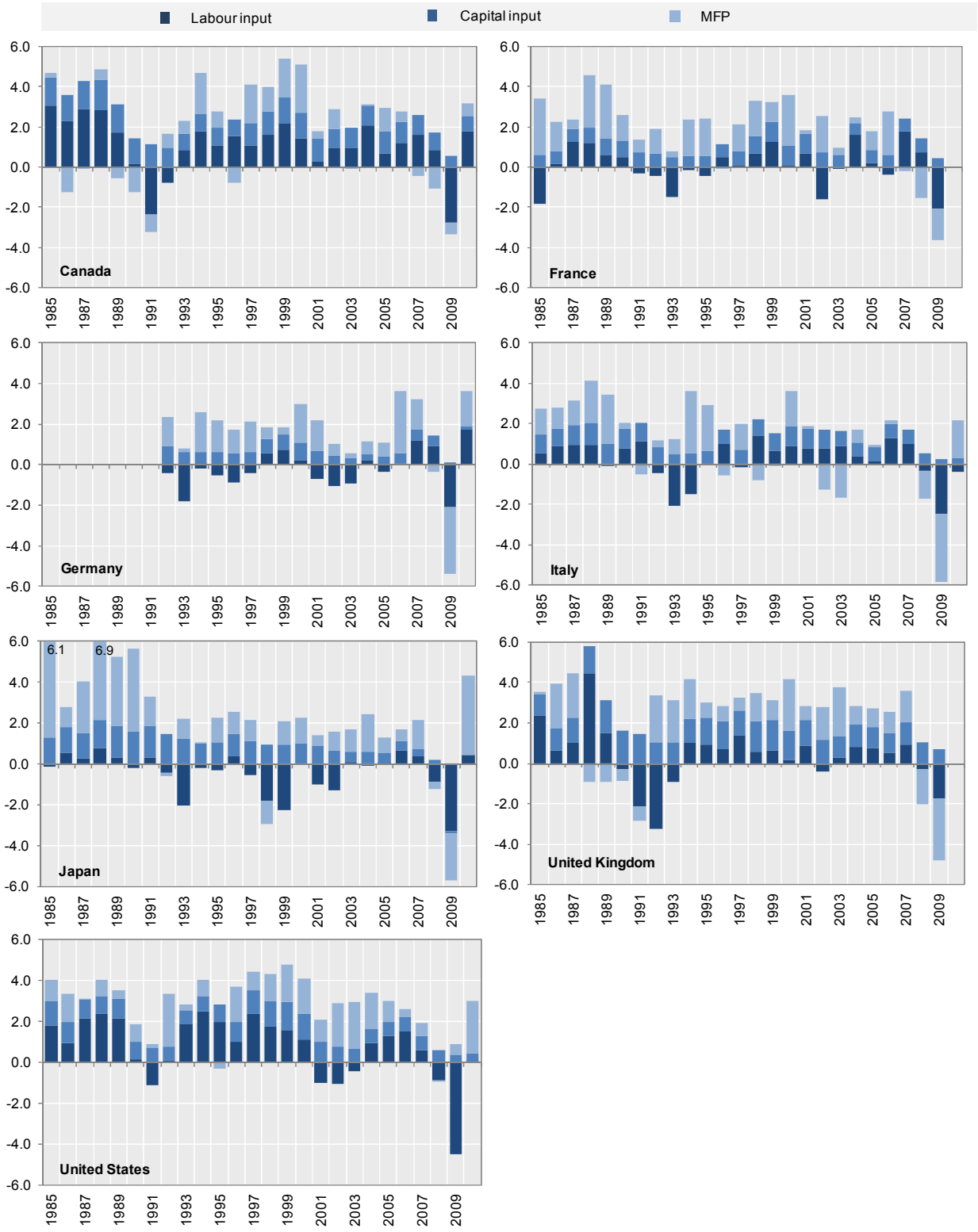
The empirical evidence confirms the cyclical pattern of MFP. In fact, MFP follows GDP growth very closely, not only in terms of the direction but also the size of the change. While the contribution of labour fluctuated relatively strongly for most G7 countries, up to 2007, adjustments in labour input typically lagged. The contribution of capital input changed little over the cycle, possibly reflecting adjustment costs. Moreover, capital input reflects the accumulation of past investment of all firms in the economy, and so although investment is typically relatively volatile, capital stock and capital services estimates are less so.

Sources and further reading

- OECD Productivity Database, www.oecd.org/statistics/productivity.
- OECD (2001), *Measuring Productivity – OECD Manual*, OECD, Paris.
- Schreyer, P. (2004), Capital Stocks, Capital Services and Multifactor Productivity Measures, *OECD Economic Studies*, Vol. 2003/2.
- Wölfl, A., D. Hajkova (2007), Measuring Multifactor Productivity Growth, *OECD Science, Technology and Industry Working Paper 2007/5*, OECD Publishing.

Figure 6.2. The contribution of labour, capital and MFP over time

Total economy, percentage change contributions at annual rate, G7 countries



StatLink http://dx.doi.org/10.1787/888932750417

PART II

METHODOLOGICAL ANNEXES

ANNEX A. THE OECD PRODUCTIVITY DATABASES PDB AND PDBI

Since its launch in 2004, the *OECD Productivity Database (PDB)* has provided annual estimates of labour and multifactor productivity growth (MFP) as a tool to analyse the drivers of economic growth in OECD member countries. In 2011, the OECD further developed this tool by providing new harmonised productivity measures at the industry level in a new *OECD Productivity Database by industry (PDBi)*. The two databases include the following indicators:

- **Growth in labour productivity:** Labour productivity is measured as GDP in basic prices (Gross Value Added) per hour worked. At the total economy level data are currently available for the period 1970-2011 for 34 OECD countries and some geographical zones. At the industry level data cover the period 1985-2011 for 14 industries or sectors and currently 17 countries based on the new ISIC Rev.4 classification (see Table A1 below, Annex D).

- **Capital input measures:** Estimates of capital services at the whole economy level are available in *PDB* (for 19 OECD countries) for the period 1985-2010. Net capital stocks by industry are currently available in *PDBi* for 8 countries and 14 industries according to ISIC Rev.4 (see Table A1 below, Annex D), for the period 1990-2010 for most countries.

- **Labour and capital cost shares:** Data are available for the period 1985-2010 for most countries.

- **Multifactor productivity:** Estimates are available for 19 OECD countries in PDB and 8 countries in the *PDBi,* for the period 1985-2010.

- **Labour productivity levels:** Data are available up to 2011, for all OECD countries and some geographical zones in the *PDB*.

Both the *PDB* and *PDBi* are updated on a continuous basis as new data become available. They are accessible through the OECD Internet site, at: www.oecd.org/statistics/productivity.

The OECD Productivity Database (total economy) (PDB)

The *PDB* combines a consistent set of data on GDP, labour input (measured as total hours worked) and capital services. The detailed measures and data sources used are as follows:

Labour input

Within the *PDB*, labour input is defined as total hours worked of all persons engaged in production. The default source for total hours worked is generally the OECD's *Annual National Accounts*. However, for a number of countries, the national accounts do not provide data on hours worked and, so, other sources have to be used. Estimates of average hours actually worked per year per person in employment are currently available on an annual basis for 34 OECD member countries and in the *PDB* and in the *OECD's Employment Outlook*. See Annex B below for more details

Capital input

Capital input (K) is measured as the volume of capital services, which is the appropriate measure for capital input within the growth accounting framework (see Annex C, and Schreyer, *et al.*, 2003 for more details on the source data used and the computation of capital services). The *OECD Productivity database* publishes capital services data with calculations based on the perpetual inventory method (PIM). The PIM calculations are carried out by the OECD, using an assumption of common service lives for given assets for all countries, and by correcting for differences in the national deflators used for information and communication technology (ICT) assets.[1] The investment series by type of asset are sourced from national statistical offices[2] and for some countries from the *EUKLEMS database* (http://www.euklems.net).[3]

Multifactor productivity (MFP)

In simple terms, MFP can be described as the change in output that cannot be explained by changes in the quantity of capital and labour inputs used to generate output. In the *PDB* it is measured by deducting the growth of labour and capital inputs from output growth as follows:

$$\ln\left(\frac{MFP^t}{MFP^{t-1}}\right) = \ln\left(\frac{Q^t}{Q^{t-1}}\right) - \ln\left(\frac{X^t}{X^{t-1}}\right),$$

where Q is output measured as real GDP. X relates to total inputs used and the rate of change of these inputs is calculated as a weighted average of the rate of change of labour and capital input, with the respective cost shares as weights. Aggregation of these inputs is by way of the Törnqvist index:

$$\ln\left(\frac{X^t}{X^{t-1}}\right) = \frac{1}{2}\left(s_L^t + s_L^{t-1}\right)\ln\left(\frac{L^t}{L^{t-1}}\right) + \frac{1}{2}\left(s_s^t + s_s^{t-1}\right)\ln\left(\frac{K^t}{K^{t-1}}\right).$$

Thereby, Labour input (L) is measured as total hours actually worked and capital input is measured as capital services (K). These are computed separately for each type of assets ($K_i^t = 1, 2, \ldots., 7$, reflecting the seven asset types in the *PDB*) and aggregated to an overall rate of change of capital services, using a Törnqvist index:

$$\ln\left(\frac{S^t}{S^{t-1}}\right) = \sum_{i=1}^{7}\frac{1}{2}\left(v_i^t + v_i^{t-1}\right)\ln\left(\frac{K_i^t}{K_i^{t-1}}\right).$$

Thereby, v_i^t is the contribution that asset *i* makes to total capital services in year *t* and K_i^t is the quantity of capital services provided by asset *i* in year *t*.

