OECD Compendium of Productivity Indicators 2013



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BETTER POLICIES FOR BETTER LIVES

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FOREWORD

Productivity measures how efficiently production inputs, such as labour and capital, are being used in an economy to produce a given level of output. It is considered a key source of economic growth and competitiveness and, as such, internationally comparable indicators of productivity are central for assessing economic performance.

To meet increasing demand from OECD countries for policy advice on international competitiveness and economic growth, continuous improvement of productivity measurement and analysis is an important focus of OECD work. A central aim in this context is to provide internationally comparable indicators 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 subsequent 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, the OECD *Compendium of Productivity Indicators* presents a broad overview of recent and longer term trends in productivity levels and growth in OECD countries. It also highlights some of the key measurement issues faced when compiling cross-country comparable productivity indicators and describes the caveats needed in analyses. It examines 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. It analyses the link between productivity, trade and international competitiveness. And it asks what determines the trend as compared to the cyclical patterns of labour and multifactor productivity growth.

The *2013 OECD 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 by Anita Wölfl, Frédéric Parrot, Julien Dupont and Agnès Cimper, with contributions from Anne-Sophie Fraisse and Bo Werth, and benefitted from comments by Andrea de Panizza. Nadim Ahmad and Colin Webb acted as editors.

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EXECUTIVE SUMMARY

Four years after the start of the financial crisis, GDP growth in the OECD area is beginning to gradually strengthen. Nevertheless, the pace has varied across countries and a sustainable recovery does not appear to have yet been established, with several OECD countries facing the challenge of slower trend growth. A good understanding of the role and the drivers of productivity growth is thus crucial to strengthening the recovery and improving growth and living standards in the longer term. The OECD Compendium of Productivity Indicators provides the ingredients for this by examining both longer term trends of productivity and how the crisis has affected patterns of productivity growth and its components across countries.

Key findings

Longer term productivity trends

- Productivity growth is key to improving GDP per capita and hence living standards. In the last fifteen years, differences in GDP per capita growth across OECD countries can be mainly attributed to differences in growth in GDP per hour worked (labour productivity). In contrast, labour utilisation (hours worked per capita) has hardly changed.
- 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 has typically been driven by strong growth in labour productivity growth. Nonetheless, differences in per capita incomes across OECD countries remained significant in 2012, mainly owing to differences in labour productivity levels and marginally to labour utilisation.
- Between 1995 and 2011 most of the growth in labour productivity reflected growth in multifactor productivity (MFP) and capital input. In fact, MFP growth accounted for one half to two thirds of aggregate labour productivity growth across countries. However, the empirical evidence confirms the pro-cyclical pattern of MFP, which follows GDP growth very closely, not only in terms of the direction but also its magnitude.
- Productivity growth in the non-agricultural business sector was almost entirely driven by manufacturing and business sector services. In general, the manufacturing sector continues to have higher productivity growth than business sector services, while the strong contribution of services reflect a continuing shift in employment and value added towards specialised services.
- Labour productivity growth varies substantially across business sector services. Those services more exposed to international competition and which typically use modern, information and telecommunication (ICT) technologies generally had much higher, and more volatile, productivity growth between 1995 and 2012.

- During the last 10 years, firms in the G7 and most of the early members of the Euro area have increased their competitiveness, as measured by unit labour costs (ULC). Very low increases in ULCs have typically been achieved by keeping unit labour costs low in both, manufacturing and business sector services. Moreover, countries with relatively low growth in ULC also displayed strong growth in labour productivity.
- Low labour costs can be an important driver of export performance. The results for G7 countries suggest that keeping labour costs low also tends to increase market shares.
- Since the early 1980s, trends in labour productivity growth have varied across G7 countries. Interestingly, indicators suggest that trend labour productivity typically declined between the mid-1990s and 2007 in G7 countries.

Impact of the crisis on productivity

- After the 2008 financial crisis, labour productivity growth has fallen significantly in most OECD countries and this decline is broadly spread across sectors. However, in a few countries, labour productivity growth seems to have picked up recently, albeit sometimes coupled with declines in output.
- Similarly, there was a sharp fall in MFP in some countries, and there are risks that this could herald declining longer term trends in labour productivity growth.
- Within the Euro area, some countries recorded strong falls in ULCs. However, this does not necessarily imply improved relative competiveness as the falls often went hand in hand with significant falls in output and labour inputs.
- Indeed, labour input fell in many countries, sometimes through reducing average hours worked per person engaged but also through job cuts. During such periods, head-counts are even less reliable as a possible proxy for measuring hours worked than during more stable times.

READER'S GUIDE

Why productivity matters

Productivity is commonly defined as a ratio between the volume of output 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. Productivity based on hours worked better captures the use of labour inputs than productivity based on numbers of persons employed. Generally, the default source for total hours worked is the *OECD National Accounts Database*, although other sources have to be used for a number of countries. Despite the progress and ongoing 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, the preferred 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, skills composition, the impact of investment in intangible assets, 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. 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 international fragmentation of production, the effects of which on competitiveness, may not be captured sufficiently by ULCs.

Aim and content of the 2013 Compendium of Productivity Indicators

This *OECD Compendium of Productivity Indicators* presents a broad overview of recent and longer terms trends in productivity levels and growth in OECD countries. The empirical evidence presented provides some insights on:

- productivity as the main driver of economic growth and convergence;
- the role played by labour, capital and multifactor productivity growth (MFP) in driving economic growth;
- the contribution of individual industries or sectors to more aggregate labour productivity growth;
- the link between productivity, ULCs and international competitiveness;
- the cyclical patterns of labour and multifactor productivity growth.

For each indicator, the publication also highlights key measurement issues, notably those faced when compiling cross-country comparable productivity indicators and describes the caveats needed in analyses. The annexes in the second part of this publication go in more detail, by describing:

- the way labour productivity, MFP, ULCs and their components are measured in the *OECD Productivity Database* (*PDB*, total economy) and the *OECD Productivity Database by industry* (*PDBi*);
- issues involved in measuring hours worked so as to ensure coherence within productivity and ULC indicators as well as comparability across countries and over time;
- the challenges involved in measuring capital stocks and capital services in the PDB and the PDBi;
- the move to the new revision of the international standard industry classification ISIC Rev.4;
- the challenges involved in measuring producer price indices in business sector services and their potential impact on productivity growth in these industries.

Country, time and industry coverage

The *OECD Compendium of Productivity Indicators* attempts to provide evidence for a large set of countries and long time series, while ensuring comparability of data across countries and over time. More data is available in the *OECD Productivity Databases* (see Annex A).

This latest version of the publication looks at longer term trends in productivity growth and its components, but also how the 2008 financial and the Euro area crises affected these patterns within and across countries. To this end, indicators are typically presented for three distinctive time periods: 1995-2011/2012; 2001-2007; and 2007-2011/12. For each country, the average value in the three different periods only takes into account the years for which data are available for the respective indicator and its components. However, the publication aims at providing the maximum country, industry and time coverage possible. Hence, for certain indicators where longer time series are not available for several countries, the data are presented for 2001-2012, instead of 1995-2012. The cut-off date for data updates is 30 September 2013.

The *OECD Compendium of Productivity Indicators* includes data for 34 OECD member countries depending on data availability. The statistical data for Israel are supplied by and under the responsibility

of the relevant Israeli authorities or third parties. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

The figures in this publication use abbreviations for country names, while full country or territorial entity names are used in the text. The ISO codes used are as follows:

AUS Australia
AUT Austria
BEL Belgium
CAN Canada
CHL Chile
CZE Czech Republic
DNK Denmark
EST Estonia
FIN Finland
FRA France
DEU Germany
GRC Greece
HUN Hungary
IRL Ireland
ISL Iceland
ISR Israel
ITA Italy
JPN Japan
KOR Korea
LUX Luxembourg
MEX Mexico
NLD Netherlands
NOR Norway
NZL New Zealand
POL Poland
PRT Portugal
SVK Slovak Republic
SVN Slovenia
ESP Spain
SWE Sweden
CHE Switzerland
TUR Turkey
GBR United Kingdom
USA United States

In cases where different time periods are presented in individual panels of the same figure, the countries are ranked according to the longer time period 1995/2001-2012. This is to make it easier for the reader to compare a country's performance over time. Similarly, in cases where individual panels of the same figure present data for different sectors or components, countries are ranked according to the most aggregate data.

Throughout this publication, the sectoral breakdown follows the International Standard Industry Classification of all Economic Activities (ISIC). Countries are presented if data are available according to its latest version, ISIC Rev.4, or the European equivalent NACE Rev.2 (Nomenclature statistique des activités économiques dans la Communauté européenne). See also Annex D as well as the link to the OECD Structural Analysis Database (www.oecd.org/industry) for more detail on the ISIC classification and the move from ISIC Rev.3 to ISIC Rev.4.

Throughout the publication, data are typically provided for the total economy or for individual sectors in the "Non-agricultural business sector, excluding real estate" (ISIC rev.4-codes B-N excl. L, see: ISIC Rev.4 classification). These include: B - Mining and quarrying; C – Manufacturing; D - Electricity, gas, steam and air conditioning supply; E - Water supply; sewerage, waste management and remediation activities; F – Construction; as well as G-N: Business sector services.

Business sector services (ISIC Rev.4 codes G-N, excl. L) include: G - Wholesale and retail trade; repair of motor vehicles and motorcycles; H - Transportation and storage; I - Accommodation and food service activities; J - Information and communication; K - Financial and insurance activities; M - Professional, scientific and technical activities; N - Administrative and support service activities. Real estate activities (ISI Rev.4 code L) are excluded, as their value-added includes the imputation made for the dwelling services provided and consumed by home-owners.

The business sector excludes activities that may typically be classified as non-market activities and for which productivity measurement is very difficult. These are: O - Public administration and defence; compulsory social security; P – Education; Q - Human health and social work activities; R - Arts, entertainment and recreation; S - Other service activities; T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; U - Activities of extraterritorial organizations and bodies.

Access to the underlying data

Links to underlying data sources and to further information are added in each indicator section. A large range of statistical as well as methodological information is available on the OECD productivity webpage: www.oecd.org/statistics/productivity.

Moreover, the publication uses the OECD StatLinks service: below each table and chart in this publication is a URL that leads to the corresponding Excel workbook containing the indicator's underlying data. These URLs are stable and remain unchanged over time.

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 growth in labour productivity (GDP per hour worked) and a part which is due to increased labour utilisation (hours worked per capita). 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 of a decreasing employment of low-productivity workers.

Definition

The indicator of growth in GDP per capita is calculated using GDP and population estimates published in the *OECD Annual National Accounts Database*. Labour utilisation is defined as hours worked per capita. By default, total hours worked are derived from the *OECD Annual National Accounts Database,* but for some countries, for which long time series are not available, data from the *OECD Employment Outlook* are used (see Annex B).

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

With the exception of Mexico, current practice in OECD countries is to derive annual estimates of real GDP using annually chain-linked volume indices. Mexico revises its fixed weights less frequently. Such practices tend to lead to biased growth rates, usually upward.

Overview

Productivity growth is key for improving GDP per capita and hence living standards. Differences in GDP per capita growth across OECD countries can be mainly attributed to differences in labour productivity growth, as measured by growth in GDP per hour worked. In contrast, during the past 15 years, labour utilisation has increased only in few countries, and then only slightly.

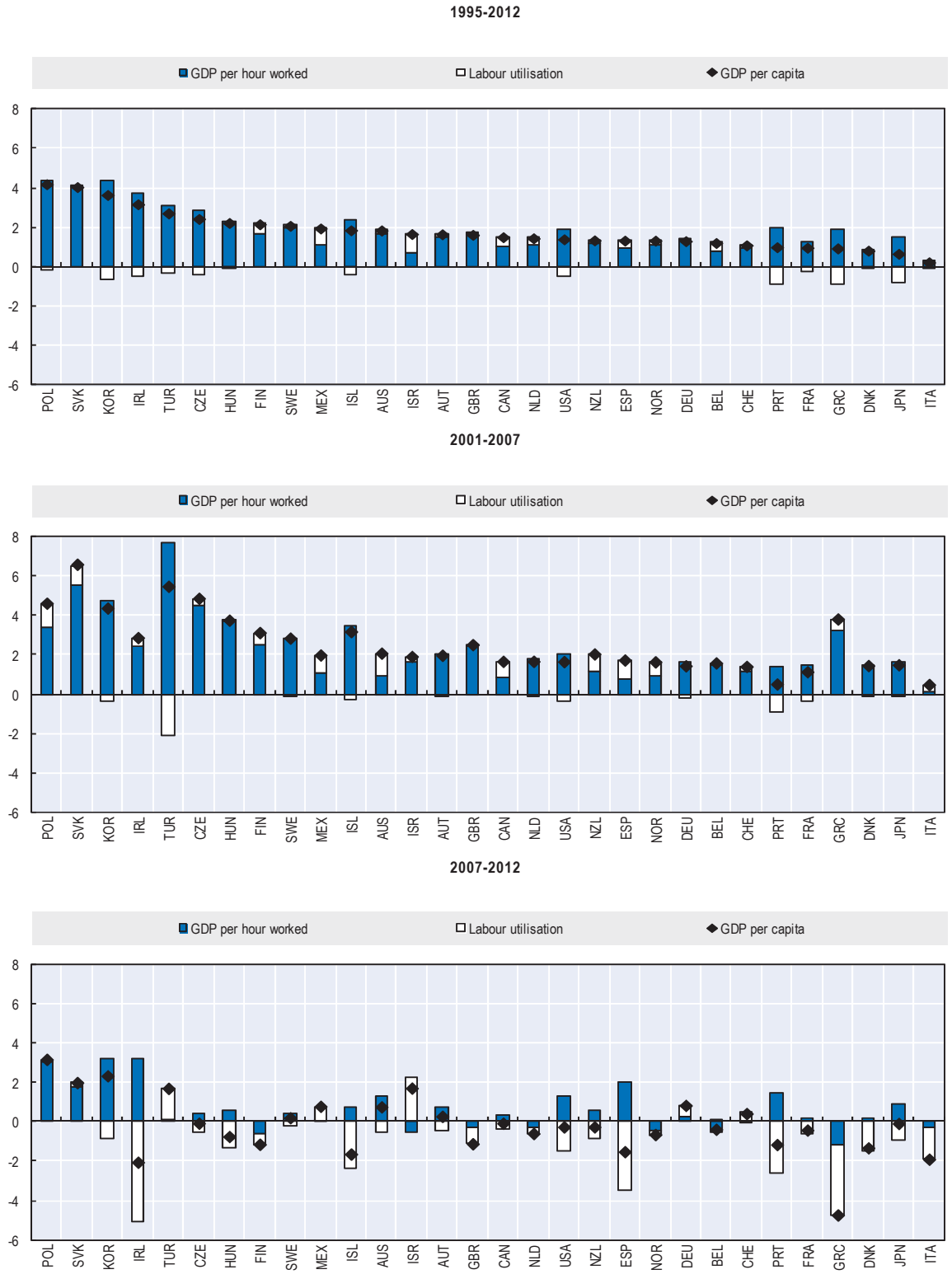
The picture has been more varied since the outset of the financial crisis in 2007. In some countries, a decline in GDP per capita was coupled with substantial declines in labour utilisation. These mainly reflected reductions in employment rates and hours worked per person, while labour force participation has remained almost constant.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
- OECD (2013), *National Accounts at a Glance* (http://dx.doi.org/10.1787/22200444).
- OECD (2001), *Measuring Productivity–OECD Manual* (http://dx.doi.org/10.1787/9789264194519-en).
- Pilat, D., and P. Schreyer (2004), "The OECD Productivity Database – An Overview", *International Productivity Monitor*, No. 8, Spring, CSLS, Ottawa.

Figure 1.1. Growth in GDP per capita and its components

Total economy, percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888932936465

GDP per capita levels

GDP per capita levels are typically used to compare living standards across countries. Differences in GDP per capita levels across countries can arise from differences in labour productivity levels and from differences in labour utilisation (hours worked per capita). 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

GDP is measured as gross value added in market prices. Total hours worked used to calculate labour productivity are based on actual hours worked (see Annex B). Labour utilisation is defined as actual hours worked per capita.

The indicator hereafter shows labour productivity and income levels in each country as percentage differences from the OECD average. GDP data at current prices are from the OECD *Annual National Accounts*. For international comparisons, data on current price GDP are converted to a common currency, using *Purchasing Power Parities* (PPPs) as these measure the prices of the same basket of consumption goods in different countries.

Comparability

For all OECD countries except Australia, the indicators presented here are based on the 1993 System of National Accounts (SNA). The 2008 SNA has been finalized but it will take a number of years before most OECD countries are in a position to provide statistics on the basis of this new system. The 2008 SNA includes some items such as the capitalization of research and development (R&D) and some military weapons systems which increase GDP levels.

The sources used to measure actual hours worked can also vary (see Annex B).

Overview

Very high growth rates in GDP per capita have 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 Estonia, Poland, the Slovak Republic, and Chile. Nevertheless, in 2012, differences in incomes remained significant across OECD countries. GDP per capita was up to 60% lower than the OECD average in Turkey, Mexico, Hungary, Poland and Chile, while it was twice the OECD average in Luxembourg, 80% higher in Norway and 45% higher in Switzerland.

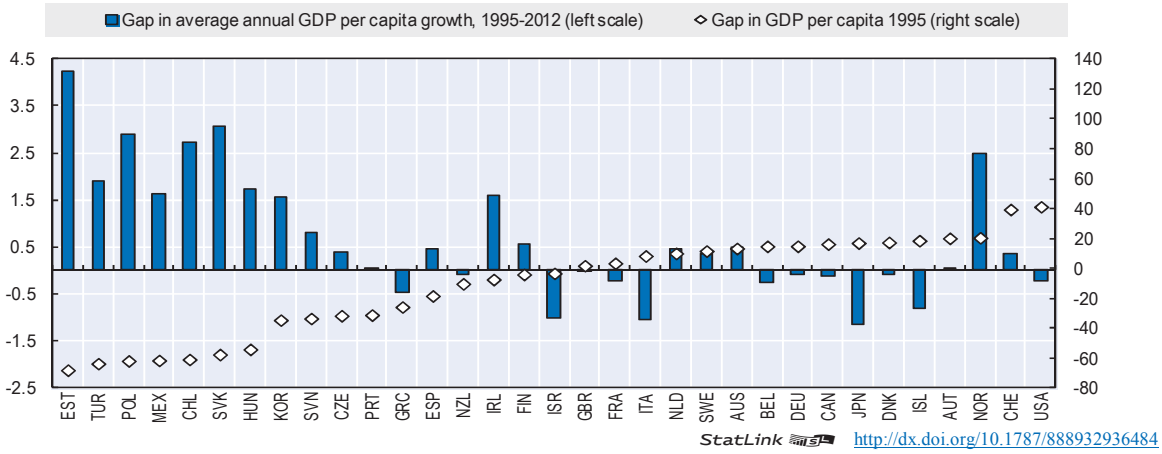
Most of these differences in GDP per capita reflect differences in labour productivity levels. Among the countries presented, eleven (the majority being non - EU countries) had higher labour utilisation levels than the OECD average, narrowing their negative or reinforcing their positive gap in GDP per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

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
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- OECD (2001), *Measuring Productivity–OECD Manual* (http://dx.doi.org/10.1787/9789264194519-en).

Figure 1.2. GDP per capita convergence

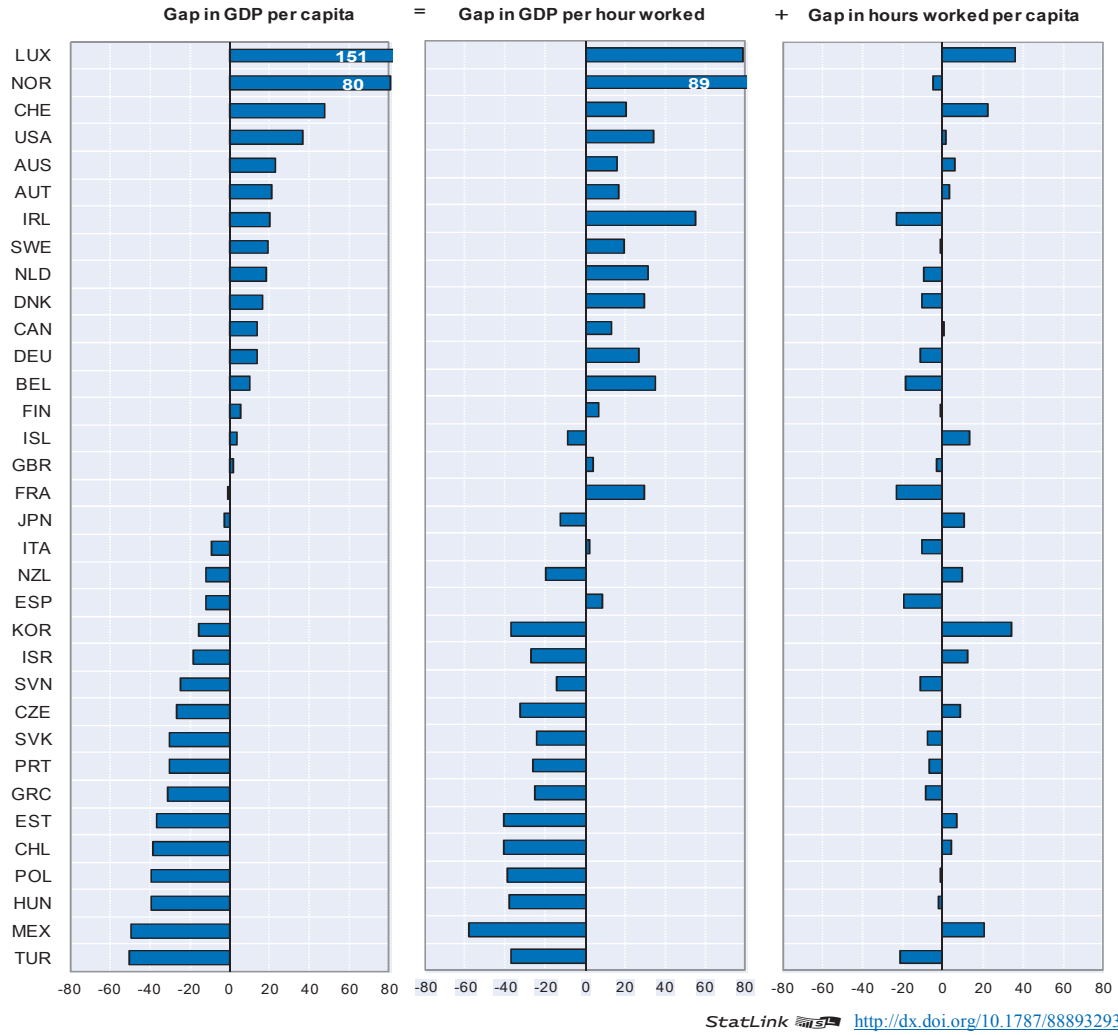
Percentage (point) differences vis-à-vis the OECD



http://dx.doi.org/10.1787/888932936484

Figure 1.3. Differences in GDP per capita levels, 2012

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



http://dx.doi.org/10.1787/888932936503

Labour productivity growth

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

Definition

In the *OECD Productivity Database*, labour productivity is defined as GDP (Gross Value Added in market prices) per hour worked (see Annex A for more detail on the measurement of productivity growth).

