# OECD Compendium of Productivity Indicators 2017

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BETTER POLICIES FOR BETTER LIVES

**Please cite this publication as:**
OECD (2017), *OECD Compendium of Productivity Indicators 2017*, OECD Publishing, Paris.
*http://dx.doi.org/10.1787/pdtvy-2017-en*

ISBN 978-92-64-27325-2 (print)
ISBN 978-92-64-27326-9 (PDF)
ISBN 978-92-64-27456-3 (epub)

ISSN 2225-2118 (print)
ISSN 2225-2126 (PDF)



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# *Foreword*

*The OECD* Compendium of Productivity Indicators *presents a broad overview of recent and longer term trends in productivity levels and growth across OECD countries and key partner economies. It highlights 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 multifactor productivity to economic growth. It looks at the contribution of individual industries or sectors as well as the role of firm size in productivity performance. It explores the link between productivity, trade and international competitiveness, and analyses trends as compared with cyclical patterns in labour and multifactor productivity growth.*

*The* 2017 OECD Compendium of Productivity Indicators *was prepared in the OECD Statistics Directorate by Frédéric Parrot and María Belén Zinni, and edited by Nadim Ahmad and Mariarosa Lunati. The contribution of Gueram Sargsyan is gratefully acknowledged. The publication has benefited from comments from the Office of the Secretary-General, the Economics Department and the Directorate for Science, Technology and Innovation.*

# *Table of contents*

## Tables



## Figures

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# Executive summary

## Long-term trends

Eight years after the global financial crisis, GDP growth remains below pre-crisis rates in most countries, leading to concerns that the global economy has been stuck in a "low-growth trap", with the post-crisis period being described by some analysts as the "decade of lost growth". A striking feature of the post-crisis period has been a continuation of a long-term slowdown in productivity growth that has gone hand-in-hand with weak levels of investment. This matters because, as an important driver of growth, productivity has also been an important driver of improvements in living standards primarily through higher wages. But significant declines in labour's share of income and a decoupling of labour productivity growth and real wage growth in many economies over the last two to three decades suggest that stylised assumptions about the relationship between labour productivity growth and wage growth may no longer hold, raising concerns about inequalities: labour income tends to play a larger role as a source of income among lower-income households and, so, a decline in the labour share may widen overall income distribution.

## Shorter-term trends

However, while the evidence points to a long-term decline in labour's share of income in most countries, it is less clear that this has continued in the post-crisis period. Although this may only be temporary, in some countries the share has stabilised or indeed shown tentative signs of improvement. This, to some extent, is consistent with slowing rates of investment and indeed the counter-cyclical nature of labour income shares, which suggests that care is needed in drawing conclusions as a full analysis of trends in the post-crisis period would require a peak-to-peak time series to control for cyclical effects. In some of these economies where labour income shares stabilised, real labour compensation growth and, albeit slow, productivity growth have moved in parallel and helped to stem or, in some cases, reverse pre-crisis trends that saw a decoupling between the two measures. But in many others, including some where labour income shares have stabilised, decoupling (with labour compensation deflated by consumer price inflation) occurred in the post-crisis period, which suggests that the current stabilisation in labour income shares may not necessarily arrest concerns about rising inequalities.

Another striking feature of the post-crisis period, which has implications for longer-term growth, relates to the contribution of labour utilisation in driving GDP per capita growth; indeed in some economies it has been the primary driver of growth.

## Key findings

The overall picture points to slowing rates of productivity growth in most countries, with rates trending down since early 2000s in Canada, the United Kingdom and the United States and even earlier in France, Germany, Italy and Japan.

The post-crisis period has been characterised by a significant increase in the contribution of labour utilisation to GDP per capita growth, which has been an important driver of growth in some economies, notably the United Kingdom and the United States. This compares starkly to the pre-crisis period where growth in labour utilisation played only a marginal role in most countries.

Most of the limited growth in labour productivity reflected growth in multifactor productivity (MFP) with the contribution from capital deepening slowing in many countries.

In general, productivity growth in manufacturing continues to outpace productivity growth in services. Within the business services sector, the key specialised services activity driving productivity growth varied by country, for example, with trade, food, accommodation and transport services driving productivity growth in business services in the Baltic States and information and communication services accounting for a significant share of productivity growth in business services in Denmark and Israel.

In most countries, gaps in labour productivity levels between micro and, to a lesser extent, SMEs and large firms, are relatively high. This is particularly true for micro firms in both manufacturing and business services sectors. However, in some countries and sectors, smaller enterprises, in terms of persons employed, can outperform larger firms, particularly in the business services sector.

Trade openness is strongly associated with economic growth in many countries, particularly in Central and Eastern European economies. However, the size of the contribution of trade to growth is also dependent on the nature of participation in global value chains.

Investment in intellectual property products (IPP) has been increasing over the last fifteen years, often at a faster pace than investment in traditional physical capital. In Sweden, for example, almost 30% of investment was in IPP, and the share of knowledge-based assets, which includes organisational capital, brand equity and design that are currently outside of the System of National Accounts (SNA) asset boundary, will be even higher.

In sectors less exposed to direct international competition, notably the services sector, unit labour costs (ULC) in some countries outpaced manufacturing ULC. However, as many of these services are used as upstream inputs to manufacturers, overall international competitiveness could be affected.

## Post-crisis period

Post-crisis trends point to a slowdown in the pace of GDP per capita convergence in countries with initially lower GDP per capita.

In most OECD countries, labour productivity growth has continued to slow in the post-crisis period, and this has been broadly spread across sectors but declines were particularly significant in manufacturing, information and communication services and finance and insurance activities. MFP growth has also fallen sharply in many countries.

The contribution of capital has also slowed in most countries, partly reflecting the sluggish recovery of investment, in particular, in tangible assets. Although investment in intellectual property products has been more resilient since the crisis, this too has slowed compared with pre-crisis rates.

In many economies, post-crisis labour productivity growth was broadly similar in SMEs and large enterprises in manufacturing. In the business services sector the picture has been more varied, with productivity growth in SMEs outperforming large firms in many countries, although showing a slower pace in employment growth compared with large firms.

The corollary of slowing productivity growth in most countries has been relatively subdued wage growth, as firms sought to maintain competitiveness.

# *Reader's guide*

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.

This *OECD Compendium of Productivity Indicators* presents a broad overview of recent and longer term trends in productivity in OECD countries, providing insights on:

- international comparisons of income per capita and the role of labour productivity;
- the role played by labour and capital inputs and multifactor productivity in driving economic growth;
- the contribution of individual industries or sectors to aggregate labour productivity growth;
- differences in productivity across enterprise size classes;
- the links between productivity and international competitiveness;
- long-term trends in productivity growth in major advanced economies.

## Measures of productivity

There are many different productivity measures. The key distinguishing factor reflects the policy focus, albeit data availability can also play an important role.

***Labour productivity***, measured as Gross Domestic Product (GDP) per hour worked, is one of the most widely used measures of productivity at country level. Productivity based on hours worked better captures the use of the labour input than productivity based on numbers of persons employed (head counts). Generally, the source for total hours worked is the *OECD National Accounts Statistics* (database), although other sources are necessarily used where data are lacking. Work continues at the national level to develop the necessary source data but despite the progress and ongoing efforts, for some countries, 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 the ***capital input*** in the production process, 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, provided by capital goods to the production process, are known as capital services. Capital services provided by

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.

each type of capital good are estimated by the rate of change of the productive capital stock, taking into account wear and tear, retirements and other sources of reduction in the productive capacity of fixed capital goods. The overall volume measure of capital services (i.e. capital input) is computed by aggregating the volume change of capital services of all individual assets using asset specific user cost shares as weights. No conceptual distinction is made between user costs of capital and rental prices of capital. In principle, the rental price is that price that 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: the user costs of capital. In other words, the user cost of capital reflects the amount that the owner of a capital good would charge if he rented out the capital good under competitive conditions.

After computing the contributions of labour and capital inputs to output growth, the so-called ***multifactor productivity*** can be derived. It measures the residual growth that cannot be explained by changes in labour and capital inputs and represents the efficiency of the combined use of labour and capital in the production process. Multifactor productivity is often perceived as a pure measure of technical change, but, in practice, it should be interpreted in a broader sense that partly reflects the way capital and labour inputs are measured. Changes in multifactor productivity reflect also the effects of changes in management practices, brand names, organisational change, general knowledge, network effects, spillovers from one production factor to another, adjustment costs, economies of scale, the effects of imperfect competition and measurement errors.

Gains in productivity also influence the development of ***unit labour costs***, one of the most commonly used indicators to assess a country's international competitiveness. However, the ability of unit labour costs to inform policies targeting international competitiveness may be limited. This relates to the increasing need to take into account the growing international fragmentation of production, the effects of which on competitiveness may not be captured sufficiently by unit labour costs.

### *The OECD Productivity Statistics*

The indicators presented in this publication are drawn from the *OECD Productivity Statistics* (database), which provides a consistent set of annual estimates of labour, capital and multifactor productivity growth, unit labour costs and many other related indicators as a tool to analyse the drivers of economic growth in OECD member countries and emerging economies. The database includes the following indicators:

- GDP per capita and labour productivity levels
- Growth in labour productivity
- Measures of labour input, such as total hours worked and total persons employed
- Measures of capital input, as an aggregate and by type of capital good
- Share of labour costs in the total cost of production
- Multifactor productivity growth
- Unit labour costs and labour compensation

Chapter 6 presents the definition of each indicator and the computation method.

## Country, time and industry coverage

Most countries covered in this publication produce their national accounts on the basis of the System of National Accounts 2008 (2008 SNA), which recognised, among other changes, that expenditures on research and development be treated as investment (Chapter 6). However, at the time of publication the indicators computed for Chile and Colombia reflect the 1993 SNA standards, meaning that some care is needed in comparing across countries. For the Russian Federation, the indicators reflect a mix between the two systems, 1993 SNA (until 2013) and 2008 SNA (from 2014 onwards).

The *OECD Compendium of Productivity Indicators* includes data for the following countries depending on data availability. The figures in this publication use ISO codes for country names as listed below.

| | | | |
|---|---|---|---|
| AUS | Australia | IRL | Ireland |
| AUT | Austria | ISL | Iceland |
| BEL | Belgium | ISR | Israel |
| BRA | Brazil | ITA | Italy |
| CAN | Canada | JPN | Japan |
| CHE | Switzerland | KOR | Korea |
| CHL | Chile | LTU | Lithuania |
| CHN | China (People's Republic of) | LUX | Luxembourg |
| COL | Colombia | LVA | Latvia |
| CRI | Costa Rica | MEX | Mexico |
| CZE | Czech Republic | NLD | Netherlands |
| DEU | Germany | NOR | Norway |
| DNK | Denmark | NZL | New Zealand |
| ESP | Spain | POL | Poland |
| EST | Estonia | PRT | Portugal |
| FIN | Finland | RUS | Russian Federation |
| FRA | France | SVK | Slovak Republic |
| GBR | United Kingdom | SVN | Slovenia |
| GRC | Greece | SWE | Sweden |
| HUN | Hungary | TUR | Turkey |
| IDN | Indonesia | USA | United States |
| IND | India | ZAF | South Africa |

This publication looks at longer term trends in productivity growth but also at productivity patterns before and after the global crisis. To this end, indicators are typically presented for distinctive time periods: 1995-2015; 2001-15; 2001-07; and 2009-15. For each country, the average value in the different periods only takes into account the years for which data are available for the respective indicator and its components.

Throughout this publication, the sectoral breakdown follows the International Standard Industry Classification of all Economic Activities (ISIC). Indicators by industry are presented according to its latest version, ISIC Rev.4, or the European equivalent, NACE Rev.2 (Nomenclature statistique des activités économiques dans la Communauté européenne).

Data are provided for the total economy and for selected sectors in the "non-agricultural business sector, excluding real estate" (ISIC rev.4-codes B-N excluding L). 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 excluding L – Business sector services, excluding real estate.

Business sector services (ISIC Rev.4 codes G-N, excluding 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 (ISIC 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 also excludes activities that are often provided by non-market producers. This reflects the fact that non-market activities are often measured on a sum-of-costs approach in current prices, with an implicit imputation made for labour productivity growth (usually zero) for volume estimates, together with an assumption of zero net operating surplus. These activities comprise: 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 organisations and bodies.

*Chapter 1*

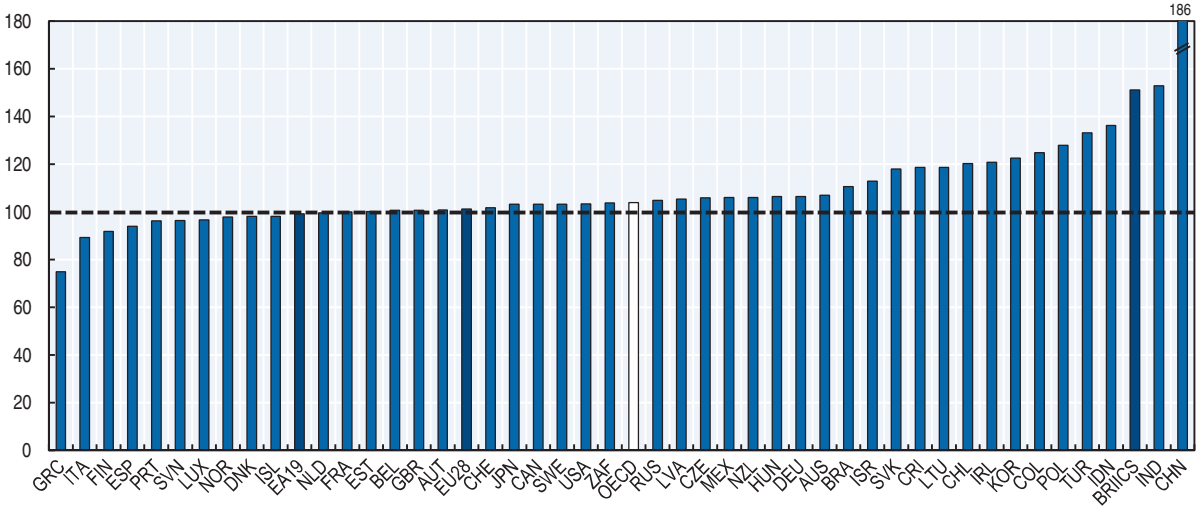
# Recent trends on productivity and post-crisis labour income

## A low growth trap

Eight years after the global financial crisis, GDP per capita remains at pre-crisis levels, or even below, in many economies. In some European economies, including Finland, Italy and Spain, GDP per capita in 2015 (in real terms) was around 10% lower than the level achieved in 2007. Indeed, among OECD countries only a handful, chiefly "catch-up" countries – Chile, Poland, Korea and Turkey – saw a significant improvement on pre-crisis levels and although emerging economies fared much better, growth rates in most have slowed considerably in the post-crisis period. The overall picture points to slowing rates of growth in most countries, compared to the pre-crisis period, and with it fears of many being trapped in a low-growth environment (Figure 1.1), as productivity growth continues its long-term decline in most economies (Figure 1.2).

Figure 1.1. **GDP per capita, national currency, constant prices, 2015**

Indices, 2007 = 100




*Source:* OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

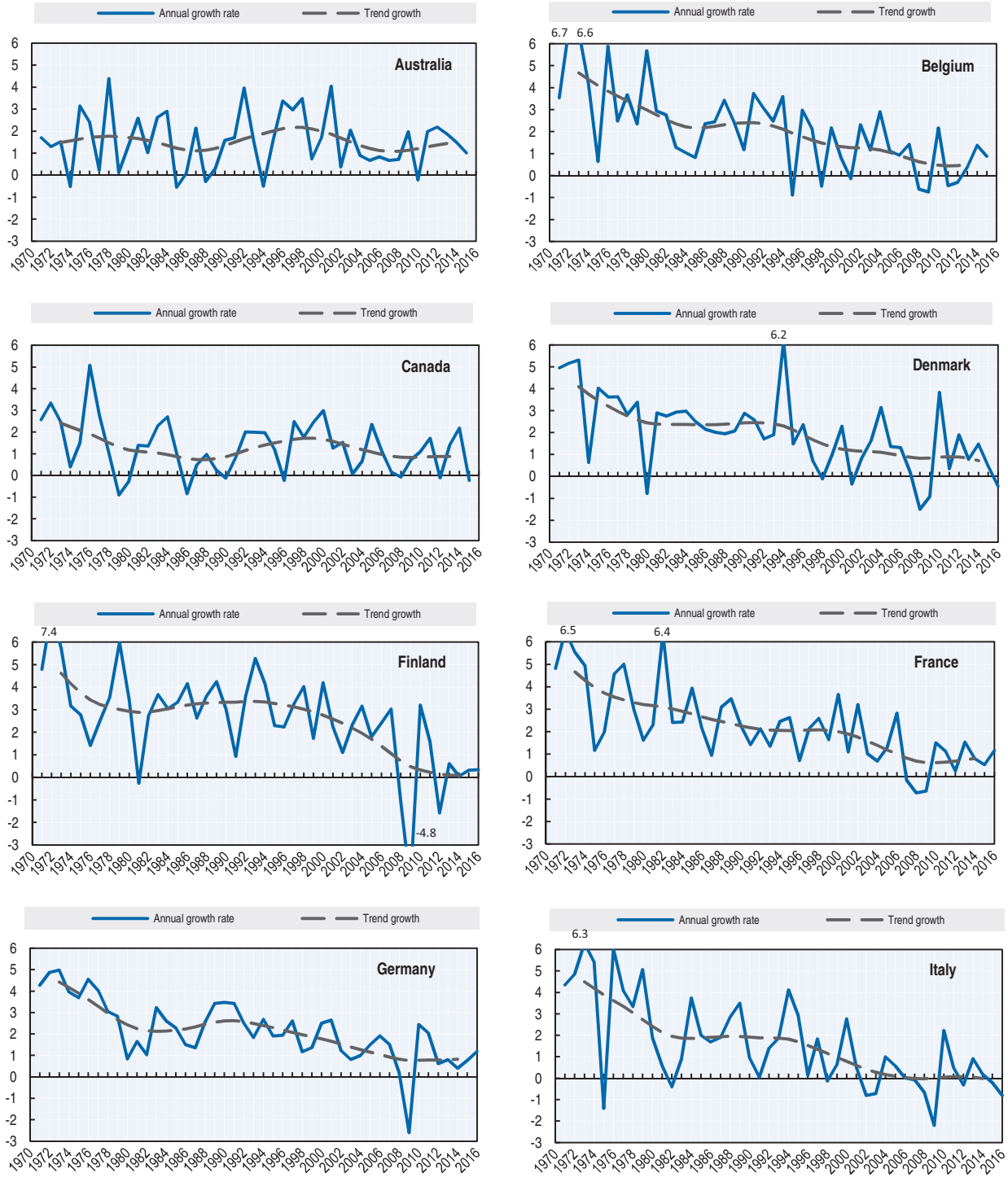
StatLink http://dx.doi.org/10.1787/888933477005

## Labour utilisation a driver of growth in the post-crisis period

In many countries, especially those that have experienced higher than average OECD growth rates, post-crisis GDP per capita growth has largely been sustained by increased contributions from labour utilisation. This differs significantly from the pre-crisis period, where the contribution from labour utilisation had only a limited impact in most countries and indeed declined in many (Figure 1.3). In some countries, notably the United Kingdom and the United States, increases in hours worked per capita accounted for a significant share of GDP per capita growth over the period 2010-15, making up for limited labour productivity growth. However, the pattern of increased contributions from labour

Figure 1.2. **Trend labour productivity growth in selected OECD countries**

Total economy, percentage change at annual rate




*Source:* OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

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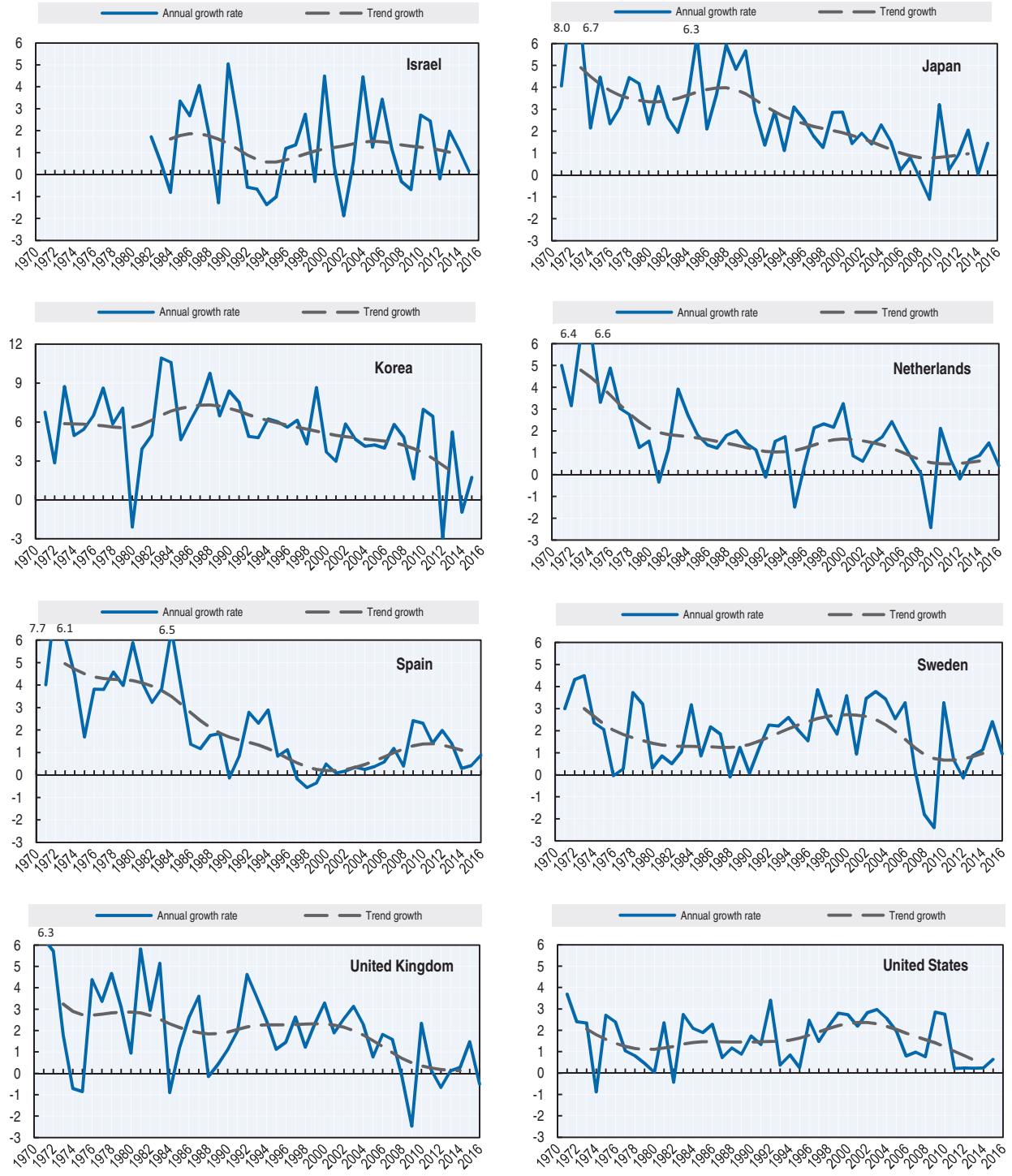
Figure 1.2. **Trend labour productivity growth in selected OECD countries** *(cont.)*