1 The following average service lives are assumed for the different assets: 7 years for IT equipment, 15 years for communication equipment, other equipment, and transport equipment, 40 years for non-residential construction, and 3 years for software.

2 Australia, Canada, Finland, France, Germany, Ireland, Italy, Japan, Korea, New Zealand, Spain, Sweden, Switzerland, the United States.

3 Austria, Belgium, Denmark, the Netherlands, Portugal, the United Kingdom.

Cost shares of inputs

The total cost of inputs is the sum of the labour input cost and the cost of capital services. The *OECD Annual National Accounts* records the income of the self-employed *as mixed income*. This identity includes both the compensation to labour and capital. As such, for the *PDB*, total labour input costs for the self-employed and employees are computed as the average remuneration per employee multiplied by the total number of persons employed. The source for data on compensation of employees and for the number of employees as well as the number of self employed is the OECD *Annual National Accounts*.

$$w^t L^t = \left(\frac{COMP^t}{EE^t}\right) E^t,$$

where $w^t L^t$ reflects the total remuneration for labour input in period *t*, $COMP^t$ is the compensation of employees in period *t*, EE^t is the number of employees in period *t*, and E^t the total number of employed persons, *i.e.,* employees plus self-employed, in period *t*.

Total capital input cost is computed as the sum over the user costs of each capital asset type *i,* $u_i^t K_i^t$, where u_i^t is the user cost per unit of capital services provided by asset type *i*.

Total cost of inputs is then given by:

$$C^t = w^t L^t + \sum_{i=1}^{7} u_i^t K_i^t \ .$$

And the corresponding cost shares for labour and capital are

$$s_L^t \equiv \frac{w^t L^t}{C^t} \text{ for labour input and } s_S^t \equiv \frac{\sum_{i=1}^{7} u_i^t K_i^t}{C^t} \text{ for capital input.}$$

Note that under perfect competition and constant returns to scale, the observed Solow residual can be viewed as an unbiased estimate of MFP growth. In this case, the shares of capital and labour in output valued at marginal costs measure the elasticity of output with respect to inputs. However, this is no longer the case under imperfect competition (see Schreyer, 2010, and Oliveira Martins *et al.,* 1996). As shown in Hall (1990), a way of overcoming this problem is to calculate MFP using cost rather than revenue shares, as is done in the *OECD Productivity Database*.

The OECD Productivity Database by Industry (PDBi)

In essence, the conceptual approach used to estimate productivity in the *PDBi* follows that in the *PDB*. However the same quantity (and quality) of data that is available for the whole economy estimates in the *PDB* is not always available at the detailed industry level. Hence some approximations are necessary making that, in practice, some differences prevail between the whole economy estimates and those given in the *PDB* arise.

The *PDBi* currently provides productivity estimates for 14 different industries (activities) each defined in accordance with the *International Standard Industry Classification* (ISIC) Rev.4 (see Table A1 below for more detailed information on data coverage for countries and industries, and Annex D).

Labour input

As in the *PDB*, labour input in the *PDBi* is based on total hours worked by all persons engaged in production (broken down by industry) sourced from the *OECD STAN database*. In the past, when this variable was not available, estimates of total hours worked of employees from the *OECD STAN database* were used as a proxy. If neither total hours worked by all persons engaged nor total hours worked by employees were available in the *OECD STAN database*, then total hours worked at the level of the total economy from the *PDB* were distributed across industries according to the structure of total employment across industries.

Capital input

Unlike the *PDB* where investment data by 7 asset types are used to construct estimates of the value of capital services, at the industry-level, data are generally only available for total capital. Hence, the *PDBi* estimate of net capital stock cannot take account of differences in relative productivity of different types of assets. One consequence of this simplification is that industry-level data are not directly comparable with the economy-wide MFP data that are based on capital services.

The *PDBi* provides time-series of capital input by industry based on a common methodology for all countries. Harmonised net capital stocks by industry are computed using the Perpetual Inventory Method (PIM) based on national investment series. This estimates constant price values of capital stocks by summing prior investments and netting out depreciation and retirement. A standard approach with geometric rates of depreciation (δ) is applied so that the stock for each industry *i* at the beginning of period *t*, K_i^t is computed as follows:

$$K_i^t = I_i^{t-1} + (1-\delta)I_i^{t-2} + (1-\delta)^2 I_i^{t-3} + \ \ldots + (1-\delta)^{T-1} I_i^{t-T-2} + (1-\delta)^T,$$

where I_i^{t-1} is gross fixed capital formation made by industry *i* in year *t-1*.

The measurement of capital costs is based on the same underlying approach as used in the *PDB*. In each industry, it measures a user cost of capital composed of an exogenous real rate of return and the rate of depreciation. The real rate of return used to calculate capital input is country specific, defined in its *ex ante* formulation, and is taken from the long run constant rate as given in the *PDB*.

Multifactor productivity and cost shares

Notwithstanding the differences in the data sources used to construct the *PDB* and the *PDBi* estimates of MFP, the approach used to measure the cost shares of labour and capital, follow the same conceptual model as given above in the *PDB*. Hence at the level of each industry, MFP growth is measured as follows:

$$MFP_i^t = \Delta \ln\left(Q_i^t\right) - \bar{\alpha}_i^t \Delta \ln\left(L_i^t\right) - (1-\bar{\alpha}_i^t)\Delta \ln\left(K_i^t\right).$$

Thereby, $\alpha_i^t = \frac{w_i^t L_i^t}{w_i^t L_i^t + u_i^t K_i^t}$ is the share of labour in total costs in industry i, $\bar{\alpha}_i^t = 0.5\left(\bar{\alpha}_i^{t-1} + \bar{\alpha}_i^t\right)$ its average over two periods, (1-$\bar{\alpha}_i^t$) is the share of capital in total costs, Q_i^t is real value-added, L_i^t the labour input from the *OECD STAN database*, and K_i^t the capital input computed as described above.

Table A.1. Data coverage in the OECD Productivity Database by Industry, ISIC Rev4

Growth in GDP per hour worked		AUT	CZE	DNK	FIN	FRA	DEU	HUN	ITA	LUX	NLD	NOR	PRT	SVK	SVN	ESP	SWE
DTOTALX	**TOTAL EXCL. REAL ESTATE**	96-11	96-11	85-10	85-11	85-11	92-11	96-10	93-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	94-11
D01T03	**AGRICULTURE, HUNTING, FORESTRY & FISHING**	96-11	96-11	85-10	85-11	85-11	92-11	96-10	85-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	85-11
D05T39	**INDUSTRY INCLUDING ENERGY**	96-11	96-11	85-10	85-11	85-10	92-11	01-07	85-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	94-11
D05T09	MINING AND QUARRYING	96-11	96-11	85-10	85-11	85-10	92-11	96-07	85-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	85-11
D10T33	MANUFACTURING	96-11	96-11	85-10	85-11	85-10	92-11	96-10	85-11	03-11	85-10	85-11	01-09	96-11	01-10	96-10	85-11
D26T28	Machinery and equipment	96-11	96-11	85-10	85-11	85-11	92-10	96-07	85-11	03-11	88-10	85-11	01-09	96-11	01-10	01-10	94-11
D29T30	Transport equipment	96-11	96-11	85-10	85-11	85-11	92-10	96-07	85-11	03-11	88-10	85-11	01-09	96-11	01-10	01-10	94-11
D35T39	UTILITIES[2]	96-11	96-11	85-10	85-11	85-10	92-11	01-07	85-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	94-11
D41T43	**CONSTRUCTION**	96-11	96-11	85-10	85-11	85-11	92-11	96-10	85-11	03-11	85-10	85-11	01-09	96-11	01-10	96-10	85-11
D45T82X	**BUSINESS SECTOR SERVICES EXCL. REAL ESTATE**	96-11	96-11	85-10	85-11	85-11	92-11	96-10	93-11	03-11	88-10	85-11	01-09	98-11	01-10	01-10	94-11
D45T47	Wholesale & retail trade; repair of motor vehicles	96-11	96-11	85-10	85-11	85-11	92-11	96-07	85-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	94-11
D55T56	Accommodation & food services	96-11	96-11	85-10	85-11	85-11	92-11	96-07	85-11	03-11	85-10	85-11	01-09	96-11	01-10	01-10	94-11