Hours worked reflect regular hours worked by full-time and part-time workers, paid and unpaid overtime, hours worked in additional jobs, and time not worked because of public holidays, annual paid leaves, strikes and labour disputes, bad weather, economic conditions and other reasons (see Annex B).

Comparability

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

In most countries, the primary source for measuring actual hours worked are 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 the 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 Poland, Korea, the Slovak Republic and Estonia, productivity growth since 1995 has averaged between 3 and 4% per year compared to less than 2% in most Euro area countries, Canada, the United Kingdom and the United States.

Some countries which experienced significant falls in their labour productivity growth following the 2007 financial crisis managed to report a recovery in 2012. This was for instance the case for Estonia and Hungary, and to a lesser extent for the Slovak Republic.

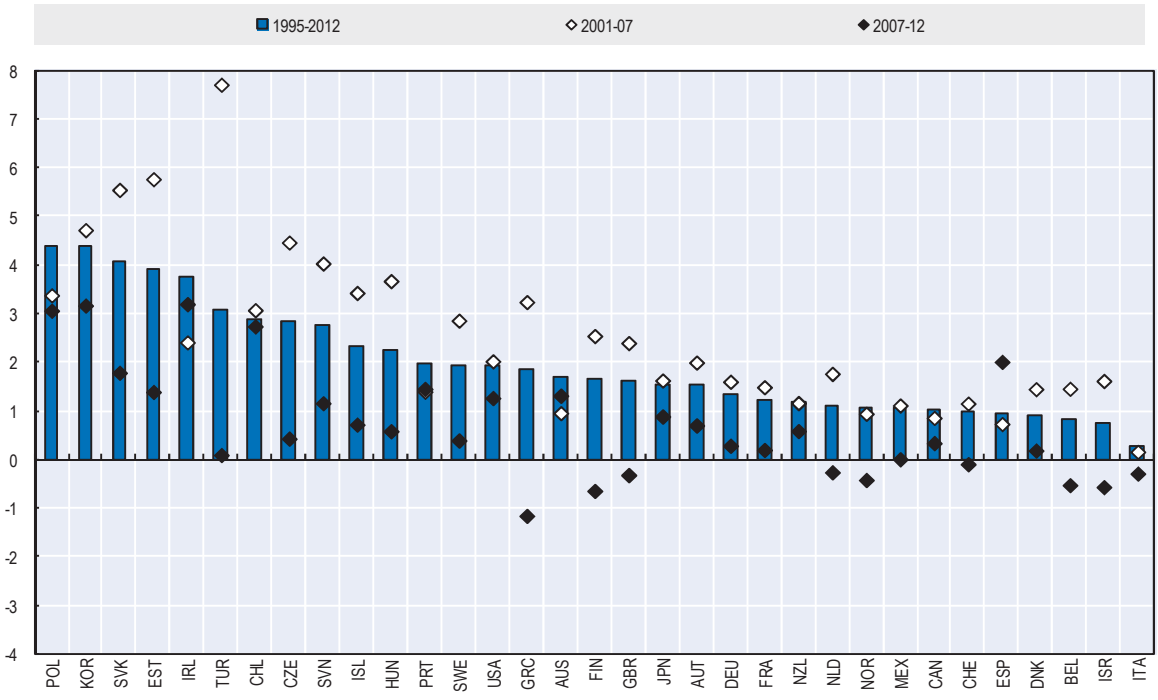
Countries have responded in different ways to the crisis. While most countries, notably, Ireland, Estonia, Germany and Korea, have reduced average hours worked per employee, Spain, Sweden, Luxembourg and Belgium have reduced head-counts. As a consequence, employment based and hours worked based labour productivity growth estimates over the 2007-2012 period show somewhat 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

- Ahmad, N., et al. (2003), "Comparing Labour Productivity Growth in the OECD Area: The Role of Measurement", *OECD Science, Technology and Industry Working Papers*, No. 2003/14 (http://dx.doi.org/10.1787/126534183836).
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- Pilat, D., and P. Schreyer (2004), "The OECD Productivity Database–An Overview", *International Productivity Monitor*, No. 8, Spring, CSLS, Ottawa.

Figure 1.4. Growth in GDP per hour worked

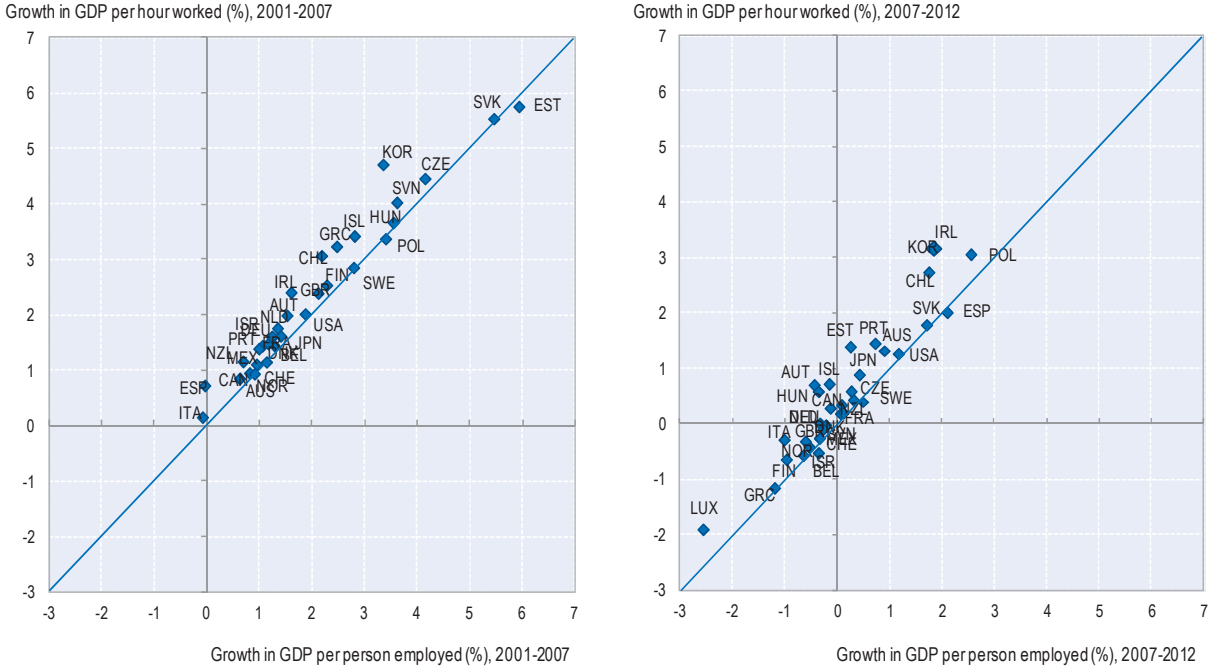
Total economy, percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888932936522

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

Total economy, percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888932936541

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 who live and work abroad for only short periods (seasonal workers).

Comparability

There are practical difficulties in the measurement of both international flows of wages and salaries and of property income.

In practice, many flows related to the use of intellectual property assets are often recorded as property income flows between affiliates. This impacts directly on GDP levels but it also creates possible inconsistencies for productivity as the underlying intellectual property being used in production in one country may be recorded on the balance sheets of another country.

Some care is also needed when interpreting productivity in countries with high numbers of cross-border workers. The labour compensation earned by these workers will not be included in the GNI of the country in which they work but their hours worked will be included in the calculation of labour input.

Overview

In general, the ranking of countries in labour productivity levels is relatively unchanged whether measured on a GDP or GNI basis. When measured on a GNI basis, the position of Australia, Canada, Iceland, Ireland, Luxembourg and New Zealand falls, reflecting outflows of property income and in some cases the high number of cross-border workers. Conversely, Switzerland's position moves up on a GNI basis, reflecting higher property income inflows offsetting the outflows driven by cross-border workers.

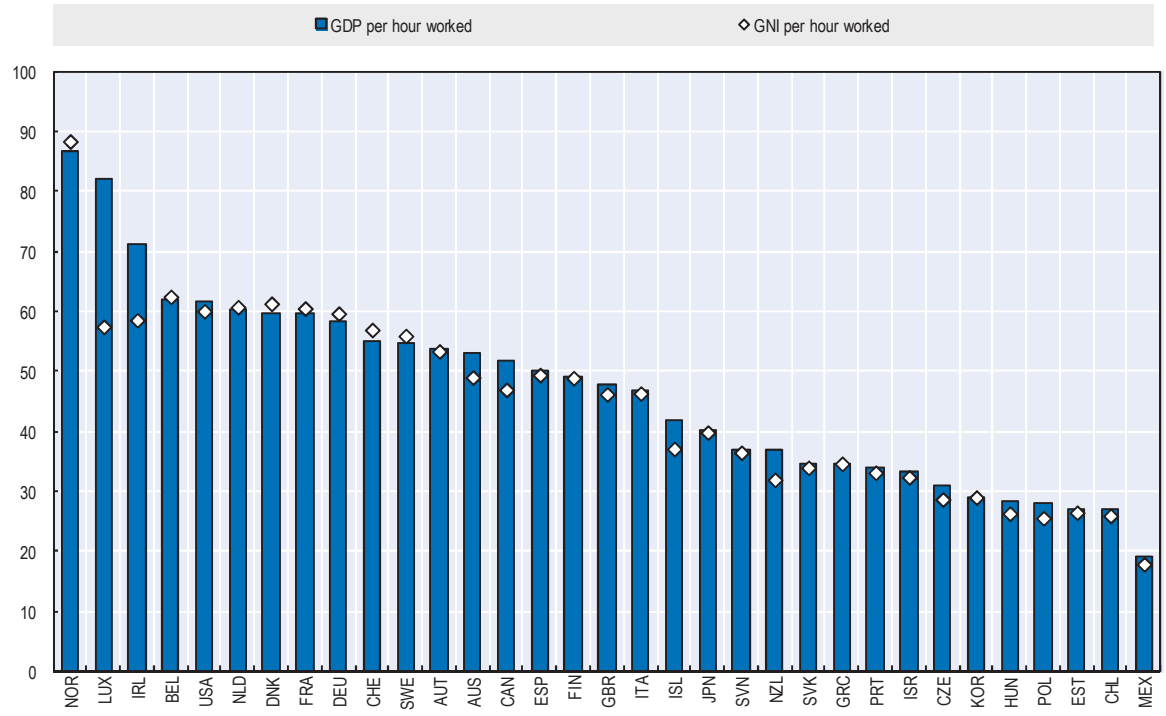
Productivity growth is also relatively similar for most countries when measured on a GNI or GDP basis, even if some noticeable differences exist. For example, in both periods shown below, Chile experienced significantly higher growth in GNI per hour worked compared to GDP per hour worked, possibly reflecting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

Sources and further reading

- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2013), *National Accounts at a Glance* (http://dx.doi.org/10.1787/22200444).
- Lequiller, F. and D. Blades (2007), *Understanding National Accounts* (http://dx.doi.org/10.1787/9789264027657-en).
- OECD (2009), *Handbook on Deriving Capital Measures of Intellectual Property Products* (http://dx.doi.org/10.1787/9789264079205-en).

Figure 1.6. GDP and GNI per hour worked, 2012

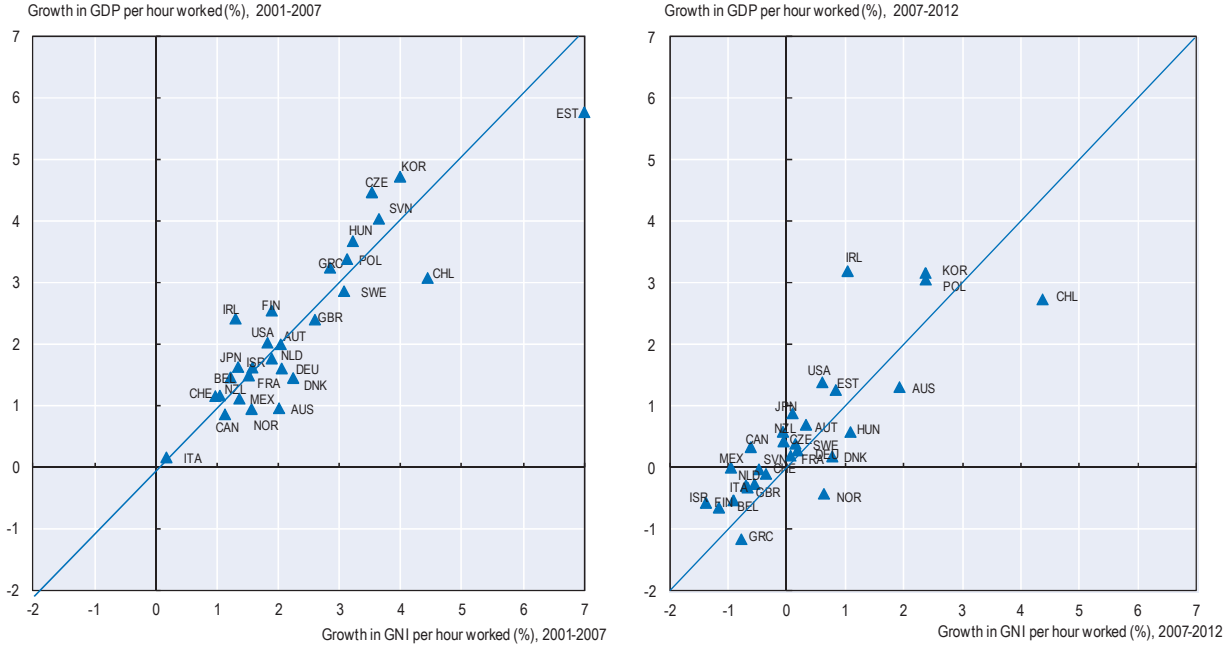
Total economy levels, current prices, USD, current PPPs



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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



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2. LABOUR, CAPITAL AND MULTIFACTOR PRODUCTIVITY

Growth accounts

The role of multifactor 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 multifactor productivity growth (MFP). Growth accounting involves decomposing total output (GDP) growth into these three components. As such, it provides an essential tool for policy makers to identify the underlying drivers for growth.

Definition

Total output growth can be decomposed into a labour input component, a capital input component and multifactor productivity (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 to highlight the contribution made by information and communication technologies (ICT) as compared to more traditional assets (Non-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 is captured by the MFP residual, rather than being attributed to labour.

Overview

From 1995 to 2011, capital services and MFP accounted for the largest part of GDP growth in most OECD countries, reflecting the strong role of embodied and disembodied technological change and efficient production as a driver of growth. In many countries, growth in capital services 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 Denmark, Sweden, and the United Kingdom, and the smallest in Finland, Germany and Ireland. Growth in labour input was important for a few countries over 1995-2011, notably Australia, Canada, and Spain. Over the same period, growth was a significant source of GDP growth in Korea, Ireland and Finland, while MFP was negligible in Belgium, Canada and Italy.

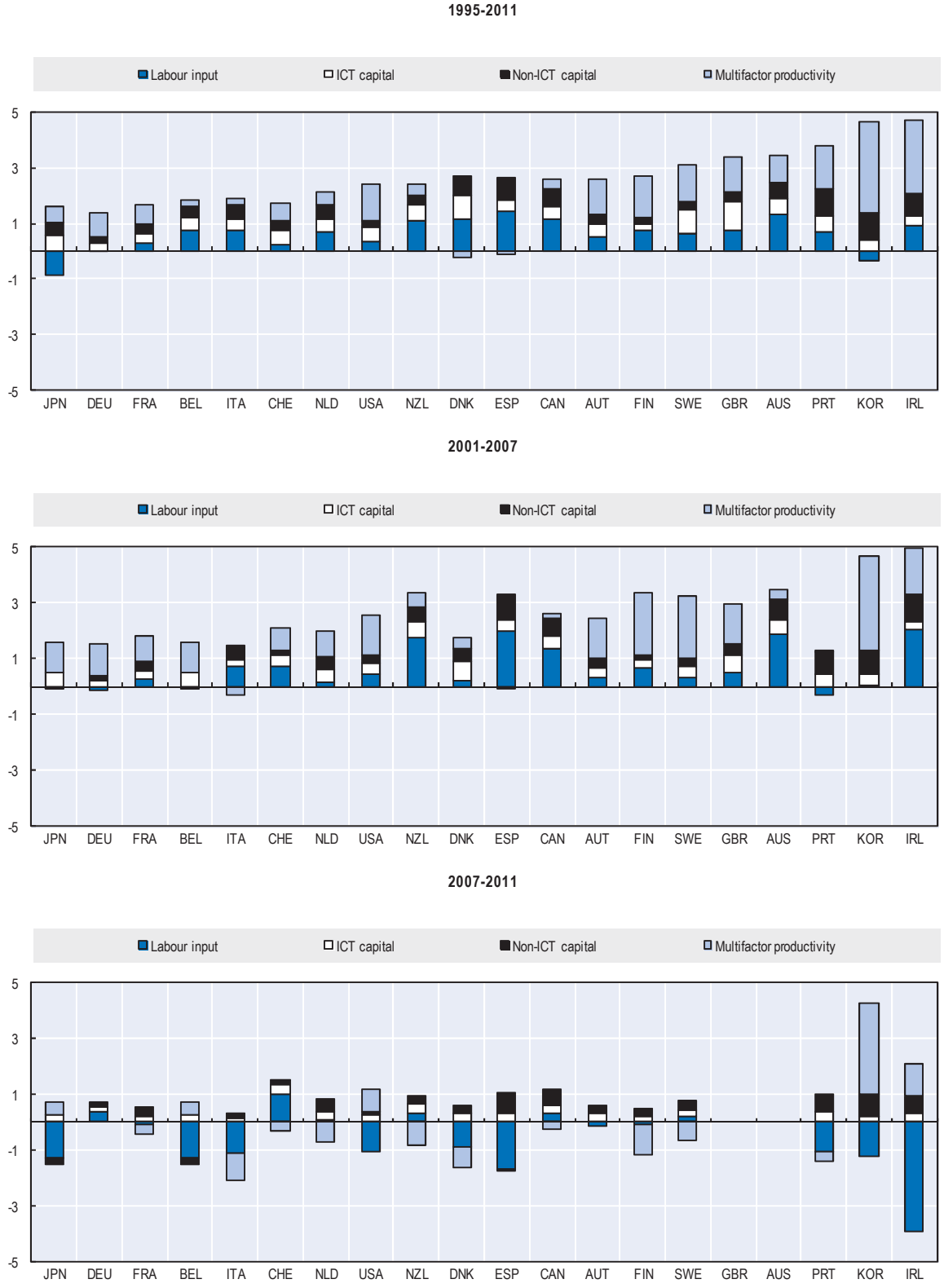
The data shown for the period 1995-2011 do not tell the full story however. For example, the contribution of ICT capital slowed in the 2000s compared to the 1990s in all countries for which data are available. MFP growth also slowed in most countries.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2001), *Measuring Productivity–OECD Manual* (http://dx.doi.org/10.1787/9789264194519-en).
- OECD (2009), *Measuring Capital – OECD Manual* (http://dx.doi.org/10.1787/9789264068476-en).
- Schreyer, P. (2004), "Capital Stocks, Capital Services and Multi-Factor Productivity Measures", *OECD Economic Studies*, Vol. 2003/2 (http://dx.doi.org/10.1787/16097491).
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Figure 2.1. Decomposition of GDP growth

Total economy, annual percentage point contribution



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The role of multifactor productivity

Labour productivity growth means a higher level of output for every hour worked. This can be achieved if more capital, such as machinery or software or better vintages of it (capital deepening) is used in production. Labour productivity can also grow by improving the overall efficiency with which labour and capital are used together, *i.e.* higher 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

Growth in MFP is measured as the residual growth, *i.e.,* that part of GDP growth that cannot be explained by growth in labour or capital input. Traditionally, the MFP residual is seen as capturing technological progress, but in practice, it should be interpreted in a much larger sense.

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 (Annexes A and C). MFP only picks up *disembodied technical change*, *e.g.,* the result of research and development or general knowledge.

Second, linked to the assumptions of the production function and to data constraints hampering a precise measurement of labour and capital input, MFP also captures factors such as adjustment costs, changes in capacity utilization, economies of scale, effects from imperfect competition and measurement errors. For instance, several OECD countries have observed an increase in educational attainment or a shift towards more skill-intensive production. If not captured in the form of quality adjusted labour input – which is not yet the case in the *OECD Productivity Database* – these improvements are captured within measured MFP.