Total economy, percentage change at annual rate



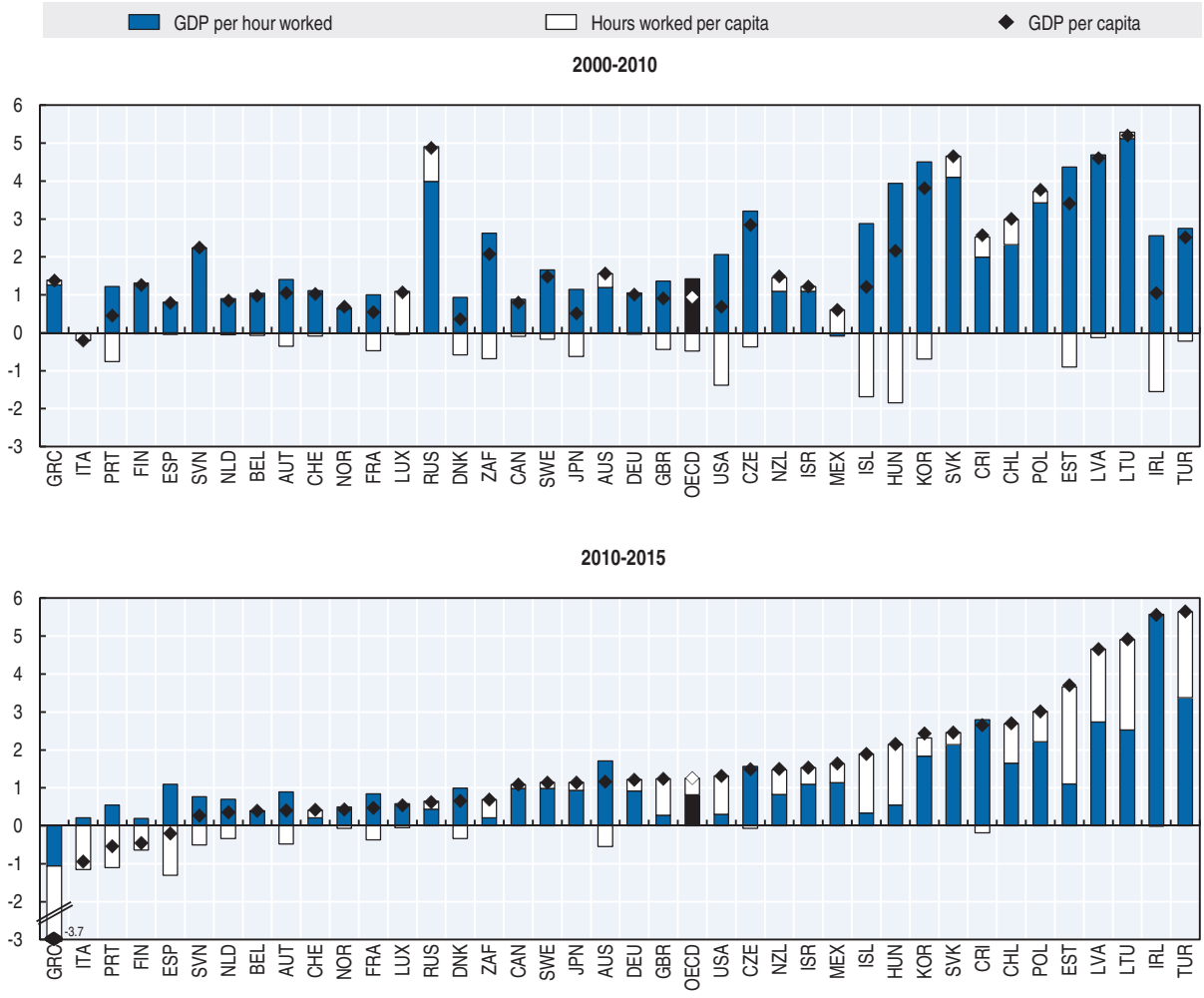

*Source:* OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477020

utilisation is not universally true; in Southern European economies, particularly those hit hard by the crisis and the euro-area crisis that followed, the contribution from labour utilisation has been negative in the post-crisis period.

Figure 1.3. **Growth in GDP per capita, labour productivity and labour utilisation**

Total economy, percentage change at annual rate



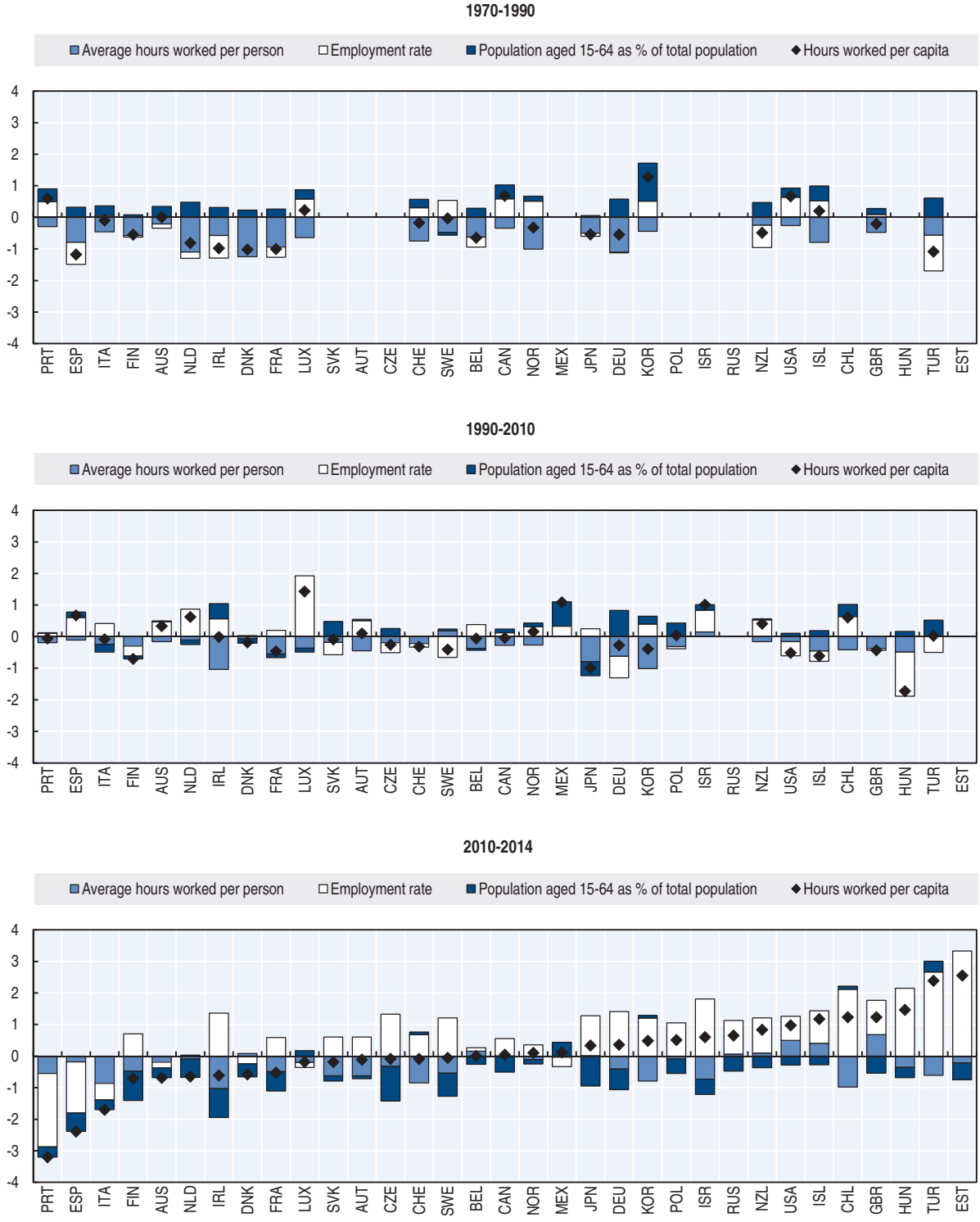

*Source:* OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477037

While increases in labour utilisation rates are welcome because they signal increasing employment rates and, possibly, reductions in involuntary unemployment (Figure 1.4), the fact that they, rather than productivity, have been the most important driver of economic growth in many economies in the post-crisis period is of concern for long-term growth. The capacity of labour utilisation to drive growth cannot be infinite, especially as in many economies demographic changes point to ageing populations, which, all other things being equal, erodes the potential for labour utilisation to continue to drive growth in the longer term (Figure 1.4). Moreover, in most economies, increases in labour utilisation have been driven by increased employment but with corresponding declines in average hours per person, likely indicating that employment growth has been driven by increases in part-time working; which may have been in lower productivity activities.

## Figure 1.4. **Growth in labour utilisation**

Total economy, selected countries, percentage change at annual rate

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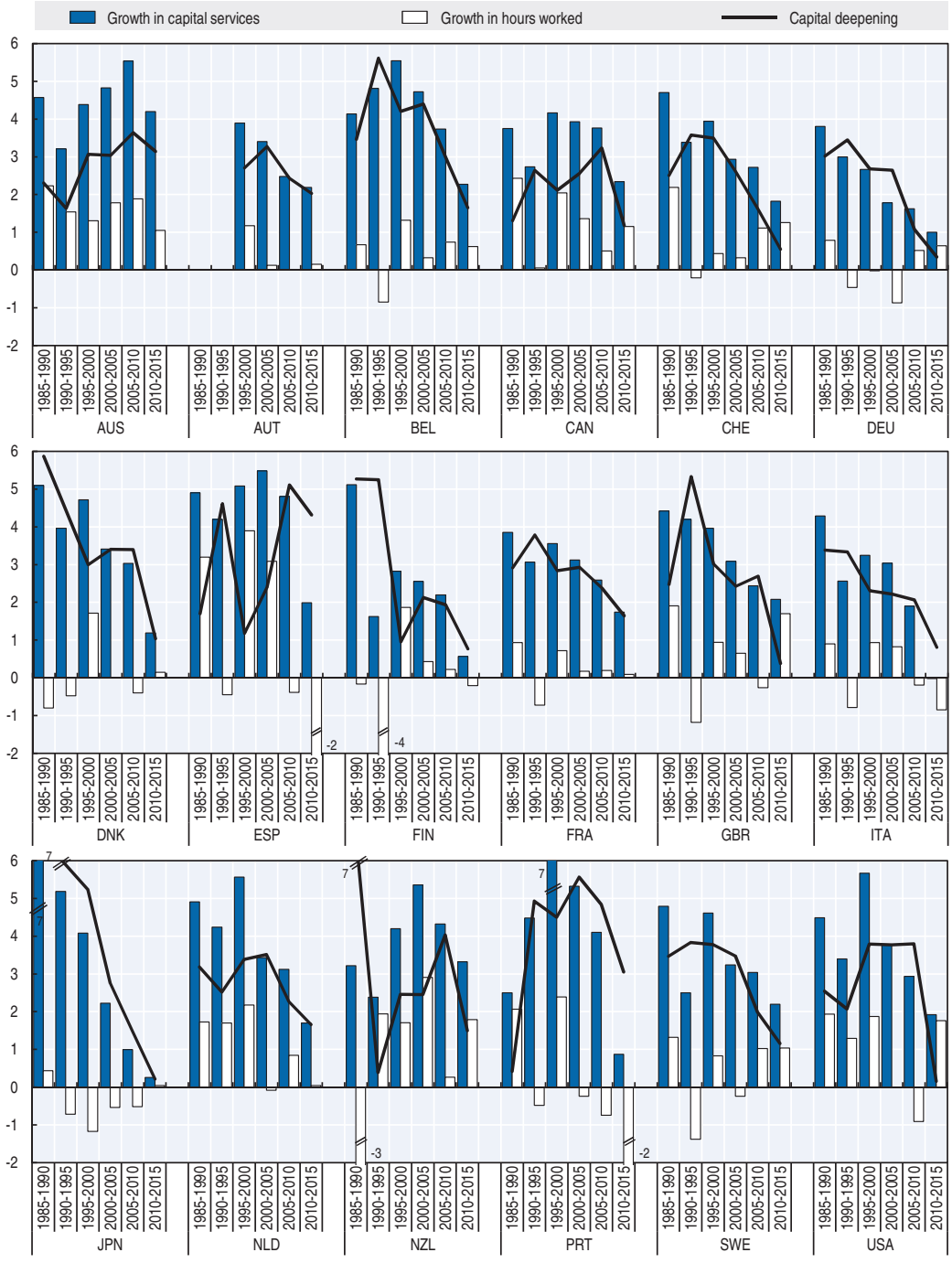
StatLink http://dx.doi.org/10.1787/888933477040

## Slow capital deepening has contributed to slower productivity growth

Capital deepening has stalled in nearly all large OECD economies and declined significantly in most (Figure 1.5). In Germany, Japan and the United States for example, capital deepening growth has fallen to close to zero in the post-crisis period.

Figure 1.5. **Capital deepening**

Total economy, percentage change at annual rate and percentage of GDP



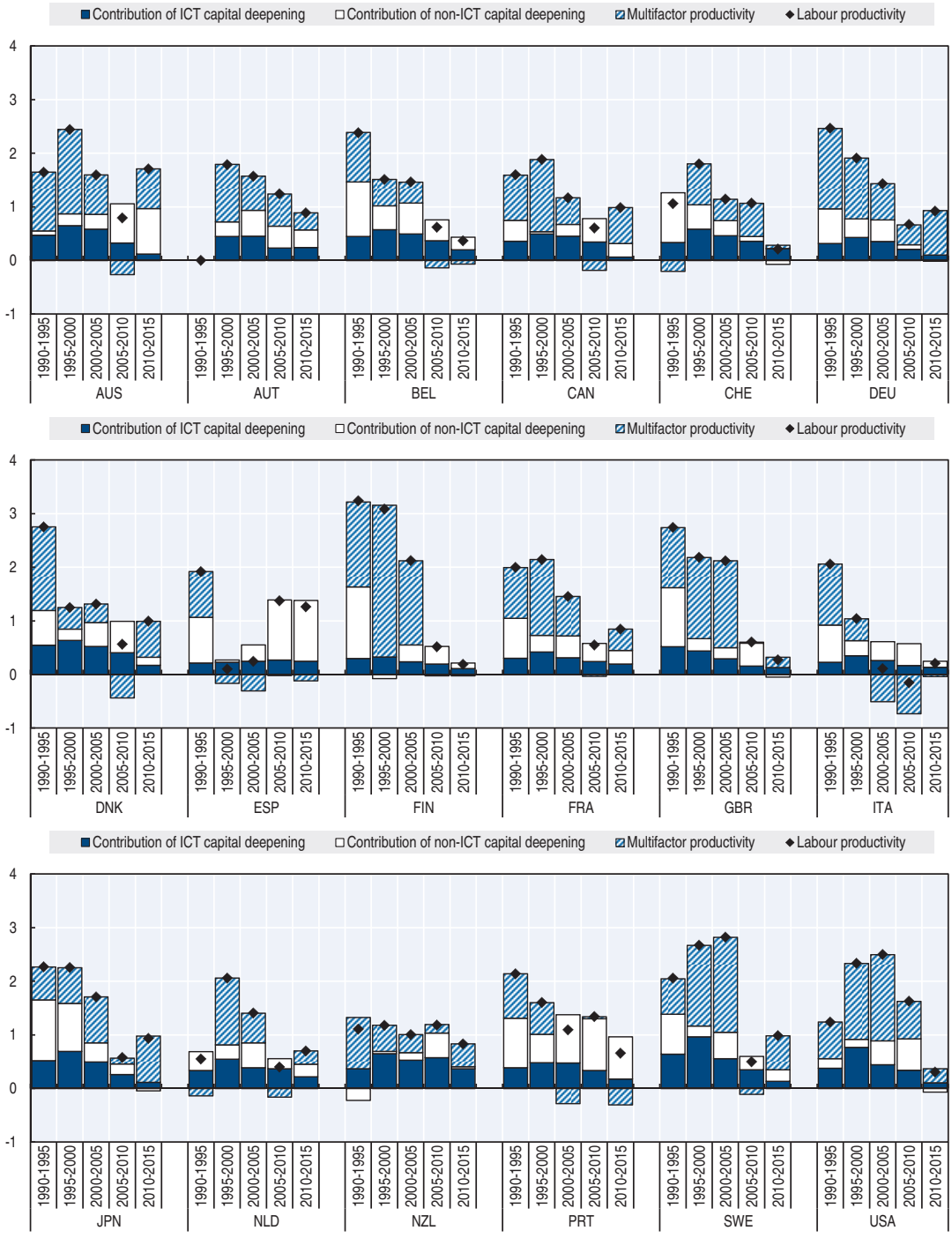

*Source:* OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477056

The rate of capital deepening was an important driver of labour productivity growth across OECD economies in the pre-crisis period, but in the aftermath of the crisis the contribution of both ICT and non-ICT investment has stalled (Figure 1.6), in line with lower rates of investment (Figure 1.7), as has MFP growth, lending some weight to the arguments

Figure 1.6. **Contributions to labour productivity growth, 1990-2015**

Selected OECD countries, total economy, percentage change at annual rate

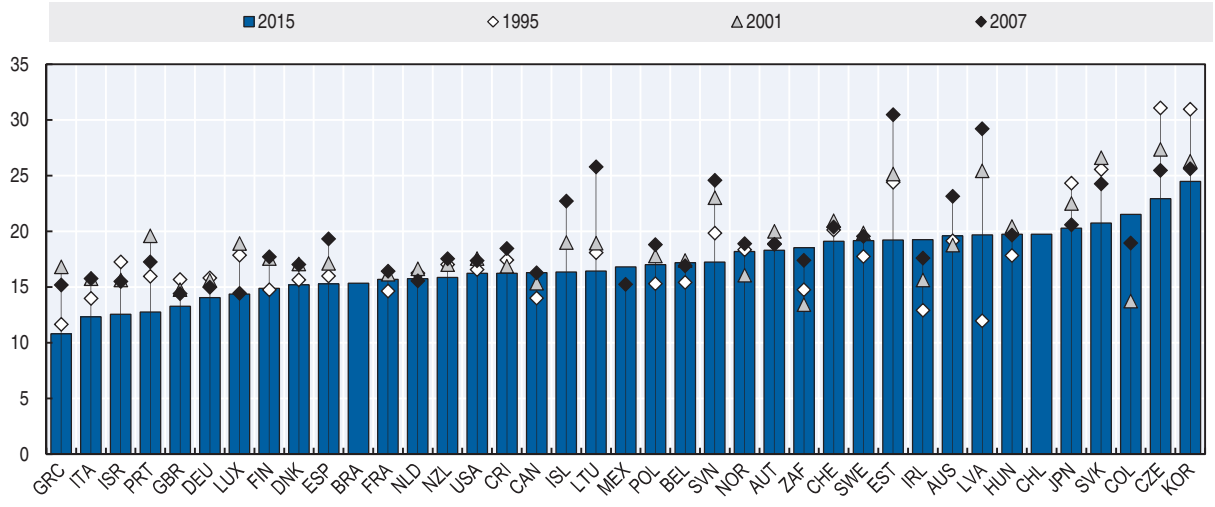



*Source:* OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477063

Figure 1.7. **Investment rates**

Non-residential gross fixed capital formation as a percent of GDP




*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477077

that technological spillovers and diffusions from Information and Communication Technologies (ICT) and other new technologies may be lower than from earlier technology breakthroughs (Cowen, 2011; Gordon, 2012, 2016). However, the evidence on this is not conclusive. For example, declining MFP may, at least in part, also reveal other inefficiencies in the combined utilisation of labour and capital inputs, notably skills mismatches (Adalet McGowan and Andrews, 2015) but also capital misallocation (Gopinath et al., 2015) or a slower pace at which innovations spread throughout the economy from frontier firms to other firms (Andrews, Criscuolo and Gal, 2015). In addition, analysis by the OECD and IMF (Ahmad et al., 2017 forthcoming) suggests that mis-measurement (such as overlooked quality improvements that might affect price measurement of ICT goods) is unlikely to explain the slowdown in MFP.