Growth in MFP		AUT	CZE	DNK	FIN	FRA	DEU	HUN	ITA	LUX	NLD	NOR	PRT	SVK	SVN	ESP	SWE
DTOTALX	**TOTAL EXCL. REAL ESTATE**	96-10	97-10	97-10	85-10		95-10					85-10					
D01T03	**AGRICULTURE, HUNTING, FORESTRY & FISHING**	96-10	97-10	97-10	85-10		95-10		85-10			85-10					
D05T39	**INDUSTRY INCLUDING ENERGY**	96-10	98-10	97-10	85-10		95-10		85-10			85-10					
D05T09	MINING AND QUARRYING	96-10	98-10	97-10	85-10		95-10		85-10			85-10					
D10T33	MANUFACTURING	96-10	98-10	97-10	85-10		95-10		85-10			85-10					
D26T28	Machinery and equipment	96-10	97-10	97-10	85-10		95-10		85-10			85-10					
D29T30	Transport equipment	96-10	97-10	97-10	85-10		95-10		85-10			85-10					
D35T39	UTILITIES[2]	96-10	97-10	97-10	85-10		95-10		85-10			85-10					
D41T43	**CONSTRUCTION**	96-10	97-10	97-10	85-10		95-10		85-10			85-10					
D45T82X	**BUSINESS SECTOR SERVICES EXCL. REAL ESTATE**	96-10	98-10	97-09	85-10		95-10					85-10					
D45T47	Wholesale and retail trade; repair of motor vehicles	96-10	97-10	97-09	85-10		95-10		85-10			85-10					
D55T56	Accommodation & food services	96-10	97-10	97-10	85-10		95-10		85-10			85-10					

Notes: (1) Based on STAN coverage (31 October 2012). Includes preliminary estimates to be released later this year. Hours worked for total employment or/and capital input data is missing for Belgium, Canada, Chile, Estonia, Greece, Iceland, Ireland, Israel, Japan, Korea, Mexico, New Zealand, Poland, Switzerland, Turkey, the United Kingdom and the United States.

2) Electricity, gas, steam, air conditioning and water supply, sewerage, waste management and remediation activities.

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Hall, R. (1990), Invariance Properties of Solow's Productivity Residual, in P. Diamond (ed.), *Growth, Productivity, Unemployment*, MIT Press, Cambridge, Massachusetts.

Oliveira-Martins, J., S. Scarpetta and D. Pilat (1996), Mark-up ratio in Manufacturing Industries, Estimates for 14 OECD Countries, *OECD Economic Department Working Papers,* N°162. This work has also been published in "Mark-ups Pricing, Market Structure and the Business Cycle"; *OECD Economic Studies*, N°34, OECD, Paris.

Schreyer, P. (2010), Measuring Multifactor Productivity when Rates of Return Are Exogenous, in Diewert et al. (2010), *Price and Productivity Measurement*, Vol.6.

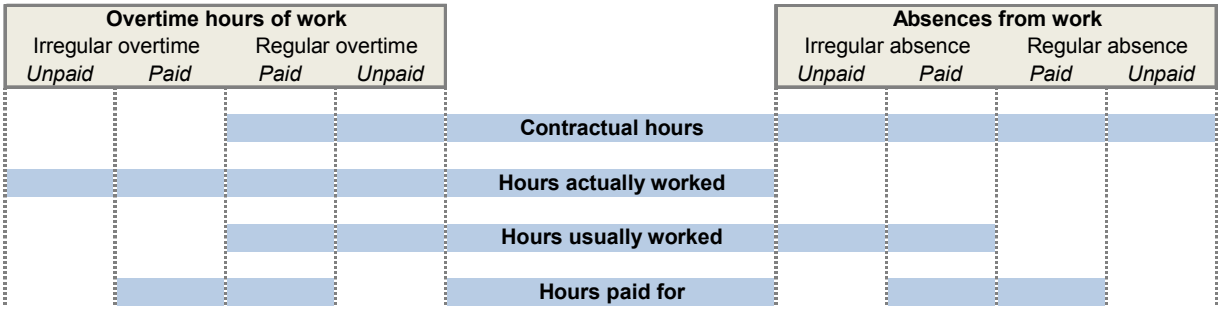
ANNEX B. MEASURING HOURS WORKED

Hours worked for productivity analysis – main definitions

Within both the *Productivity Database* (PDB) and the *Productivity Database by Industry* (PDBI), the underlying concept for labour input is *total hours actually worked by all persons engaged in production*. It is instructive to consider the relationship between this concept and related measures of working time (Figure B1):

- *Hours actually worked* - hours actually spent on productive activities;
- *Hours usually worked* - the typical hours worked during a short reference period such as a week over a longer observation period;
- *Hours paid for* - the hours worked for which remuneration is paid;
- *Contractual hours of work* - the hours time that individuals are expected to work based on work contracts;
- *Overtime hours of work* - the hours actually worked in excess of contractual hours; and
- *Absence from work hours* - the hours that persons are expected to work but do not work.

Figure B.1. Relationship between different concepts of hours worked



Note: Establishing the relationship between normal hours and the five other concepts is not possible, as normal hours are established on a case-by-case basis.

Source: ILO (2008), Measurement of working time, 18th ICLS.

Because productivity analysis is interested in measuring the inputs used in producing a given output, the underlying concept for labour input should include all hours used in production, whether paid or not. They should exclude those hours not used in production, even if some compensation is received for those hours. As such the relevant concept for measuring labour input is *hours actually worked*. The productive

or non-productive characteristic of an activity is determined by its inclusion in, or exclusion from, the SNA production boundary. *Hours actually worked* are defined as (ILO, 2008):

- the hours spent directly on productive activities or in activities in relation to them (maintenance time, cleaning time, training time, waiting time, time spent on call duty, travelling time between work locations);
- the time spent in between these hours when the person continues to be available for work (for reasons that are either inherent to the job or due to temporary interruptions); and
- short resting time.

Conversely, *hours actually worked* should exclude:

- annual leave and public holidays;
- longer breaks from work (*e.g.* meal breaks);
- commuting time (when no productive activity is performed); and
- educational activities other than on-the-job training time.

Measuring hours worked

In general, *Labour Force Surveys* (LFS) are the main source used to compile hours worked data in a majority of countries. LFS is most often also the principal underlying source in *National Accounts* – the main source ultimately used in the *PDB* and *PDBi.* LFS include questions on the number of hours actually and usually worked in the reference period, and questions concerning the differences between the time usually spent working and the time actually worked during the reference week. Additional LFS questions concerning working time components such as work at home, commuting time, short breaks, overtime and absence from work are also often available.

Continuous labour force surveys are especially appropriate for measuring working time as they allow direct collection of data on hours actually worked through the year. This method is known as the *direct method*, as it is based on a direct measure of average actual hours of work during each reference week. Since the survey refers to all weeks of the year, it takes into account all types of absences from work and overtime.

However, in most cases, LFS surveys are not continuous and so the *direct method* to measure actual hours worked during the year is not applicable. In these cases, estimates are built using the *component method.* Thereby, data are collected for a specific reference week (e.g. one week during a month) and complemented with other data to build annual estimates of actual hours worked during the year. The component method starts with the usual hours of work collected in the LFS and then adjusts for absences from work such as holidays, bank holidays, illness, maternity leave, overtime, etc. Annual totals are then derived by scaling up the weekly estimate.

In some countries, LFS surveys are not used or are complemented with information from other sources. Among such other sources are the following:

1. *Establishment (and enterprise) surveys*. These are typically the main source of information for hours worked estimates by industry. One of the main drawbacks of this source is that the data collected generally refer to hours *paid* rather than actual hours *worked*, hence include paid absences and exclude unpaid overtime.

2. *Administrative records,* such as social security and tax registers. These are the main sources of information for adjusting data from labour force surveys and establishment surveys to obtain estimates of absences from work due to illness, maternity leave, occupational injuries, strikes and lockouts.

3. *Time Use Surveys*. These are useful to compare the results from other sources but their irregularity, low frequency and limited international comparability is a drawback. Labour force survey based estimates of working time typically over-report hours worked when compared to estimates from time use surveys.

For productivity analysis, consistency of LFS based data on hours worked with the *National Accounts* concepts needs to be ensured (OECD, 2009; Ypma and van Ark, 2006). This implies adjusting the coverage of activities included in the LFS to that used to compute GDP, and adapting the geographical and economic boundaries of employment to GDP. The notion of economic territory used to compute GDP refers to the domestic concept, *i.e.* resident persons working outside the country are excluded. Some of these adjustments can be considered as negligible for most countries although they are made in all countries. Likewise, measures of hours actually worked should refer to productive activities within the SNA production boundaries (by definition); persons spending time on productive activities excluded from the original sources should therefore be included.