Overview

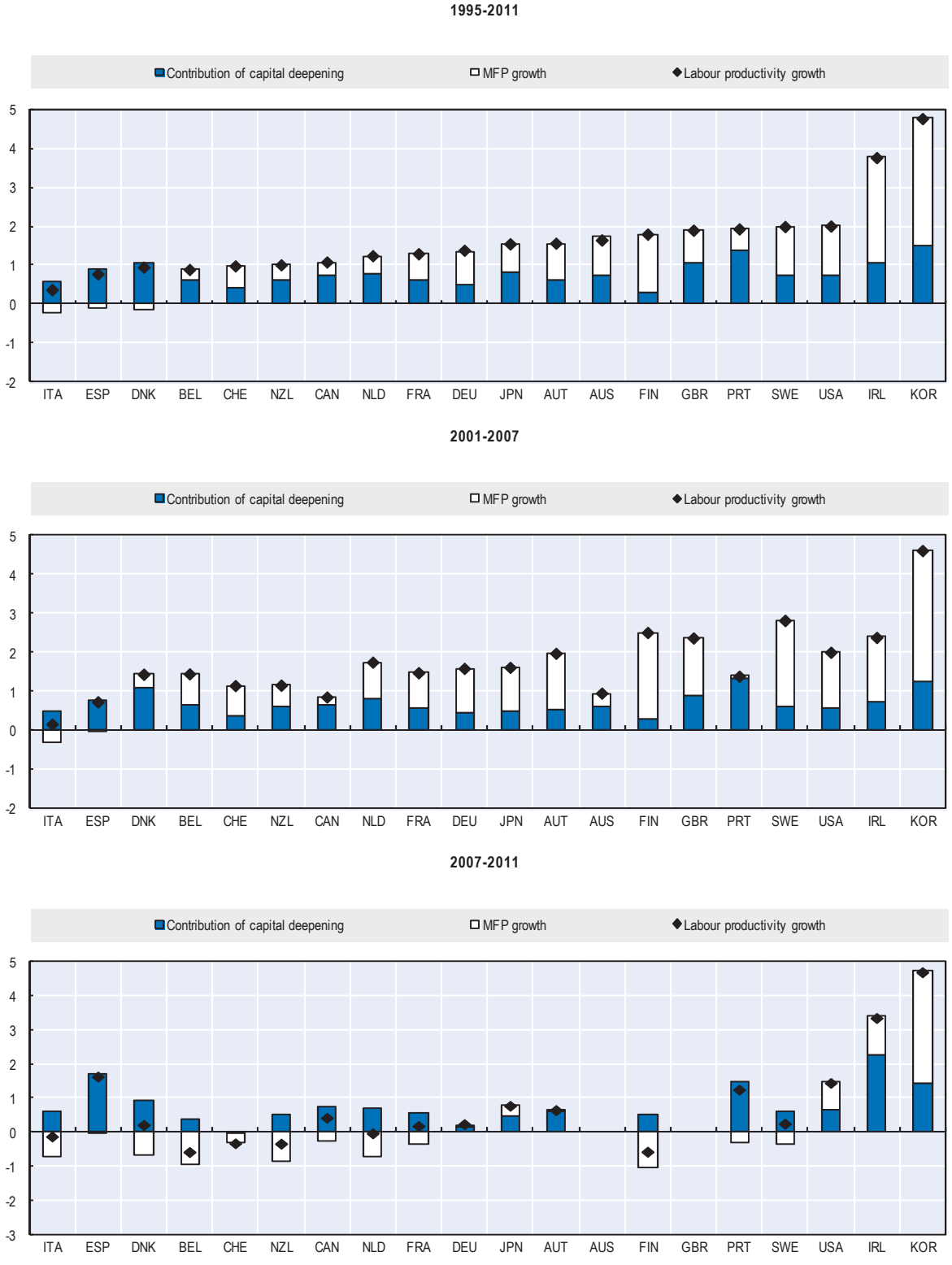
MFP contributed strongly to labour productivity growth and represented between one half and two thirds of aggregate labour productivity growth across countries over the period 1995 to 2011. In most countries, MFP appears to have moved in a pro-cyclical way, as reflected in substantial falls in MFP since 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 Chapter 5.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2001), *Measuring Productivity–OECD Manual* (http://dx.doi.org/10.1787/9789264194519-en).
- Schreyer, P. (2010), Measuring Multi-Factor Productivity when Rates of Return Are Exogenous, in Diewert et al. (2010), *Price and Productivity Measurement*, Vol.6.
- Schreyer, P. (2004), "Capital Stocks, Capital Services and Multi-Factor Productivity Measures", *OECD Economic Studies*, Vol. 2003/2 (http://dx.doi.org/10.1787/16097491).
- Wölfl, A. and D. Hajkova (2007), "Measuring Multifactor Productivity Growth", *OECD Science, Technology and Industry Working Papers*, No. 2007/05 (http://dx.doi.org/10.1787/246367010342).

Figure 2.2. Labour productivity growth and its components

Total economy, annual percentage point contribution



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Capital productivity

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 the capital stock, enables new technologies to enter the production process and is hence 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 Annexes A and C).

Measures of investment (gross fixed capital formation) used to estimate the productive capital stock and capital services follow the definitions described in the 1993 *System of National Accounts (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 yet 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 the ICT investment series, 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 assumptions about the use of specific assets over their service lives. 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 and Spain between 2007 and 2011, while, over the same period, a relative improvement was observed in Japan, Korea and the United States.

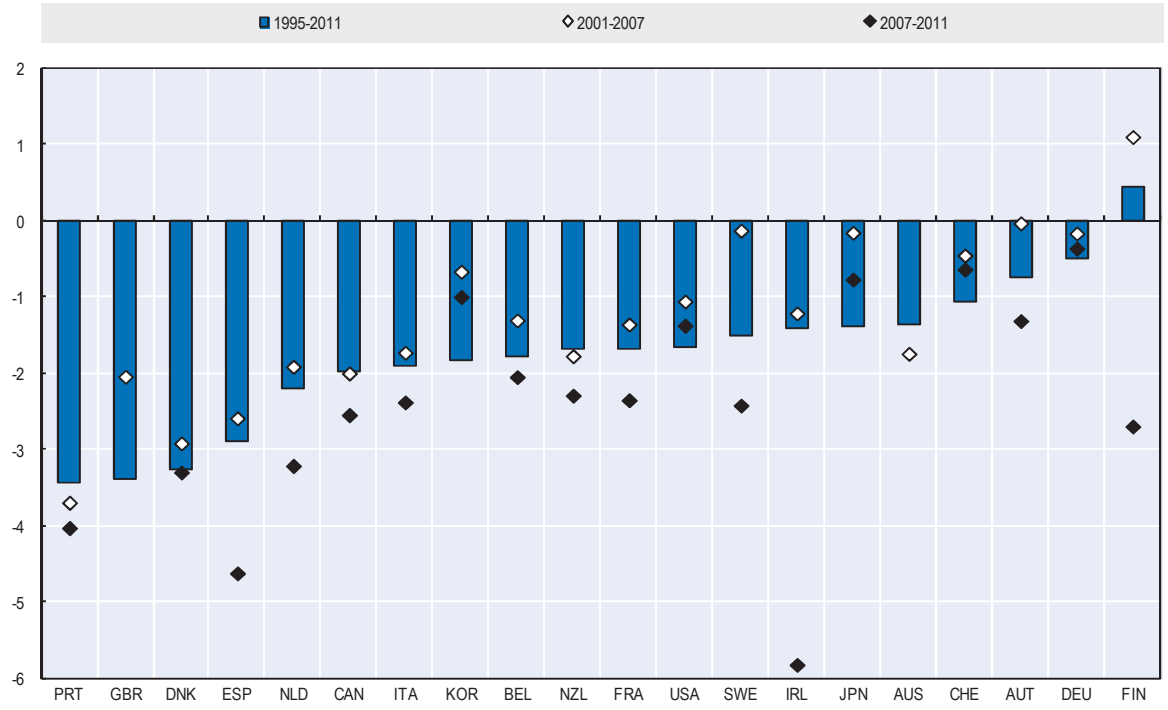
Some of the decline in overall costs of capital may relate to ICT where new products' prices typically fall very rapidly, which may have spurred the increased use of ICT in production. In fact, the share of ICT assets in total investment increased significantly in nearly all OECD countries in the second half of the 1990s, although they have fallen again since then. In 2011, the share of ICT ranged from 10% of total investment in Korea and Italy, to more than one quarter in Denmark, Germany, and the United States. In Australia, shares fell significantly between 2001 and 2011, possibly reflecting significant investment in mining capital equipment.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2009), *Handbook on Deriving Capital Measures of Intellectual Property Products* (http://dx.doi.org/10.1787/9789264079205-en).
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Figure 2.3. Growth in capital services per hour worked

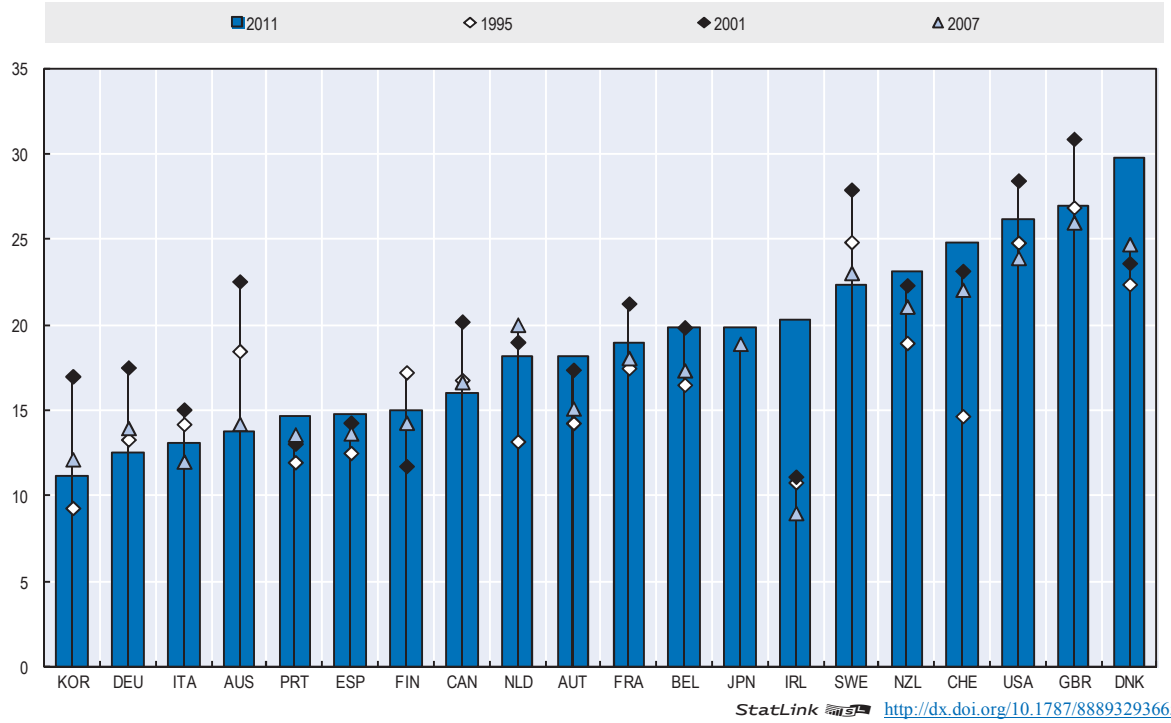
Total economy, percentage change at annual rate



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Figure 2.4. Share of ICT investment

Total economy, in percent of non-residential gross fixed capital formation



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3. SECTOR PRODUCTIVITY

Labour productivity by main activity

Sector composition of total economy productivity

Labour productivity of business sector services

Sector composition of services productivity

Labour productivity by main activity

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

Definition

Labour productivity is defined as real value added per hour worked. The non-agricultural business sector, excluding real estate covers mining and quarrying; manufacturing; utilities; construction; and business sector services. The latter cover wholesale and retail trade, repair; accommodation, food services, and transport services; information and communication; financial and insurance activities; professional, scientific and support activities. The figures present sectoral productivity growth for those countries for which sectoral data for real value added (in basic prices) and hours worked are available by ISIC Rev.4 breakdown (Annex D) in the *OECD Annual National Accounts Database*.

Comparability

The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added, especially in services (Annex E). Most countries assume no change in labour productivity for public administration activities, which is why this industry is not included here. Also excluded from the below are real estate services, as their value-added includes the imputation made for the dwelling services provided and consumed by home-owners.

For some countries, labour force surveys (LFS) provide long time series for hours worked at the total economy level, and hence for these countries, LFS data for hours worked are used in the *OECD Productivity Database* for the whole economy. However, to ensure coherence across sectors, sectoral hours worked data are taken from the *OECD Annual National Accounts Database*. This can affect comparability of productivity growth data by industry with that of the total economy presented above.

Overview

Differences in productivity growth rates across countries increase when compared at the sectoral level. Although in most countries the highest growth rates are typically in the manufacturing sector and also in some business sector services, productivity growth rates can differ considerably. For instance, in manufacturing, productivity growth rates ranged from less than 1% in Italy to 12% in the Slovak Republic, between 2001 and 2012.

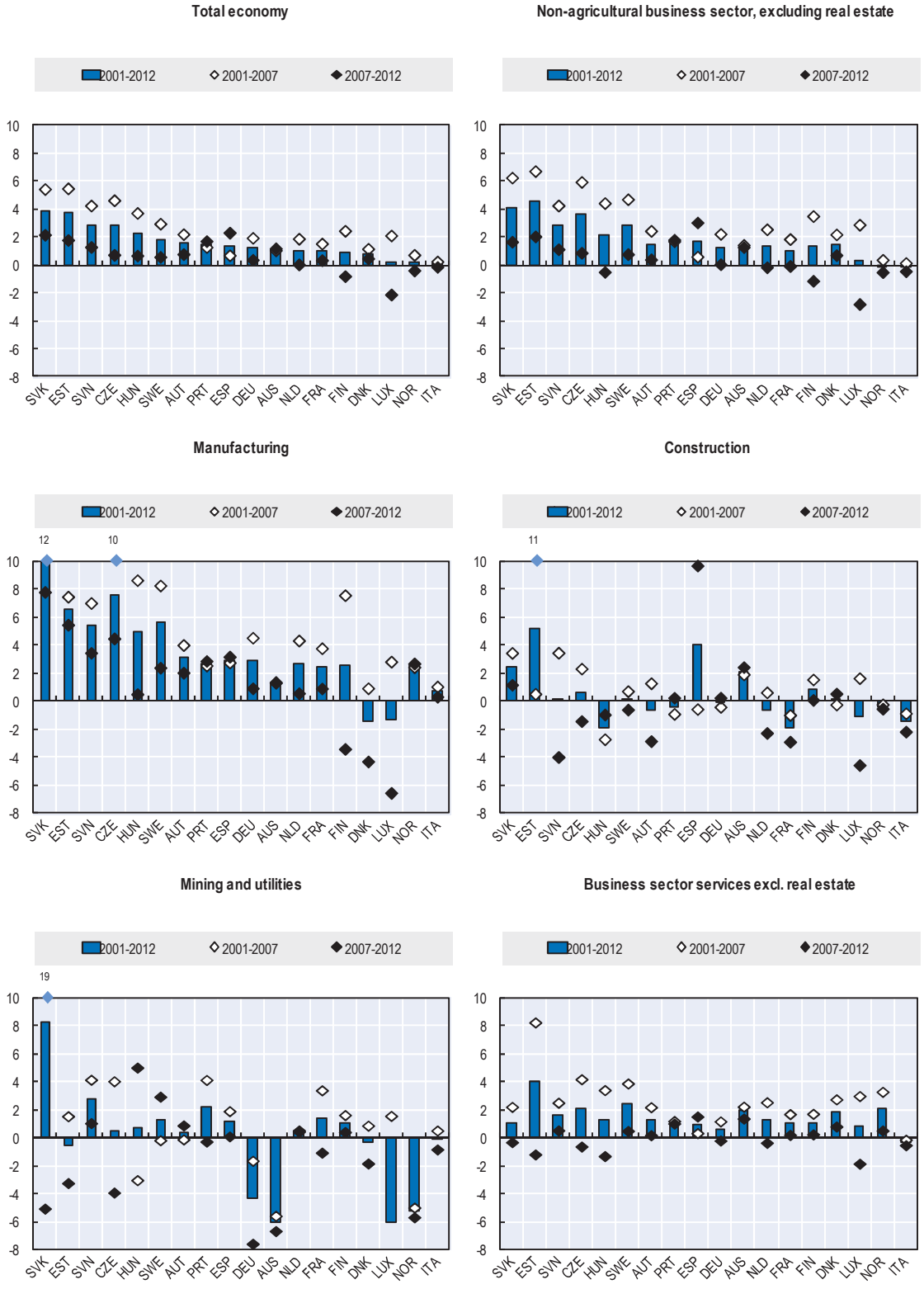
For most OECD countries where labour productivity growth slowed since the onset of the financial crisis, it was broadly spread across sectors. 2012 saw some picking up in productivity growth for Estonia and Hungary, though, mainly resulting from business sector services. Productivity growth also picked up somewhat for the Slovak Republic, where it was essentially driven by manufacturing.

Sources and further reading

- Ahmad, N., et al. (2003), "Comparing Labour Productivity Growth in the OECD Area: The Role of Measurement", *OECD STI Working Paper*, No. 2003/14 (http://dx.doi.org/10.1787/126534183836).
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- Wölfl, A. (2003), "Productivity Growth in Services Industries – an Assessment of Recent Patterns and the Role of Measurement", *OECD STI-Working Paper* 2003-7, (http://dx.doi.org/10.1787/086461104618).

Figure 3.1. Growth in real value added per hour worked by main activity

Percentage change at annual rate



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Sector composition of total economy productivity

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

Definition

Labour productivity growth per industry is defined as the rate of change of real value added (in basic prices) per hour worked. The contribution of each sector to labour productivity growth of the total business sector is computed as the difference between the growth rate of 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. Data are presented for those countries for which data for real value added and hours worked by sector are available by ISIC Rev.4 breakdown (Annex D) in the *OECD Annual National Accounts Database*.

Comparability

In addition to the difficulties encountered in measuring appropriately real value added, it is also difficult to accurately measure nominal output and value added for some services. This is for example true for the financial services sector, where some financial intermediation services, such as implicit banking charges, are indirectly measured.

Under- or over-estimation of the output of a particular sector, notably 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 may have an impact on the comparability across sectors it may have a smaller impact on overall productivity growth.

Overview

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

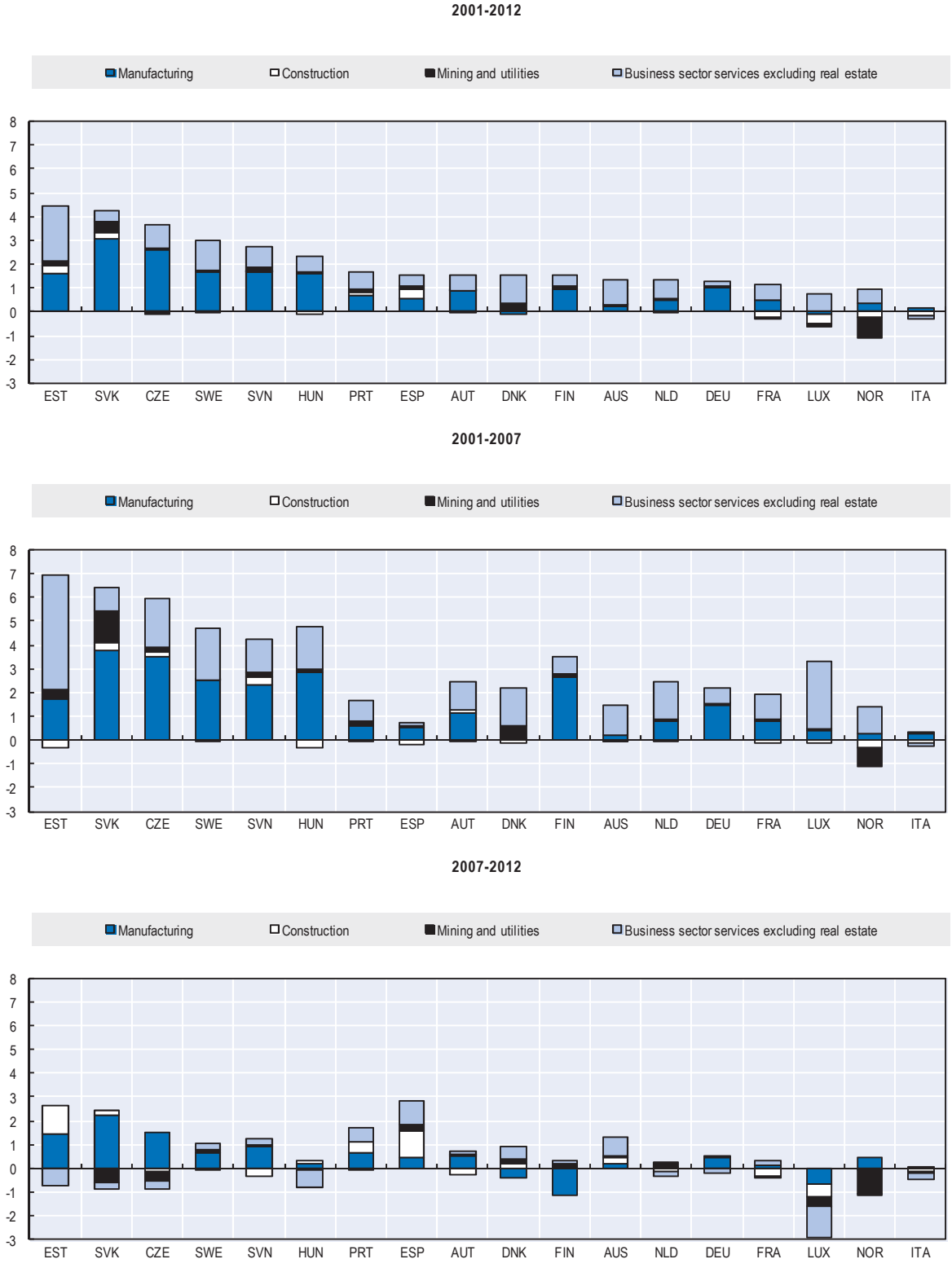
The evidence available so far suggests that reallocation effects have not been the primary drivers for overall labour productivity movements since the 2008 financial crisis. Rather, the changes in sector contributions reflect those in productivity growth per sector.