## Labour income shares are beginning to stabilise…

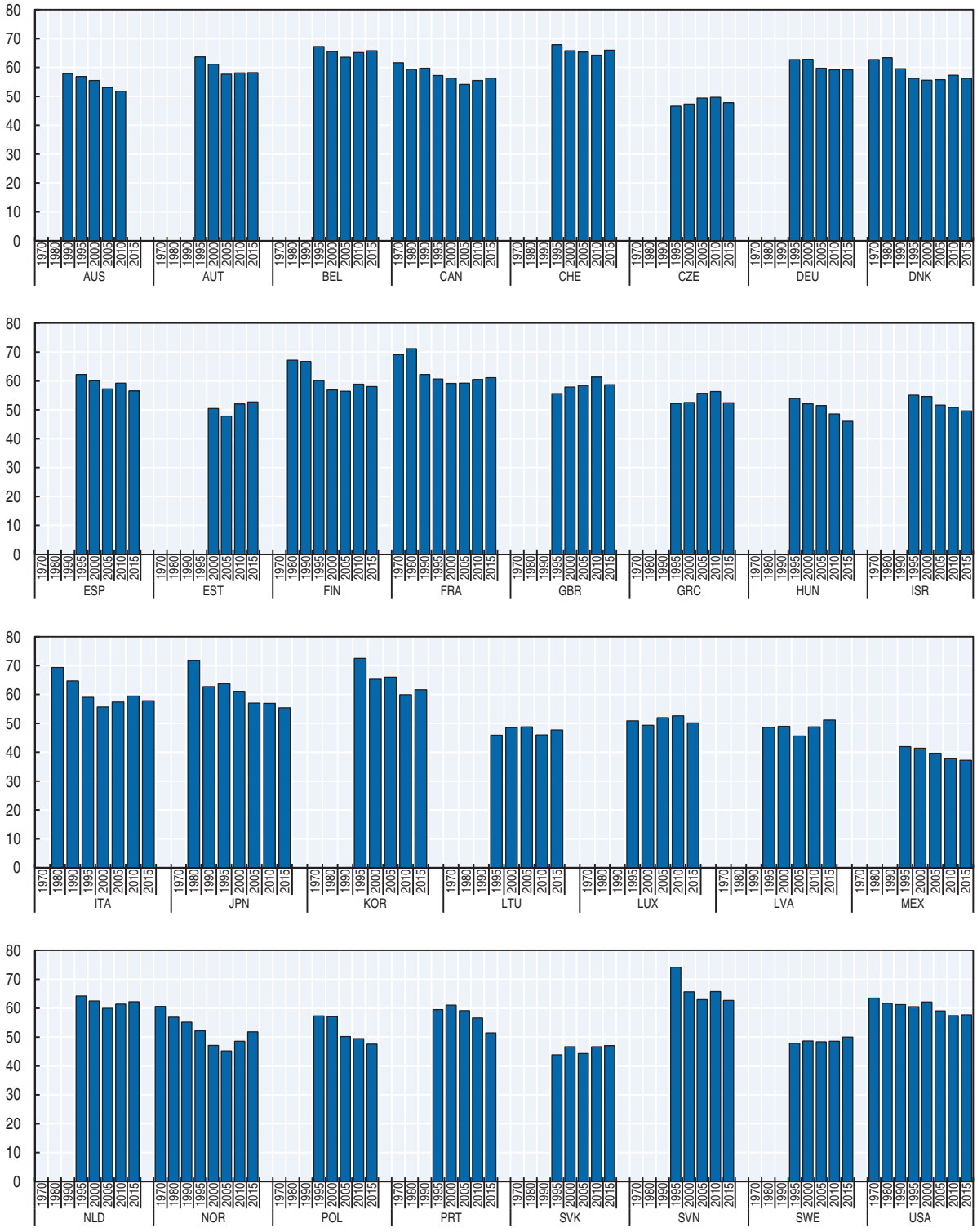
A striking feature and cause of growing concern in recent years has been the long-term decline in labour income shares seen in most economies over the last two to three decades. However in many economies signs have emerged that these declines may have abated; notwithstanding the fact that labour income shares may be counter-cyclical, which may explain the temporary upward blip in the shares that occurred at the height of the crisis in some countries (Figure 1.8) nor the fact that measurement challenges counsel some caution (Box 1.1 and Cho et al., 2017).

In theory, movements in labour income shares and corresponding movements in labour productivity and real labour compensation align; when labour compensation costs are adjusted for inflation using the same price index used to deflate value added (and so productivity). However, this reflects a firm/producer's view of inflation, which may not align with the perspective of workers, who are instead more concerned with how their compensation moves in relation to overall inflation: in particular, consumer price inflation, which is more relevant for considerations of inequalities.

In many economies, a post-crisis stabilisation in labour income shares has seen real labour compensation – deflated with CPI, i.e. from a consumer perspective – rising in line

## Figure 1.8. **Labour income shares**

Total economy, total labour compensation as a share of GDP




*Note:* Labour compensation received by self-employed is assumed to be the same hourly labour compensation received by an employee.
*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en* and OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477088

### Box 1.1. **Challenges in measuring the labour income share and the wage-productivity gap**

The relationship between wages and productivity has gained considerable attention in recent years, not only because of its relevance for the design of labour market policies. Empirically, determining the nature of the relationship between the two is far from trivial, resulting in divergent opinions on the size of any decoupling between wages and productivity and whether this decoupling has occurred. A central measurement challenge relates to the way in which real labour income is defined, which in turn is closely related to the measurement of labour income shares, a subject that has recently attracted the attention of many analysts and researchers (Elsby et al., 2013; Karabarbounis and Neiman, 2014; Rognglie, 2015; Cho et al., 2017; Giandrea and Sprague, 2017). A declining labour income share often reflects a more rapid growth in labour productivity compared with that of real average labour compensation per hour worked.

The key measurement challenge in this perspective possibly concerns the choice of the deflator used to determine real labour compensation, which is typically at the heart of the debate, and confusion, relating to the decoupling. There are in effect two fundamental views on the appropriate deflator: the producer's perspective and the worker's perspective.

From a producer's perspective, and for an assessment of enterprise hiring decisions, it is more appropriate to measure the gap between labour productivity growth and real average hourly labour compensation growth using the same value added price index as a deflator. In this way, the "decoupling" of average hourly labour compensation growth from labour productivity growth, if any, would directly reflect declines in labour income shares (Schwellnus et al., 2017). From a worker's perspective, however, and of greater relevance in considerations of inequalities, it is more appropriate to use a measure of general price inflation that reflects the worker's purchasing power, for example, the consumer price index (CPI). In Figures 1.9a and 1.9b both measures are presented, showing a broad pattern of decoupling in many countries, whichever measure is used, although a generally larger decoupling is observed when using the CPI.

However, other measurement challenges warrant caution in interpreting results:

i. **Wages and salaries vs. labour compensation.** Wages and salaries represent only one component of labour costs (and labour income). Most studies, including the data presented in this publication, analyse the wage-productivity gap (or the labour income share) using total labour compensation, which includes wages and salaries payable in cash and in kind as well as social insurance contributions payed by employers.

ii. **Average vs. median hourly labour compensation.** Comparisons of average real labour compensation per hour and labour productivity growth, such as those presented in this publication, can be directly computed from national accounts data. However, this simple comparison cannot capture income (or wage) inequalities across different categories of workers. Indeed comparisons at a more granular level seem likely to point more strongly to decoupling in some categories, as shown for example in those that use median hourly labour compensation (Bivens and Mishels, 2015; Schwellnus et al., 2017).

iii. **Compensation of employees vs. total labour compensation.** Total labour income (or total labour compensation) is the sum of the compensation received by two groups of workers for their labour input: employees and self-employed. The compensation received by employees is readily available in national accounts statistics as *compensation of employees*. However, national accounts show the total income received by the self-employed as *mixed income*, without providing any distinction between the returns of their work effort (labour) and the returns to the business property (capital) they invested. Therefore, self-employed labour compensation is necessarily imputed relying on different assumptions (Kravis, 1959). Under the "labour basis" assumption, labour income received by the self-employed is assumed to be equal to the average labour compensation received by the employee working in the same sector. Under the "asset basis" assumption, capital income accruing to the self-employed is calculated by assuming that the return to capital is the same between the self-employed

Box 1.1. **Challenges in measuring the labour income share and the wage-productivity gap** *(cont.)*

and corporations. In this publication, self-employed labour compensation is imputed following the "labour basis" applied to hours worked. However, Elby et al. (2013) argued that this method has overestimated the self-employed labour income, and therefore total labour compensation, in the United States.

iv. **Total persons employed vs. employees.** Labour productivity measures accounts for the productivity of both employees and self-employed. When self-employed labour compensation is imputed following the "labour basis", labour compensation per hour worked is based only on employees' labour compensation and hours worked.

v. **Market prices vs. basic prices.** Valuation at basic prices includes taxes minus subsidies on production reflecting the value actually received by the producer. Instead, valuation at market prices includes all taxes minus subsidies on products and production reflecting the consumer (or demand) perspective. Cho et al. (2017) highlight that in measuring labour income shares, total income is best measured as GDP at market prices for the purposes of distributional analysis (income perspective) whereas for the purposes of the production analysis (the production perspective) total income is best measured as gross value added (GVA) at basic prices.

vi. **Gross vs. net measures.** From an income or welfare perspective, only gross value added net of capital depreciation is available for compensating workers and capital owners for their labour and capital services to production. However, from the producer perspective, it may be more appropriate to use gross value added and gross capital measures, as they better reflect the structure of production (Rognlie, 2015).

vii. **Total economy vs. business economy sector excluding the primary sector and real estate services (housing services).** Measurement of value added in certain industries is subject to a number of conceptual and measurement issues (Cho et al., 2017; Schwellnus et al., 2017). Value added and aggregate profits in the primary sector are partly driven by developments in commodity prices, which can be volatile, and are not necessarily reflected as changes to wages in the sector. In addition, national accounting conventions for measuring value added in non-market activities, such as public administration, may bias the results, as the value added is measured as the sum of labour costs and capital depreciation, which introduces a downward bias in the remuneration of government-owned capital. The real estate sector is also often excluded from analyses as the value added generated in this sector is driven by the imputed value of housing services produced and received by persons living in their own house, and because there are no labour services associated with the provision of housing services in the national accounts.

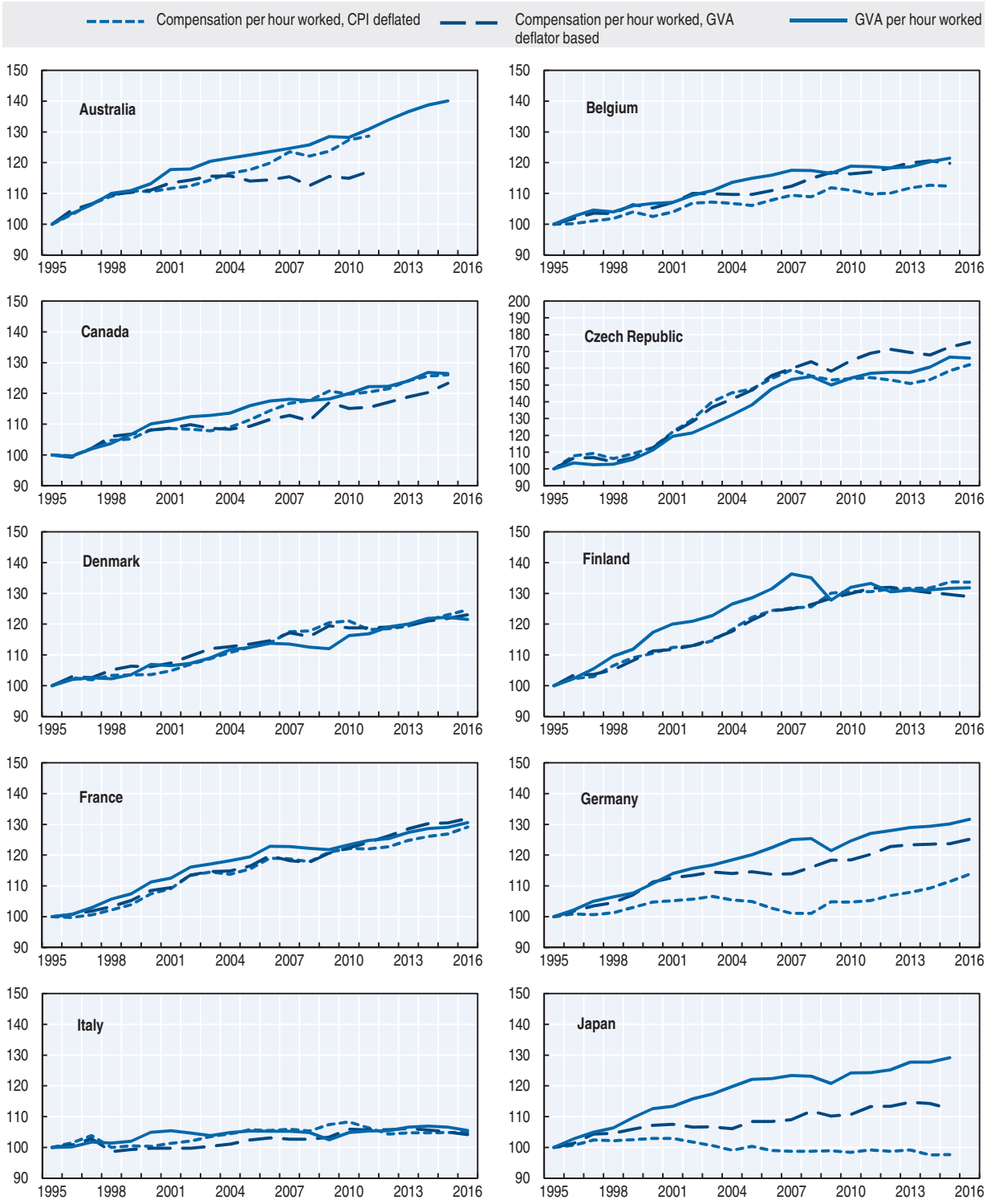
viii. **The production perspective versus the consumer/income perspective of labour income shares.** The analysis on labour income shares presented in this Chapter takes a production perspective view of labour income shares, which uses gross income as a reference point. An alternative view – the "consumer" perspective – takes net (of depreciation) income, including taxes and subsidies. Cho et al. (2017) confirm that labour income shares in OECD countries have declined over the last two decades using the former measure, but find little evidence of declines using the latter.

with, (albeit slow) productivity growth; helping to arrest and in some countries, such as Germany and more recently the United States, reverse, longer term trends where the two measures decoupled (see Figure 1.9a for longer-term trends and Figure 1.9b for the post-crisis period).

However, this has not been universally true in the post-crisis period. In many countries (Japan, the Netherlands, Poland, Spain, the Slovak Republic, Slovenia and the United

Figure 1.9a. **Labour productivity and average labour compensation per hour, total economy**

Selected OECD countries, GVA per hour worked and average hourly labour compensation, indices 1995 = 100



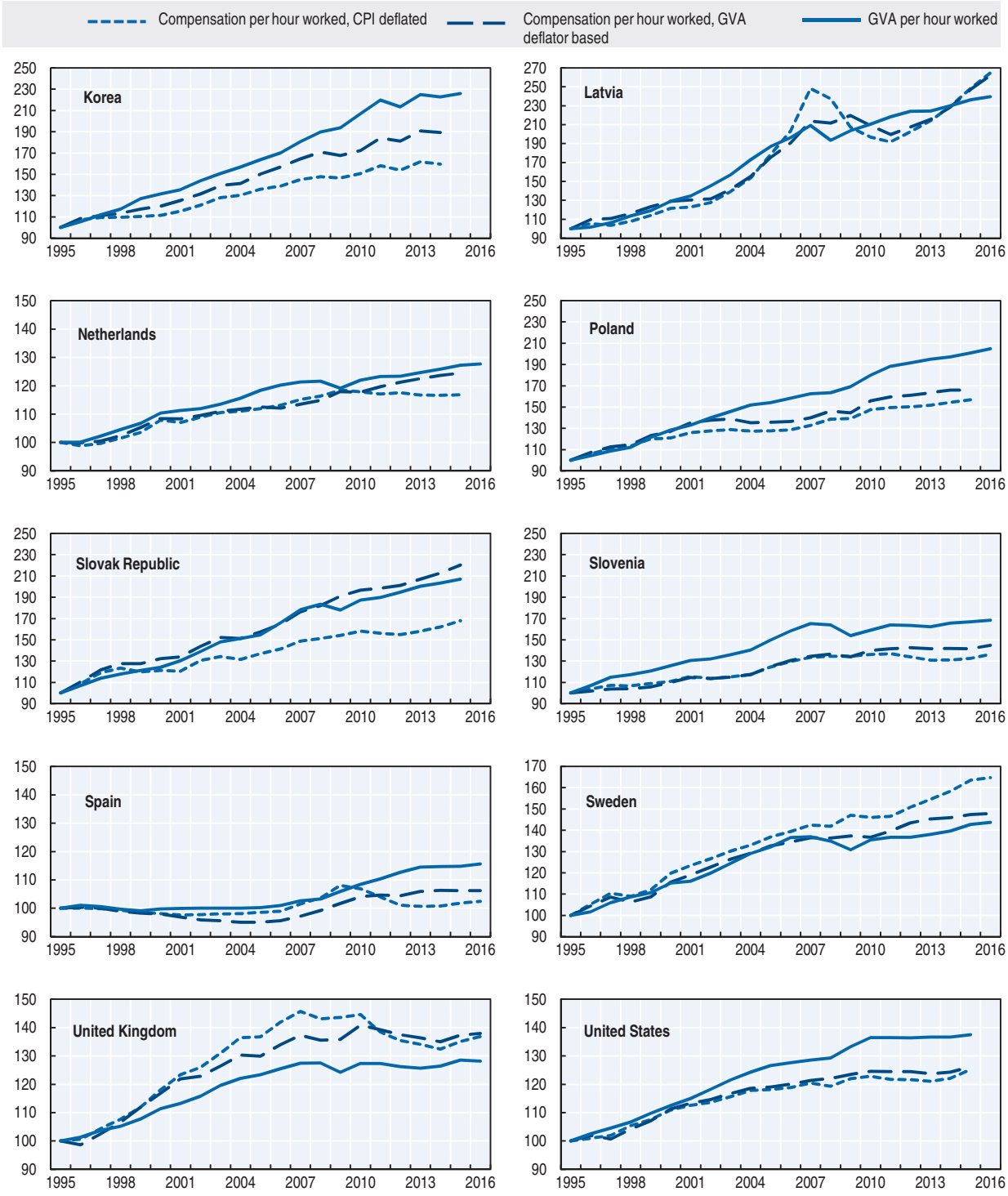

*Notes:* Gross value added (GVA) at basic prices per hour worked (by total persons employed) is deflated using the GVA deflator. Average labour compensation per hour worked (by employees) is deflated using country's GVA deflator and the CPI (all items).

*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, and OECD Main Economic Indicators (database) *http://dx.doi.org/10.1787/data-00047-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477090

Figure 1.9a. **Labour productivity and average labour compensation per hour, total economy** *(cont.)*

Selected OECD countries, GVA per hour worked and average hourly labour compensation, indices 1995 = 100



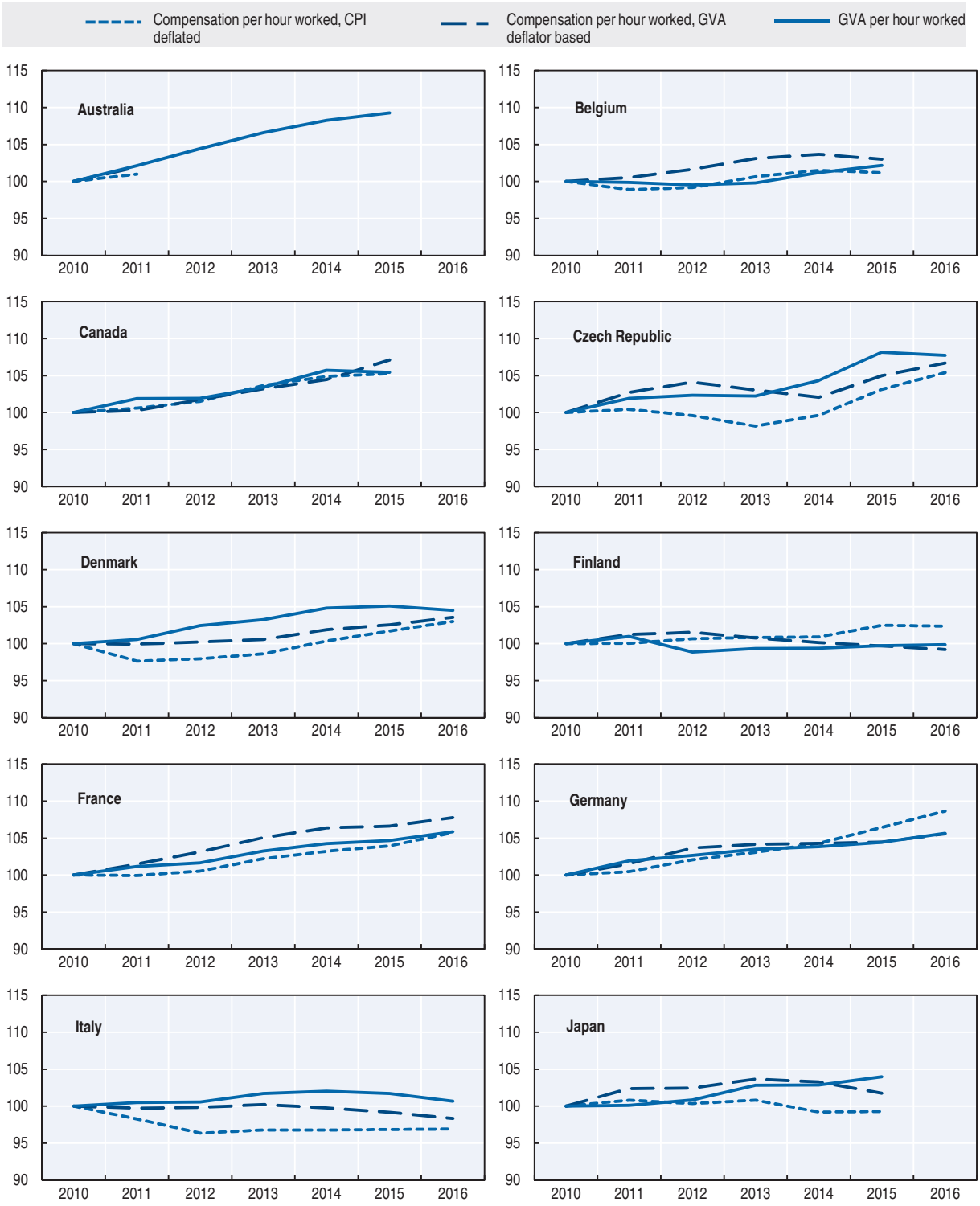

*Notes:* Gross value added (GVA) at basic prices per hour worked (by total persons employed) is deflated using the GVA deflator. Average labour compensation per hour worked (by employees) is deflated using country's GVA deflator and the CPI (all items).

*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, and OECD Main Economic Indicators (database) *http://dx.doi.org/10.1787/data-00047-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477090

Figure 1.9b. **Labour productivity and average labour compensation per hour, total economy**

Selected OECD countries, GVA per hour worked and average hourly labour compensation, indices 2010 = 100




*Notes:* Gross value added (GVA) at basic prices per hour worked (by total persons employed) is deflated using the GVA deflator. Average labour compensation per hour worked (by employees) is deflated using country's GVA deflator and the CPI (all items).

*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, and OECD Main Economic Indicators (database) *http://dx.doi.org/10.1787/data-00047-en*, April 2017.