In general, when LFS is the main source of information for employment, adjustments concern persons outside the LFS universe but who need to be included as persons engaged in production, as defined in the SNA. The causes for differences between these two measures are:

- age threshold (e.g. people under 15 engaged in production are generally not included in LFS estimates);
- non-coverage of particular groups: persons living in collective households, armed forces, and non-resident persons working within the economic territory of the country are generally not surveyed in LFSs;
- non-coverage of certain activities: The LFS may not include hours worked in certain activities such as subsistence work and volunteer work;
- non-coverage of some territories: The LFS may not cover the entire economic territory covered in GDP.

Hours worked data in the OECD Productivity Databases

For the Productivity Database, the main requirement is that the most internationally comparable hours worked data are used (OECD, 2007). The default source for total hours worked is generally the *National Accounts* which are presented in *OECD's Annual National Accounts (ANA) database* (total economy and aggregate economic activities) and the *OECD STAN database* (detailed economic activities). However, for a number of countries, long time series of hours worked were not available. For these countries, estimates from *OECD's Employment Outlook* are used, which are based on national annual LFS results supplemented with information from a detailed OECD survey sent to member countries. Total economy estimates of average hours actually worked per year per person in employment are currently available on an annual basis for all 34 OECD member countries as follows:

- For 20 countries, actual hours worked data are sourced from the *OECD ANA*: Austria, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel,

Italy, Korea, the Netherlands, Norway, the Slovak Republic, Slovenia, Spain, Sweden and Switzerland;

- For 13 countries hours worked data are not or have only been available recently in *OECD ANA,* or are measured per job. For these countries, the *PDB* use still hours worked from the *OECD Employment Outlook*: Australia, Belgium, Chile, Iceland, Ireland, Japan, Luxembourg, Mexico, New Zealand, Poland, Portugal, Turkey and the United Kingdom;

- In the case of the United States, SNA based hours worked are sourced from BLS and refer to jobs. An adjustment is made to convert them to hours worked per person in the *OECD Employment Outlook* are used in PDB.

References

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ANNEX C. CAPITAL INPUT MEASURES AT THE OECD

Introduction

Two key measures of capital stock exist. The first is *productive capital stock*, which looks at capital in its function as a provider of capital services in production. The second is gross (or net) capital stock, which captures the role of capital as a store of wealth.[1] This Annex provides supplementary information on these two measures and the approaches used to estimate them. It also provides further information on data availability for capital at the OECD and provides some pointers to future developments at the OECD.

Definitions

Productive capital stock (and capital services)

When the purpose of capital measurement is to gauge its role in production and productivity, via capital services, it is necessary to construct measures of the *productive capital stock.* The productive capital stock per type of capital asset is constructed by applying an age-efficiency and a retirement pattern when past investments of each asset are summed up over time. For example, a 10-year old lorry would be given a lower weight compared to a new lorry when past purchases of lorries are added up to construct a measure of today's productive stock of lorries. Moreover, lorries are scrapped after a certain number of years and investments that date back by say 30 years would not enter today's productive stock. Unlike gross or net capital stock measures, aggregate productive stock measures weight different types of assets by their relative productivity, using the user costs of each capital type. The resulting aggregate constitutes a measure for the potential flow of productive services that all fixed assets can deliver in production.

Net and gross capital stocks

Perhaps the best known measure of capital stock is that used to value assets on a company, industry or nation's balance sheets, that is, the gross or net capital stock measures described in the SNA. These provide measures of wealth but they are not conceptually appropriate for productivity analysis. This reflects the fact that the implicit weighting used for the different assets used in building up wealth measures of capital stock is based on the values of the different assets. However changes in the relative productivity of the different assets are not necessarily consistent with changes in the relative price of the assets. For productivity analysis it is the former measure (and weighting of different asset types) that is relevant.

1. For more information on capital measures and their uses see OECD (2001, 2009) and Schreyer (2004).

Measuring capital input

In general, capital stock series are not directly measured.[2] In common with most measures presented in the *National Accounts,* they are estimated by national statisticians using available underlying data with local methodology and assumptions – although there is increasing convergence towards international standards. However, for capital stock estimates there are heavy data requirements which include the following:

- a benchmark level of capital stock for at least one year (preferably by asset type);
- a long-time-series of investment volumes and price deflators (preferably by asset type);
- as much asset type detail as possible;
- depending on the type of capital stock being estimated, estimates of average services lives by asset and/or depreciation rates for each asset;
- industry-by-asset-type investment matrices for capital stock by industry.

All OECD countries follow the 1993 SNA's new standards, except Australia which follows the 2008 SNA. An important recommendation of the 2008 SNA is to recognise research and development expenditure as investment (OECD, 2010). The 2008 SNA also recommends to extend the scope of fixed capital formation with the inclusion of expenditures on military equipment.

Capital measures in OECD statistics

Several OECD databases, described below, contain capital stock data (OECD, 2011). However some differences exist between them:

- *The origin of the data*. In some of the databases described below only official data made available to the OECD by national statistics institutes are used. In other databases however, particularly those that are considered more analytical databases, such as the *PDB* and *PDBi,* other sources are often used to estimate missing data or to create estimates based on comparable estimation techniques.
- *The coverage of the data*. As shown in Table C1 below, some databases are confined to aggregate statistics, such as the *OECD Economic Outlook* database (EO) or the *OECD Productivity Database.* Others provide a break-down by industry, such as the *OECD's Structural Analysis (STAN)*, the *Annual National Accounts (ANA)* and the *Productivity by Industry (PDBi)* databases.
- *The capital stock variable*. The *OECD Productivity Database* measures productive stocks whereas the *National Accounts database* contains measures of net and/or gross capital stocks.

[2] Exceptions include Netherlands and South Korea which carry out surveys every 5 and 10 years respectively.

Table C.1. Asset and industry break-down of capital stock data in OECD databases

		Asset breakdown	
		Yes	No
Industry breakdown	Yes	**ANA** (9-way asset classification, 1-digit industries ISIC Rev. 3)	**STAN and PDBi** (2-digit industries ISIC Rev.4, total fixed assets),
	No	**Productivity database** (7-way asset break-down, total economy)	**Economic Outlook**

Capital services for the total economy, 7-way asset break down

Estimates of capital services in the *OECD Productivity databases* are based on a common computation method for all countries (Schreyer, 2001, Schreyer *et al.,* 2003). This approach estimates productive stock for all countries on the assumption that the same service lives are applicable for any given asset irrespective of the country it is used in. The approach further uses harmonised deflators for hardware, communications equipment and software assets, for all countries, reflecting comparability problems that exist in national practices for deflation for this group of assets.

Capital service flows in the PDB relate to non-residential fixed capital only and have been computed at the level of the total economy for 19 OECD countries. They can be broken down by seven types of assets: Hardware and office machinery; Communication equipment; Other machinery and equipment; Transport equipment; Non residential construction; Software; and Other products. By their very nature, capital services flows are presented as rates of change or indices and not as levels of stocks as is the case for measures of net and gross stocks.

Net and gross capital stocks by broad economic activities, with 9-way asset break-down

The *OECD Annual National Accounts database* (ANA) brings together a large number of national accounts series for OECD countries. This includes data on net and gross capital stocks broken down by main economic activity (A10) and by nine types of assets (dwellings, other buildings and structures, transport equipment, other machinery and equipment, of which office machinery and hardware, radio, TV and communication equipment; cultivated assets; intangible fixed assets, of which software). The data are transmitted by OECD Member countries in reply to an official questionnaire and are provided in values and volumes. The level of industry detail and the time period covered varies across countries.

Net and gross capital stocks by detailed industries, no asset break-down

The *OECD STAN database* provides data on volume measures of *gross and net capital stock* by industry. STAN is currently moving to a new ISIC Rev4 based industry list which covers all ISIC Rev4 aggregations used for national accounts, some additional 2- and 3- digit ISIC Rev4 detail, as well as specific aggregates (Annex D). The level of industry detail and the time period covered varies across countries. A detailed overview of available data in STAN can be found at www.oecd.org/sti/stan.

Productive stock (and capital services) by detailed industrial activity, no asset breakdown

The *OECD Productivity database by industry (PDBi)* computes a series of harmonised net productive stocks by industry based on the OECD STAN database. The value of capital stocks per industry is estimated by the Perpetual Inventory Method (PIM). The PIM cumulates past flows of Gross Fixed Capital Formation in volume terms and corrects them for the retirement and for their loss in value due to ageing and depreciation. The *OECD PDBi* uses the same assumptions about depreciation patterns and the same level of asset detail for all countries, so as to produce harmonised estimates across countries. Since information on investment by industry and by asset is not available, the industry capital stocks cannot account for differences in productivity of assets. This entails an underestimation of the contribution of capital to economic growth.

Alternative capital stocks, for the total economy, no asset break-down

The OECD Economic Outlook is a key twice-yearly publication with economic forecasts and analyses for OECD countries. One of the series available is the volume measure for non-residential capital services for the total economy.