Sources and further reading

- Ahmad, N., et al. (2003), "Comparing Labour Productivity Growth in the OECD Area: The Role of Measurement", *OECD Science, Technology and Industry Working Paper* 2003-14 (http://dx.doi.org/10.1787/126534183836).
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- 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 (http://dx.doi.org/10.1787/086461104618).

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

Total economy, percentage point contribution at annual rate



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Labour productivity of business sector services

Developments in information and telecommunications technologies (ICT) combined with internationally fragmented production processes are making business services increasingly dynamic, transportable and tradable. As a result, several business sector services show characteristics similar to high-productivity manufacturing industries; they are intensive in physical, notably ICT-capital, innovative, show economies of scale, and are exposed to international competition.

Definition

Labour productivity growth by industry is defined as the rate of growth in real value added (in basic prices) per hour worked by industry. The figures present sectoral productivity growth for those countries for which data for real value added and hours worked by sector are available by ISIC Rev.4 breakdown (Annex D) in the *OECD Annual National Accounts Database*.

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 those business sector 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 constant price value added still vary across OECD countries, impacting on measured productivity growth (Annex E).

Excluded from the below are the real estate services, as their value-added includes the imputation made for the dwelling services provided and consumed by home-owners.

For some countries, labour force surveys (LFS) provide long time series for hours worked data at the total economy level, and hence for these countries, LFS data for hours worked are used in the *OECD Productivity Database* for the whole economy. However, to ensure coherence across sectors, all sectoral hours worked data are taken from the *OECD Annual National Accounts Database*. This can affect comparability of productivity growth by industry with that of the total economy presented above. In addition, certain 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

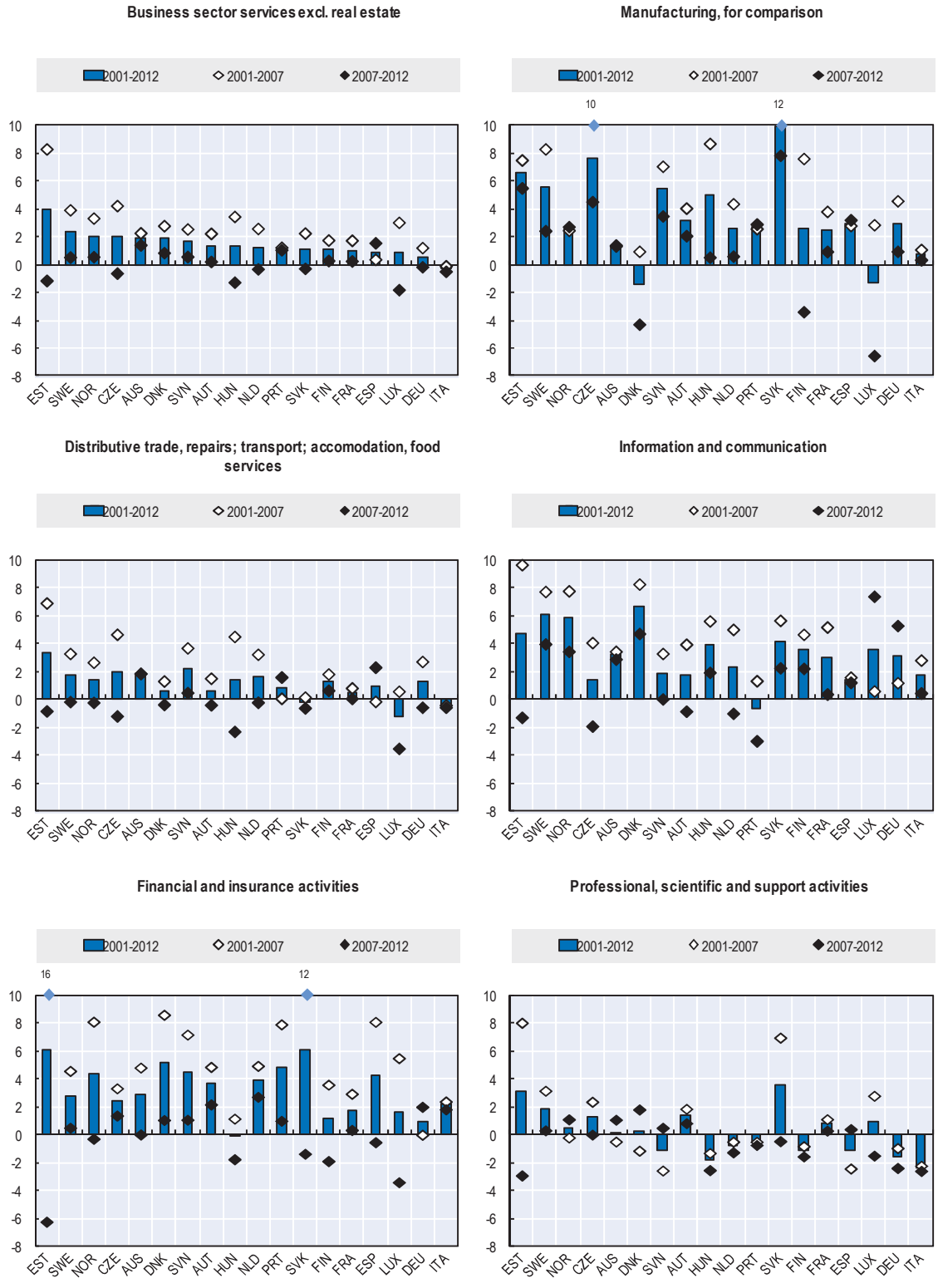
Labour productivity growth varies substantially across business sector services. Services with the highest productivity growth tend to be those more exposed to international competition and typically use modern information and communication technologies (ICT). For instance, finance and insurance services as well as information and communication services show labour productivity growth rates that are as high, or even higher than average productivity growth in the manufacturing sector. These business sector services sectors show also more volatile productivity growth over time as compared to, for example, professional services.

Sources and further reading

- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
- Pilat, D., A. Wölfl (2005), "Measuring the Interaction between Manufacturing and Services", *OECD Science, Technology and Industry Working Paper* 2005-5 (http://dx.doi.org/10.1787/882376471514).
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- 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 (http://dx.doi.org/10.1787/086461104618).

Figure 3.3. Growth in real value added per hour worked by business sector service

Percentage change at annual rate



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Sector composition of services productivity

The business services sector has contributed significantly to GDP growth across OECD countries in recent decades, driven in large part by an increase in firms providing intermediate services to other firms, including in the manufacturing sector. This process of outsourcing activities previously conducted in-house has increased efficiencies, and hence, labour productivity, of both outsourcing firms as well as the specialised intermediary firms. Hence, over the long term, both factors may produce a structural shift towards intermediate services industries and a direct positive contribution of high productivity business services to productivity growth of the total economy.

Definition

The contribution of each services sector to labour productivity growth of total business sector services is computed as the weighted difference between the growth rate of value added and that of hours worked. The weights are computed as each individual sector's share in nominal value added and total hours worked respectively of total business sector services. Business sector services cover wholesale and retail trade, repairs, accommodation, food and transport services ("trade, hotels and transport"); information and communication; financial and insurance activities; and professional, scientific and support activities ("professional services") (Annex D).

Comparability

The contribution of one services industry to total business sector services productivity depends critically on its share as measured by nominal value added, respectively hours worked. In addition to the difficulties encountered in measuring appropriately real value added, it is also difficult to accurately measure nominal output and value added for some services. In financial services, for example, the services provided are not always charged for explicitly and can only be measured indirectly.

Overview

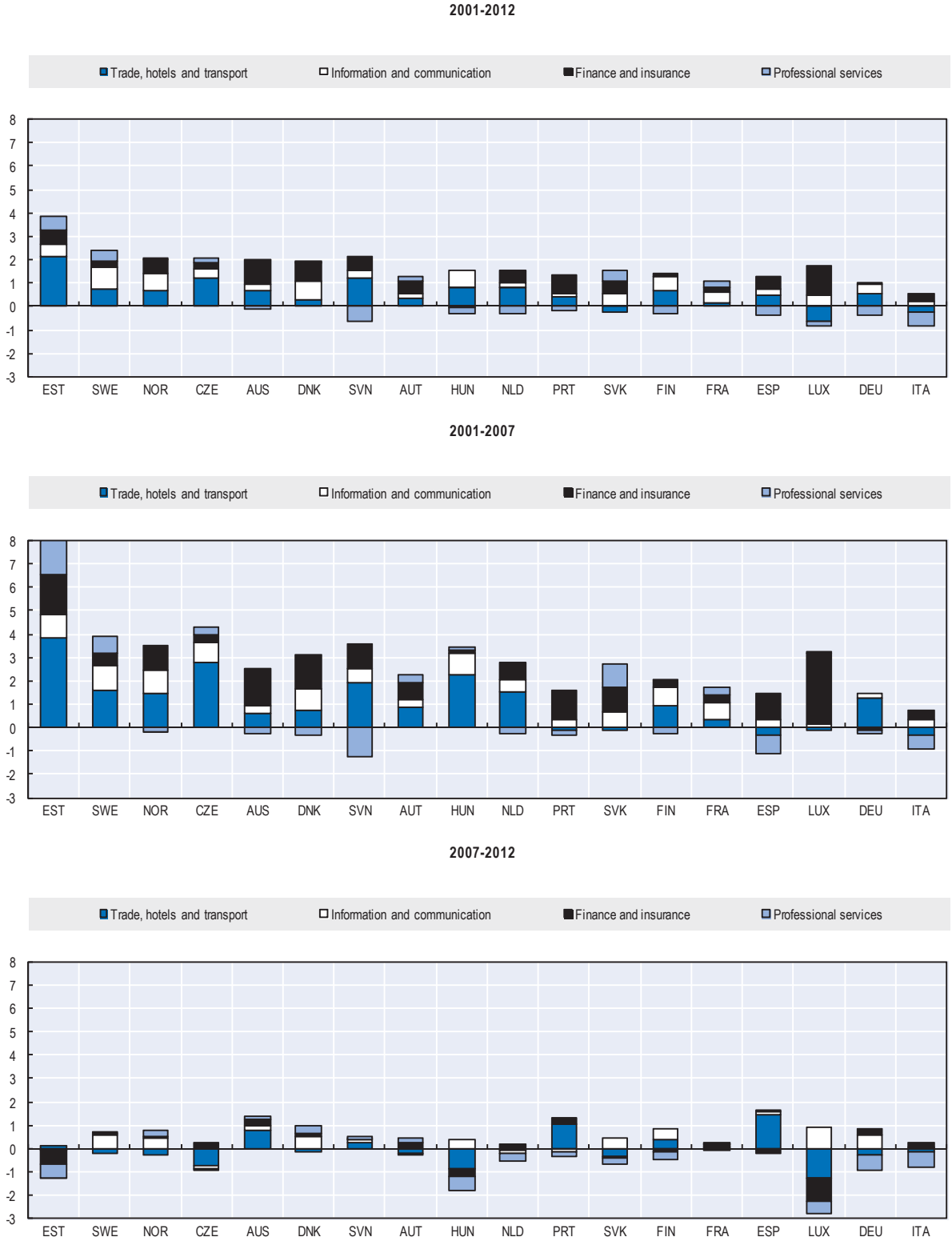
For most OECD countries for which data are available, labour productivity growth in the business sector services over the past 15 years was mainly attributable to distributive trade, hotels and transport services, and finance and insurance services. For finance and insurance services, this mainly reflected strong productivity growth. For, hotels and transport services, it was mainly due to large shares of these activities in total business sector services value added and hours worked.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- Pilat, D., A. Wölfl (2005), "Measuring the Interaction between Manufacturing and Services", *OECD Science, Technology and Industry Working Paper* 2005-5 (http://dx.doi.org/10.1787/882376471514).
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Figure 3.4. Composition of growth in business sector services value added per hour worked

Percentage change contribution at annual rate



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4. PRODUCTIVITY, TRADE AND INTERNATIONAL COMPETITIVENESS

Unit labour costs

International competitiveness

Trade and productivity

Unit labour costs

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

Definition

ULCs are defined as the average cost of labour per unit of output produced. They can be expressed as the ratio of total labour compensation per hour worked to output per hour worked (labour productivity). Compensation of employees is defined as the total remuneration payable by an enterprise to an employee in return for work done by the latter during the accounting period. It includes wages and salaries payable in cash or in kind, as well as social insurance contributions paid by employers. Total labour compensation is for total persons employed and so includes employees and the self-employed.

Comparability

The data are presented for the total economy, manufacturing and business sector services (which exclude real estate services) according to the ISIC Rev. 4 classification (Annexes A and D). All the ULC components are sourced from the *OECD Annual National Accounts Database*, respectively the *OECD Productivity Databases PDB and PDBi.* The figures present the data for those countries for which time series of sectoral hours worked are available in the *OECD Annual National Accounts Database*.

Manufacturing ULCs are often perceived as more representative for assessing competition in tradable products. Services prices are often not very reliable, which may affect the cross-country comparability of measured business sector services ULC.

Overview

Over the last 10 years, firms in the G7 countries and most of the early members of the Euro area increased their competitiveness relative to those of other countries. Very low increases in ULC have typically been achieved by keeping unit labour costs low in both manufacturing and business sector services, as was the case in Germany and Austria.

Within Europe, Ireland, Spain, Portugal and Greece, saw strong falls in their ULC since the onset of the financial crisis. However, care is needed in interpreting these results as improved relative competiveness as they need 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 show signs of being reversed in the second half of the 2000s.

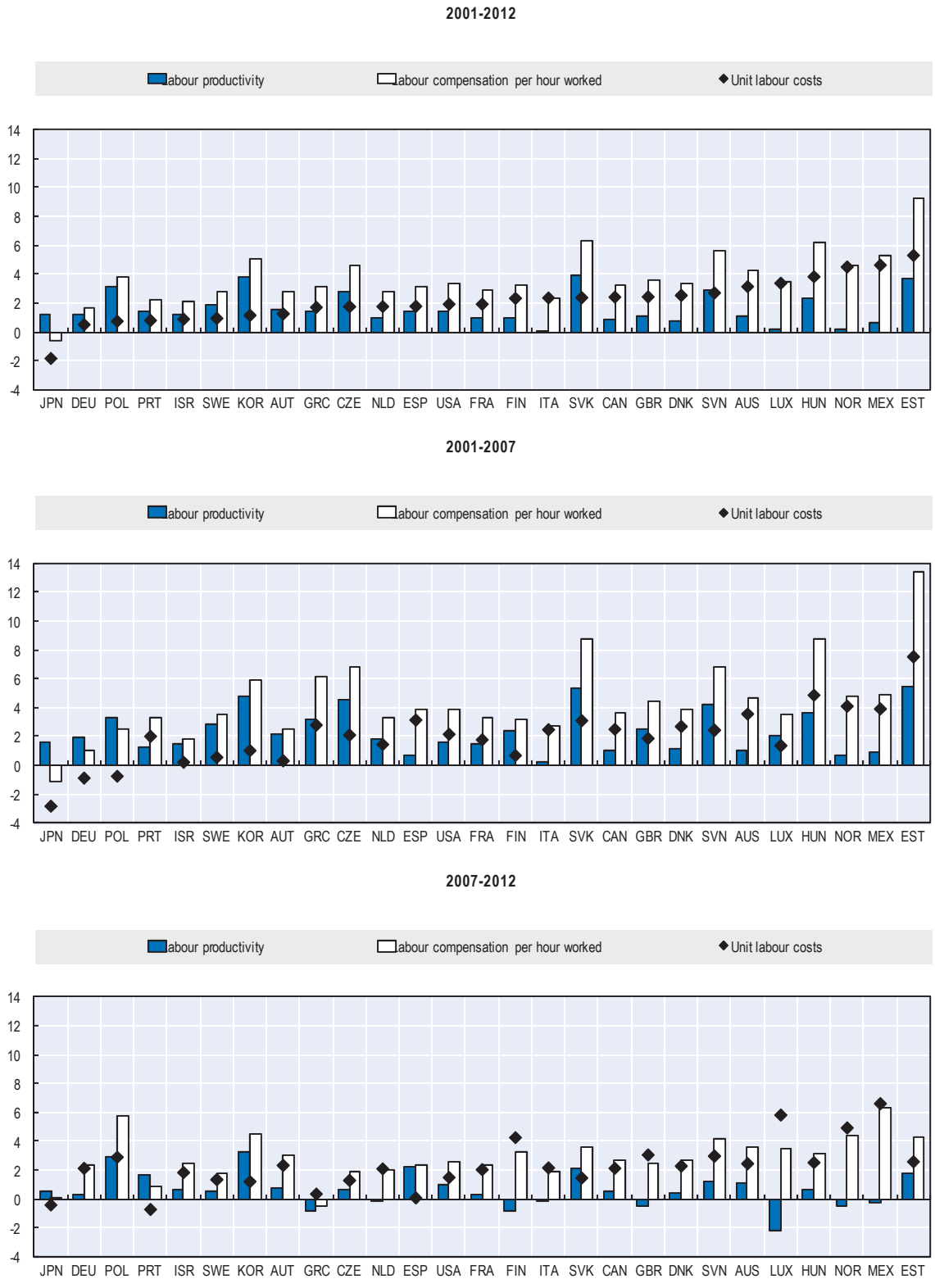
Comparing the data for ULC with those for labour productivity growth can provide some information on the possible sources for changes in ULC. For instance, over the past 10 years, some countries, notably those countries with relatively low growth in ULC, such as Germany, Israel, Poland, and Sweden, displayed stronger growth in labour productivity than in ULCs. In these countries, relatively higher productivity growth coincided with wage moderation. In contrast, in most of those countries where there was a relative deterioration in competitiveness could be observed, there was also relatively weak growth in labour productivity.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
- OECD (2013), OECD Main Economic Indicators Database (http://dx.doi.org/10.1787/mei-v2013-10-en).

Figure 4.1. ULC, hourly labour compensation and productivity, Total economy

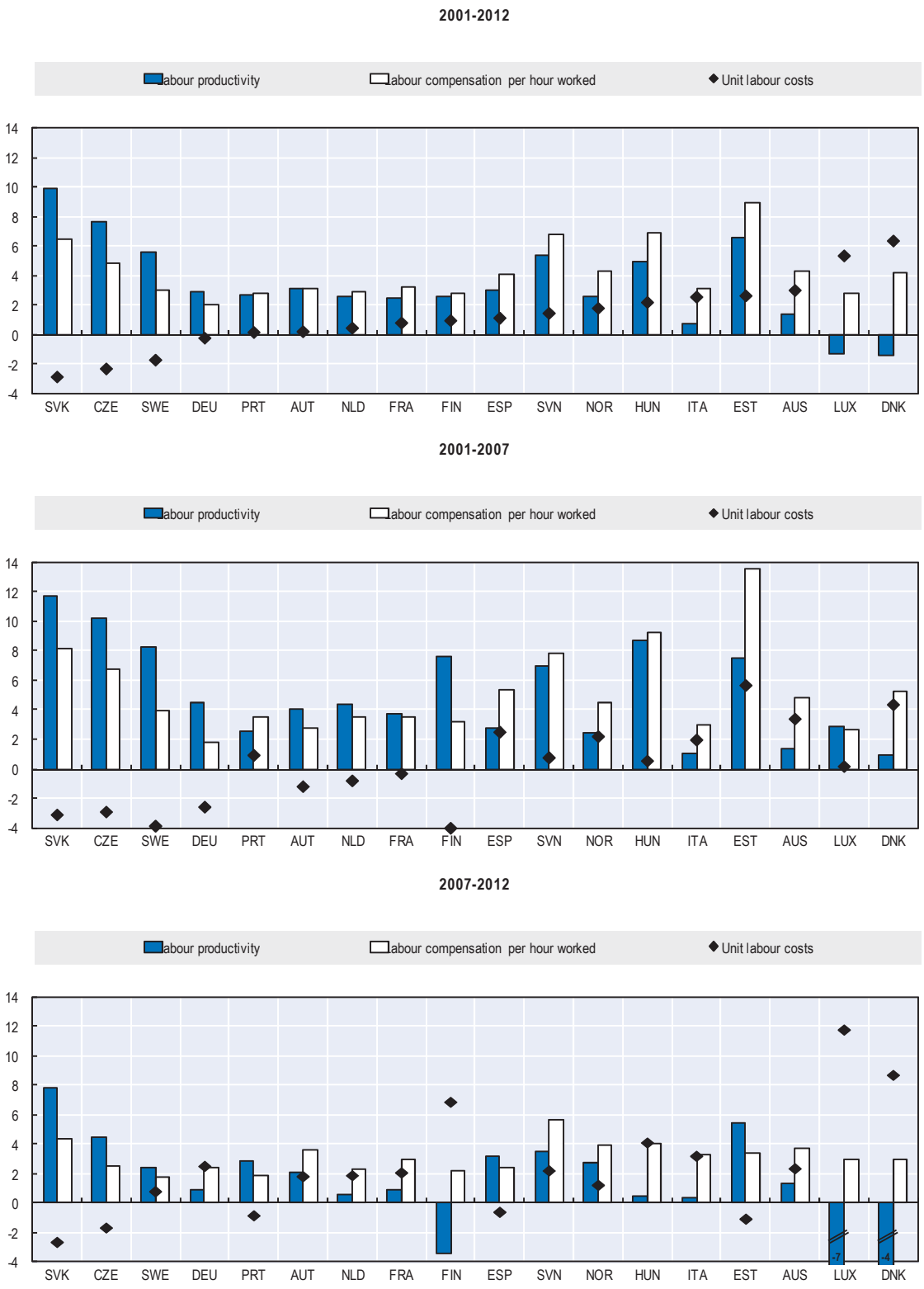
Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888932936750