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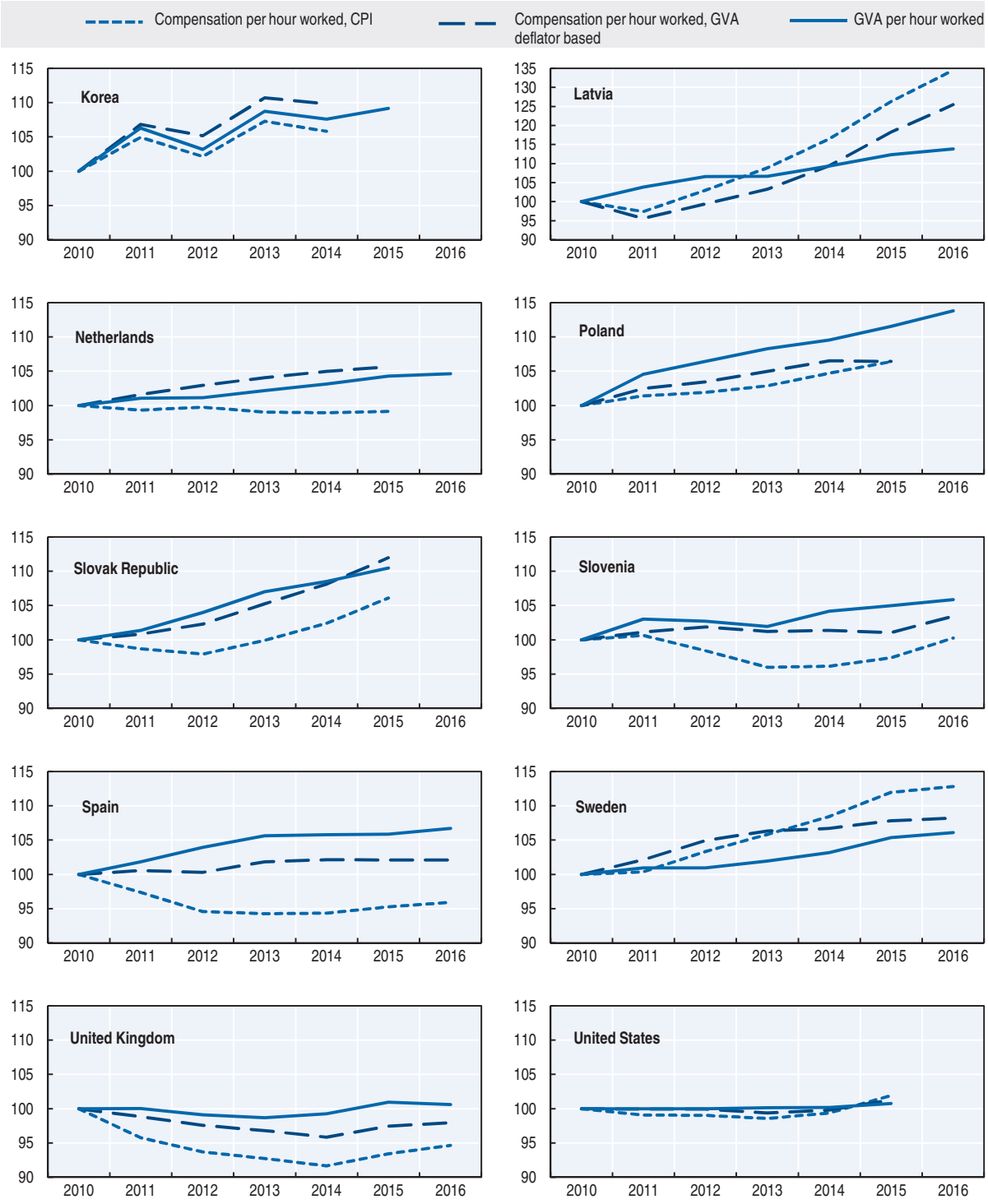
Figure 1.9b. **Labour productivity and average labour compensation per hour, total economy** *(cont.)*

Selected OECD countries, GVA per hour worked and average hourly labour compensation, indices 2010 = 100




*Notes:* Gross value added (GVA) at basic prices per hour worked (by total persons employed) is deflated using the GVA deflator. Average labour compensation per hour worked (by employees) is deflated using country's GVA deflator and the CPI (all items).

*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, OECD Productivity Statistics (database), *http://dx.doi.org/10.1787/pdtvy-data-en*, and OECD Main Economic Indicators (database) *http://dx.doi.org/10.1787/data-00047-en*, April 2017.

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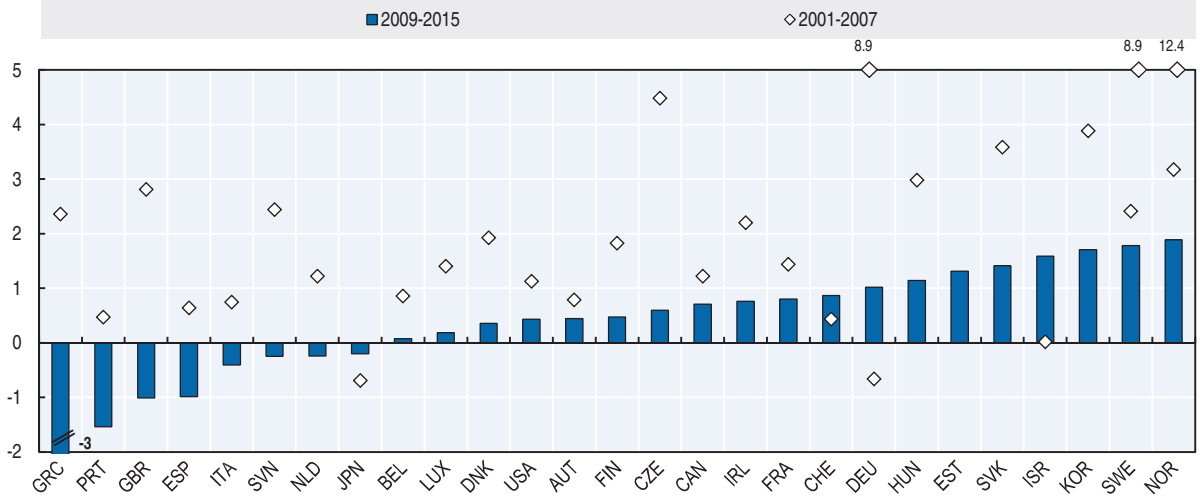
Kingdom), decoupling occurred over the post-crisis period as consumer prices outpaced producer (or rather value added) prices, suggesting that stabilising labour income shares may not necessarily have translated into improvements in material well-being, or indeed abated concerns about inequalities. However, in the most recent years for which data are available, real wages grew broadly in line with labour productivity in Spain, the Slovak Republic and Slovenia, while in the United Kingdom real wage growth outpaced productivity growth in 2015 and 2016. However, real wage growth in the United Kingdom showed signs of stalling towards the end of 2016 and first quarter of 2017.

In a climate of slower rates of productivity growth, which limits the scope of employers to provide significant real wage increases, this continued decoupling – of labour productivity growth and real average compensation costs deflated by the CPI – may magnify concerns around inequalities, despite the stabilisation in labour income shares seen in these countries. This is especially so because the evidence presented below on decoupling refers to total economy averages and not to particular occupations or salary ranges. To that extent, the evidence does not capture divergent patterns of wage increases between high-skilled, high earners and low-skilled, low earners. In addition, a slowdown in real wage growth, which has been significant in many OECD economies since the crisis (Figure 1.10), may also be contributing to sluggish consumption growth (OECD, 2016).

Figure 1.10. **Growth in average compensation per hour worked (employees)**

Total economy, CPI all items-deflated, percentage change at annual rate




*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, and OECD Main Economic Indicators (database) *http://dx.doi.org/10.1787/data-00047-en*, April 2017.

StatLink http://dx.doi.org/10.1787/888933477117

A number of explanations have been put forward to account for the slower growth in labour compensation, and in particular their decoupling from labour productivity growth, ranging from the rapid decline in the relative prices of investment goods that induce firms to substitute labour for capital and where the elasticities are large (Karabarbounis and Neiman, 2014), a surge in highly profitable-low labour share firms (Autor et al., 2017), right through to trade and investment. The latter may have acted to depress wages, in particular, in low-skilled but labour intensive activities in developed economies, where the scope for off-shoring or import substitution may be particularly high (IMF, 2017). Certainly these factors

appear to have been at work in the pre-crisis period but since then, real investment and decoupling appear to have slowed in many, but not all, with labour income shares stabilising.

Moreover, it is possible that the current stabilisation in labour income shares is a temporary phenomenon and merely reflects the counter-cyclical nature of labour income shares or, indeed, structural shocks from the crisis

In addition, while declines in labour income shares in the pre-crisis period may be partly explained by the substitution of labour with capital, especially ICT capital where costs were declining rapidly, the dynamic in the post-crisis period, at least in some sectors of the economy, may have changed, as the differential between investment price inflation and wage inflation has shrunk considerably in many OECD countries (Figure 1.11). While digitalisation creates significant challenges for measuring prices, and hence volumes, in particular, for ICT investment (Ahmad and Schreyer, 2016), in some economies (Greece, Hungary, Italy, Portugal, Slovenia and the United Kingdom), inflation in investment prices outpaced inflation in hourly compensation costs in the post-crisis period.

This may also partly explain the recent stabilisation in labour income shares in many OECD economies and the slow rate of growth of investment. In most economies, albeit not those hit particularly hard by the crisis and where employment rates continued to contract in the post-crisis period (Figure 1.4), faced with (relatively) cheaper labour and perhaps some residual post-crisis uncertainty, some firms may have chosen to defer investment decisions and instead increase the size of the workforce or hours worked; which would square the story of low labour productivity growth, driven largely by low MFP growth, low investment, and low relative wage rises.

But it is still too early to tell. First, where signs of stabilisation have occurred, which is not the case in all countries, the effects may only be temporary, reflecting counter-cyclical forces at work. Secondly, stabilising shares in some countries have coincided with an interruption in labour productivity growth and/or differential movements between consumer and producer prices, and so have not necessarily translated into improved purchasing power for workers.

## Figure 1.11. **Growth differential between labour costs and investment prices, total economy**

Growth in average hourly labour compensation of employees (current prices) minus growth in non-residential GFCF price index, percentage change at annual rate


*Source:* OECD National Accounts Statistics (database), *http://dx.doi.org/10.1787/na-data-en*, April 2017.

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*Chapter 2*

# Economic growth and productivity

Size of GDP

Growth in GDP per capita

GDP per capita convergence

Labour productivity

Alternative measures of labour productivity

Alternative measures of income

Capital productivity and the role of ICT and intangible assets

Growth accounting

Multifactor productivity

## Size of GDP

Gross Domestic Product (GDP) is the standard measure of the value of final goods and services produced in a country during a given period of time minus the value of imports. GDP per capita is a core indicator of economic performance and commonly used as a broad measure of average living standards or economic well-being.

### Key findings

In 2015, the size of GDP for the OECD as a whole was about USD 52 400 billion based on current PPPs. G7 countries accounted for almost 70% of that total. GDP per capita was on average about USD 41 000 for the OECD area and about USD 11 400 on average for the BRIICS. However, there are large disparities in GDP per capita across countries within these geographical areas. Within the OECD, GDP per capita was above USD 50 000 in Ireland, Luxembourg, Norway, Switzerland and the United States and less than half the OECD average in Mexico. Among emerging economies, GDP per capita in the Russian Federation was almost twice the BRIICS average and about half the average in India.

GDP growth remains below pre-crisis rates in most countries, particularly in Finland, Greece, Iceland, Spain, and most Eastern European economies. GDP growth also eased significantly in the Russian Federation and although growth in China remains high relative to other large economies, it too has slowed considerably compared to the pre-crisis period.

### *Definitions*

Countries measure GDP in their own currencies. In order to compare these estimates across countries, they have to be converted into a common currency. The conversion is often made using current exchange rates but these can give a misleading comparison of the true volumes of final goods and services measured in the GDP. A better approach is to use purchasing power parities (PPPs), which are currency converters that control for differences in the price levels between countries and allow an international comparison of the volumes of GDP and the size of economies (Chapter 6).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

GDP measures are generally very comparable across countries, although not all countries have yet implemented the latest international standards for the compilation of national accounts, the System of National Accounts 2008 (2008 SNA), which can have an impact on comparisons of GDP across countries. Indeed, data reported here for Chile and Colombia are in line with the 1993 SNA. The measurement of the Non-Observed Economy can also affect comparability as exhaustive coverage of production activities missed by the statistical system can be difficult to achieve and national estimates may differ in their coverage of non-observed activities. The size of the non-observed economy is generally larger in emerging economies reflecting, in part, the higher degree of informal activities and employment.

Population estimates are comparable across countries. However, some care is needed in interpretation: for example Luxembourg and, to a lesser extent, Switzerland, have a relatively large number of frontier workers. Such workers contribute to GDP but are excluded from the population figures, which is one of the reasons why cross-country comparisons of income per capita based on gross or net national income are also relevant.

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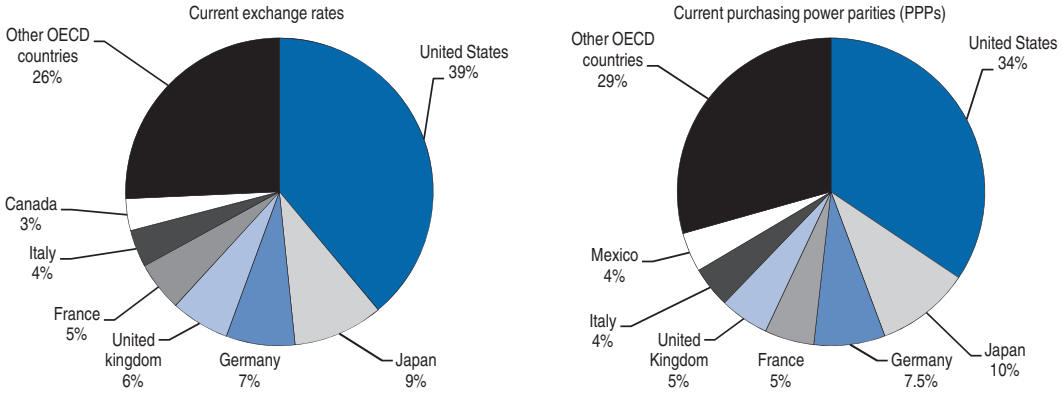
## Figure 2.1. **Gross domestic product, current PPPs and current exchange rates**

The seven largest economies in the OECD, percentage of OECD total, 2015

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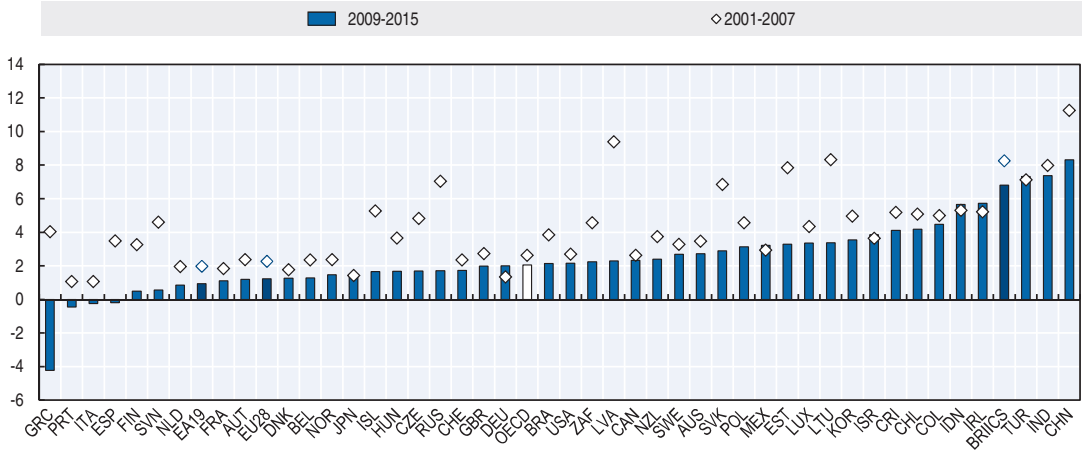
## Figure 2.2. **Growth in gross domestic product**

Volume, percentage change at annual rate

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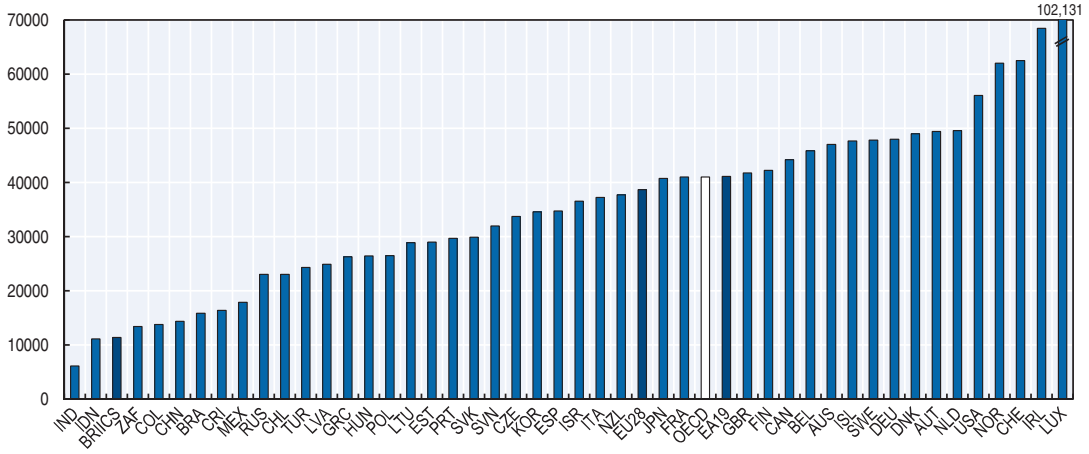
## Figure 2.3. **GDP per capita**

US dollar per head of population, current prices and current PPPs, 2015

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## 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. Growth in GDP per capita can result from changes in labour productivity (GDP per hour worked) and 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 structural shifts to higher-productivity activities.

**Key findings**

Differences in GDP per capita growth across countries can be mainly attributed to differences in labour productivity growth. While labour productivity growth remains a significant driver of growth, it has slowed across the board in recent years, and in Chile, Mexico, Turkey, the United Kingdom and the United States, in particular, increased labour utilisation rates were significant drivers of growth. In many other countries, including some large European economies, growth in labour utilisation rates slowed considerably, and in many, labour utilisation rates fell.

### *Definitions*

Growth in GDP per capita is calculated using GDP and population series published in the *OECD National Accounts Statistics* (database). Labour productivity is measured as GDP per hour worked and labour utilisation as hours worked per capita. Total hours worked are primarily sourced from the *OECD National Accounts Statistics* (database). For some countries, however, longer time series and/or more recent estimates need to be derived from the OECD *Employment and Labour Market Statistics* (database), the *OECD Economic Outlook: Statistics and Projections* (database) and national statistical offices (Chapter 6).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

Most countries derive annual estimates of real GDP using annually chain-linked volume indices. However, China, India, Indonesia, Mexico and South Africa currently produce fixed-base volume estimates with the base year updated less periodically. The System of National Accounts 2008 (2008 SNA) recommends the production of estimates on the basis of annual chain volume series. These produce better estimates of growth as the weights used for the contribution of different goods and services are more relevant to the period in question.

### *Sources and further reading*

*OECD Economic Outlook: Statistics and Projections* (database), *http://dx.doi.org/10.1787/eo-data-en*.

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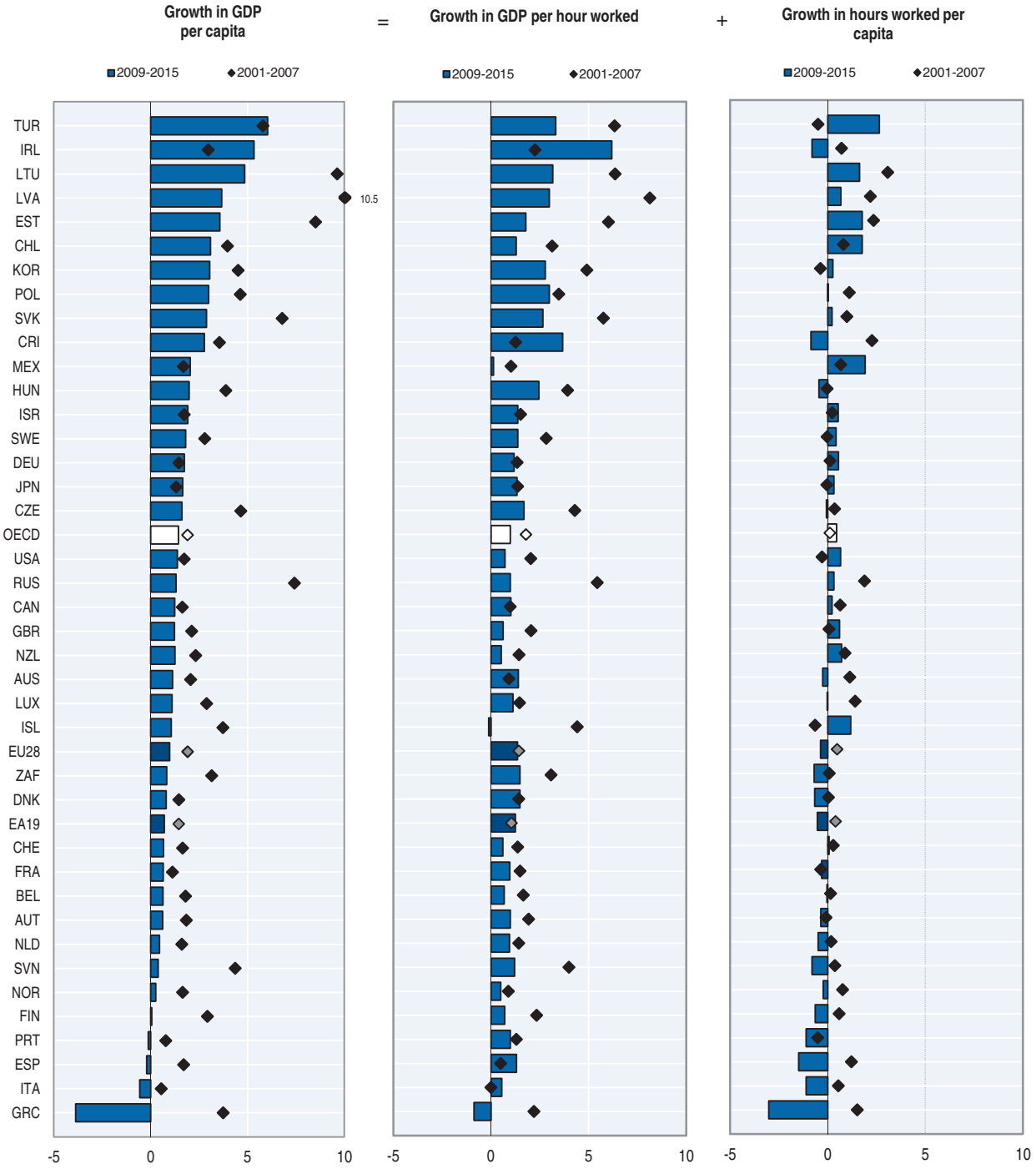
## Figure 2.4. **Contributions to growth in GDP per capita**

Total economy, percentage change at annual rate

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## GDP per capita convergence

GDP per capita convergence, often described as the catch-up process, refers to the process by which less advanced economies with lower income per capita converge towards more advanced economies through higher growth rates, as they capitalise on technology transfer, inward investment, and relatively lower labour costs.