How to access OECD capital input measures

All OECD databases are freely available to government officials with access to OLIS (the OECD Online Information System) or to fee paying subscribers, via the online data browsing service OECD.STAT. *OECD Productivity Database*, *PDBi* and *STAN Databases* can be accessed for free:

- Aggregate capital services series in *OECD's Productivity Database*, along with methodological information and analytical papers and publications can be found on: www.oecd.org/statistics/productivity or http://stats.oecd.org/Index.aspx?DataSetCode=CS;

- Data on gross/net capital stocks by industry can be found in the OECD STAN database on: www.oecd.org/sti/stan.

- Capital stock information used in the *OECD PDBi database* can be found at http://dotstat.oecd.org/Index.aspx?*DataSet*Code=PDBI;

- Gross/net capital stocks in the *Annual National Accounts Database* can be found under the theme of the national accounts via: http://stats.oecd.org/, then selecting Annual National Accounts; Main Aggregates; Detailed Tables and Simplified Accounts; Fixed Assets by Activity and by Type of Product;

- Data used for the *Economic Outlook,* such as the total economy capital stock volume series, are published separately and can be found under the item 'Supply Block' through the current Economic Outlook theme on OECD.STAT (http://stats.oecd.org/).

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System of National Accounts (SNA) 2008, New York: http://unstats.un.org/unsd/nationalaccount/sna2008.asp.

ANNEX D. ISIC REV4 - A NEW CLASSIFICATION FOR INDUSTRIAL STATISTICS

Introduction

In 2008, the United Nations Statistical Division (UNSD) released the 4th revision of the International Standard Industrial Classification (ISIC Rev.4). Revisions to ISIC are periodically undertaken to account for new and emerging products or industries, and to reflect changes in the organisation of production often resulting from technological innovations. ISIC Rev.4 was broadly developed in parallel with the implementation of NACE Rev.2, the European equivalent.

The implementation of ISIC Rev.4 at OECD has been driven mainly by the implementation of NACE Rev.2 by EU countries in accordance with EU regulations. Since 2008, EU countries have been compiling activity based survey statistics according to NACE Rev.2 (*e.g.* Structural Business Statistics and Labour Force Surveys) and since September 2011, EU countries have been obliged to submit *National Accounts* (SNA) by activity statistics according NACE Rev.2 – the latter being a principle source of data for deriving comparative measures of productivity.

ISIC Rev.4 and NACE Rev.2 are the same at the 2-digit level while at the 3- and 4-digit level NACE Rev.2 is slightly more detailed. Converting the latest industry statistics from EU countries to ISIC Rev.4 is thus relatively straightforward. Most other OECD countries continue to use national or regional industrial classifications (e.g. ANZSIC, JSIC or NAICS) and, since these are more aligned with ISIC Rev.4 than ISIC Rev.3, data availability notwithstanding, the conversions require fewer compromises than before. Difficulties can arise when attempting, for analytical purposes, to extend new ISIC Rev.4 SNA series backwards using vintage ISIC Rev.3 (NACE Rev.1) data – *e.g.* when updating *OECD's Structural Analysis (STAN) database* (see below).

From ISIC Rev. 3 to ISIC Rev.4

A full description of ISIC Rev.4 and related correspondences can be found on the UNSD website.[1] Basically, ISIC Rev. 4 consists of more Sections, Divisions, Groups and Classes than its predecessors (see Table D1.) and better distinguishes service activities.

Table D.1. Simple comparison of categories in ISIC Rev.3, ISIC Rev.3.1 and ISIC Rev.4

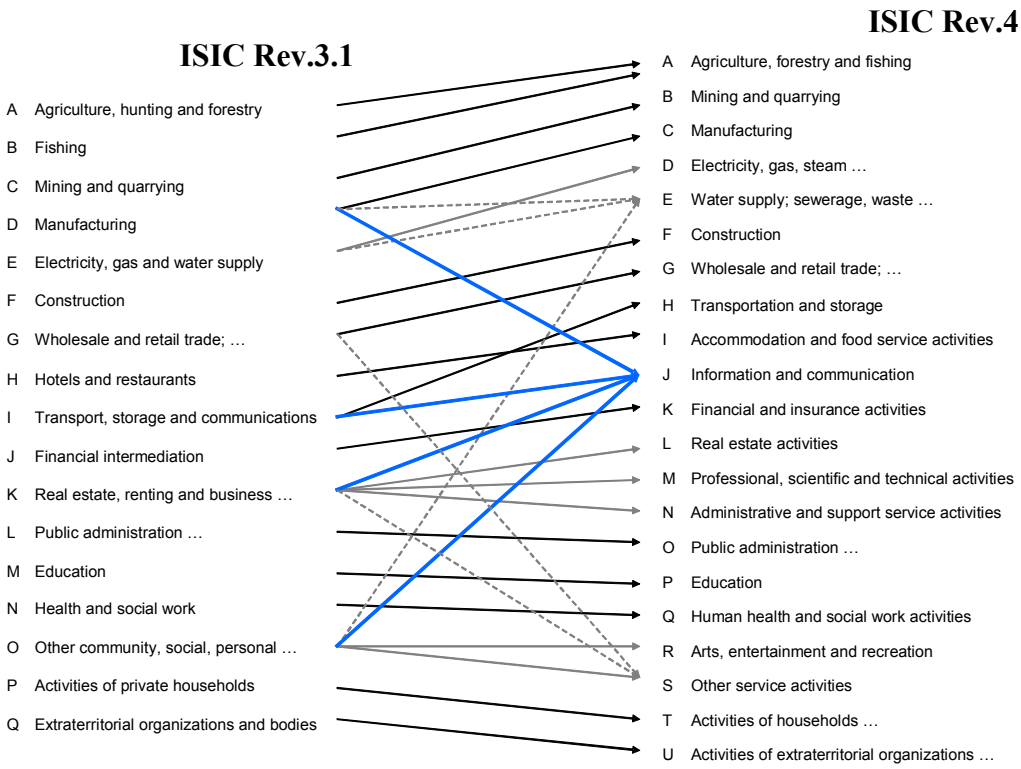
	ISIC Rev. 3 (1990)	ISIC Rev. 3.1 (2002)	ISIC Rev. 4 (2008)
Sections	17	17	21
Divisions	60	62	88
Groups	159	161	238
Classes	292	298	419

Source: Becker, R. (2008), ISIC Rev. 4 officially released, OECD Statistics Newsletter, Issue no. 43, OECD Publishing, Paris.

1 http://unstats.un.org/unsd/cr/registry/isic-4.asp.

For statisticians and analysts, an important issue is the extent to which ISIC Rev.4 differs from ISIC Rev.3 in terms of scope and structure, particularly if one wants to construct relevant time series of indicators of industrial activity. Figure D1 provides a summary of the relationship between ISIC Rev.3 and ISIC Rev.4 at the highest level of aggregation (Section), and highlights the major differences.

Figure D.1. ISIC Rev.3 versus ISIC Rev.4 at the highest level of classification



Source: Becker, R. (2008), ISIC Rev. 4 officially released, *OECD Statistics Newsletter,* Issue no. 43, OECD Publishing, Paris.

Notable changes include:

- ISIC Rev.4 introduces an '*Information and Communication'* Section (J) consisting of *'Publishing activities'* (Division 58), *'Audiovisual and broadcasting activities'* (59-60), *'Telecommunications'* (61), and *'IT and other information services'* (62-63). It brings together elements of four ISIC Rev.3 sections. For example, under ISIC Rev.3, '*publishing*' was found in under section D, '*Manufacturing*' Division 22 while broadcasting activities were part of Section O, *'Other community, social and personal services'*.

- An environment-oriented Section (E) groups together '*Water collection, treatment and supply'* previously in ISIC Rev.3 Division 41*, 'Sewerage'* and *'Waste collection, treatment and disposal'* (ISIC Rev.3 Division 90), and *'Materials recovery'*, previously labelled '*Recycling'* and found in ISIC Rev.3 'Manufacturing' Division 37.

- The ISIC Rev.3 Section K, *'Real estate, renting and business activities',* has been split into three distinct ISIC Rev.4 Sections (L, M and N).

- *'Veterinary activities'* is now separated from '*Human health activities*' and has moved to its own ISIC Rev.4 Division (75) under section M *'Professional, scientific and technical services'*.

- *'Repairs of Household Goods'* is now found in Division 95, Section S when previously it was part of ISIC Rev.3 Division 52 in section G. Without an equivalent in ISIC Rev.3, a new Division (33) under ISIC Rev.4 manufacturing covers *'Installation and repair of machinery and equipment'* and consists of activities previously included in numerous ISIC Rev.3 manufacturing Divisions.

- *'Postal and courier activities'* is allocated to ISIC Rev.4 Division 53 whereas in ISIC Rev.3 these activities were grouped together with telecommunication services in Division 64.