Figure 4.2. ULC, hourly labour compensation and productivity, Manufacturing

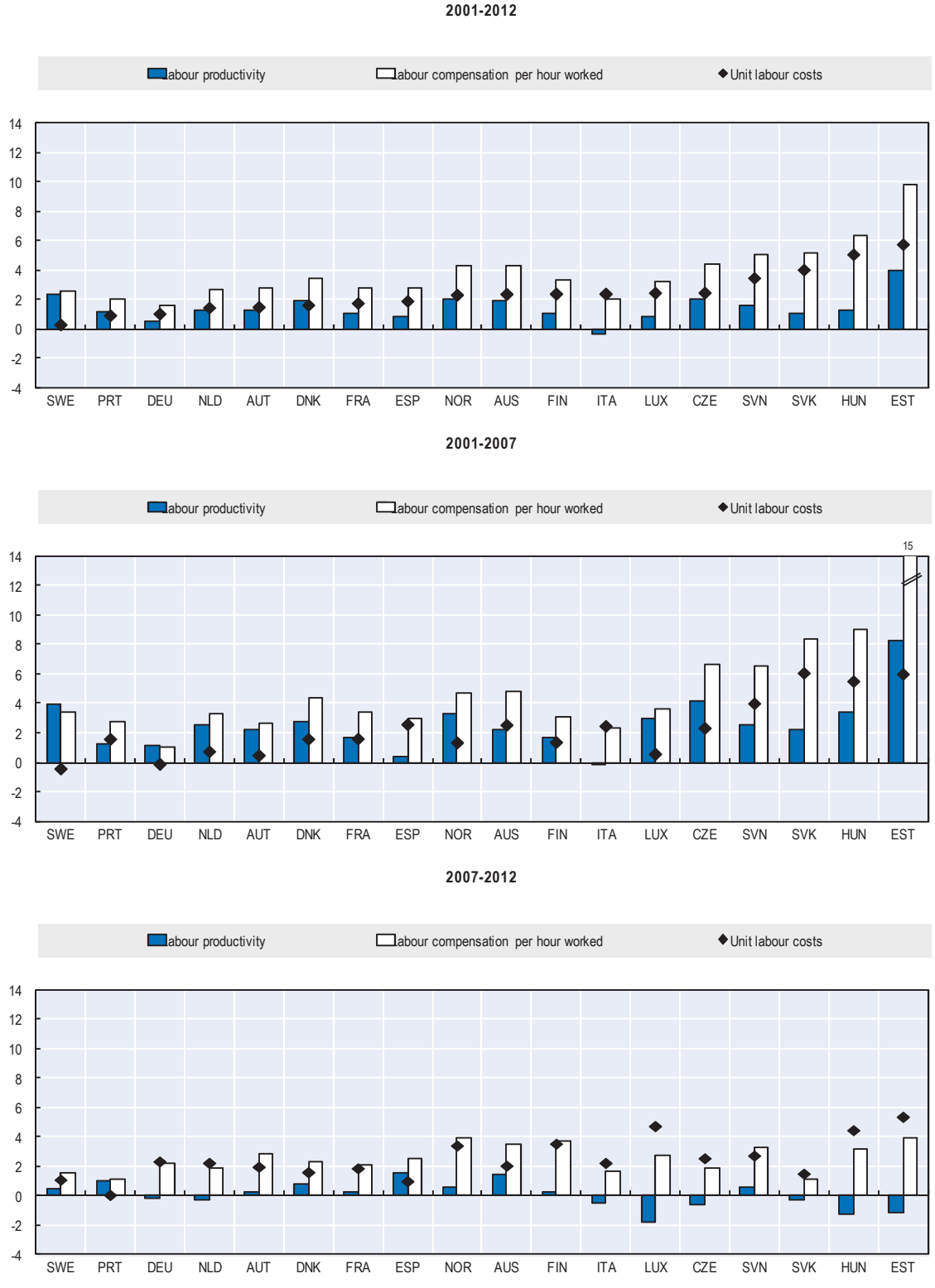
Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888932936769

Figure 4.3. ULC, hourly labour compensation and productivity, Business sector services

Percentage change at annual rate



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International competitiveness

Despite their frequent use, unit labour costs (ULC) are an incomplete measure of international competitiveness and they need to be complemented with other indicators. 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 firms within 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 measured as actual growth in exports relative to the growth of the country's export market. The export market share for a single country measures the share of exports by firms in this country in relation to world exports of all countries. 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. ULCs are defined as the average cost of labour per unit of output produced.

Comparability

Export performance and export market shares are based on gross trade data which may overstate the performance of countries specialised on goods and services that are typically downstream in global value-chains (see below).

Trade statistics do not always consistently measure flows between affiliated enterprises. This is especially so for trade in intellectual property products where payments may often be recorded as property income payments.

Manufacturing ULCs are often perceived as more representative for competition in tradable products, but they do not account for the increasing trade in services. Services prices are often not very reliable, and therefore may affect cross-country comparability of business sector service ULCs. Looking at total economy ULCs somewhat alleviates these concerns, but their coverage goes significantly beyond the tradable sector. ULC data are only presented for those countries for which sectoral hours worked data are available according to the ISIC Rev.4 classification in the *OECD Annual National Accounts Database*.

Overview

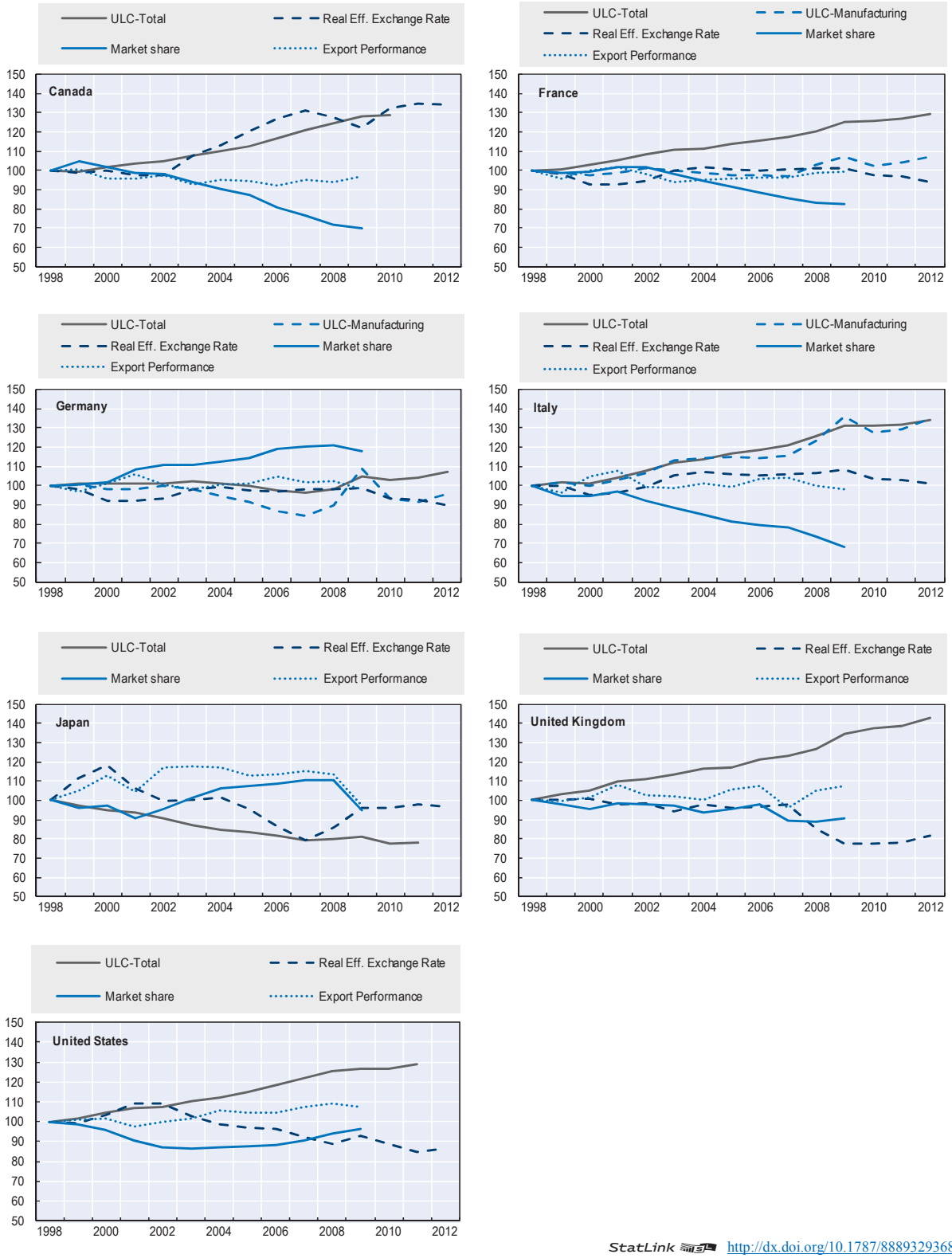
In the last 15 years, those G7 countries that kept labour costs low increased export performance and vice versa and this observation is more noticeable for the Euro area countries which do not have recourse to exchange rate adjustment. For instance, Germany has reduced ULCs and has gained in world export market shares, while the opposite was true for France and Italy. The United Kingdom, in turn, has had relatively constant market shares over the same period despite rising unit labour costs, due to a declining real effective exchange rate. However, the weight of services and the relative cost developments between manufacturing and services appear to matter. For instance, low manufacturing ULCs as compared to total economy ULCs have allowed France to mitigate declines in global export market shares, while the opposite is true for Italy.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
- OECD (2012), OECD Statistics on Globalisation (http://dx.doi.org/10.1787/global-data-en).
- Durand, M., Simon, J., and C. Webb (1992), "Indicators of international competitiveness", *OECD Economics Department Working Paper* No. 120, (http://dx.doi.org/10.1787/708306180711).

Figure 4.4. Indicators of international competitiveness

Indices, 1998=100



StatLink http://dx.doi.org/10.1787/888932936807

Trade and productivity

Economic theory suggests that more open countries should grow faster and have higher income levels than less open ones. International trade enables firms to specialise on goods and services that can be most efficiently produced in the home country. Trade may enable firms to sell to larger markets, hence exploiting economies of scale. Trade also puts pressure on prices for final goods and intermediate inputs and increases international fragmentation of production processes, further reducing costs. Finally, firms exposed to international competition are continuously forced to innovate in order to succeed.

Definition

Trade can be measured in two ways. Typically international trade statistics measure trade on a gross basis, as is the case for the net exports, i.e., exports minus imports, presented in the top and the bottom left panel in Figures 4.6. Exports on a gross basis include the value of imports embodied in goods and services as well as some value-added created in other domestic sectors that returns embodied in imports. This 'double-counting' particularly affects those countries where firms are closely integrated into global value chains.

Measuring international trade in value-added terms attempts to correct for this ‘double-counting’. Value-added embodied in foreign final demand – as represented in the bottom right panel – can most readily be interpreted as ‘exports of value-added’. It shows how industries export value added that is produced in the home country to foreign final consumers, both through direct final exports and via indirect exports of intermediate inputs.

Comparability

The indicators in the joint *OECD/WTO Trade in Value Added (TiVA) Database* are derived from OECD Input Output Tables linked together using bilateral trade flows in goods and services. Some assumptions are necessary to create the TiVA indicators, implying that some care is needed in interpreting the results. Key in this context is the underlying “production assumption” that assumes that for a given industry, all firms allocated to that industry use the same goods and services, and so imports, to produce the same outputs. Typically, firms engaged in global value chains, particularly foreign owned affiliates, are likely to have higher import content than firms in the same sector producing goods or services for domestic markets. This means that TiVA estimates will, more likely than not, underestimate the import content of exports.

Overview

The empirical evidence confirms the strong link between exports and growth. More open countries, as represented here by a higher ratio of net exports to GDP, also have a higher level of GDP as compared to countries with lower net exports. Moreover, countries that have been able to increase their export-to-GDP ratio over time have also improved labour productivity over the same period. This is particularly the case for catching up economies such as Korea, Turkey and Chile, suggesting that integration in the global value chains has been a driver of the catching up process.

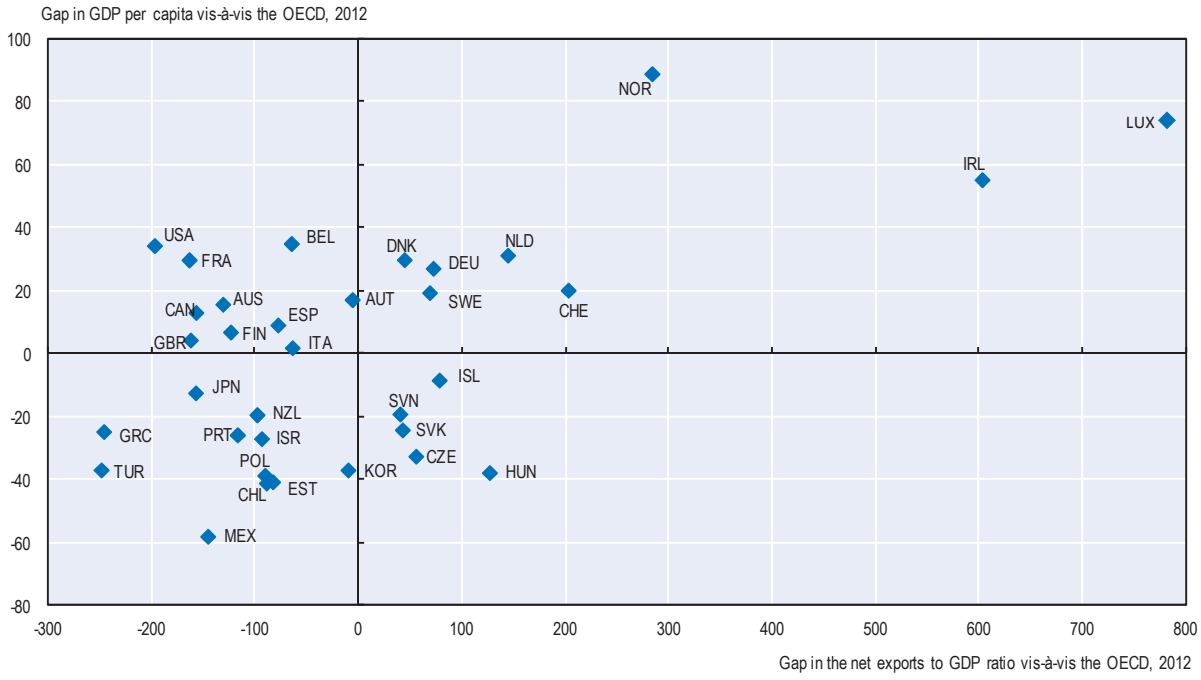
Measures of exports based on gross terms can however overstate the importance that a given growth in exports makes to overall GDP growth. This reflects the fact that exports increasingly embody imports, as shown in the charts below.

Sources and further reading

- OECD (2013), OECD National Accounts Database (http://dx.doi.org/10.1787/na-data-en).
- OECD (2013), OECD Trade in Value Added Database (http://oe.cd/tiva).
- OECD-WTO (2012), Trade in Value-Added: Concepts, Methodologies and Challenges.

Figure 4.5. Net export to GDP ratio and GDP per capita vis-à-vis the OECD, 2012

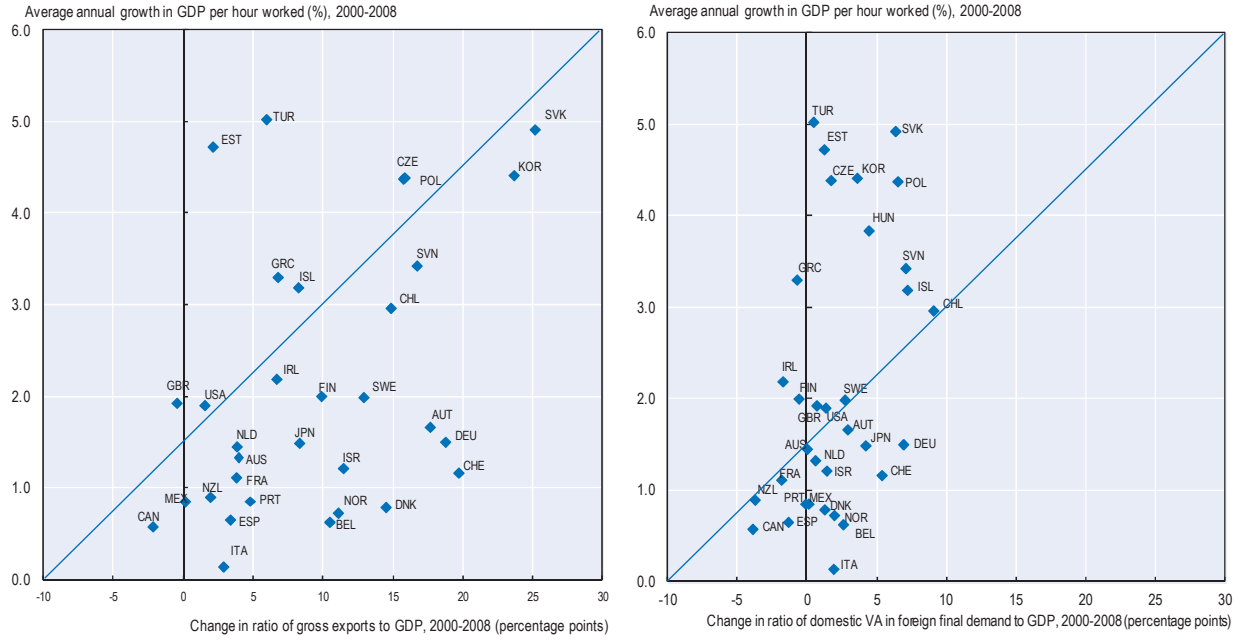
Total economy, in percent, OECD = 100



StatLink http://dx.doi.org/10.1787/888932936826

Figure 4.6. Change in exports to GDP ratio and growth in GDP per hour worked

Total economy, exports in gross terms (left panel) and in value added terms (right panel)



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5. PRODUCTIVITY OVER THE CYCLE

Labour productivity growth - trend versus cycle

Determinants of trend productivity growth

Multifactor productivity over the cycle

Labour productivity growth – trend versus cycle

Labour productivity is a key driver of economic growth and living standards. Understanding how much actual labour productivity growth is driven by structural factors and how much by reactions to the productivity cycle or the economic cycle is hence important for policy makers. This requires decomposing the time series of actual annual labour productivity growth into a trend (or structural) component and a cyclical component.

Definition

Labour productivity is defined here as GDP per hour worked. Its decomposition into a trend and a cyclical component 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 trend. The smoothing follows a geometric average, assuming that annual labour productivity growth is constant between the mid-points of each cycle.

However, determining the cycle lengths and hence the trend may be somewhat arbitrary especially at the end of the time series. In view of this uncertainty, trend series are not computed for the last two years of the time series for which data on actual labour productivity growth are available.

Comparability

Trend series are commonly computed using filter techniques, such as the Hodrick-Prescott (HP) filter. 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 economic cycles into account.

Overview

Looked over the last three decades, labour productivity growth has followed very different trends across the G7 countries. But seen over the 15 years preceding the crisis, trend labour productivity growth has declined for nearly all G7 countries, the fall being particularly marked in Canada and Italy. In the case of the United Kingdom and the United States, this decline since the mid 1990s marked some reversal of a previous acceleration of productivity growth. In other countries, trend labour productivity growth has shown a gradual decline almost throughout the past 30 years, partly from relatively high rates.