**Key findings**

Pre-crisis trends pointed to a rapid pace of convergence of countries with below average GDP per capita levels towards the OECD average. However, post-crisis trends point to a slowdown in the pace of convergence in many economies, particularly in Eastern Europe.

### *Definition*

GDP is measured as gross value added in market prices. Data on GDP at current prices are sourced from the *OECD National Accounts Statistics* (database). For international comparisons, these data are converted to a common currency, US dollars, using *Purchasing Power Parities* (PPPs). Unlike currency exchange rates, the PPPs are currency converters that control for differences in the price levels between countries, making possible to compare absolute volumes across them (Chapter 6).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

For Chile and Colombia, indicators are based on the System of National Accounts 1993 (1993 SNA). For the Russian Federation, the indicators are on a 1993 SNA basis for data up to 2013 and 2008 SNA thereafter. For all the other countries, the indicators presented are based on the 2008 SNA. The 2008 SNA includes items such as the capitalisation of research and development (R&D) and military weapons systems which increase GDP levels (Chapter 6).

Population estimates are comparable across countries and are also sourced from the *OECD National Accounts Statistics* (database). However, some care is needed in interpretation as countries like Luxembourg and, to a lesser extent, Switzerland, have a relatively large number of frontier workers that contribute to GDP but are excluded from the population figures. In this context, cross-country comparisons of income per capita based on gross or net national income are also relevant.

### *Sources and further reading*

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

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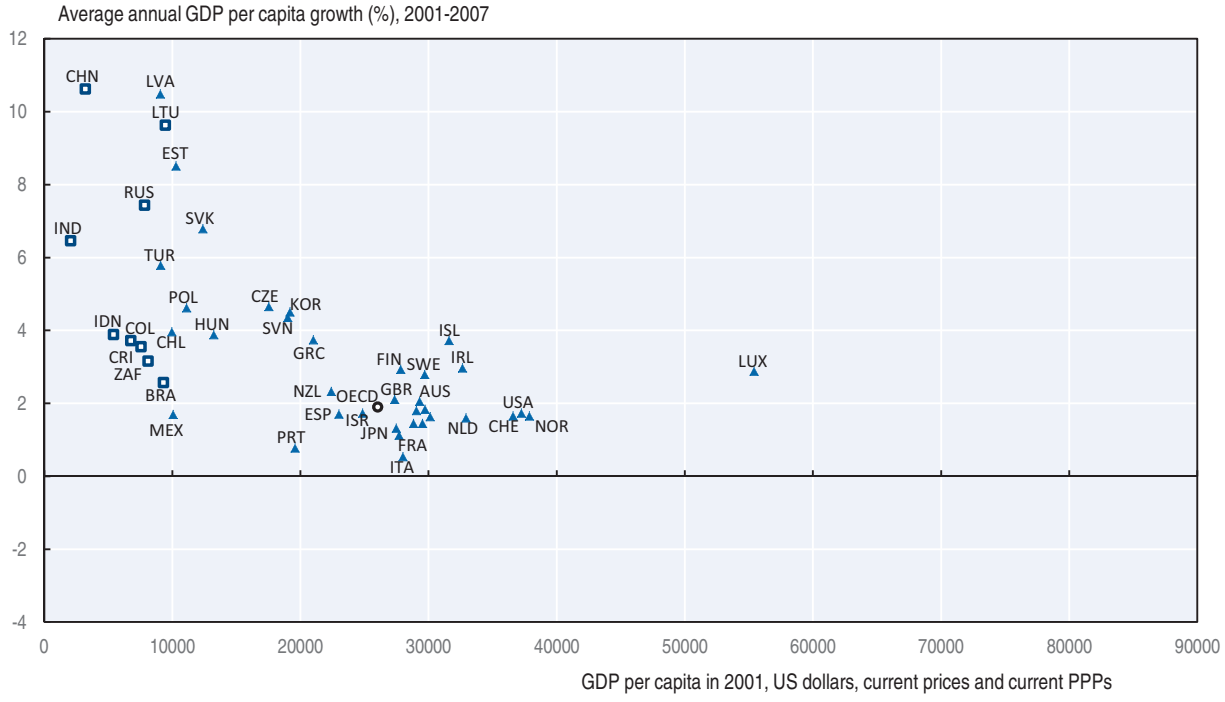
## Figure 2.5. **GDP per capita convergence, 2001-07**

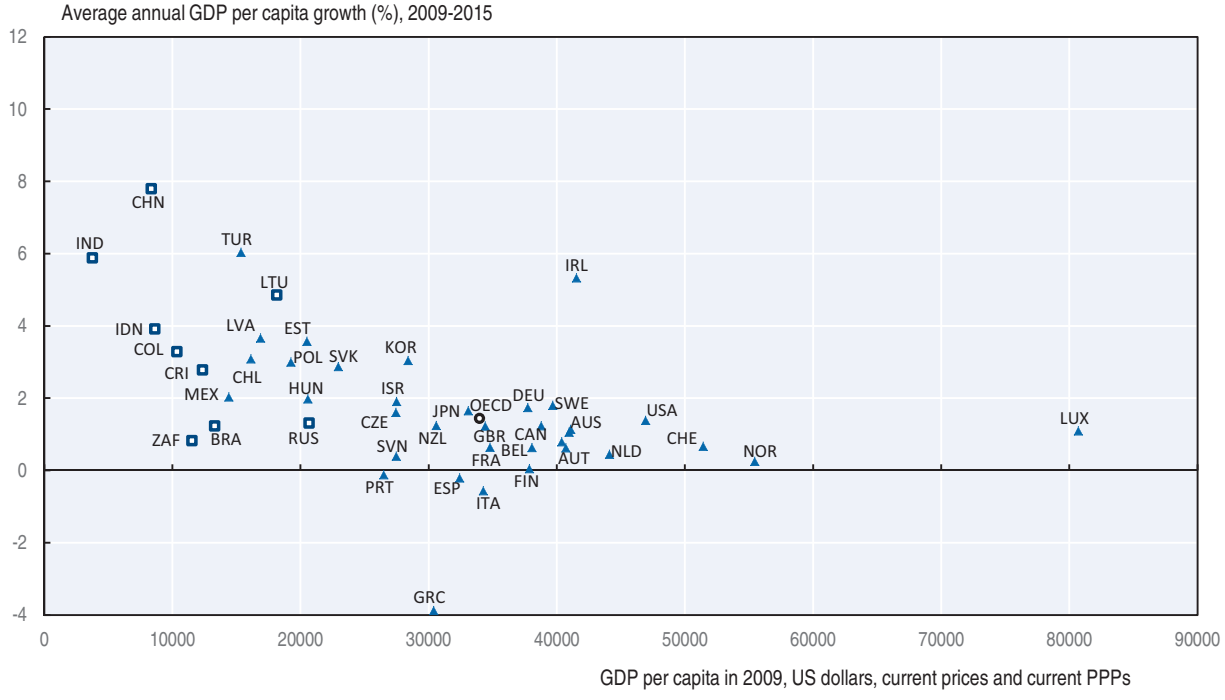
Percentage change at annual rate (Y-axis); US dollars, current prices, current PPPs (X-axis)




StatLink http://dx.doi.org/10.1787/888933477178

## Figure 2.6. **GDP per capita convergence, 2009-15**

Percentage change at annual rate (Y-axis); US dollars, current prices, current PPPs (X-axis)




StatLink http://dx.doi.org/10.1787/888933477186

## Labour productivity

Labour productivity is the most frequently computed productivity indicator. It represents the volume of output produced per unit of labour input. The ratio between output and labour input depends to a large degree on the presence of other inputs, such as physical capital and increasingly intangible fixed assets used in production, and technical efficiency and organisational change. Labour productivity is a key dimension of economic performance and an essential driver of changes in living standards.

### Key findings

In countries with relatively low labour productivity levels, stronger labour productivity growth over the last two decades has helped to reduce the productivity gap, especially in many Eastern European economies and Korea. However their labour productivity levels remain below the OECD average and post crisis rates of convergence have slowed. Labour productivity growth has also been relatively weak in the United States and in some large European economies – Italy and the United Kingdom – compared with the OECD average. In Ireland, corporate restructuring, including through the relocation of firms with significant intellectual property assets and aircraft leasing companies, led to significant increases in GDP and labour productivity in 2015.

### *Definition*

Labour productivity is defined as GDP per hour worked. GDP is measured as gross value added in market prices. For international comparisons of labour productivity levels, the series of GDP in national currency and at current prices are converted to a common currency, US dollars, using current *Purchasing Power Parities* (PPPs). Growth rates of labour productivity, instead, are based on measures of GDP in national currency and at constant prices.

In productivity analysis, and ignoring quality differences for the moment, labour input is most appropriately measured as the total number of hours actually worked, this is, effectively used in production, whether paid or not (System of National Accounts 2008, 2008 SNA, 19.47). Hours actually worked reflect regular hours worked by full-time and part-time workers, paid and unpaid overtime, hours worked in additional jobs, excluding time not worked because of public holidays, annual paid leaves, strikes and labour disputes, bad weather, economic conditions, among other reasons (Chapter 6).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

GDP measures follow the 2008 SNA, except for Chile and Colombia, which follow the 1993 SNA, and for the Russian Federation, which follows the 1993 SNA (for data up to 2013) and the 2008 SNA (from 2014 onwards) (Chapter 6).

In most countries, the primary sources for measuring hours actually worked are labour force surveys. However, several countries rely -only or in addition- on establishment surveys and administrative sources (Chapter 6). The use of different sources may affect the comparability of labour productivity levels but comparisons of labour productivity growth are less likely to be affected.

In practice, the effective quantity of labour input depends not only on the total number of hours actually worked but also on the education, working experience, business functions and other worker characteristics. The measure of labour input used in this publication, i.e. total hours worked, does not account for the composition of the labour force and likely underestimate the effective use of labour in production affecting cross-country comparability.

### *Sources and further reading*

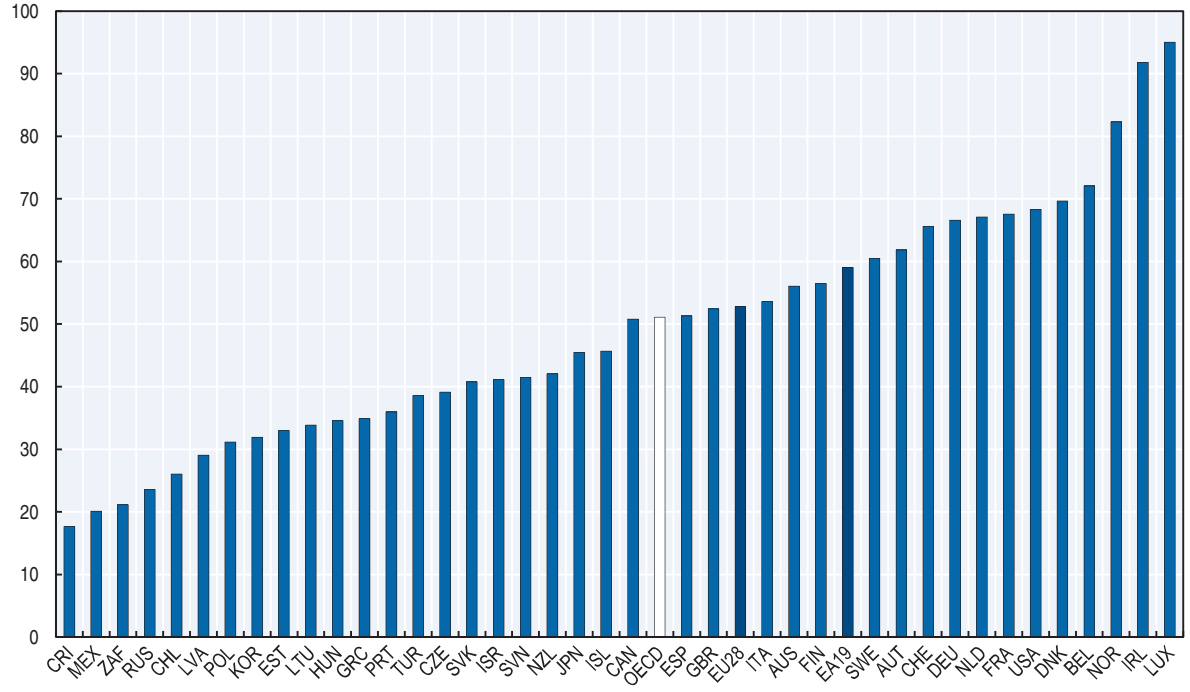
*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

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*.

OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

Figure 2.7. **Labour productivity, 2015**

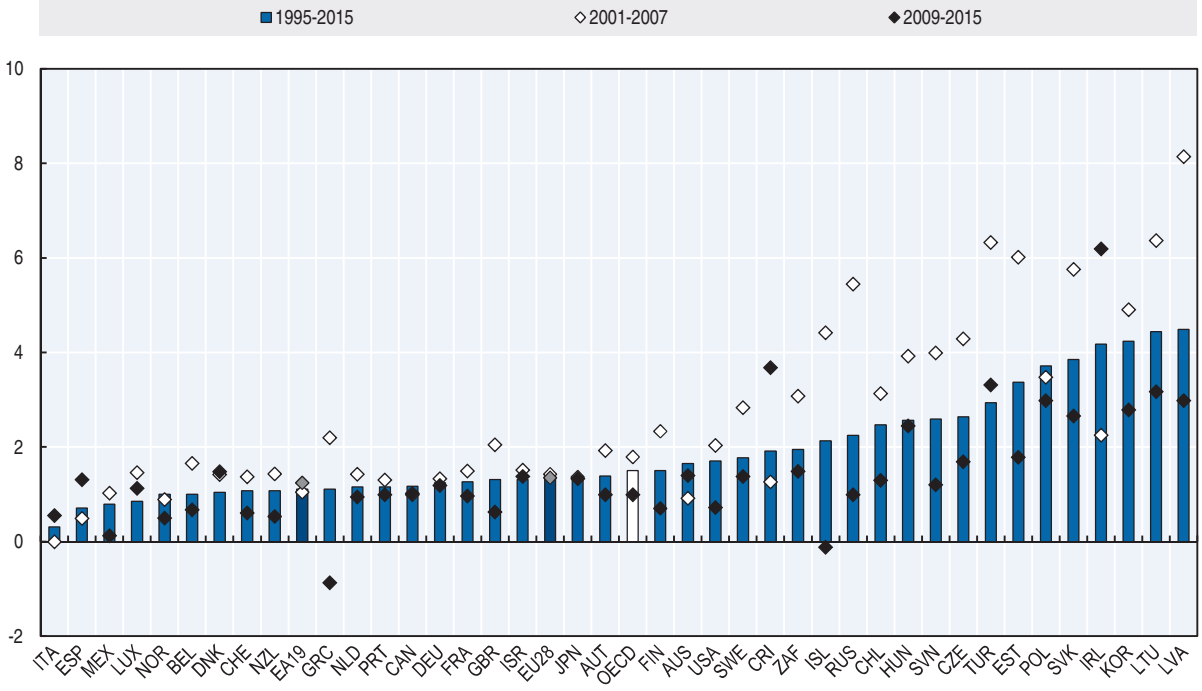
GDP per hour worked, total economy, US dollars, current prices and current PPPs




StatLink http://dx.doi.org/10.1787/888933477196

Figure 2.8. **Growth in labour productivity**

GDP per hour worked, total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477200

## Alternative measures of labour productivity

Labour productivity is most appropriately measured as a volume of output generated per hour worked. However the number of persons employed (i.e. total employment) is often used as a proxy for labour input, in particular, when data on total hours worked cannot be estimated.

**Key findings**

International and inter-temporal comparisons of labour productivity can differ depending on the measures of labour input used. For example, higher incidences of part-time employment in Germany and the Netherlands, or lower statutory hours, for example in France, are likely to result in lower international rankings of labour productivity for these countries, when calculated on a head-count basis, compared with measures based on hours worked. The opposite is true for countries with longer statutory hours or average working weeks (like Costa Rica, Chile, Eastern European economies, Mexico, South Africa and Turkey), or with a lower incidence of part-time employment (Eastern European countries, the Russian Federation and South Africa).

Over the period 2001-2015, GDP per hour worked increased more rapidly than GDP per person employed in nearly all countries, partly reflecting the increasing incidence of part-time employment and declines in statutory hours.

### *Definition*

Total employment is measured as the total number of persons engaged in production, including both employees and self-employed.

Hours worked refer to the total number of hours actually worked, whether paid or not, by both employees and self-employed. They reflect regular hours worked by full-time and part-time workers, paid and unpaid overtime, hours worked in additional jobs, excluding time not worked because of public holidays, annual paid leaves, strikes and labour disputes, bad weather, economic conditions, among other reasons (Chapter 6).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

Variations in working patterns (e.g. part-time vs full time employment) and employment legislations (e.g. statutory hours) across countries and over time affect the time consistency and cross-country comparability of total employment figures, justifying, when possible, the use of total hours worked as a measure of labour input.

The preferred source for total employment is *OECD National Accounts Statistics* (database). For some countries, however, longer time series and/or more recent estimates need to be derived from the *OECD Employment and Labour Market Statistics* (database), the *OECD Economic Outlook: Statistics and Projections* (database) and national statistics office websites (Chapter 6).

### *Sources and further reading*

*OECD Economic Outlook: Statistics and Projections* (database), *http://dx.doi.org/10.1787/eo-data-en*.

*OECD Employment and Labour Market Statistics* (database), *http://dx.doi.org/10.1787/lfs-data-en*.

*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

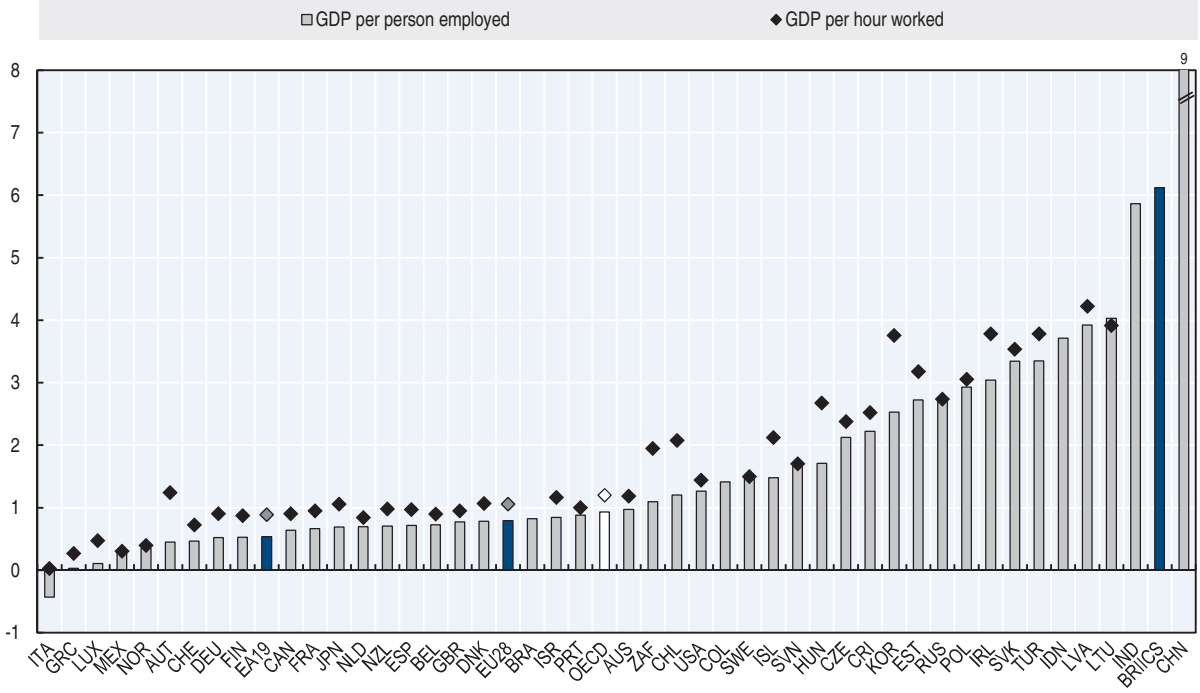
Figure 2.9. **GDP per hour worked and GDP per person employed, 2015**

As percentage of the OECD average (OECD=100), current prices and current PPPs


StatLink http://dx.doi.org/10.1787/888933477215

Figure 2.10. **Growth in GDP per hour worked and growth in GDP per person employed, 2001-15**

Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477227

## Alternative measures of income

It is a stylised fact that intangible capital plays an increasingly important role in growth and productivity. But less well known are the potential measurement challenges these bring, in particular with regards to whether the underlying use of the intangible is recorded in the accounts as generating cross-border services flows – which increase gross domestic product (GDP) – or cross-border flows of primary income, recorded in gross national income (GNI). This matters for labour productivity measures. In this regard, productivity measures based on GNI are able to provide a complementary view that may shed light on possible measurement distortions.

**Key findings**

In most countries labour productivity measures based on GDP and GNI are similar, as the underlying income flows are relatively small or offset each other. In Ireland and Luxembourg, however, significant differences arise between the two measures reflecting the significant role played by multinationals with high intellectual property content in generating value added, and in turn the significant redistribution of that value added to shareholders, and often parents, as income flows.

### *Definition*

GNI is defined as GDP plus net receipts from abroad of compensation of employees and 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. Compensation of employees from abroad is that earned by residents who essentially live and consume inside the economic territory but work abroad. They also include compensation of employees earned by non-residents who live and work abroad only for short periods (seasonal workers).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

There are practical difficulties in the measurement of both international flows of compensation of employees 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. Measures of labour productivity based on GNI in part "correct" for these potential inconsistencies.

Some care is also needed when interpreting productivity in countries with high numbers of cross-border workers. 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.