Implementation in OECD's STAN Database

The *OECD STAN Database* is primarily based on member countries' annual SNA by activity tables and, where feasible, uses data from other sources, such as national industrial surveys/censuses, to estimate any missing detail.[2] The latest version is based on ISIC Rev.4 and the timing of its development has been driven by the provision of NACE Rev.2 SNA data from EU countries since 2011. While the maximum level of detail required by the official Eurostat/OECD SNA questionnaire is a list of 64 ISIC Rev.4 /NACE Rev.2 Divisions and aggregates, the STAN industry list includes all 88 2-digit Divisions (Table D.3).[3]

When countries make major revisions to SNA, such as a change in classification, the latest statistics may only be available for a limited number of recent years in the first instance. One of the features of the STAN database is to take the latest SNA by activity data and, where appropriate, make estimates for earlier years using previous versions of SNA or STAN. A change in classification thus requires the transformation of vintage data to the new classification as a first step in using them for estimation purposes. In this case, an approximate ISIC Rev.3 to ISIC Rev.4 conversion regime is needed.

The official UN correspondence between ISIC Rev.3 and ISIC Rev.4 is a many-to-many (n:n) relationship.[4] For practical purposes however, an approximate, many-to-one (n:1, 1:1) conversion key based on two-digit sector detail is applied to convert previous SNA data compiled in ISIC Rev.3 to ISIC Rev.4 (see Table D4). The converted vintage ISIC Rev.3 data are then used, where necessary, to extend available ISIC Rev.4/NACE Rev.2 series back in time. This is the case, in general, for European countries. For non-EU countries where this level of detail may be achieved from the respective national classification, a more approximate (aggregate) standard conversion key may be applied. For countries where the coverage changes over time, a country-specific approximate conversion key may be applied to increase time coverage and to complete backcasting for aggregate ISIC Rev.4 sectors. Note that converted ISIC Rev.3 series are only used to extend available ISIC Rev.4 data i.e. by linking to the earliest available ISIC Rev.4 data points. Because of the approximate nature of the conversion keys they are not used to make estimates of complete ISIC Rev.4 series. After linking, further adjustments are made to ensure summation within the industry hierarchies.

2 See www.oecd.org/sti/stan.

3 For a summary of Eurostat NACE Rev.2 aggregations for National Accounts (A10, A21, A38 and A64), see OECD (2012).

4 http://unstats.un.org/unsd/cr/registry/regso.asp?Ci=61&Lg=1.

A particular challenge concerns Section J, *'Information and Communication'*, a major aggregate in the new SNA A10 list consisting of Divisions 58 to 63. When a country's latest SNA figures are only provided for recent years (e.g. series start in 1995 or 2000) making estimates for earlier years based on converted ISIC Rev.3 SNA series is relatively straightforward for most ISIC Rev.4 aggregates. For Section J with its particular combination of elements from four ISIC Rev.3 Divisions, a proxy series is derived for *backcasting* based on an approximate conversion from ISIC Rev.4 to ISIC Rev.3 (Table D.2). Using ISIC Rev.4 data for the earliest available year, the proxy series consists of the sum of fixed shares of vintage series for ISIC Rev.3 Divisions 22, 64 and 92 + Division 72. For ISIC Rev.3 22, the share is earliest ISIC Rev.4 58/(18+58); for ISIC Rev.3 64, ISIC Rev.4 61/(53+61); and, for ISIC Rev.3 92, ISIC Rev.4 (59-60)/(59-60)+(90-93).

Table D.2. Approximate ISIC Rev.4 to ISIC Rev.3 conversion for ISIC Rev.4 Sector J

ISIC Rev. 4		ISIC Rev. 3	
18	Printing and reproduction of recorded media	22	Publishing, printing and reproduction of recorded media
58	**Publishing activities**		
59-60	**Audiovisual and broadcasting activities**	92	Recreational, cultural and sporting activities
90-93	Arts, entertainment and recreation		
53	Postal and courier activities	64	Post and telecommunications
61	**Telecommunications**		
62-63	**IT and other information services**	72	Computer and related activities

References

Becker, R. (2008), ISIC Rev. 4 officially released, *OECD Statistics Newsletter*, Issue no. 43, OECD Publishing, Paris.

OECD (2012), OECD STAN industry list, www.oecd.org/sti/industryandglobalisation/3max.pdf.