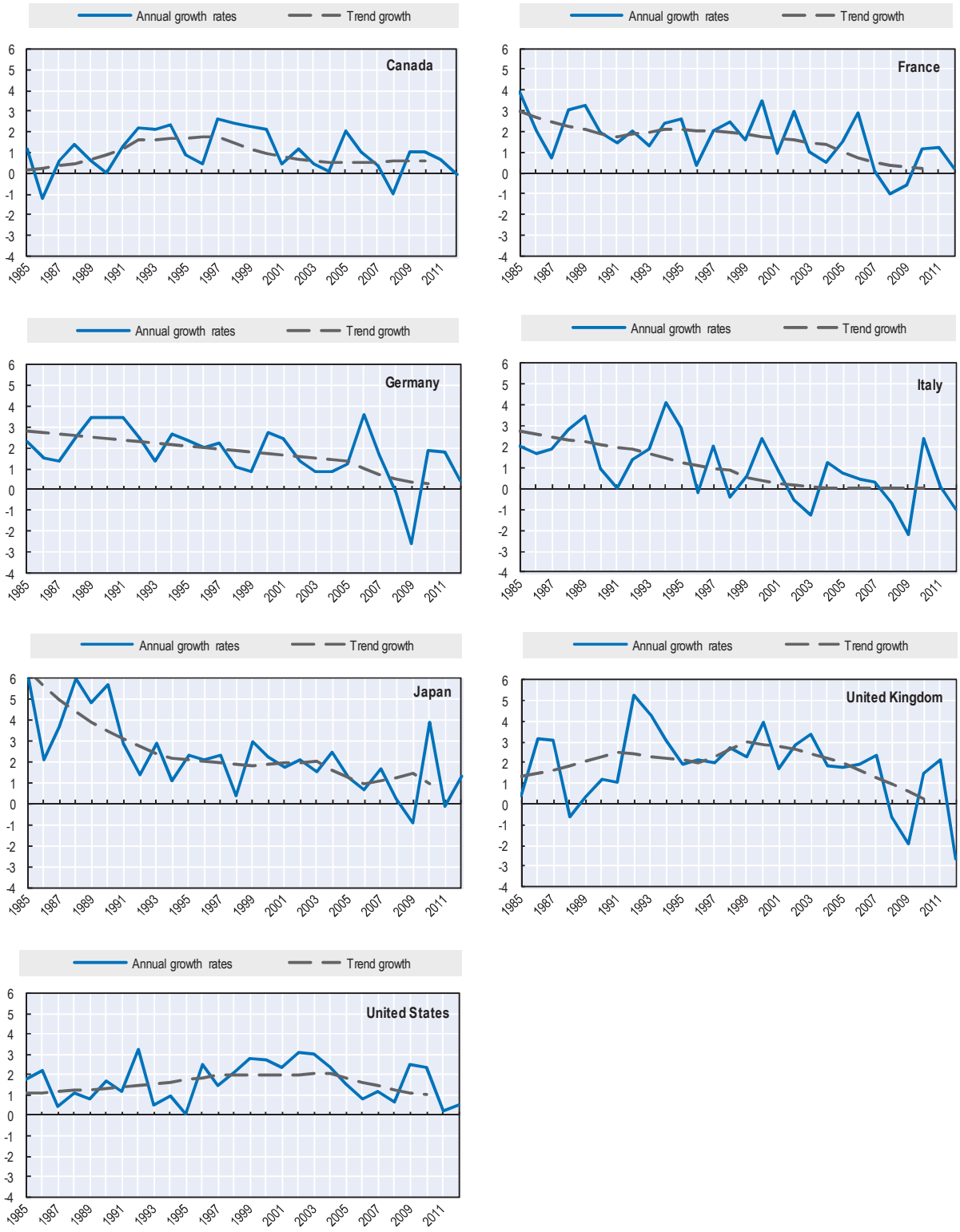
While one needs to be cautious in interpreting this as a post-crisis trend, especially in view of the volatility introduced by the crisis, average labour productivity growth over the 2007-2012 period declined significantly in Germany, France and the United Kingdom. Average productivity growth over the same period also fell in Canada and the United States but at a much more moderate rate.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2001), *Measuring Productivity – OECD Manual* (http://dx.doi.org/10.1787/9789264194519-en).
- OECD (2013), OECD Composite Leading Indicators, www.oecd.org/std/leading-indicators.
- Parham, D. (2003), Sources of Australia's Productivity Revival, Canberra.

Figure 5.1. Labour productivity growth and its trend

Total economy, percentage change at annual rate, G7 countries



StatLink http://dx.doi.org/10.1787/888932936864

Determinants of trend productivity growth

Policy makers are interested in analysing the structural factors determining labour productivity growth. For instance, a low level of trend labour productivity growth may be due to low investment in capital relative to hours worked (capital deepening), be it information and communication technologies (ICT) or more traditional assets (Non-ICT). Or it could be indicative of factors that hamper growth in multifactor productivity (MFP), such as low innovative activity, skills mismatches or inefficiencies due to barriers to competition. To shed light on these structural factors, one needs to decompose the time series of labour productivity growth as well as its components capital deepening and MFP into a trend component on the one hand and a cyclical component on the other.

Definition

To decompose the time series of labour productivity and its components into a trend and a cyclical component, average annual growth is first calculated for each economic cycle, as defined according to the OECD's *Composite Leading Indicators*. These average growth rates are then linked so as to develop a time series of smoothed trend. Determining the trend may be somewhat arbitrary, notably at the end of the time series. In view of this uncertainty, trend series are not computed for the last two years of the time series for which data on actual labour productivity growth or its components are available.

In the *OECD Productivity Database*, 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).

Comparability

To ensure cross-country comparability of capital services and MFP data, the OECD uses the same assumptions as to the overall production function as well as harmonised ICT investment deflators, depreciation rates and service lives for all countries for all capital assets.

Some care is needed in interpretation. Growth in MFP is the residual part of GDP growth that cannot be explained by growth in either labour or capital input. Conceptually, it can be seen as technological change. In practice, some part of technological change, including improvements in the design and quality of new vintages of capital, is embodied in physical, notably ICT capital. Moreover, linked to the assumptions used in the *OECD Productivity Database* and to problems measuring all inputs correctly, MFP also reflects other factors, *e.g.,* economies of scale, pure efficiency change, organisational change, variations in capacity utilisation, skills composition, and measurement errors (Annex A and C).

Overview

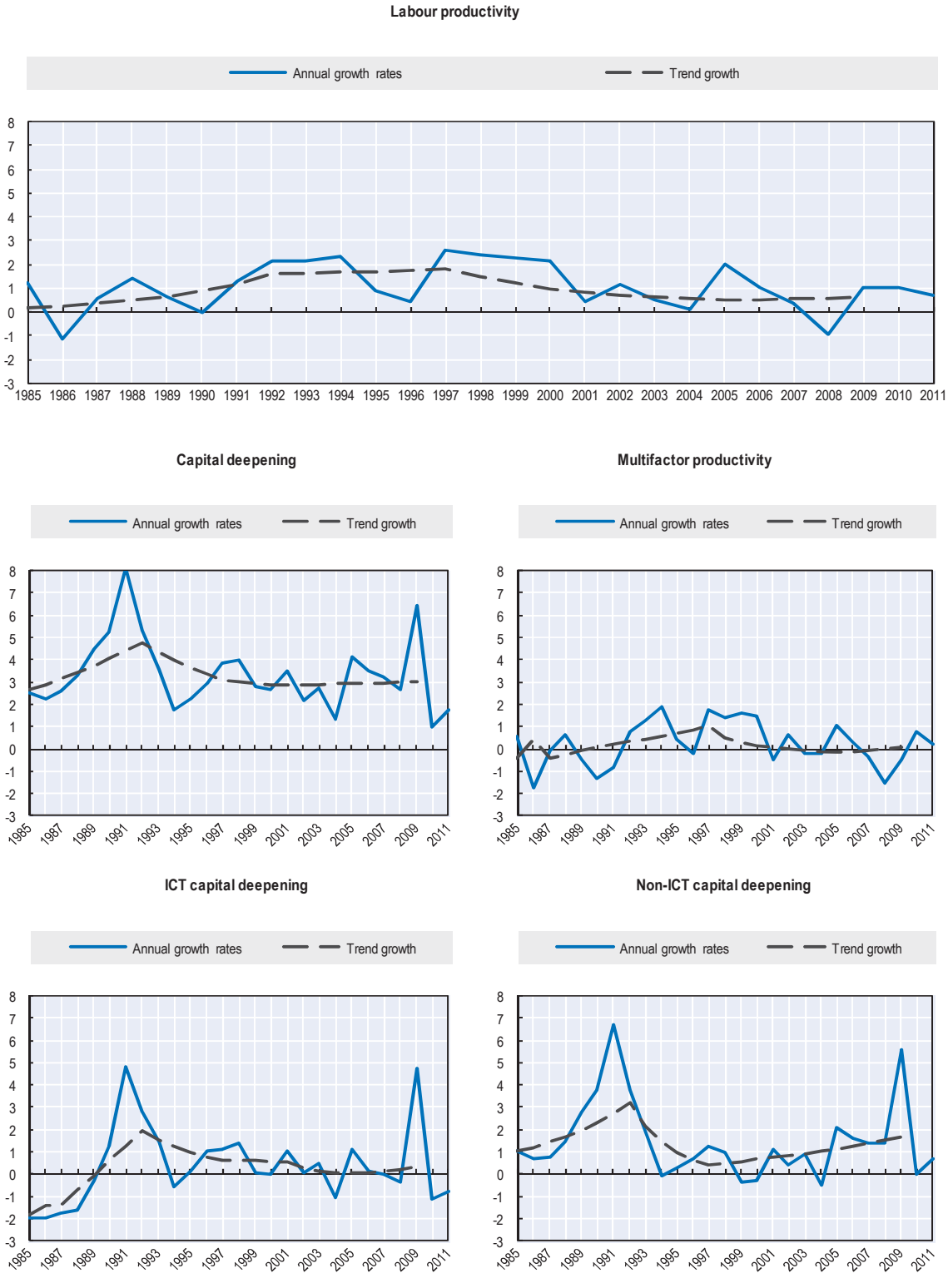
While all G7 countries show some decline in trend labour productivity since the mid 1990s or already before, the sources for this decline vary across countries. In Canada for instance, growth in capital relative to hours worked declined in the first half of the 1990s, followed by a strong decline in trend MFP in the second half. In France and Italy trend MFP growth declined continuously since the beginning of the 1990s, respectively over the whole period of the past 25 years. Japan has seen a decline in labour productivity growth since 2000, due to a drastic decline in ICT and Non-ICT capital deepening. In the United Kingdom and the United States, trend labour productivity growth declined only in the second half of the 2000s, driven by drastic decline in MFP in the United Kingdom and in capital deepening in the United States.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2001), *Measuring Productivity – OECD Manual* (http://dx.doi.org/10.1787/9789264194519-en).
- OECD (2013), OECD Composite Leading Indicators, www.oecd.org/std/leading-indicators.

Figure 5.2. Labour productivity growth trend and its components, Canada

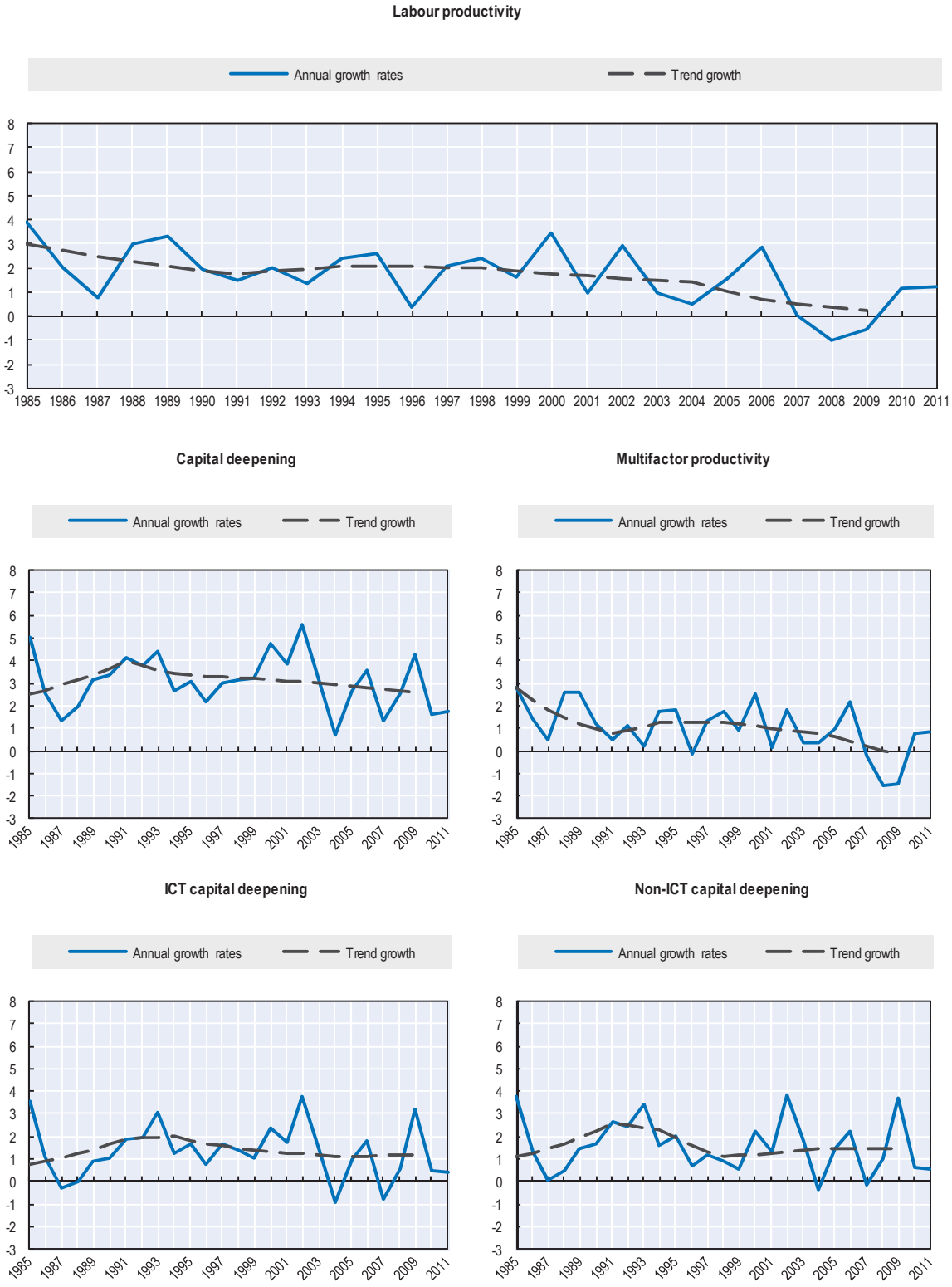
Total economy, percentage change at annual rates



StatLink http://dx.doi.org/10.1787/888932936883

Figure 5.3. Labour productivity growth trend and its components, France

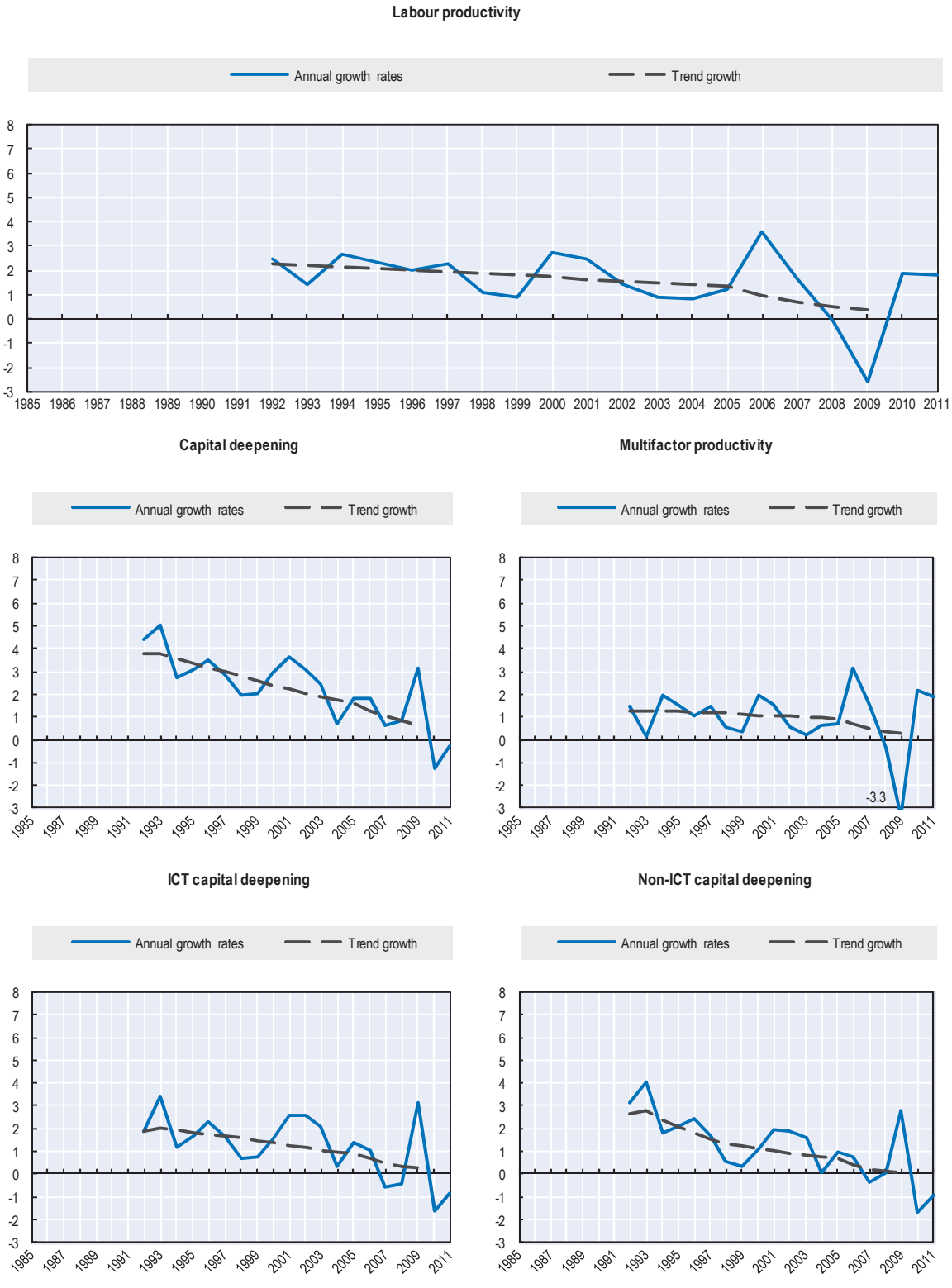
Total economy, percentage change at annual rates



StatLink http://dx.doi.org/10.1787/888932936902

Figure 5.4. Labour productivity growth trend and its components, Germany

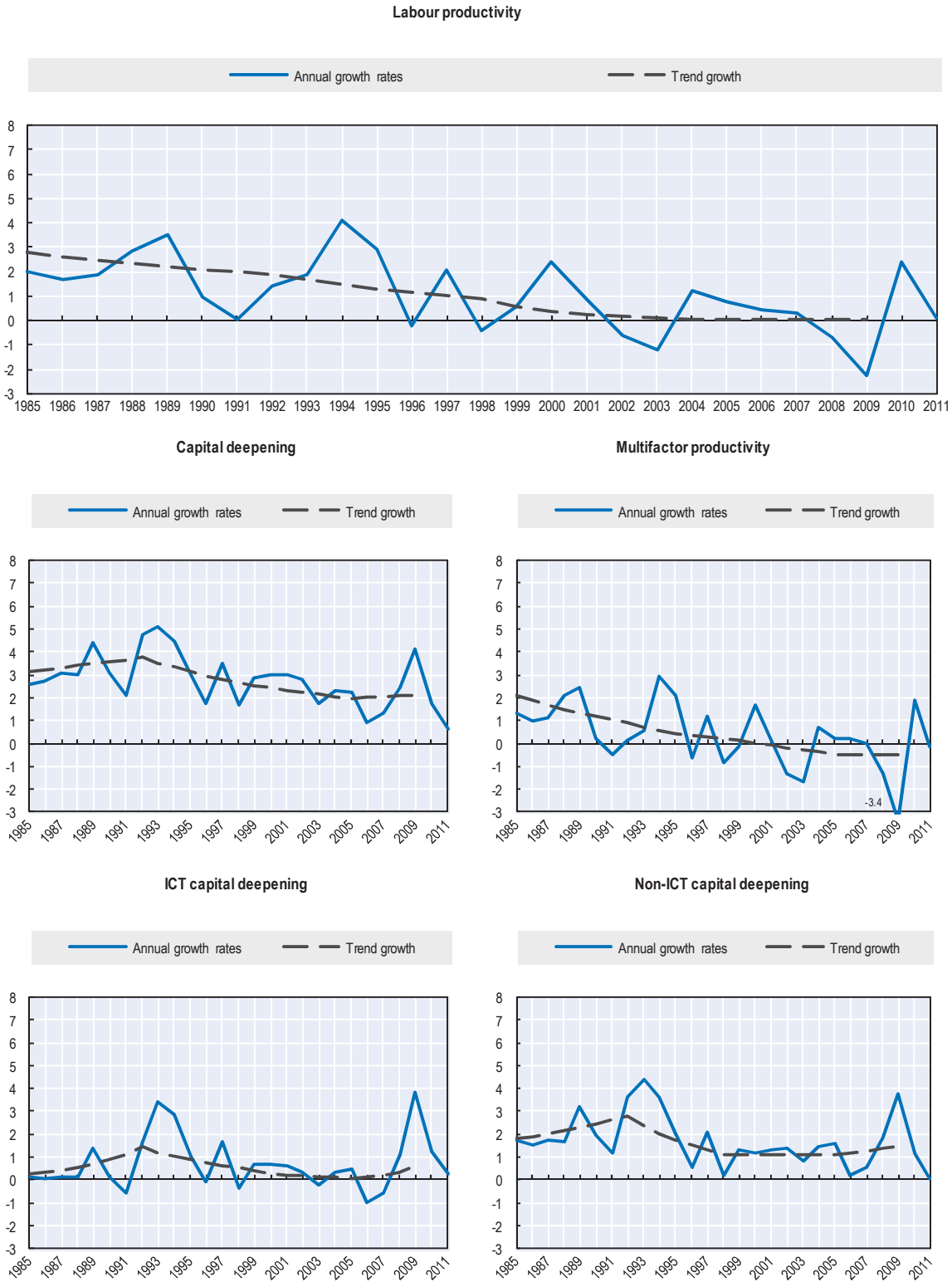
Total economy, percentage change at annual rates