### *Sources and further reading*

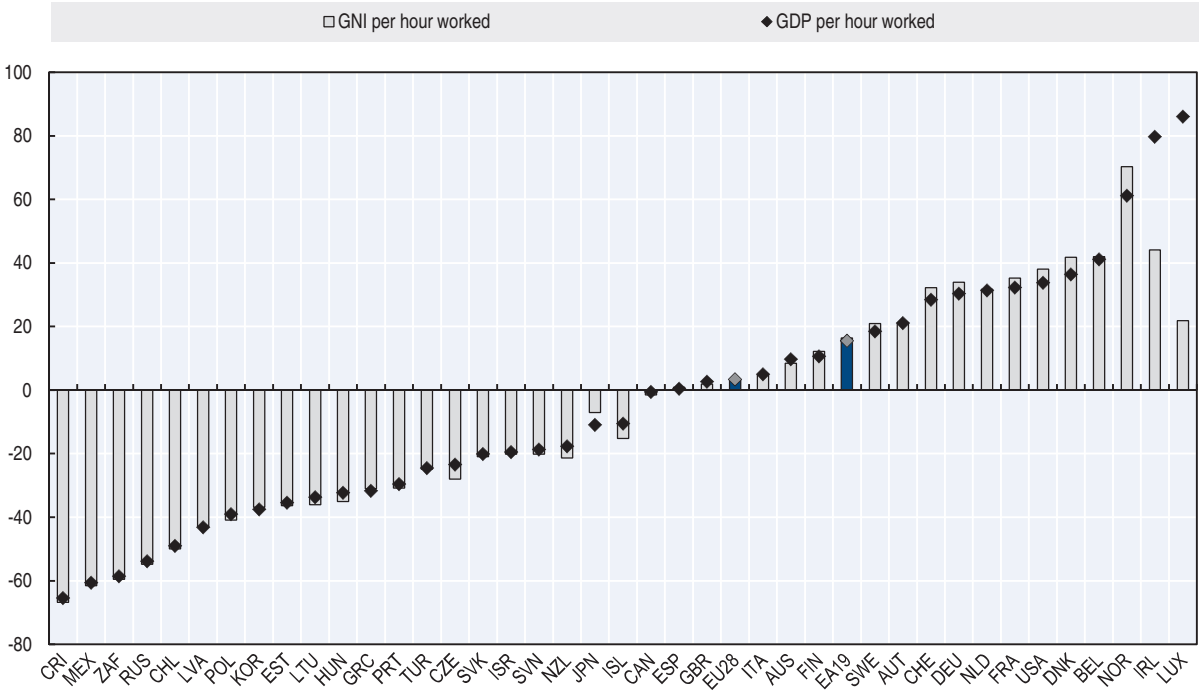
*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

*OECD Productivity Statistics* (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*.

## Figure 2.11. **GDP and GNI per hour worked, 2015**

Percentage point difference from the OECD (OECD = 0), current prices and current PPPs

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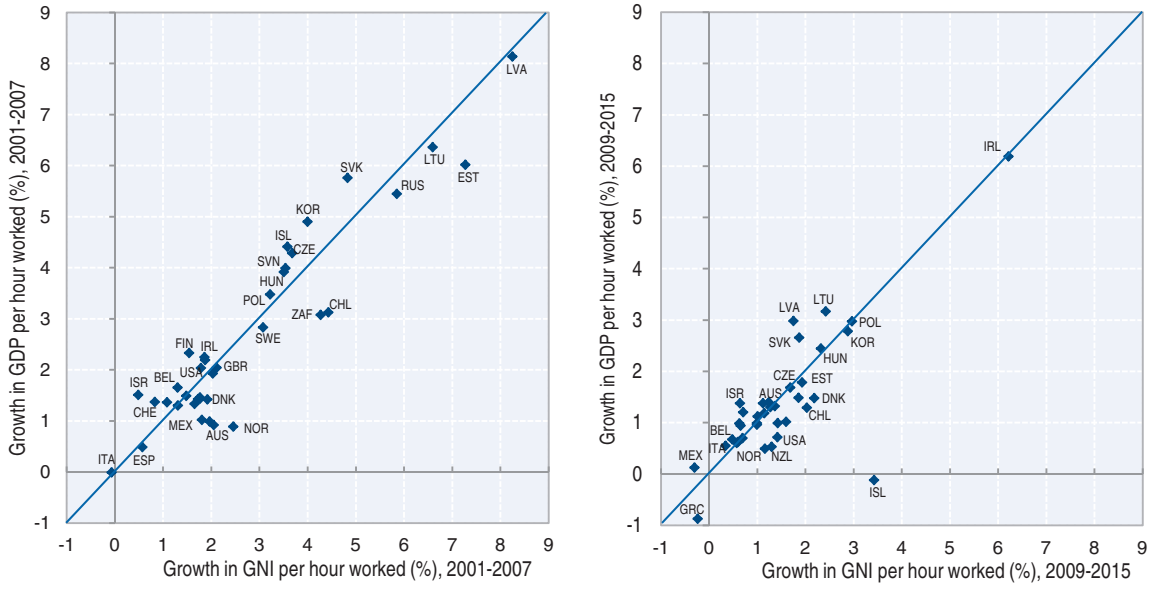
## Figure 2.12. **Growth in GDP per hour worked and growth in GNI per hour worked**

Total economy, percentage change at annual rate

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## Capital productivity and the role of ICT and intangible assets

Capital productivity shows how efficiently capital is used to generate output. Investment in information and communication technologies (ICT) enables new technologies to enter the production process and is seen as an important driver of productivity growth. Investment in intellectual property products, such as R&D, not only contribute to expand the technological frontier but also enhances the ability of firms to adopt existing technologies, playing an important role in productivity performance.

### Key findings

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 20 years. Some of the decline in overall costs of capital relates to ICT assets where new products' prices have typically fallen very rapidly, and which in turn may have spurred the increased use of ICT in production. In fact, the shares of ICT assets in total non-residential investment increased in nearly all countries over the last two decades.

However, the fall in capital productivity has been less pronounced after the crisis, partly reflecting the slowdown in capital services. This can be partly explained by the sluggish recovery of investment, in particular, in tangible assets, as investment in intellectual property products has been more resilient to the crisis, possibly reflecting their less cyclical nature due to the higher sunk costs. Indeed, while there are still significant differences across countries, investment in intellectual property products, in particular, in R&D, has accounted for an increasing share of total investment in most of them over the past 20 years.

### *Definition*

Capital productivity is measured as the ratio between the volume of output, measured as GDP, and the volume of capital input, defined as the flow of productive services that capital delivers in production, i.e. capital services (Chapter 6).

Series of gross fixed capital formation by asset type are used to estimate productive capital stocks and to compute an aggregate measure of total capital services, in line with the asset boundary of the System of National Accounts 2008 (*2008 SNA*). ICT capital includes: i) computer hardware; ii) telecommunications equipment; and iii) computer software and databases. Non-ICT capital includes: i) non-residential construction, ii) transport equipment; iii) other machinery and equipment and weapons systems; iv) R&D; v) other intellectual property products.

While the 2008 SNA recognises a number of intellectual property assets (i.e. R&D, computer software and databases, mineral exploration and evaluation costs and artistic and literary originals), other forms of knowledge-based assets such as organisational capital, brand-equity, copyrights and design, can play an important role for GDP growth and productivity. Their exclusion from the SNA asset boundary, and therefore from the capital services measures here presented, relies on the practical difficulties involved in their measurement.

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

Countries use different approaches to deflate ICT investment, where constant quality price changes are particularly important but difficult to measure, and assume different depreciation rates and assets' service lives. To counteract for these differences, the OECD computes aggregate measures of capital services using a set of harmonised ICT investment deflators as well as common depreciation rates and average service lives for the different assets across countries (Schreyer, 2004).

### *Sources and further reading*

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

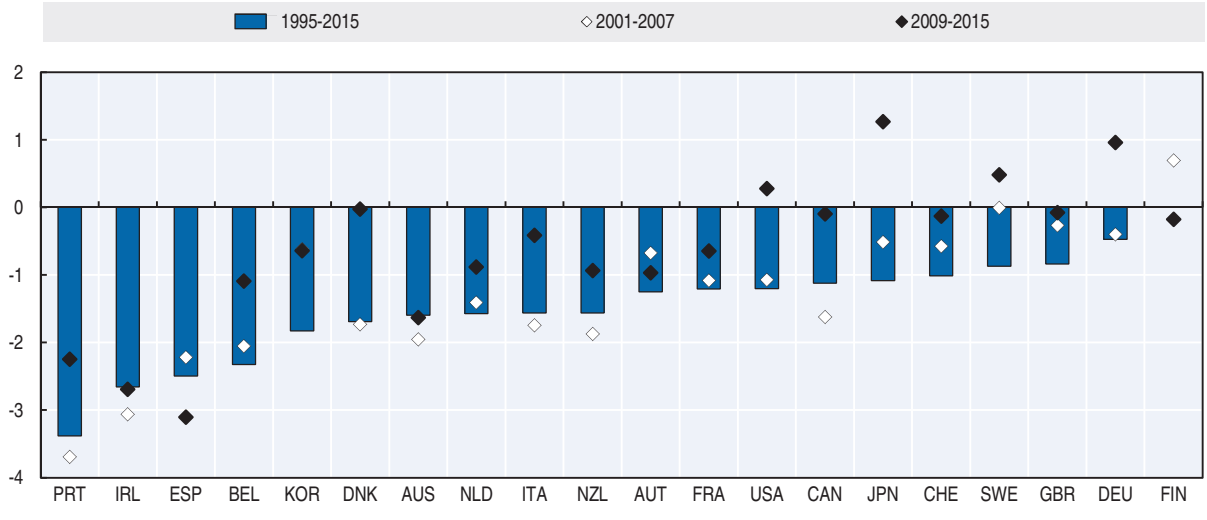
OECD (2009), *Measuring Capital – OECD Manual*, *http://dx.doi.org/10.1787/9789264068476-en*.

OECD (2009), *Handbook on Deriving Capital Measures of Intellectual Property Products*, *http://dx.doi.org/10.1787/9789264079205-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/eco_studies-v2003-art11-en*.

Figure 2.13. **Growth in capital productivity**

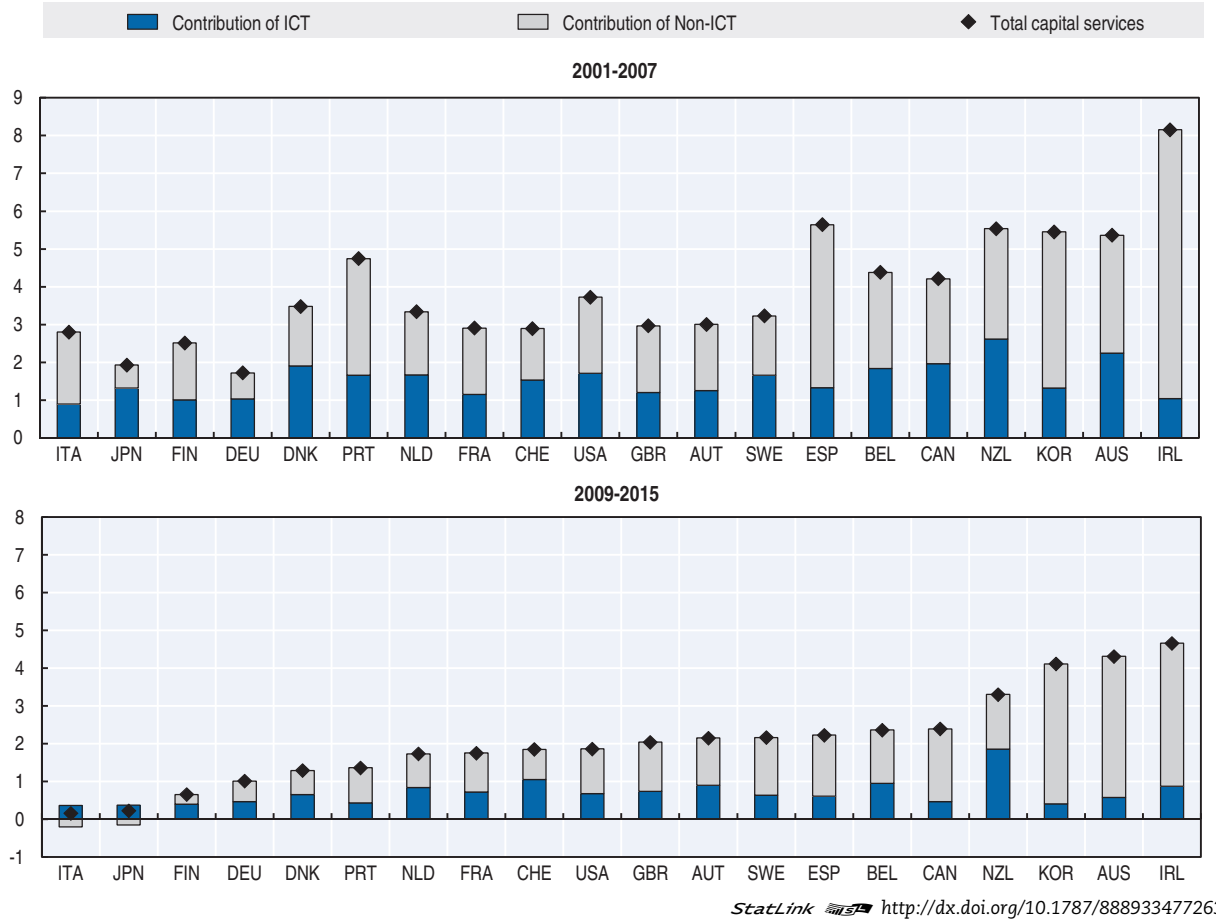
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477259

Figure 2.14. **Contributions of ICT and non-ICT capital to total capital services**

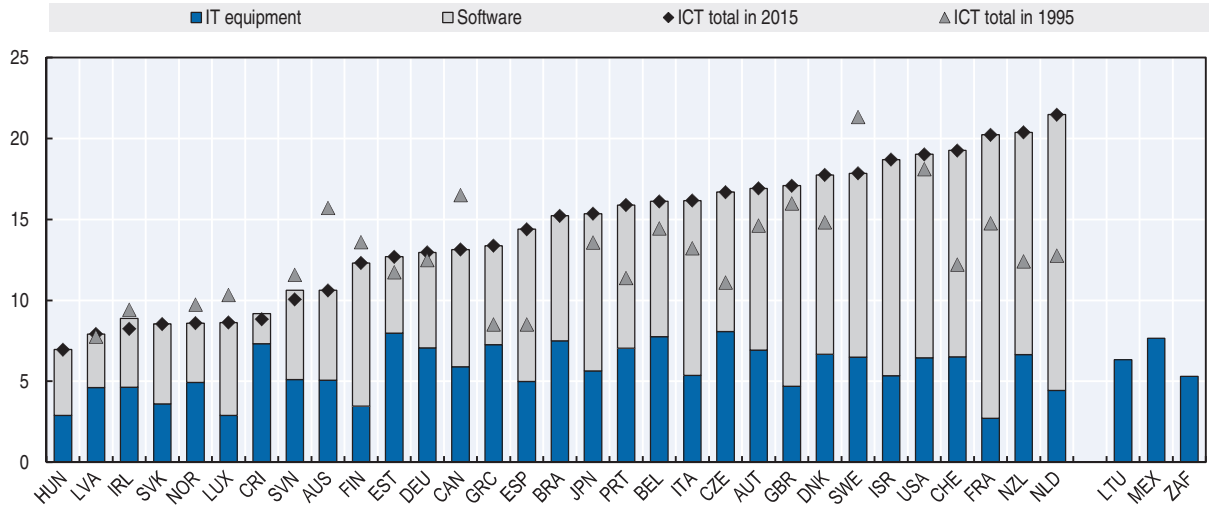
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477263

## Figure 2.15. **Share of ICT investment**

Total economy, current prices, as a percentage of non-residential gross fixed capital formation

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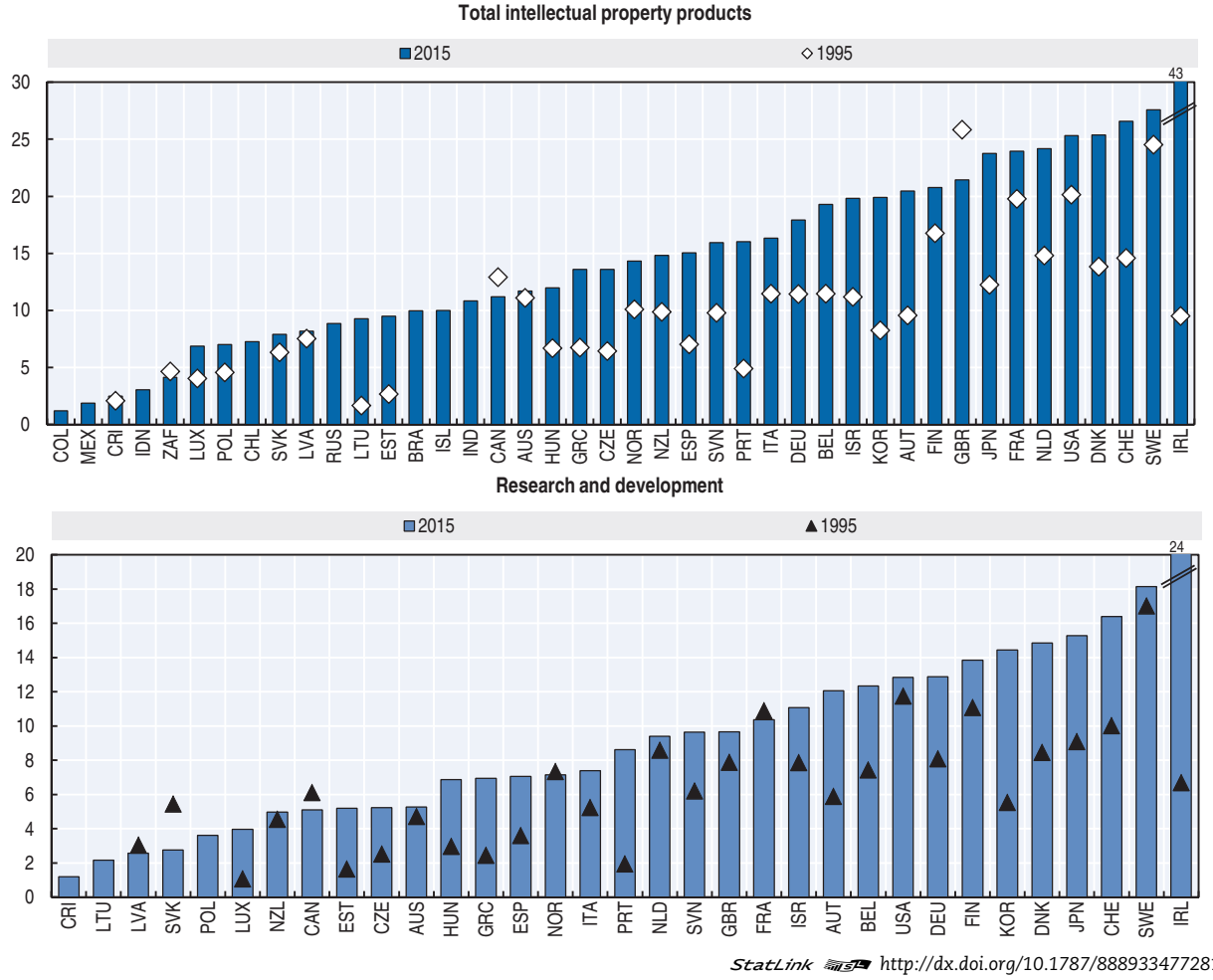
## Figure 2.16. **Share of investment in intellectual property products**

Total economy, current prices, as a percentage of gross fixed capital formation




StatLink http://dx.doi.org/10.1787/888933477281

Figure 2.17. **Investment in tangible assets and intellectual property products**

Total economy, constant prices, index 2007 = 100

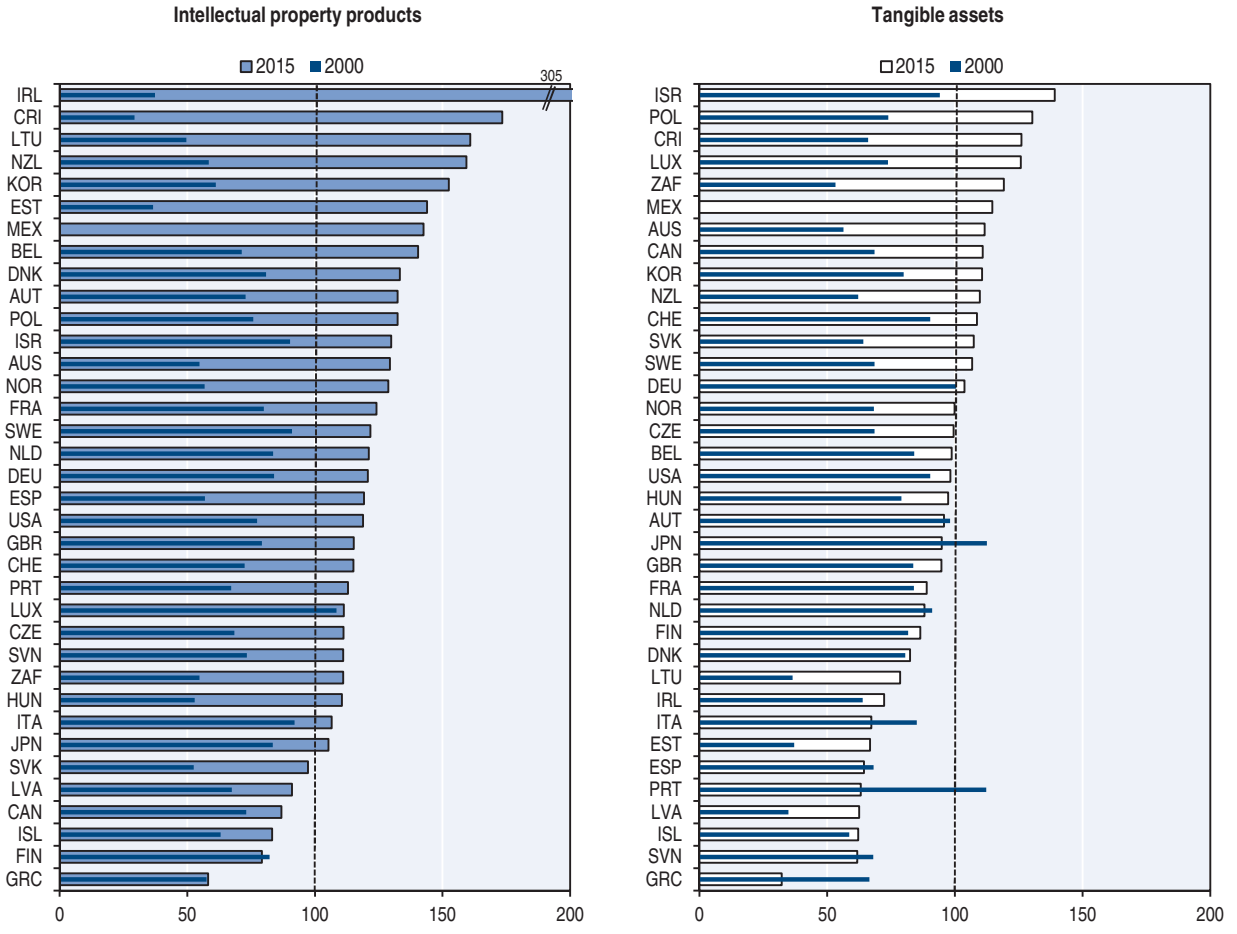



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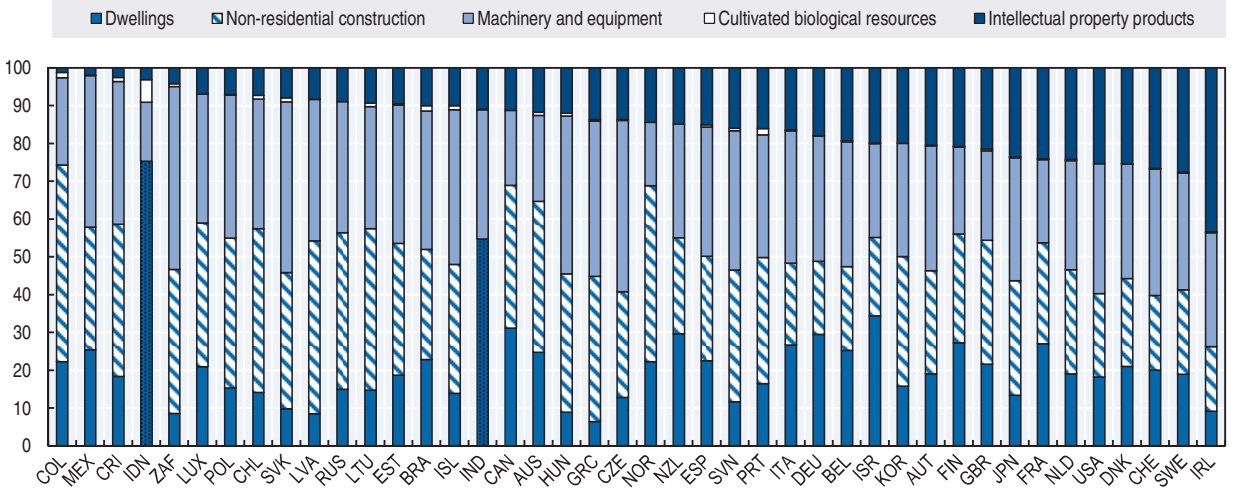
Figure 2.18. **Gross fixed capital formation by asset type, 2015**

Total economy, as a percentage of total gross fixed capital formation

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## Growth accounting

Economic growth can be fostered either by raising the labour and capital inputs used in production, or by improving the overall efficiency with which these inputs are used together, i.e. higher multifactor productivity growth (MFP). Growth accounting involves decomposing total output growth, measured here as GDP growth, into these three components. As such, it provides an essential tool for policy makers to identify the underlying drivers of growth.