Table D.3. STAN ISIC Rev.4 industry list

Description	ISIC Rev.4		Description	ISIC Rev.4	
TOTAL	**01-99**	x			
AGRICULTURE, HUNTING, FORESTRY AND FISHING	**01-03**	x	**WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES; TRANSPORTATION AND STORAGE; ACCOMMODATION AND FOOD SERVICE ACTIVITIES**	**45-56**	x
AGRICULTURE, HUNTING AND FORESTRY	01-02	o	WHOLESALE AND RETAIL TRADE, REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	45-47	x
CROP AND ANIMAL PRODUCTION, HUNTING AND RELATED SERVICE ACTIVITIES	01	o	....WHOLESALE, RETAIL AND REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	45	o
FORESTRY AND LOGGING	02	o	....WHOLESALE TRADE - EXCEPT MOTOR VEHICLES	46	o
FISHING, FISH HATCHERIES, FISH FARMS AND RELATED SERVICES	03	o	....RETAIL TRADE - EXCEPT MOTOR VEHICLES	47	o
			TRANSPORTATION AND STORAGE	49-53	x
INDUSTRY INCLUDING ENERGY	**05-39**	x	....LAND TRANSPORT AND TRANSPORT VIA PIPELINES	49	o
			....WATER TRANSPORT	50	o
MINING AND QUARRYING	**05-09**	x	....AIR TRANSPORT	51	o
MINING AND QUARRYING OF ENERGY PRODUCING MATERIALS	05-06		....WAREHOUSING AND SUPPORT ACTIVITIES FOR TRANSPORTATION	52	o
MINING AND QUARRYING EXCEPT ENERGY PRODUCING MATERIALS	07-09		....POSTAL AND COURIER ACTIVITIES	53	o
			ACCOMMODATION AND FOOD SERVICE ACTIVITIES	55-56	x
MANUFACTURING	**10-33**	x			
FOOD PRODUCTS, BEVERAGES AND TOBACCO	10-12	x	**INFORMATION AND COMMUNICATION**	**58-63**	x
....FOOD PRODUCTS AND BEVERAGES	10-11		PUBLISHING, AUDIOVISUAL AND BROADCASTING ACTIVITIES	58-60	x
.....FOOD PRODUCTS	10		....PUBLISHING ACTIVITIES	58	o
.....BEVERAGES	11		....AUDIOVISUAL AND BROADCASTING ACTIVITIES	59-60	o
....TOBACCO PRODUCTS	12		TELECOMMUNICATIONS	61	x
TEXTILES, WEARING APPAREL, LEATHER AND RELATED PRODUCTS	13-15	x	IT AND OTHER INFORMATION SERVICES	62-63	x
....TEXTILES AND WEARING APPAREL	13-14				
.....TEXTILES	13		**FINANCIAL AND INSURANCE ACTIVITIES**	**64-66**	x
.....WEARING APPAREL	14		FINANCIAL SERVICE ACTIVITIES, EXCEPT INSURANCE AND PENSION FUNDING	64	o
....LEATHER AND RELATED PRODUCTS	15		INSURANCE AND PENSION FUNDING, EXCEPT COMPULSORY SOCIAL SECURITY	65	o
WOOD AND PAPER PRODUCTS, AND PRINTING	16-18	x	ACTIVITIES AUXILIARY TO FINANCIAL SERVICE AND INSURANCE ACTIVITIES	66	o
....WOOD AND PRODUCTS OF WOOD AND CORK, EXCEPT FURNITURE	16	o			
....PAPER AND PAPER PRODUCTS	17	o	**REAL ESTATE, RENTING AND BUSINESS ACTIVITIES**	**68-82**	
....PRINTING AND REPRODUCTION OF RECORDED MEDIA	18	o	**REAL ESTATE ACTIVITIES**	**68**	x
CHEMICALS, RUBBER, PLASTICS, FUEL AND OTHER NON-METALLIC MINERAL PRODUCTS	19-23				
....COKE AND REFINED PETROLEUM PRODUCTS	19	x	**PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES; ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES**	**69-82**	x
....CHEMICAL AND PHARMACEUTICAL PRODUCTS	20-21		PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	69-75	x
.....CHEMICALS AND CHEMICAL PRODUCTS	20	x	....LEGAL AND ACCOUNTING ACTIVITIES; HEAD OFFICES; MANAGEMENT CONSULTANCY; ARCHITECTURE AND ENGINEERING ACTIVITIES; TECHNICAL TESTING AND ANALYSIS	69-71	x
.....BASIC PHARMACEUTICAL PRODUCTS AND PHARMACEUTICAL PREPARATIONS	21	x	.....LEGAL AND ACCOUNTING ACTIVITIES; HEAD OFFICES; MANAGEMENT CONSULTANCY	69-70	o
....RUBBER, PLASTICS AND OTHER NON-METALLIC MINERAL PRODUCTS	22-23	x	.....ARCHITECTURAL AND ENGINEERING ACTIVITIES; TECHNICAL TESTING AND ANALYSIS	71	o
.....RUBBER AND PLASTICS PRODUCTS	22	o	....SCIENTIFIC RESEARCH AND DEVELOPMENT	72	x
.....OTHER NON-METALLIC MINERAL PRODUCTS	23	o	ADVERTISING, MARKET RESEARCH; OTHER PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	73-75	x
BASIC METALS AND FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	24-25	x	....ADVERTISING AND MARKET RESEARCH	73	o
....BASIC METALS	24	o	....OTHER PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES; VETERINARY ACTIVITIES	74-75	o
.....IRON AND STEEL	241+2431				
.....NON-FERROUS METALS	242+2432		**ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES**	**77-82**	x
....FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	25	o	RENTAL AND LEASING ACTIVITIES	77	o
MACHINERY AND EQUIPMENT	**26-28**		EMPLOYMENT ACTIVITIES	78	o
....COMPUTER, ELECTRONIC AND OPTICAL PRODUCTS	26	x	TRAVEL AGENCY, TOUR OPERATOR, RESERVATION SERVICE AND RELATED ACTIVITIES	79	o
.....COMPUTERS AND PERIPHERAL EQUIPMENT	262		SECURITY AND INVESTIGATION; SERVICES TO BUILDINGS AND LANDSCAPE ACTIVITIES; OFFICE ADMINISTRATION, OFFICE SUPPORT AND OTHER BUSINESS SUPPORT	80-82	o
.....ELECTRONIC AND OPTICAL PRODUCTS AND SCIENTIFIC INSTRUMENTS	26X				
....ELECTRICAL EQUIPMENT	27	x	**COMMUNITY, SOCIAL AND PERSONAL SERVICES**	**84-99**	
....MACHINERY AND EQUIPMENT N.E.C.	28	x	**PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY; EDUCATION; HUMAN HEALTH AND SOCIAL WORK ACTIVITIES**	**84-88**	x
TRANSPORT EQUIPMENT	29-30	x	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	84	x
....MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	29	o	EDUCATION	85	x
....OTHER TRANSPORT EQUIPMENT	30	o	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	86-88	x
.....BUILDING OF SHIPS AND BOATS	301		....HUMAN HEALTH ACTIVITIES	86	x
.....AIR AND SPACECRAFT AND RELATED MACHINERY	303		....RESIDENTIAL CARE AND SOCIAL WORK ACTIVITIES	87-88	x
.....MILITARY FIGHTING VEHICLES	304				
.....RAILROAD EQUIPMENT AND TRANSPORT EQUIPMENT N.E.C.	302+309		**ARTS, ENTERTAINMENT, REPAIR OF HOUSEHOLD GOODS AND OTHER SERVICES**	**90-99**	x
FURNITURE; OTHER MANUFACTURING; REPAIR AND INSTALLATION	31-33	x	ARTS, ENTERTAINMENT AND RECREATION	90-93	x
....FURNITURE, OTHER MANUFACTURING	31-32	o	....CREATIVE, ARTS AND ENTERTAINMENT ACTIVITIES; LIBRARIES, ARCHIVES, MUSEUMS AND OTHER CULTURAL ACTIVITIES; GAMBLING AND BETTING ACTIVITIES	90-92	o
....REPAIR AND INSTALLATION OF MACHINERY AND EQUIPMENT	33	o	....SPORTS ACTIVITIES AND AMUSEMENT AND RECREATION ACTIVITIES	93	o
			OTHER SERVICE ACTIVITIES	94-96	x
ELECTRICITY, GAS, STEAM, AIR CONDITIONING AND WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	**35-39**		....ACTIVITIES OF MEMBERSHIP ORGANIZATIONS	94	o
ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	35	x	....REPAIR OF COMPUTERS AND PERSONAL AND HOUSEHOLD GOODS	95	o
WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	36-39	x	....OTHER PERSONAL SERVICE ACTIVITIES	96	o
....WATER COLLECTION, TREATMENT AND SUPPLY	36	o	ACTIVITIES OF HOUSEHOLDS AS EMPLOYERS; UNDIFFERENTIATED GOODS- AND SERVICES-PRODUCING ACTIVITIES OF HOUSEHOLDS FOR OWN USE	97-98	x
....SEWERAGE, REMEDIATION ACTIVITIES AND WASTE MANAGEMENT	37-39	o	ACTIVITIES OF EXTRATERRITORIAL ORGANIZATIONS AND BODIES	99	x
CONSTRUCTION	**41-43**	x			
			TOTAL SERVICES	**45-99**	
			BUSINESS SECTOR SERVICES	**45-82**	
			BUSINESS SECTOR SERVICES EXCLUDING REAL ESTATE	**45-66, 69-82**	
			NON-AGRICULTURE BUSINESS SECTOR EXCLUDING REAL ESTATE	**05-66, 69-82**	

x: present in the SNA A*10, A*21 or A*38 lists; o: present in the SNA A*64 list

Source: OECD (2012), STAN Industry list, www.oecd.org/sti/industryandglobalisation/2stan-indlist.pdf.

Table D.4. STAN approximate 2-digit mapping of ISIC Rev. 3 to ISIC Rev. 4

Table 1.

ISIC Rev. 4		ISIC Rev. 3		ISIC Rev. 4		ISIC Rev. 3
TOTAL		**TOTAL**		*35-39**	*D-E*	*37 + 40-41 + 90*
01-03	**A**	**01-05**		**35**	**D**	**40**
01-02		01-02		**36-39**	**E**	**37 + 41 + 90**
01		01		36		41
02		02		37-39		37 + 90
03		05		**41-43**	**F**	**45**
05-39	**B-E**	**10-41 + 90**		**45-56**	**G-I**	**50-55 + 60-63**
05-09	**B**	**10-14**		**45-47**	**G**	**50-52**
05-06		10-12		45		50
07-09		13-14		46		51
10-33	**C**	**15-37**		47		52
10-12	CA	15-16		**49-53**	**H**	**60-63**
10-11		15		49		60
12		16		50		61
13-15	CB	17-19		51		62
13-14		17-18		52		63
15		19		53		*(64)**
16-18	CC	20 + 21-22		**55-56**	**I**	**55**
16		20		**58-63**	**J**	*(22, 64, 92)** + 72*
17		21		58-60	JA	*(22, 92)**
18		*(22)**		61	JB	*(64)**
*19-23**	*CD-CG*	*23-25 + 26*		62-63	JC	72
19	CD	23		**64-66**	**K**	**65-67**
*20-21**	*CE-CF*	*24*		64		65
22-23	CG	25 + 26		65		66
22		25		66		67
23		26		*68-82**	*L-N*	*70-74*
24-25	CH	27-28		**68**	**L**	**70**
24		27		**69-82**	**M-N**	**71-74**
25		28		*84-99**	*O-U*	*75-99*
*26-28**	*CI-CK*	*29-33*		**84-88**	**O-Q**	**75 + 80 + 85**
*26-27**	*CI-CJ*	*30-33*		**84**	**O**	**75**
26	CI	30 + 32 + 33		**85**	**P**	**80**
27	CJ	31		**86-88**	**Q**	**85**
28	CK	29		**90-99**	**R-U**	**91 + 92 + 93+ 95**
29-30	CL	34-35		**90-93**	**R**	**92**
29		34		**94-96**	**S**	**91 + 93**
30		35		**97-98**	**T**	**95**
31-33	CM	36		**99**	**U**	**99**

SNA A10 list

The other aggregates in **bold** complete the A21 list (A,...,U)

**Special STAN aggregates (for linking with ISIC Rev.3 aggregates)*

() applying constant shares based on earliest ISIC Rev. 4 data*

ANNEX E. OECD ESTIMATES OF UNIT LABOUR COSTS

Unit labour costs and their components

Unit labour costs (ULC) measure the average cost of labour per unit of output produced. They are calculated as the ratio of total labour costs to real output. Equivalently, they may be expressed as the ratio of total labour costs per hour worked to output per hour worked, *i.e.,* labour productivity. In line with this definition, the OECD publishes on a continuous basis annual (and quarterly) data on unit labour costs and its components.

The OECD publishes unit labour cost estimates for three activities: Total economy, Industry and Market services. Currently, data are available for about 33 OECD countries for the Total economy. For Industry and Market services, based on the ISIC Rev.4 classification, data are only available for a shorter time period and for 23 OECD countries (see Tables E1 to E3 below). Estimates as well as their metadata are available through the user interface at: http://stats.oecd.org/mei/default.asp?rev=3.

The OECD publishes estimates for the following ULC related variables:

- Unit labour costs
- Total labour costs
- Labour compensation per unit of labour input
- Self employment ratio
- Labour productivity

Measurement and compilation

Total labour costs

In principle, the appropriate numerator for ULC calculations is total labour costs of all persons engaged. In practice, however, this information is not readily available for most countries. As such, in practice, OECD total labour cost estimates used in calculating ULCs are based on adjusted estimates of compensation of employees (COE), compiled according to the *System of National Accounts* (SNA).