StatLink http://dx.doi.org/10.1787/888932936921

Figure 5.5. Labour productivity growth trend and its components, Italy

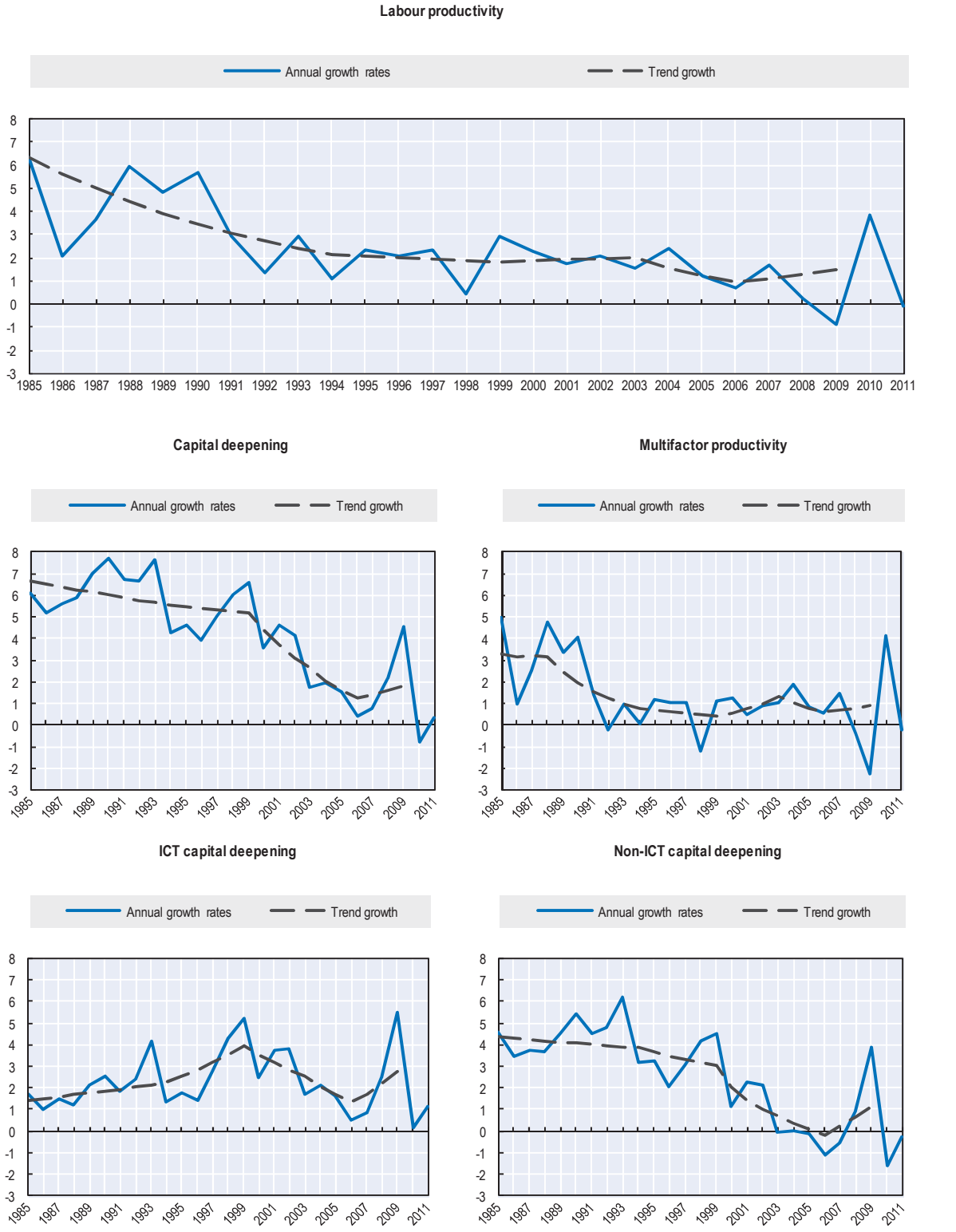
Total economy, percentage change at annual rates



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Figure 5.6. Labour productivity growth trend and its components, Japan

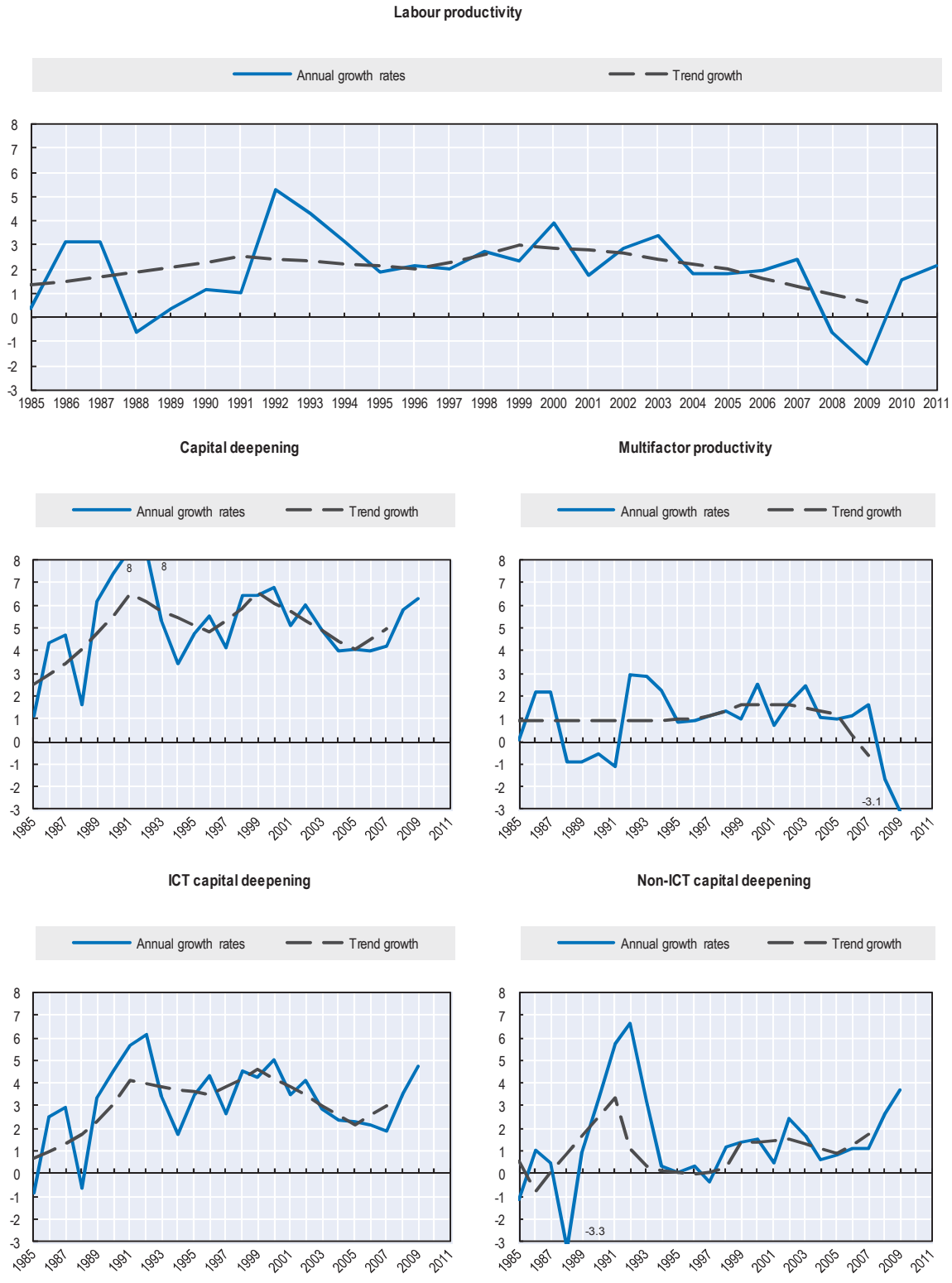
Total economy, percentage change at annual rates



StatLink http://dx.doi.org/10.1787/888932936959

Figure 5.7. Labour productivity growth trend and its components, United Kingdom

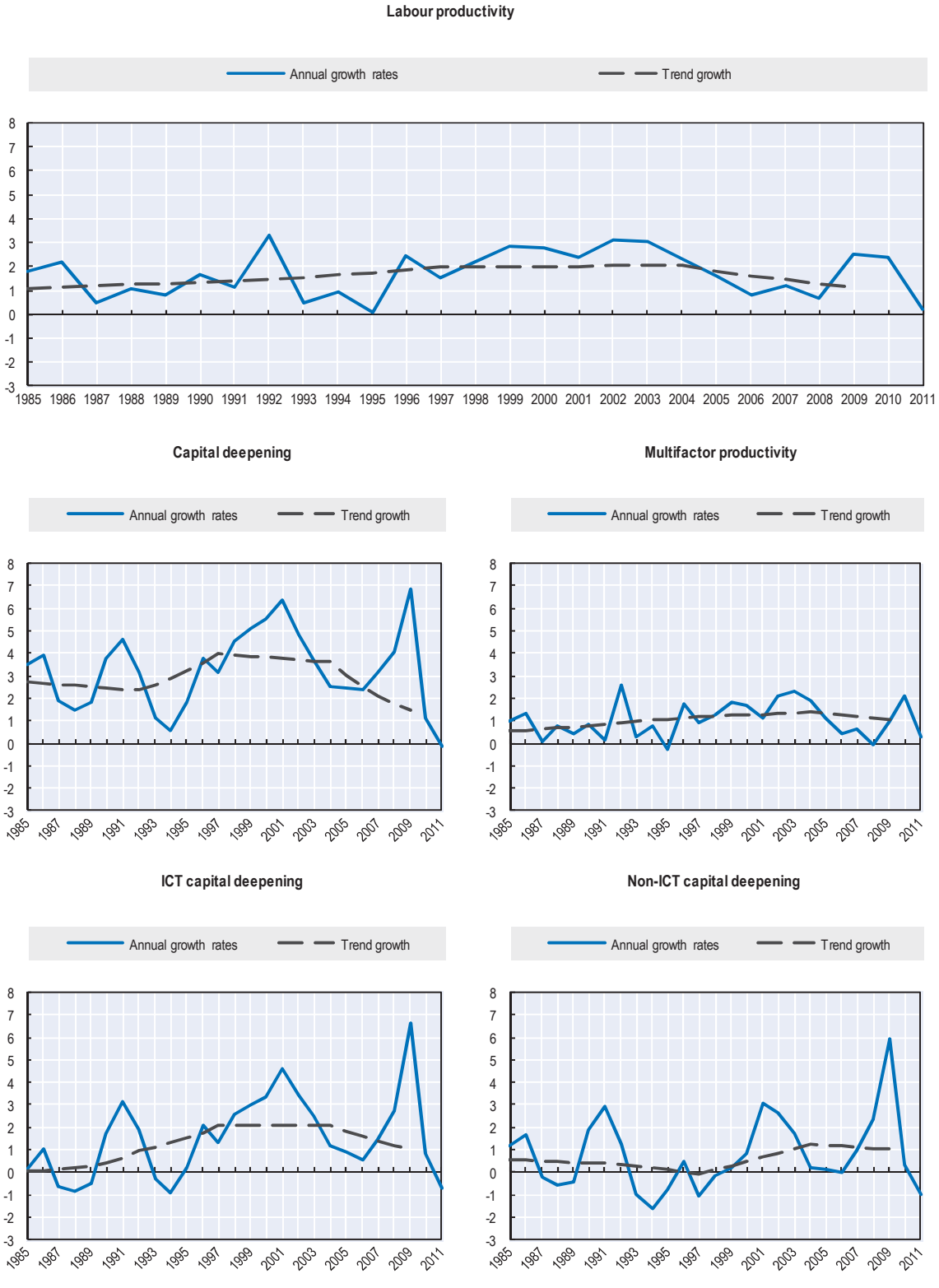
Total economy, percentage change at annual rates



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Figure 5.8. Labour productivity growth trend and its components, United States

Total economy, percentage change at annual rates



StatLink http://dx.doi.org/10.1787/888932936997

Multifactor productivity over the cycle

A number of studies have indicated that multifactor productivity growth (MFP) behaves cyclical, *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 explain this cyclical movement and 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 capture sufficiently 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

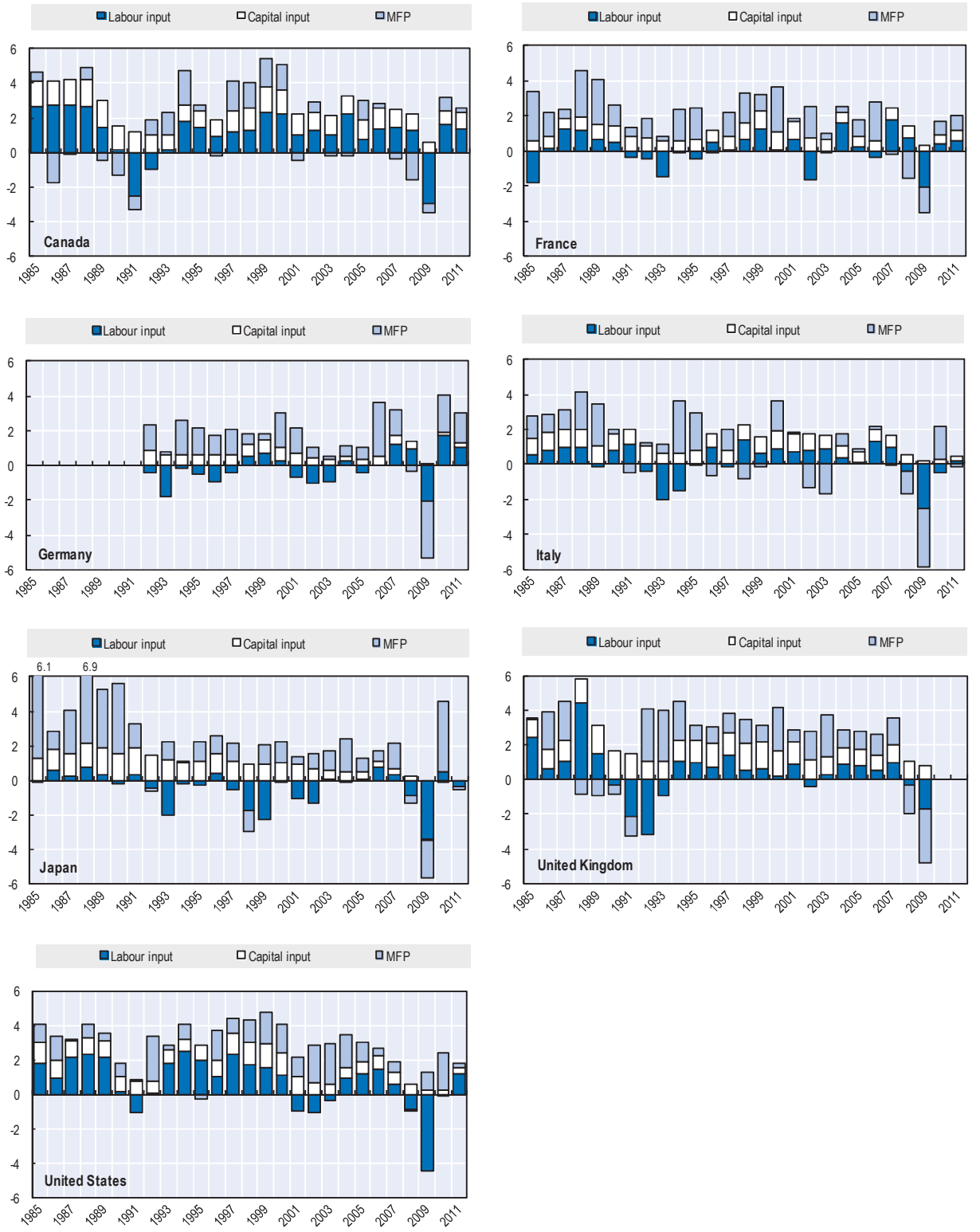
The empirical evidence confirms the cyclical pattern of MFP. In fact, MFP follows GDP growth very closely, not only in terms of the direction but also in terms of the size of the change. While the contribution of labour fluctuated relatively strongly for most G7 countries, up to 2007, adjustments in 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. Hence, although investment is typically relatively volatile, capital stock and capital services estimates are less so.

Sources and further reading

- OECD (2013), OECD Productivity Database (http://dx.doi.org/10.1787/pdtvy-data-en).
- OECD (2001), *Measuring Productivity – OECD Manual*, (http://dx.doi.org/10.1787/9789264194519-en).
- OECD (2009), *Measuring Capital – OECD Manual* (http://dx.doi.org/10.1787/9789264068476-en).
- Wölfl, A. and D. Hajkova (2007), "Measuring Multifactor Productivity Growth", *OECD STI Working Papers* 2007/05 (http://dx.doi.org/10.1787/246367010342).

Figure 5.9. The contribution of labour, capital and MFP over time

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



StatLink http://dx.doi.org/10.1787/888932937016

METHODOLOGICAL ANNEXES

A. The OECD productivity databases PDB and PDBI

B. Measuring hours worked

C. Capital input measures at the OECD

D. ISIC Rev4 - A new classification for industrial statistics

E. Measuring producer prices and productivity in services

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)*. From end of 2013 onwards, the PDB and PDBi incorporate equally data for annual unit labour costs ensuring a coherent methodology for all variables. 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 1970-2012 for 34 OECD member countries, the Russian Federation and some geographical zones. At the industry level data cover the period 1995-2012 for currently 18 countries based on the new ISIC Rev.4 classification;

- **Capital input measures:** Estimates of capital services at the total economy level are available in PDB (for 20 OECD countries) for the period 1985-2011. Net capital stocks by industry are currently available in PDBi for 8 countries and 14 industries according to ISIC Rev4, for the period 1990-2011 for most countries;

- **Labour and capital cost shares:** Data are available for the period 1985-2011 for most countries;

- **Multifactor productivity:** Estimates are available for 20 OECD countries in PDB and 8 countries in the PDBi, for the period 1985-2011;

- **Labour productivity levels:** Data are available up to 2012, for all OECD countries and some geographical zones in the PDB.

- **Unit labour costs (ULC)** and its components "Total labour costs", "Labour compensation per unit of labour input", and the "Self employment ratio". ULC data for the total economy level are available for 27 countries and ULC by ISIC Rev.4 economic activity for 18 countries. Data are available for the period 1995-2012 for most of the countries covered, with longer time series available for the total economy for Australia (1985), Canada (1970), Denmark (1966), Finland (1975), France (1950), Italy (1980) and Norway (1970).

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 Gross Domestic Product, 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 the Russian Federation 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 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. The investment series by type of asset are sourced from national statistical offices.

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 GDP at constant prices. 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*.

Cost shares of inputs

The total cost of inputs is the sum of the labour input cost and the cost of capital services. The 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

$s_L^t \equiv \frac{w^t L^t}{C^t}$ for labour input and

$s_S^t \equiv \frac{\sum_{i=1}^{7} u_i^t K_i^t}{C^t}$ 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 may prevail between the whole economy estimates and those given in the PDB.

The PDBi currently provides productivity estimates for 14 different industries (activities) each defined in accordance with the International Standard Industry Classification (ISIC) Rev.4. As the availability of data improves over time (and as countries move towards ISIC Rev 4), the coverage of industries and countries included in the PDBi will improve,.

Moreover, from the end of 2013 onwards, the PDBi is conceived in a dynamic approach. Updated data for labour productivity and ULCs are made available for the SNA main activities once updated data are available from the *OECD Annual National Accounts database* and the Employment outlook. More detailed coverage is then added on a continuous basis following the updates in the OECD STAN *Database*. The aim of this approach is to allow timely data for labour productivity and ULCs for the total economy level and main economic activities for a large range of countries.

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).

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 is generally only available for total capital. Hence, the PDBi estimates harmonised measure of net capital stock, which cannot take account of differences in relative productivity of different types of assets, though. 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 value-added at constant

prices, L_i^t the labour input from the OECD STAN database, and K_i^t the capital input computed as described above.

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 data on unit labour costs and its components.

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).

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. This assumption may be more or less valid across different countries and economic activities. For Switzerland and Iceland, data is not available to perform the adjustment.

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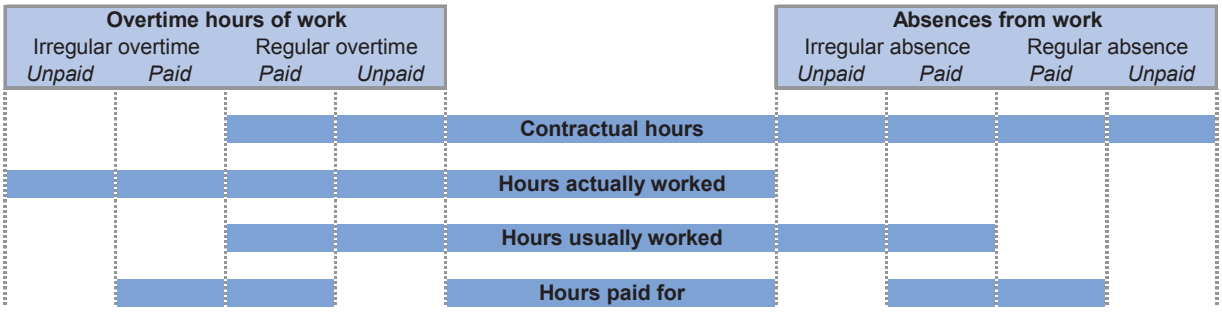
Annex B. Measuring hours worked

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:

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.

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.

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 21 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, Luxembourg, the Netherlands, Norway, the Slovak Republic, Slovenia, Spain, Sweden, and Switzerland. ANA based hours worked for Austria refer to jobs.

- For 14 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, Mexico, New Zealand, Poland, Portugal, the Russian Federation, Turkey, the United Kingdom and the United States.

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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.

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 and the united States which follow 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 *OECD Annual National Accounts Database* contains measures of net and/or gross capital stocks.

Table C.1. Asset and industry breakdown 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.[3] 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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1 For more information on capital measures and their uses see OECD (2001, 2009) and Schreyer (2004).

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

3 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.

Annex D. ISIC Rev.4 – a new classification for industrial statistics

The 4th revision of the International Standard Industrial Classification (ISIC Rev4)

In 2008, the United Nations Statistical Division (UNSD) released the 4th revision of the International Standard Industrial Classification for All Economic Activities (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 (Nomenclature statistique des activités économiques dans la Communauté européenne), 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 (http://unstats.un.org/unsd/cr/registry/isic-4.asp). Basically, ISIC Rev. 4 consists of more Sections, Divisions, Groups and Classes than its predecessors (see Table D1.) and better distinguishes service activities.