**Key findings**

Over the past 15 years, capital services and MFP accounted for the largest part of GDP growth in most OECD countries. ICT capital services represented between 0.2 and 0.6 percentage point of growth in GDP, with the largest contributions recorded in New Zealand and Sweden, and the smallest in Finland and Italy. Growth in labour input was important for very few countries between 1995 and 2015, notably Australia and New Zealand, while non-ICT capital accounted for 40% of GDP growth in Spain and more than 60% in Portugal. Over the same period, MFP growth was a significant source of GDP growth in Finland, Germany, Japan and Korea, but was negligible in Belgium, Denmark and Portugal, and negative in Italy and Spain.

However, when contributions to GDP growth are analysed before and after the crisis, important differences arise. The slowdown in GDP growth over the period 2009-2015 was driven by the negative contribution of labour input in Italy, Portugal, Spain, and, to a lesser extent, Ireland, and by the smaller contribution of MFP in Austria, Belgium, Finland, Korea, the United Kingdom and the United States. However, over the same period, GDP growth was driven by the larger contribution of labour input in Sweden, the United Kingdom and the United States, partly reflecting higher employment rates, and by higher MFP growth in Canada, Denmark, Germany and Japan.

### *Definition*

GDP growth can be decomposed into a labour input component, a capital input component and MFP growth, computed as a residual (Chapter 6). 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 of production. 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 with more traditional assets (non-ICT).

### *Comparability*

In productivity analysis, the appropriate measure for capital input is the flow of capital services, this is, the flow of productive services that can be drawn from the cumulative stock of past investments in capital assets. Conceptually, capital services reflect a quantity, or physical concept, not to be confused with the value, or price concept of capital. To illustrate, the services flows provided by a taxi relate to the number of trips, distance driven, comfort of the taxi, etc., rather than the value of the motor vehicle. These services are estimated using the rate of change of the productive capital stock of different capital goods (Chapter 6).

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, such as those due to higher educational attainment and work experience. In the absence of these adjustments, as is the case in the series presented here, more rapid output growth due to a rise in workers skills is captured by the MFP, rather than being attributed to the labour input.

### *Sources and further reading*

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

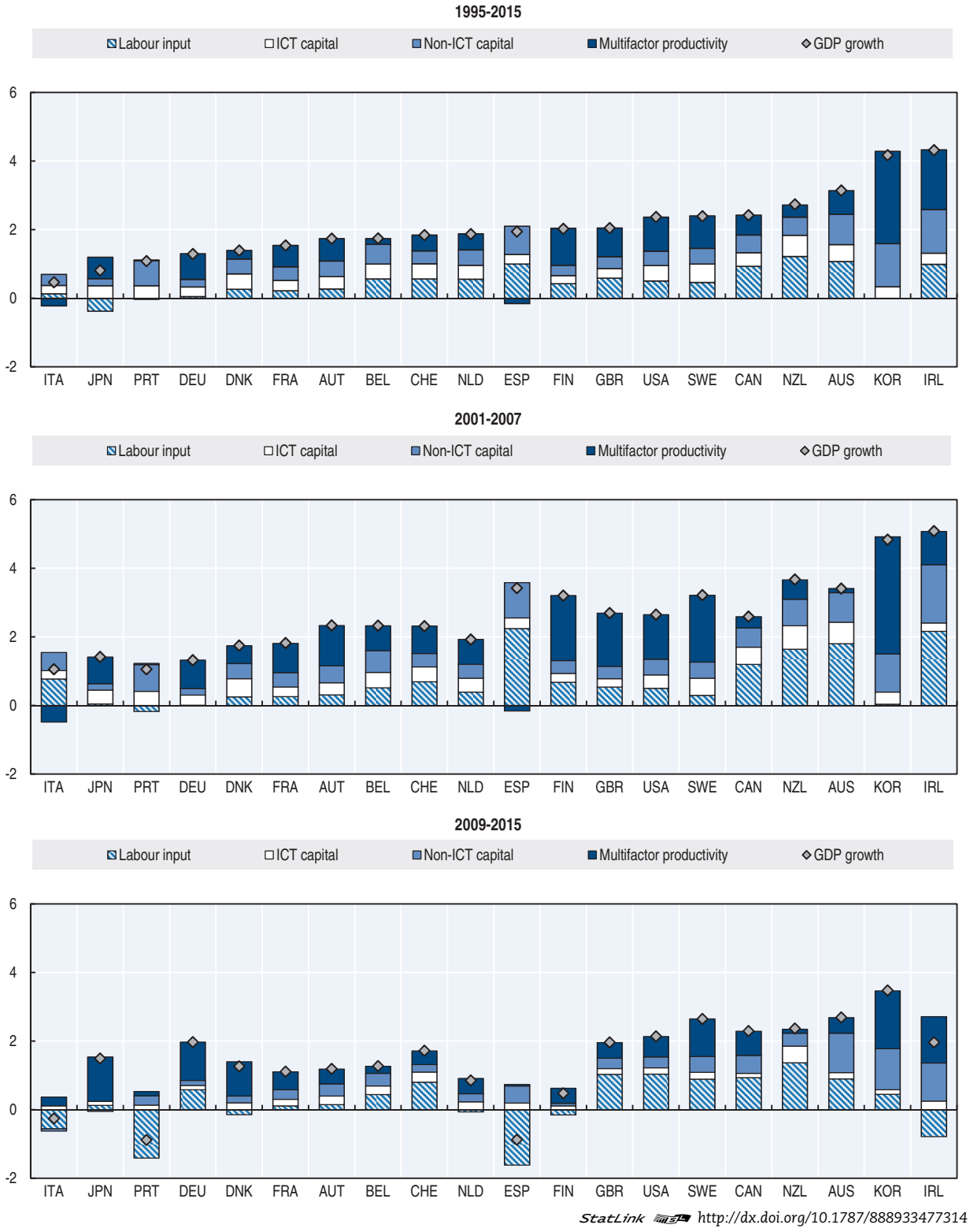
OECD (2009), *Measuring Capital – OECD Manual*, *http://dx.doi.org/10.1787/9789264068476-en*.

Schreyer, P. (2004), "Capital Stocks, Capital Services and Multi-Factor Productivity Measures", *OECD Economic Studies*, Vol. 2003/2, *http://dx.doi.org/10.1787/eco_studies-v2003-art11-en*.

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 2.19. **Contributions to GDP growth**

Total economy, annual percentage point contribution

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## Multifactor productivity

Multifactor productivity (MFP) reflects the overall efficiency with which labour and capital inputs are used together in the production process. Labour productivity growth represents a higher level of output for every hour worked. This can be achieved if more capital per labour unit, i.e. capital deepening, is used in production, or by improving the overall efficiency with which labour and capital are used together, i.e. higher MFP.

### Key findings

Over the past two decades, MFP growth varied considerably among OECD countries. Italy and Spain recorded the lowest (and negative) rates, lagging far behind the top performers Korea and Ireland. MFP growth decelerated in nearly all countries after the crisis compared with the period 2001-2007, with significant slowdowns in Finland, Sweden and the United Kingdom.

Large differences in MFP growth heavily affected labour productivity growth differentials. Prior to the crisis, relatively high MFP growth in most OECD countries contributed strongly to labour productivity growth, compared with the contributions of ICT and non-ICT capital deepening. In the post-crisis period, MFP appears to have moved pro-cyclically in most countries, as reflected by the slowdown in MFP growth and its much lower contribution to labour productivity growth, notably in Finland, Sweden, the United Kingdom and the United States.

### *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 changes in the ratio of the total volume of capital services to total hours worked. Its contribution to labour productivity growth is calculated by weighting it with the share of capital costs in total costs (Chapter 6).

### *Comparability*

Growth in MFP is measured as a residual, i.e. that part of GDP growth that cannot be explained by growth in labour and capital inputs. Traditionally, MFP growth is seen as capturing technological progress but, in practice, this interpretation needs some caution. Some part of technological change is embodied in capital input, e.g. improvements in design and quality between two vintages of the same capital asset, and so its effects on GDP growth are attributed to the respective factor. The measure of capital services in the *OECD Productivity Statistics* (database) takes explicit account of different productivities across assets, and price indices of ICT assets are adjusted for quality changes (Chapter 6). Therefore, MFP only picks up disembodied technical change, e.g. network effects or spillovers from production factors, the effects of better management practices, brand names, organisational change and general knowledge.

Moreover, MFP also captures other factors such as adjustment costs, economies of scale, effects from imperfect competition and measurement errors. For instance, increases in educational attainment or a shift towards a more skill-intensive production process, if not captured in the form of quality adjusted labour input – as is the case here – are captured by the MFP.

### *Sources and further reading*

OECD, *OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

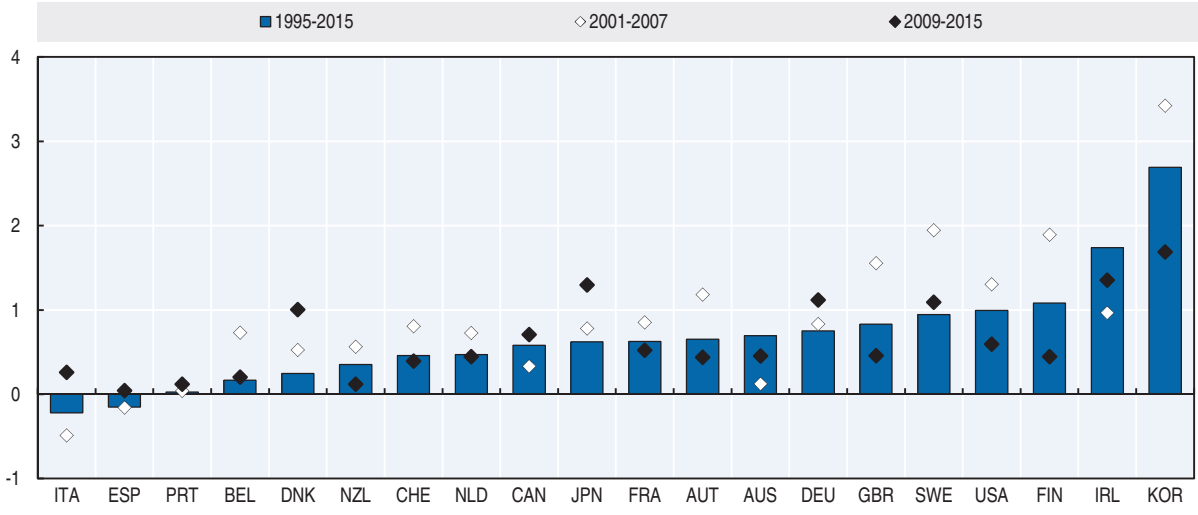
OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

Schreyer, P. (2004), "Capital Stocks, Capital Services and Multi-Factor Productivity Measures", *OECD Economic Studies*, Vol. 2003/2, *http://dx.doi.org/10.1787/eco_studies-v2003-art11-en*.

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 2.20. **Multifactor productivity growth**

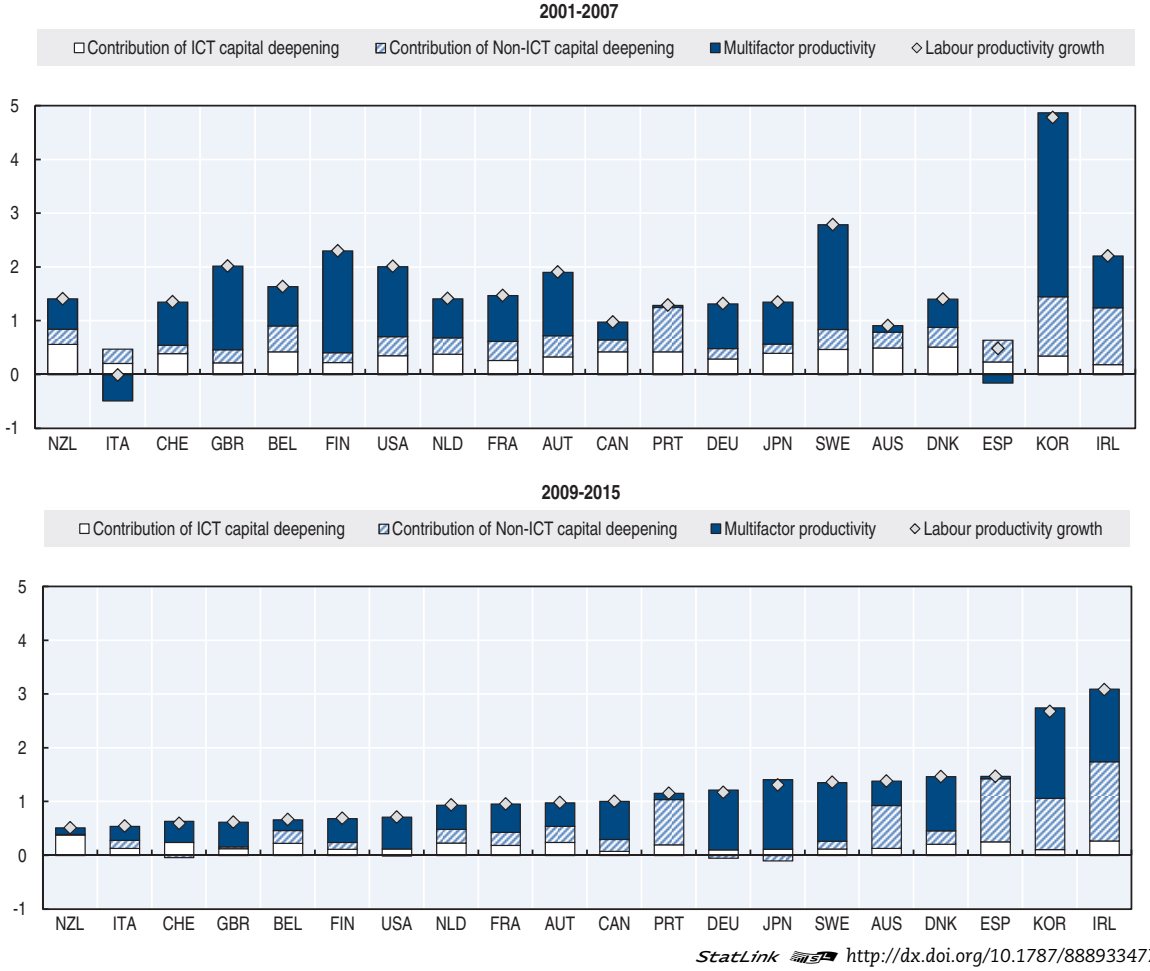
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477326

Figure 2.21. **Contributions to labour productivity growth**

Total economy, annual percentage point contribution

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*Chapter 3*

# Productivity by industry

## Labour productivity by main economic 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 skilled labour and physical and knowledge-based capital in their production, the scope for product and process innovation, the absorption of external knowledge, the degree of product standardisation, the scope for economies of scale, and the exposure to international competition through their participation in global value chains.

### Key findings

Differences in productivity growth rates across countries at the total economy level cannot be explained by differences in economic structures alone as even at the sectoral level significant differences in productivity growth exist across countries; although in general, in most countries, the growth rates in the manufacturing sector have typically outpaced those in the services sector. For instance, between 2009 and 2015, labour productivity growth rates in manufacturing ranged from 0.35% in New Zealand to 9% in the Slovak Republic. In Ireland, corporate restructuring, including through the relocation of firms with significant intellectual property assets and aircraft leasing companies, led to significant increases in labour productivity in 2015.

Compared with pre-crisis rates, labour productivity in manufacturing slowed in most OECD countries after the crisis, particularly in the Czech Republic, Finland and Korea. In business sector services, labour productivity also slowed after the crisis, notably in Estonia, Greece, Latvia and, to a lesser extent, the United Kingdom.

### *Definition*

Labour productivity is defined as real gross 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 covers wholesale and retail trade, repair of motor vehicles and motor cycles; accommodation and food services; transportation and storage; information and communication services; financial and insurance activities; and professional, scientific and support activities. This publication presents sectoral productivity growth for those countries for which sectoral data for real gross value added (in basic prices) and total hours worked by all persons employed (employees and self-employed) are available by ISIC Rev.4 breakdown in the *OECD National Accounts Statistics* (database).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added. This is particularly relevant for services, as measurement of price changes is complicated by difficulties in identifying quality changes and the provision of bundled services (Chapter 6). In some industries, estimates of real value added may be based on a sum-of-costs approach, which deflates, using some assumptions, compensation of employees in the specific sector. For example, most countries assume no change in labour productivity for public administration activities, which is why this industry is not included here. Real estate services are also excluded, as their value added includes the imputation made for the dwelling services provided and consumed by home-owners.

### *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*.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

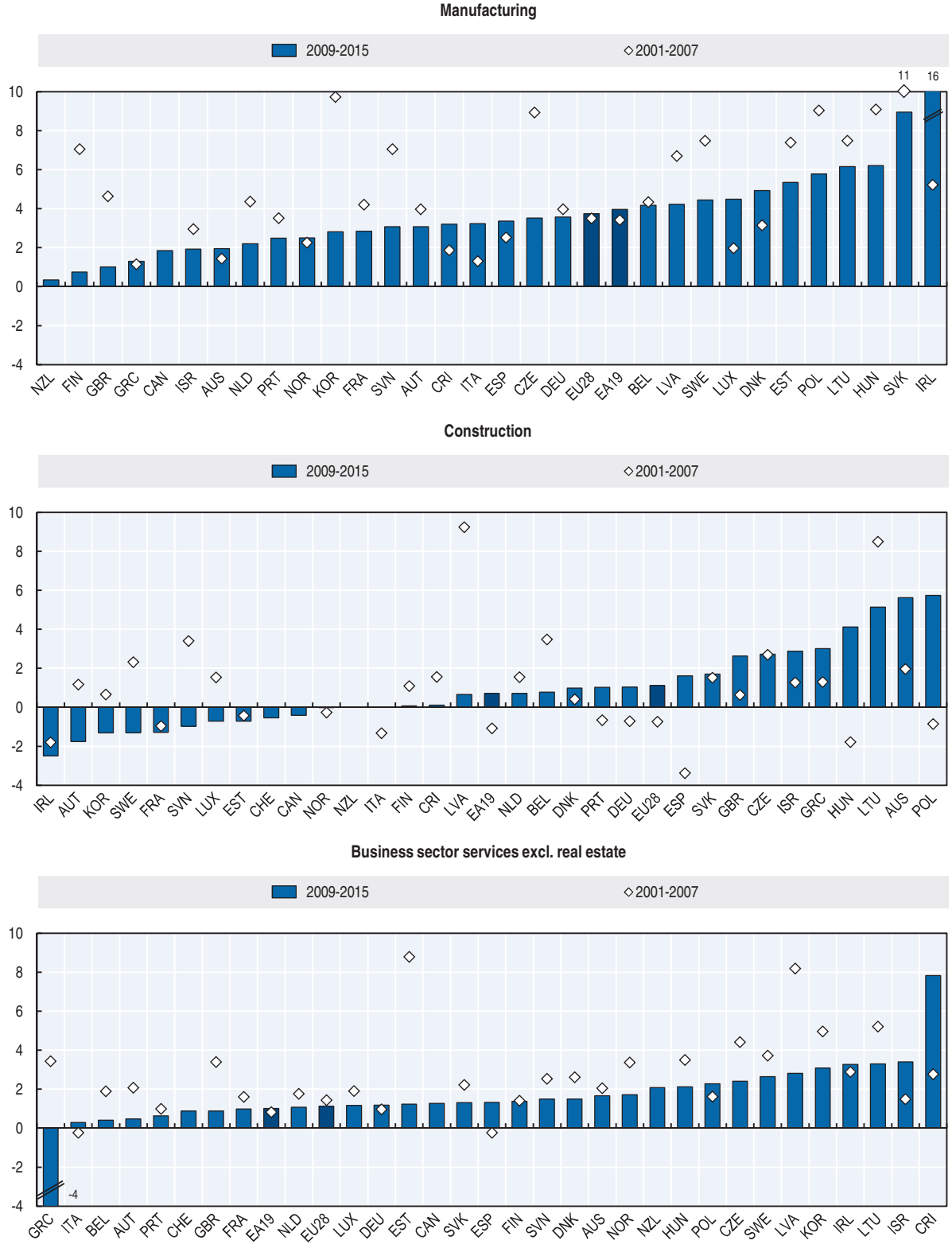
*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

Wölfl, A. (2003), "Productivity Growth in Service 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. **Labour productivity by main economic activity**

Real gross value added per hour worked, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477340

## Industry contribution to business sector productivity

Understanding the drivers of productivity growth in the business sector requires an awareness of the contribution that each industry makes. The contribution of an individual sector depends not only on its productivity growth but also on its share in total value added and total hours worked.