Compensation of employees as defined in the SNA does not include labour compensation for the self-employed which is covered in the item 'mixed income'. However, the output of the self-employed contributes to value added, and, so, the OECD estimates of total labour costs include explicit adjustments to capture the labour compensation component of mixed income. This adjustment is made by multiplying compensation of employees by the self-employment ratio (the ratio of hours worked for total employment to hours worked of employees). If hours worked are not available for a specific country, employment is used as a proxy.

The adjustment for the self employed assumes that labour compensation per hour or per person is equivalent for the self employed and employees of businesses. For Switzerland and Iceland, data is not available to perform the adjustment and, so, only unit labour cost indexes are made available for analysis.

Real output

The target variable for annual real output is constant price value added compiled according to the *System of National Accounts*. All volume series of real output are re-referenced such that the national currency series are expressed in prices of the prevailing OECD base year. Series for activity aggregates are compiled through annual chain linking of their respective components, using nominal value added data as weights.

Unit labour costs

Annual unit labour costs are calculated as the ratio between total labour costs and real output. Time series are presented in level and index form where the base year of real output is 2005. Every effort has been made to ensure that data are comparable across countries. However, for some countries, unit labour cost levels are not presented due to a lack of data needed to make an adjustment for the self-employed. For these countries only unit labour cost indexes are made available.

Labour compensation per unit of labour input and Labour productivity for ULC decomposition

Expressing ULC as the ratio between Labour compensation per unit of labour input and Labour productivity can provide some information on the sources for changes in ULCs (and competitiveness).

All labour input data (*i.e.* total hours worked or total employment) are sourced from the OECD *System of Annual National Accounts* database. However, hours worked data for total employment are not available for Belgium and the United Kingdom. For these countries total employment is used as the labour input measure. In some countries only a short-time series of hours worked data is available in the *Annual National Accounts* (ANA). In these cases the historical series, for the periods where hours worked is not available, is compiled using total employment data. As a consequence of both approximations above, productivity levels and growth rates computed in the framework of the ULC compilation may differ from those shown in the *OECD Productivity Database*. However work is on-going to integrate the *OECD Unit Labour Cost Indicators* database with the *OECD Productivity Database* to create a coherent dataset.

Data coverage

The following metadata tables present the current data coverage of the OECD ULC estimates and the two components Labour productivity and Labour compensation per unit of labour input. Industry and Market Services follow the ISIC Rev. 4 classification.

- Industry covers the following economic activities: Mining and quarrying (B); Manufacturing (C); Electricity, gas, steam and air conditioning supply (D); Water supply; sewerage, waste management and remediation (E).

- Market services cover the following economic activities: Wholesale and retail trade; repair of motor vehicles and motorcycles (G); Transportation and storage (H); Accommodation and food service activities (I); Information and communication (J); Financial and insurance services (K); Real estate (L); Professional, scientific and technical services (M); Administrative and support services (N).

Table E.1. Annual Unit labour costs

Country	Total Economy	Industry	Market Services
Australia	1970-2010	1989-2010	1989-2010
Austria	1970-2011	1995-2011	1995-2011
Belgium	1970-2011	1995-2011	1995-2011
Canada	1970-2010	NA	NA
Czech Republic	1992-2011	1995-2011	1995-2011
Denmark	1966-2011	1990-2011	1990-2011
Estonia	1995-2011	2000-2011	2000-2011
Euro area	1970-2011	2000-2011	2000-2011
Finland	1970-2011	1975-2011	1975-2011
France	1959-2011	1950-2011	1950-2011
Germany	1970-2011	1991-2011	1991-2011
Greece	1970-2011	2005-2011	2005-2011
Hungary	1992-2011	1995-2011	1995-2011
Iceland	1973-2009	NA	NA
Ireland	1970-2010	2000-2010	2000-2010
Israel	1995-2009	NA	NA
Italy	1970-2011	1992-2011	1992-2011
Japan	1970-2010	NA	NA
Korea	1970-2011	2004-2010	2004-2010
Luxembourg	1970-2010	NA	NA
Mexico	1970-2009	NA	NA
Netherlands	1969-2011	1995-2011	1995-2011
New Zealand	1977-2009	NA	NA
Norway	1970-2011	1970-2011	1970-2011
Poland	1992-2010	2004-2010	2004-2010
Portugal	1970-2010	2000-2009	2000-2009
Slovak Republic	1993-2011	2000-2011	2000-2011
Slovenia	1995-2011	2000-2011	2000-2011
Spain	1970-2011	2000-2011	2000-2011
Sweden	1970-2011	1993-2011	1993-2011
Switzerland	1980-2010	NA	NA
Turkey	1970-2006	NA	NA
United Kingdom	1970-2011	1997-2011	1997-2011
United States	1970-2010	NA	NA

Note: NA – In these cases, the countries have not yet supplied the OECD with National Accounts data according to the ISIC Rev.4 classification.

Table E.2. Annual Labour productivity

Country	Total Economy	Industry	Market Services
Australia	1970-2010	1985-2010	1985-2010
Austria	1976-2011	1995-2011	1995-2011
Belgium	1970-2011	1995-2011	1995-2011
Canada	1970-2010	NA	NA
Czech Republic	1995-2011	1995-2011	1995-2011
Denmark	1966-2011	1990-2011	1990-2011
Estonia	1995-2011	2000-2011	2000-2011
Euro area	1980-2011	2000-2011	2000-2011
Finland	1970-2011	1975-2011	1975-2011
France	1950-2011	1950-2011	1950-2011
Germany	1970-2011	1991-2011	1991-2011
Greece	1995-2011	2005-2011	2005-2011
Hungary	1995-2011	1995-2011	1995-2011
Ireland	1970-2010	2000-2010	2000-2010
Israel	1995-2009	NA	NA
Italy	1970-2011	1992-2011	1992-2011
Japan	1970-2010	NA	NA
Korea	1970-2011	2004-2011	2004-2011
Luxembourg	1985-2010	NA	NA
Mexico	1995-2009	NA	NA
Netherlands	1969-2011	1995-2011	1995-2011
New Zealand	1989-2009	NA	NA
Norway	1970-2011	1970-2011	1970-2011
Poland	1992-2011	2004-2011	2004-2011
Portugal	1977-2010	2000-2011	2000-2011
Slovak Republic	1995-2011	2000-2011	2000-2011
Slovenia	1995-2011	2000-2011	2000-2011
Spain	1980-2011	2000-2011	2000-2011
Sweden	1970-2011	1993-2011	1993-2011
Switzerland	1991-2008	NA	NA
Turkey	1970-2011	NA	NA
United Kingdom	1970-2011	1997-2011	1997-2011
United States	1970-2010	NA	NA

Note: NA – In these cases, the countries have not yet supplied the OECD with National Accounts data according to the ISIC Rev.4 classification.

Table E.3. Annual Labour compensation per unit of labour input

Country	Total Economy	Industry	Market Services
Australia	1977-2010	1989-2010	1989-2010
Austria	1976-2011	1995-2011	1995-2011
Belgium	1970-2011	1995-2011	1995-2011
Canada	1970-2010	NA	NA
Czech Republic	1995-2011	1995-2011	1995-2011
Denmark	1966-2011	1990-2011	1990-2011
Estonia	1995-2011	2000-2011	2000-2011
Euro area	1981-2011	2000-2011	2000-2011
Finland	1970-2011	1975-2011	1975-2011
France	1950-2011	1950-2011	1950-2011
Germany	1970-2011	1991-2011	1991-2011
Greece	1995-2011	2005-2011	2005-2011
Hungary	1995-2011	1995-2011	1995-2011
Ireland	1995-2010	2000-2010	2000-2010
Israel	1995-2010	NA	NA
Italy	1970-2011	1992-2011	1992-2011
Japan	1970-2010	NA	NA
Korea	1970-2011	2004-2010	2004-2010
Luxembourg	1985-2010	NA	NA
Mexico	1995-2009	NA	NA
Netherlands	1969-2011	1995-2011	1995-2011
New Zealand	1989-2009	NA	NA
Norway	1970-2011	1970-2011	1970-2011
Poland	1991-2010	2004-2010	2004-2010
Portugal	1995-2010	2000-2009	2000-2009
Slovak Republic	1995-2011	2000-2011	2000-2011
Slovenia	1995-2011	2000-2011	2000-2011
Spain	1980-2011	2000-2011	2000-2011
Sweden	1993-2011	1993-2011	1993-2011
Turkey	1988-2006	NA	NA
United Kingdom	1970-2011	1997-2011	1997-2011
United States	1970-2011	NA	NA

Note: NA – In these cases, the countries have not yet supplied the OECD with National Accounts data according to the ISIC Rev.4 classification.

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