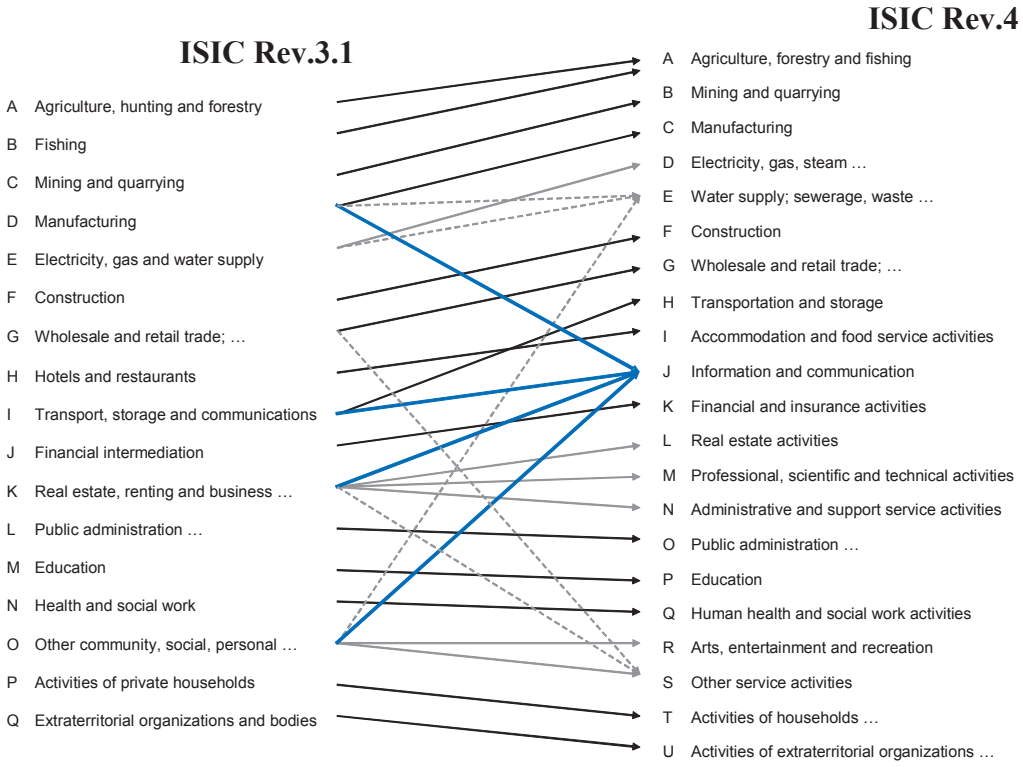
Table D.1. Simple comparison of categories in ISIC Rev.3, ISIC Rev.3.1 and ISIC Rev.4

	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.

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. 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).

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.

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

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

Description	ISIC Rev.4	
TOTAL	**01-99**	x
AGRICULTURE, HUNTING, FORESTRY AND FISHING	**01-03**	x
AGRICULTURE, HUNTING AND FORESTRY	01-02	o
CROP AND ANIMAL PRODUCTION, HUNTING AND RELATED SERVICE ACTIVITIES	01	o
FORESTRY AND LOGGING	02	o
FISHING, FISH HATCHERIES, FISH FARMS AND RELATED SERVICES	03	o
INDUSTRY INCLUDING ENERGY	**05-39**	x
MINING AND QUARRYING	**05-09**	x
MINING AND QUARRYING OF ENERGY PRODUCING MATERIALS	05-06	
MINING AND QUARRYING EXCEPT ENERGY PRODUCING MATERIALS	07-09	
MANUFACTURING	**10-33**	x
FOOD PRODUCTS, BEVERAGES AND TOBACCO	10-12	x
....FOOD PRODUCTS AND BEVERAGES	10-11	
.....FOOD PRODUCTS	10	
.....BEVERAGES	11	
....TOBACCO PRODUCTS	12	
TEXTILES, WEARING APPAREL, LEATHER AND RELATED PRODUCTS	13-15	x
....TEXTILES AND WEARING APPAREL	13-14	
.....TEXTILES	13	
.....WEARING APPAREL	14	
....LEATHER AND RELATED PRODUCTS	15	
WOOD AND PAPER PRODUCTS, AND PRINTING	16-18	x
....WOOD AND PRODUCTS OF WOOD AND CORK, EXCEPT FURNITURE	16	o
....PAPER AND PAPER PRODUCTS	17	o
....PRINTING AND REPRODUCTION OF RECORDED MEDIA	18	o
CHEMICALS, RUBBER, PLASTICS, FUEL AND OTHER NON-METALLIC MINERAL PRODUCTS	19-23	
....COKE AND REFINED PETROLEUM PRODUCTS	19	x
....CHEMICAL AND PHARMACEUTICAL PRODUCTS	20-21	
.....CHEMICALS AND CHEMICAL PRODUCTS	20	x
.....BASIC PHARMACEUTICAL PRODUCTS AND PHARMACEUTICAL PREPARATIONS	21	x
....RUBBER, PLASTICS AND OTHER NON-METALLIC MINERAL PRODUCTS	22-23	x
.....RUBBER AND PLASTICS PRODUCTS	22	o
.....OTHER NON-METALLIC MINERAL PRODUCTS	23	o
BASIC METALS AND FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	24-25	x
....BASIC METALS	24	o
.....IRON AND STEEL	241+2431	
.....NON-FERROUS METALS	242+2432	
....FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENT	25	o
MACHINERY AND EQUIPMENT	**26-28**	
....COMPUTER, ELECTRONIC AND OPTICAL PRODUCTS	26	x
.....COMPUTERS AND PERIPHERAL EQUIPMENT	262	
.....ELECTRONIC AND OPTICAL PRODUCTS AND SCIENTIFIC INSTRUMENTS	26X	
....ELECTRICAL EQUIPMENT	27	x
....MACHINERY AND EQUIPMENT N.E.C.	28	x
TRANSPORT EQUIPMENT	29-30	x
....MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	29	o
....OTHER TRANSPORT EQUIPMENT	30	o
.....BUILDING OF SHIPS AND BOATS	301	
.....AIR AND SPACECRAFT AND RELATED MACHINERY	303	
.....MILITARY FIGHTING VEHICLES	304	
.....RAILROAD EQUIPMENT AND TRANSPORT EQUIPMENT N.E.C.	302+309	
FURNITURE; OTHER MANUFACTURING; REPAIR AND INSTALLATION	31-33	x
....FURNITURE, OTHER MANUFACTURING	31-32	o
....REPAIR AND INSTALLATION OF MACHINERY AND EQUIPMENT	33	o
ELECTRICITY, GAS, STEAM, AIR CONDITIONING AND WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	**35-39**	
ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	35	x
WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	36-39	x
....WATER COLLECTION, TREATMENT AND SUPPLY	36	o
....SEWERAGE, REMEDIATION ACTIVITIES AND WASTE MANAGEMENT	37-39	o
CONSTRUCTION	**41-43**	x

Table D.3. cont'd. STAN ISIC Rev.4 industry list

Description	ISIC Rev.4	
WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES; TRANSPORTATION AND STORAGE; ACCOMMODATION AND FOOD SERVICE ACTIVITIES	**45-56**	x
WHOLESALE AND RETAIL TRADE, REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	45-47	x
....WHOLESALE, RETAIL AND REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	45	o
....WHOLESALE TRADE - EXCEPT MOTOR VEHICLES	46	o
....RETAIL TRADE - EXCEPT MOTOR VEHICLES	47	o
TRANSPORTATION AND STORAGE	49-53	x
....LAND TRANSPORT AND TRANSPORT VIA PIPELINES	49	o
....WATER TRANSPORT	50	o
....AIR TRANSPORT	51	o
....WAREHOUSING AND SUPPORT ACTIVITIES FOR TRANSPORTATION	52	o
....POSTAL AND COURIER ACTIVITIES	53	o
ACCOMMODATION AND FOOD SERVICE ACTIVITIES	55-56	x
INFORMATION AND COMMUNICATION	**58-63**	x
PUBLISHING, AUDIOVISUAL AND BROADCASTING ACTIVITIES	58-60	x
....PUBLISHING ACTIVITIES	58	o
....AUDIOVISUAL AND BROADCASTING ACTIVITIES	59-60	o
TELECOMMUNICATIONS	61	x
IT AND OTHER INFORMATION SERVICES	62-63	x
FINANCIAL AND INSURANCE ACTIVITIES	**64-66**	x
FINANCIAL SERVICE ACTIVITIES, EXCEPT INSURANCE AND PENSION FUNDING	64	o
INSURANCE AND PENSION FUNDING, EXCEPT COMPULSORY SOCIAL SECURITY	65	o
ACTIVITIES AUXILIARY TO FINANCIAL SERVICE AND INSURANCE ACTIVITIES	66	o
REAL ESTATE, RENTING AND BUSINESS ACTIVITIES	**68-82**	
REAL ESTATE ACTIVITIES	**68**	x
PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES; ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	**69-82**	x
PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	69-75	x
....LEGAL AND ACCOUNTING ACTIVITIES; HEAD OFFICES; MANAGEMENT CONSULTANCY; ARCHITECTURE AND ENGINEERING ACTIVITIES; TECHNICAL TESTING AND ANALYSIS	69-71	x
.....LEGAL AND ACCOUNTING ACTIVITIES; HEAD OFFICES; MANAGEMENT CONSULTANCY	69-70	o
.....ARCHITECTURAL AND ENGINEERING ACTIVITIES; TECHNICAL TESTING AND ANALYSIS	71	o
....SCIENTIFIC RESEARCH AND DEVELOPMENT	72	x
ADVERTISING, MARKET RESEARCH; OTHER PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	73-75	x
....ADVERTISING AND MARKET RESEARCH	73	o
....OTHER PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES; VETERINARY ACTIVITIES	74-75	o
ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	**77-82**	x
RENTAL AND LEASING ACTIVITIES	77	o
EMPLOYMENT ACTIVITIES	78	o
TRAVEL AGENCY, TOUR OPERATOR, RESERVATION SERVICE AND RELATED ACTIVITIES	79	o
SECURITY AND INVESTIGATION; SERVICES TO BUILDINGS AND LANDSCAPE ACTIVITIES; OFFICE ADMINISTRATION, OFFICE SUPPORT AND OTHER BUSINESS SUPPORT	80-82	o
COMMUNITY, SOCIAL AND PERSONAL SERVICES	**84-99**	
PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY; EDUCATION; HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	**84-88**	x
PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	84	x
EDUCATION	85	x
HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	86-88	x
....HUMAN HEALTH ACTIVITIES	86	x
....RESIDENTIAL CARE AND SOCIAL WORK ACTIVITIES	87-88	x
ARTS, ENTERTAINMENT, REPAIR OF HOUSEHOLD GOODS AND OTHER SERVICES	**90-99**	x
ARTS, ENTERTAINMENT AND RECREATION	90-93	x
....CREATIVE, ARTS AND ENTERTAINMENT ACTIVITIES; LIBRARIES, ARCHIVES, MUSEUMS AND OTHER CULTURAL ACTIVITIES; GAMBLING AND BETTING ACTIVITIES	90-92	o
....SPORTS ACTIVITIES AND AMUSEMENT AND RECREATION ACTIVITIES	93	o
OTHER SERVICE ACTIVITIES	94-96	x
....ACTIVITIES OF MEMBERSHIP ORGANIZATIONS	94	o
....REPAIR OF COMPUTERS AND PERSONAL AND HOUSEHOLD GOODS	95	o
....OTHER PERSONAL SERVICE ACTIVITIES	96	o
ACTIVITIES OF HOUSEHOLDS AS EMPLOYERS; UNDIFFERENTIATED GOODS- AND SERVICES-PRODUCING ACTIVITIES OF HOUSEHOLDS FOR OWN USE	97-98	x
ACTIVITIES OF EXTRATERRITORIAL ORGANIZATIONS AND BODIES	99	x

Note: 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

ISIC Rev. 4		ISIC Rev. 3
TOTAL		**TOTAL**
01-03	**A**	**01-05**
01-02		01-02
01		01
02		02
03		05
05-39	**B-E**	**10-41 + 90**
05-09	**B**	**10-14**
05-06		10-12
07-09		13-14
10-33	**C**	**15-37**
10-12	CA	15-16
10-11		15
12		16
13-15	CB	17-19
13-14		17-18
15		19
16-18	CC	20 + 21-22
16		20
17		21
18		*(22)**
*19-23**	*CD-CG*	*23-25 + 26*
19	CD	23
*20-21**	*CE-CF*	*24*
22-23	CG	25 + 26
22		25
23		26
24-25	CH	27-28
24		27
25		28
*26-28**	*CI-CK*	*29-33*
*26-27**	*CI-CJ*	*30-33*
26	CI	30 + 32 + 33
27	CJ	31
28	CK	29
29-30	CL	34-35
29		34
30		35
31-33	CM	36
SNA A10 list		

ISIC Rev. 4		ISIC Rev. 3
*35-39**	*D-E*	*37 + 40-41 + 90*
35	**D**	**40**
36-39	**E**	**37 + 41 + 90**
36		41
37-39		37 + 90
41-43	**F**	**45**
45-56	**G-I**	**50-55 + 60-63**
45-47	**G**	**50-52**
45		50
46		51
47		52
49-53	**H**	**60-63**
49		60
50		61
51		62
52		63
53		*(64)**
55-56	**I**	**55**
58-63	**J**	*(22, 64, 92)* + 72*
58-60	JA	*(22, 92)**
61	JB	*(64)**
62-63	JC	72
64-66	**K**	**65-67**
64		65
65		66
66		67
*68-82**	*L-N*	*70-74*
68	**L**	**70**
69-82	**M-N**	**71-74**
*84-99**	*O-U*	*75-99*
84-88	**O-Q**	**75 + 80 + 85**
84	**O**	**75**
85	**P**	**80**
86-88	**Q**	**85**
90-99	**R-U**	**91 + 92 + 93+ 95**
90-93	**R**	**92**
94-96	**S**	**91 + 93**
97-98	**T**	**95**
99	**U**	**99**

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*

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.

[4] See the official correspondence between ISIC Rev.4 and ISIC Rev.3.1 at the United Nations Website: http://unstats.un.org/unsd/cr/registry/regso.asp?Ci=61&Lg=1.

Annex E. Measuring producer prices and productivity growth in services

The price index-productivity link

Empirical evidence presented above points to relatively low productivity growth rates over long periods for several service industries. This is true even for some business sector services for which rapid technological change and increasing competitive pressures may argue for an opposite trend. However, for some services, this evidence may reflect an under-estimation of service productivity growth, linked to difficulties measuring price indices, and hence volume series of services value added (Wölfl, 2003). While problems estimating an appropriate price index may arise in several manufacturing industries, there are reasons that measurement problems may be stronger in the service sector than in manufacturing.

Because of the difficulty in measuring SPPIs, different methods are used in OECD countries to compute volume series of value added. Moreover, even if producer price indices can be computed, different methods are typically used depending on the type of the service under consideration as well as data and availability. Over the past ten years, much progress has been made by OECD countries in measuring services producer price indices (SPPIs), in particular in business sector services. This has significantly increased the availability of SPPIs and has improved their comparability across countries. However, even where SPPIs have been computed, they are based on different pricing methods across industries and countries, potentially affecting comparability of productivity growth estimates.

General measurement issues when tracking price changes for services

Measurement of price changes in services is not trivial, in large part complicated by the way businesses provide and charge for services, by problems identifying quality change, through the provision of bundled services, and by the difficulty identifying separate price indices per end-user.

Pricing methods

The way businesses provide and charge for services can make it difficult for statisticians to observe prices for a repeated service transaction. As such, standard price measurement methods designed for repeated products can be difficult to apply for services. In practice, price statisticians are then obliged to use a number of methods to track price changes in services, with the methods typically varying across countries, depending on the pricing mechanisms used, and also on the producing industry or product.

However, over the last ten years, considerable efforts have been made by price statisticians to provide a better understanding of the variety of methods used by countries to facilitate international comparability and hence improve matters. The three main classes of pricing methods[5] are:

- **Price of final service output:** Price observations refer directly to specified service outputs and result in prices of final services output; examples are: direct use of prices of repeated services, contract pricing, unit value, percentage fee, component pricing and model pricing.

- **Time-based prices:** price observations refer to the time used for the provision of the service rather than to the service itself. Several time-based methods can be distinguished: hourly charge out rate, hourly list rate, wage rates and working days.

- **Margin prices:** price observations refer to the price that would have to be paid by the service provider for the good or service they provided and the price paid by the final consumer.

It is important to bear in mind that how firms in a given sector charge for their products can impact considerably on the reliability of measured prices indices of the index for the industry. For example, when price indices are either based on a specified service output or are time-based, results of pricing methods can have a different interpretation. In the first case, the volume of output is, in principle, correctly measured (albeit depending on how well price-determining factors are specified). However, this is not necessarily the case for time-based methods, particularly whenever quality changes have occurred, or productivity changes impact on the input (hours spent). Indeed, for pricing based on working time, the price of the service finally provided is not identified. Rather, service provision is assumed to correspond directly or predominantly to different types of chargeable hours, actually worked for a client. The validity of the method depends on how realistic this assumption is, i.e., to what extent the quantity and quality of one chargeable hour's work remains the same in consecutive periods.

Quality changes

While in principle, the same quality adjustment methods can be used for goods and services, in practice, for services, fewer options are available and much more difficult to implement (Loranger, 2012). First, over time, the way in which a certain service is provided may change (e.g. a service is delivered in less time or by a better qualified employee). Second, the structure of services that are provided in a certain service industry will vary from one period to the next. Third, many service products are unique. In this case, prices cannot be observed over multiple periods requiring assumptions about quality changes that are mostly based on convention rather than reflecting "reality"; typically, constant quality is assumed.

Treatment of bundled services

Services are frequently (and increasingly) bundled with either another service or a good. This is particularly true in the case of Transport and storage and Information and communication services. Two main alternatives are commonly used: *i)* breaking down the bundle into components and price these separately, or *ii)* pricing bundled services together as a group. Each of these alternatives poses difficulties that are likely to imply biased measure of prices. A particular concern is keeping the bundle constant over time either through quality adjustment or regular updating of the selected bundled services. The ability to reflect the non monetary benefits of the bundle in the price index may also be a complicated task. Finally, the treatment of bundled services may lead to a heavy calculation and response burden, in particular where bundled components are priced separately.

Decomposition by type of end-users

Breaking down SPPIs by type of user is an important requirement for the national accounts when price discrimination occurs which feeds through into heterogeneous price changes. Currently, decompositions of SPPI by type of end-users focus mainly on Business to Business (BtoB), Business to Consumers (BtoC) and Business to All (BtoAll) transactions.

The potential role of price measurement for measured productivity growth

Table 1 provides some indication of the potential effects on volume series of value added that may result from using different deflators for two services "Telecommunication services", on the one hand,

and "legal and accounting services", on the other.[6] These services provide two interesting examples of how price index measurement could impact on measured productivity growth.[7] They are *i)* characterised by very different factors of service output and the way they are provided, and *ii)* by different availability of producer price indices and underlying methods.

The table provides evidence for France and the United States, for which time series data are available for a large range of input and output variables, such that several different price and volume indices can be derived. The different deflators compared are those that are commonly used in countries either directly for a deflator of value added or as a reference for the computation of producer price indices:

- *Producer Price Indices (SPPI).* From a methodological point of view, using PPIs, especially in the form of a *price of final service output* as defined above, would represent the most appropriate way to deflate value added if the aim is the computation of productivity growth. Ideally, SPPIs would exist for both, gross output and intermediate inputs used in producing the good or service under consideration, and SPPIs would adjust for quality changes so that the resulting value added volume series reflect productivity growth changes properly.

- *Consumer Price Indices (CPI),* for goods or services that are close to the services analysed, or the *CPI All items*. Using CPI's for deflation may result in measurement biases vis-à-vis SPPIs as they cover only household consumption and are not valued in basic prices. This may be particularly relevant for those services where the share of final household consumption in total output is low, and where price changes differ significantly between intermediate (business) and final use (consumption) (Eurostat, 2001).

- *Wage rate indices* per employed person or per hour worked (WRIE, WRIH). The latter can be seen as a proxy for a *time-based producer price index* as defined above. Productivity growth rates based on wage rate indices may underestimate true productivity developments.

Table E1. Average annual growth rates in gross value added per person employed using different deflators of value added, in %

			Base	Wage rate Employment	CPI - All items	CPI - related service	SPPI
France	Telecommunication services	2000-2010	6.37	0.55	2.71	6.32	
		2005-2010	4.73	-2.01	0.22	4.92	8.60
	Legal and accounting services	2000-2010	-0.24		1.17	1.02	
		2005-2010	-1.18	-3.26	-0.88	-1.58	-2.70
United States	Broadcasting & telecommunication	2000-2011	6.82	2.28	1.88	7.41	6.00
		2005-2011	5.64	0.40	0.85	5.67	3.12
	Legal services	2000-2011	-1.60	-0.28	0.53	-1.65	-2.68
		2005-2011	-3.00	-1.13	-0.36	-1.88	-4.12

Note: All results based on double deflation. "Base": value added deflator as given in National Accounts.
Source: OECD STAN database, INSEE, Bureau of Labour Statistics.

The table suggests that the choice of the implicit value added deflator, or the pricing method for computing producer price indices, may matter significantly for measured labour productivity growth. For instance, in telecommunication services, average annual labour productivity growth rates over the 2000-2011 period would differ by between 5 percentage points (United States, both periods) and 10 percentage

points (France, 2005-11) using different deflators. In the case of legal services, the overall variation is with 1 to 4 percentage points lower, but still significant, especially given the generally lower level of productivity growth in this services activity.

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5 A pricing method is a procedure put in place by statisticians to make price data eligible to be entered in an index which is largely determined by the *pricing mechanism* (Fraisse, 2013)

6 This exercise is of a purely hypothetical nature. Its aim is to simulate how value added volume series and hence productivity growth could be affected if different pricing methods were used.

7 In the empirical results presented in Table 1, labour productivity growth has been calculated as real value added per employment and not per hour worked. While hours worked is typically the more appropriate measure of labour input, employment has been chosen here for data availability reasons.

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