### Key findings

Over the past 15 years, labour 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 of the sector. In the case of business sector services, the strong contribution also reflects its increasing share in the overall economy. Excluding real estate, business sector services account for about 35 to 50% of total value added and total employment across OECD countries.

When contributions to business sector productivity growth are analysed before and after the crisis, important differences arise. In the Czech Republic, Finland, Slovenia and the Slovak Republic, the productivity slowdown was mainly driven by lower contributions from the manufacturing sector compared with the pre-crisis period. In the Baltic States, Greece and the United Kingdom, the slowdown was driven by lower contributions from business sector services.

### *Definition*

Labour productivity growth by industry is defined as the rate of change of real gross 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 real gross value added and hours worked by sector are available by ISIC Rev.4 breakdown in the *OECD National Accounts Statistics* (database). Hours worked comprises the total number of hours worked by all persons employed, i.e. employees and self-employed.

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

Business sector refers to non-agricultural business sector excluding real estate activities. Real estate activities are excluded, as value added in this sector includes the imputation made for the dwelling services provided and consumed by home-owners.

In addition to the difficulties encountered in measuring real value added, particularly in the services sector, it is also difficult to accurately measure nominal output in some cases. This is for example the case 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.

### *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*.

Inter-Secretariat Working Group on National Accounts (ISWGNA), Task Force on FISIM (2013), *Final Report*.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

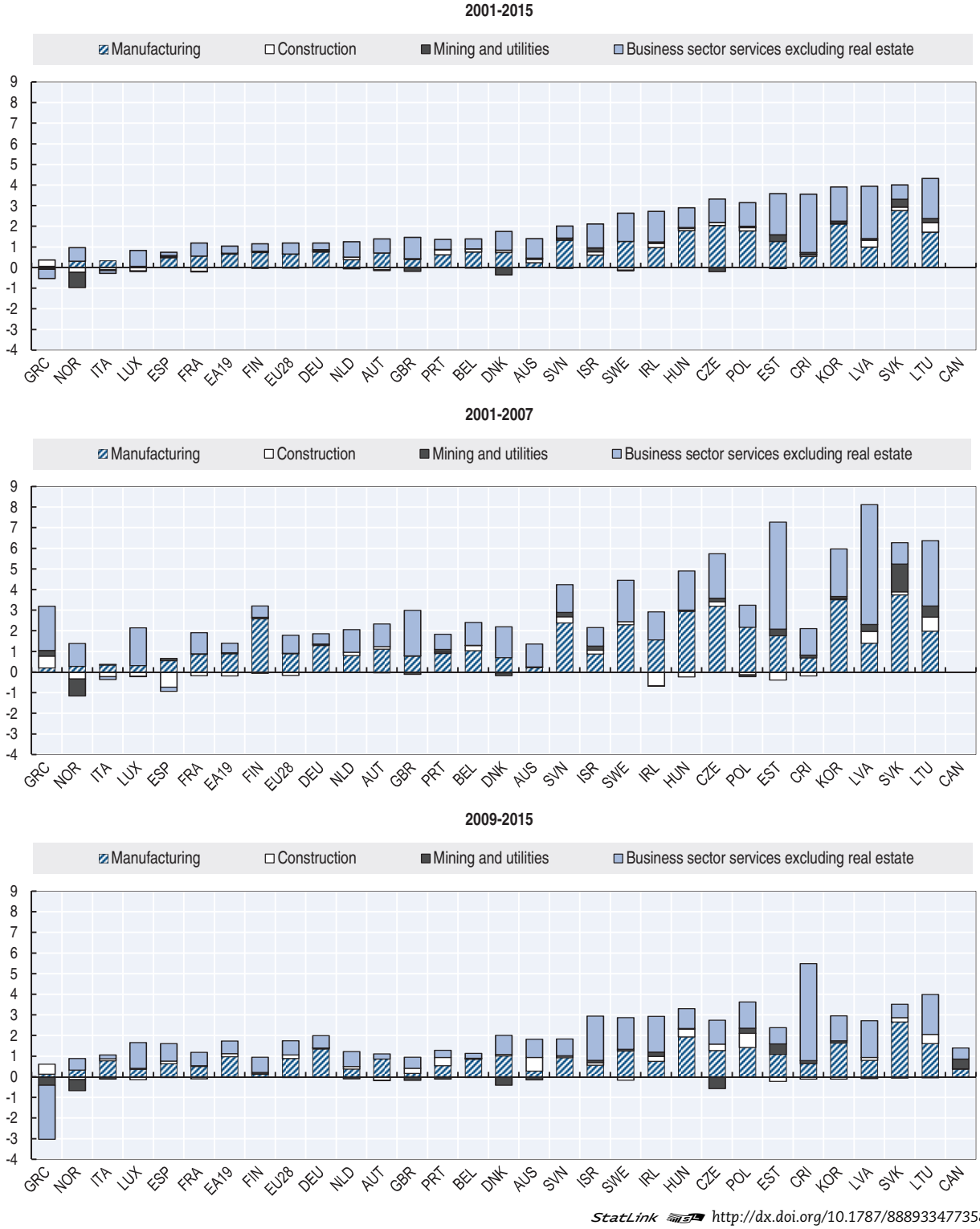
OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

Pilat, D. and 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*.

Wölfl, A. (2003), "Productivity Growth in Service 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 business sector productivity growth**

Real gross value added per hour worked, percentage point contribution at annual rate

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## Labour productivity of business sector services

Developments in information and communication technologies (ICT) combined with internationally fragmented production processes are making business services increasingly dynamic, transportable and tradeable. As a result, several business sector services show characteristics similar to high-productivity manufacturing industries; they intensively use ICT and knowledge-based capital, exploit economies of scale, and are increasingly exposed to international competition.

**Key findings**

Labour productivity growth varies substantially across business sector services. In the pre-crisis period, services that are traded internationally and thus with a higher exposure to international competition, such as information and communication services and finance and insurance activities, showed labour productivity growth rates that were as high as or even higher than those in the manufacturing sector. However, post the crisis, labour productivity growth in manufacturing was higher in most countries than in finance and insurance and information and communication services.

Labour productivity growth decelerated significantly in finance and insurance services in most countries, with negative growth rates in countries whose banking sectors were severely hit by the crisis, such as Portugal, Spain and the United Kingdom. Productivity growth also slowed considerably in information and communication services, especially in Austria, Estonia, Greece, Latvia and the Slovak Republic. Costa Rica and Ireland, on the other hand, recorded the highest labour productivity growth in information and communication services in the post-crisis period, reflecting increasing flows of high-tech foreign direct investment in the case of Costa Rica and IT multinationals in Ireland.

### *Definition*

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

The business sector services covers wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage as well as accommodation and food services – presented here as "distributive trade, repairs; transport; accommodation, food services" –; information and communication services; financial and insurance activities; and professional, scientific and support activities.

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added. This is particularly relevant for those business sector services where it is difficult to isolate price effects that are due to changes in the quality (or in the mix of services provided as a bundle) from pure price changes. Despite substantial progress made over the past 15 years in compiling service producer price indices (SPPIs), the methods used to compute constant price value added still vary across countries, affecting the measurement of productivity growth (Chapter 6).

Real estate activities are excluded from the business sector services, as their value added includes the imputation made for the dwelling services provided and consumed by home-owners.

Data on hours worked by sector are sourced from the *OECD National Accounts Statistics* (database). 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.

### *Sources and further reading*

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

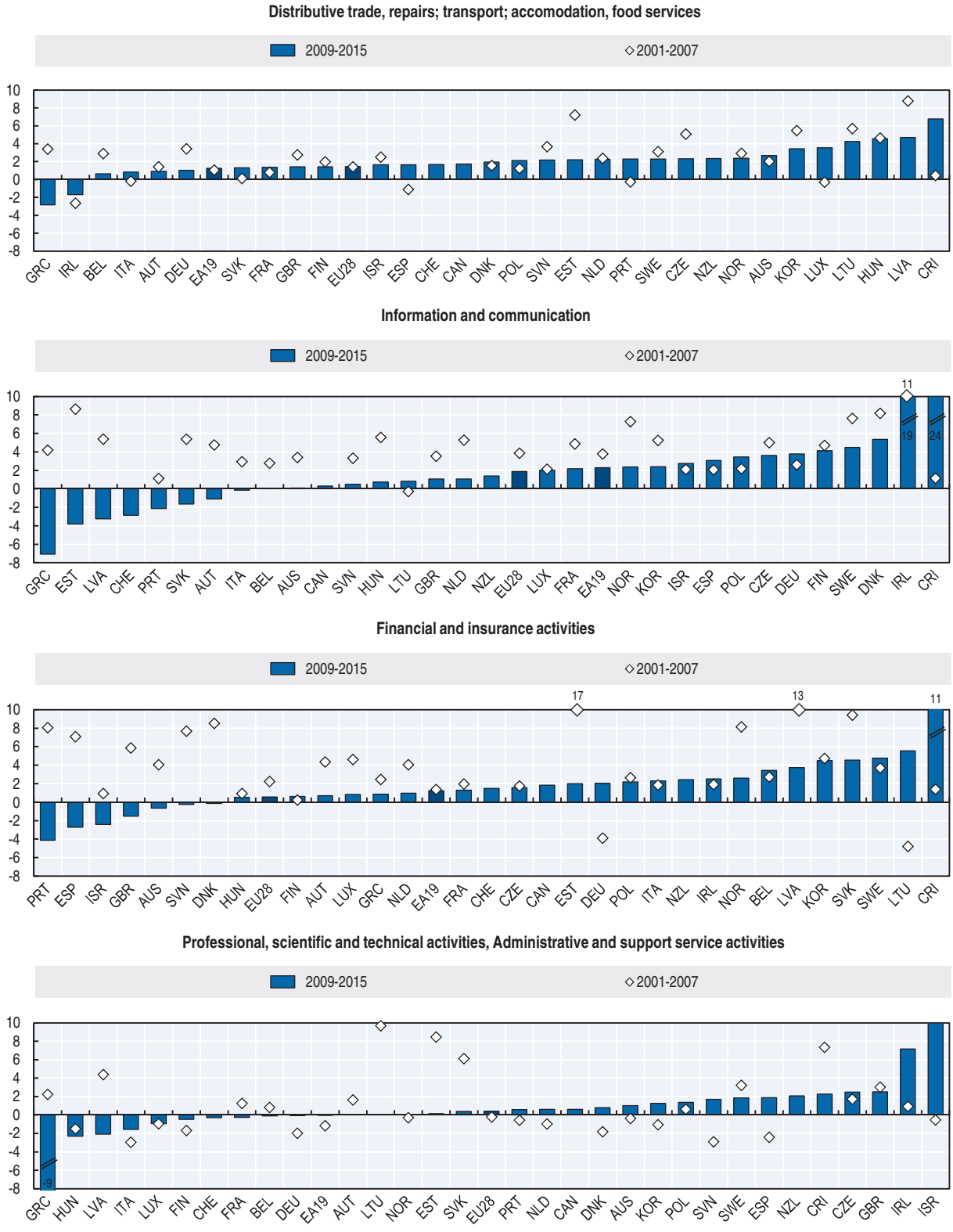
Pilat, D. and A. Wölfl (2005), "Measuring the Interaction between Manufacturing and Services", *OECD Science, Technology and Industry Working Paper* 2005-5, *http://dx.doi.org/10.1787/882376471514*.

Wölfl, A. (2005), "The Service Economy in OECD Countries", *OECD Science, Technology and Industry – Working Paper* 2005-3, *http://dx.doi.org/10.1787/212257000720*.

Wölfl, A. (2003), "Productivity Growth in Service 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. **Labour productivity by business sector services**

Real gross value added per hour worked, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477368

## Contributions to business sector 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, also in the manufacturing sector. This process of outsourcing activities previously conducted in-house has increased efficiencies, and hence, labour productivity, of both outsourcing firms and specialised intermediary firms. Over the long term, this 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.

### Key findings

For most OECD countries, labour productivity growth in the business sector services over the past 15 years was mainly driven by distributive trade, hotels and transport services, and finance and insurance activities. In the case of finance and insurance services, this mainly reflected strong productivity growth. For trade, hotels and transport services, it was essentially due to the large shares of this sector in total business sector services value added and hours worked.

However, since the crisis, the contribution to business services' labour productivity growth by the information and communication and finance and insurance sectors slowed sharply in most OECD countries.

### *Definition*

The contribution of each services sector to labour productivity growth of the total business sector services is computed as the weighted difference between the growth rate of real gross value added and that of hours worked. The weights are computed as each individual sector's share in nominal gross value added and total hours worked respectively of total business sector services. Business sector services include wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage as well as accommodation and food services – presented here as "trade, hotels and transport" –; information and communication services; financial and insurance activities; and professional, scientific and support activities – reported here as "professional services".

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

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

### *Sources and further reading*

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

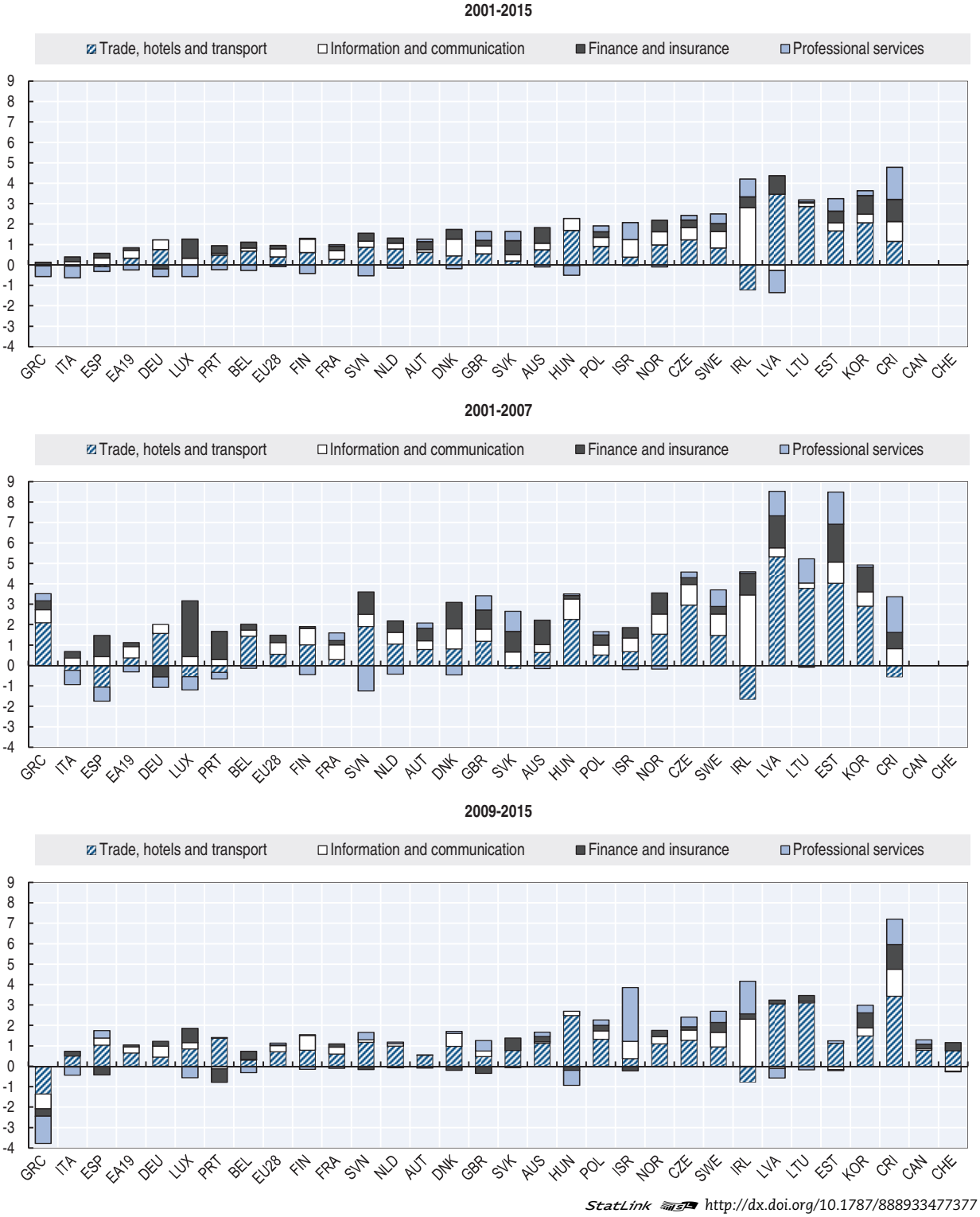
Pilat, D. and A. Wölfl (2005), "Measuring the Interaction between Manufacturing and Services", *OECD Science, Technology and Industry Working Paper* 2005-5, *http://dx.doi.org/10.1787/882376471514*.

Wölfl, A. (2005), "The Service Economy in OECD Countries", *OECD Science, Technology and Industry – Working Paper* 2005-3, *http://dx.doi.org/10.1787/212257000720*.

Wölfl, A. (2003), "Productivity Growth in Service 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 3.4. **Contributions to productivity growth of business sector services**

Real gross value added per hour worked, percentage point contribution at annual rate




StatLink http://dx.doi.org/10.1787/888933477377

## Productivity by enterprise size

Many examples of productivity analyses typically focus on relatively aggregated industries, masking the heterogeneity in productivity among firms within the same sector and, in particular, the contribution of SMEs, recognised as important drivers of growth as they scale-up. In this sense, firm heterogeneity matters for productivity. To the extent that large firms can exploit increasing returns to scale, productivity tends to increase with firm size. However, new small firms are often found to spur aggregate productivity growth as they enter with new technologies and stimulate productivity-enhancing changes by incumbents.

### Key findings

Larger firms are on average more productive than smaller ones, particularly in the manufacturing sector, partly reflecting increasing returns to scale, for instance, through capital intensive production. But smaller firms can outperform larger firms, particularly in the services sector, reflecting competitive advantages in niche, high brand or high intellectual property content activities as well as the intensive use of affordable ICT. In most countries, labour productivity gaps between micro and, to a lesser extent small and medium-sized firms, and large firms are relatively high, in particular, in the manufacturing sector. However, differences in productivity across size classes are relatively smaller in the business services sector.

In many economies, post-crisis labour productivity growth was broadly similar in SMEs and large enterprises in manufacturing but more varied in the business services sector. However, in some countries, like Italy and Spain, productivity growth both in SMEs and large firms in manufacturing occurred against a backdrop of declining employment.

### *Definition*

Labour productivity by enterprise size class is measured as gross value added in current prices per person employed. Labour input is measured as total employment, which includes employees and all other paid or unpaid persons who worked for the concerned unit during the reference year. Data on hours worked by all persons employed are typically not available by industry and enterprise size class.

In the *OECD Structural and Demographic Business Statistics* (database), business economy covers: mining and quarrying, manufacturing, electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management and remediation activities, construction and business services (excluding finance and insurance activities). Business services include wholesale and retail trade, repair of motor vehicles and motorcycles; transportation and storage; accommodation and food services; information and communication services; real estate activities; and professional and support activities.

### *Comparability*

Value added estimates for different enterprise size classes are based on *OECD Structural and Demographic Business Statistics* (database) and will typically not align with estimates in national accounts. The latter include a number of adjustments to reflect businesses and activities that may not be covered in structural business statistics, such as those made to reflect the Non-Observed Economy. Since labour input is measured as total employment, comparability of labour productivity measures by size class may be affected by differences in the share of part-time employment. In addition, productivity differences in main aggregate sectors could mask different productivity patterns in more narrowly defined industries. This may in turn reflect differences in the value of goods and services produced, as well as different intensities in the use of knowledge-based capital.

### *Sources and further reading*

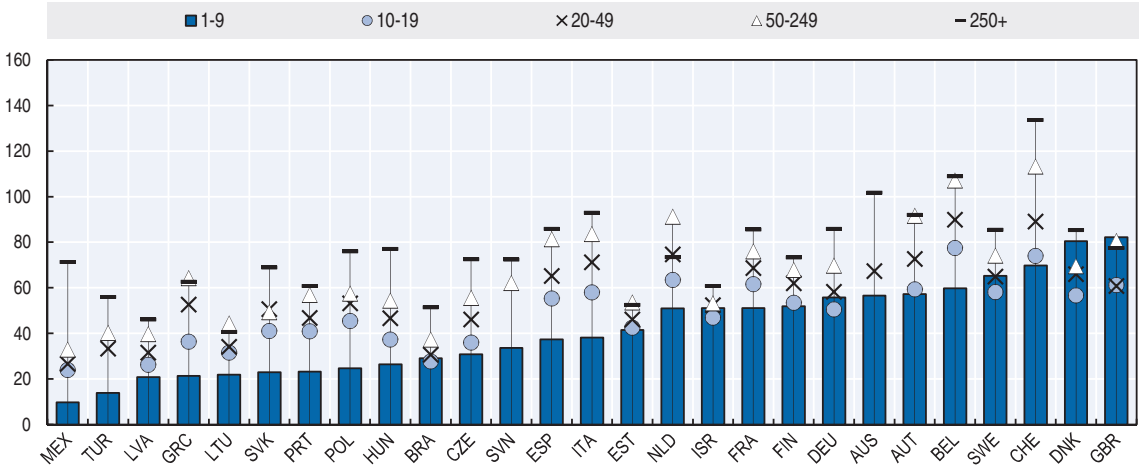
*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

*OECD Structural and Demographic Business Statistics* (database), *http://dx.doi.org/10.1787/sdbs-data-en*.

OECD (2016), *Entrepreneurship at a Glance 2016*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/entrepreneur_aag-2016-en*.

Figure 3.5. **Labour productivity by firm size, business economy**

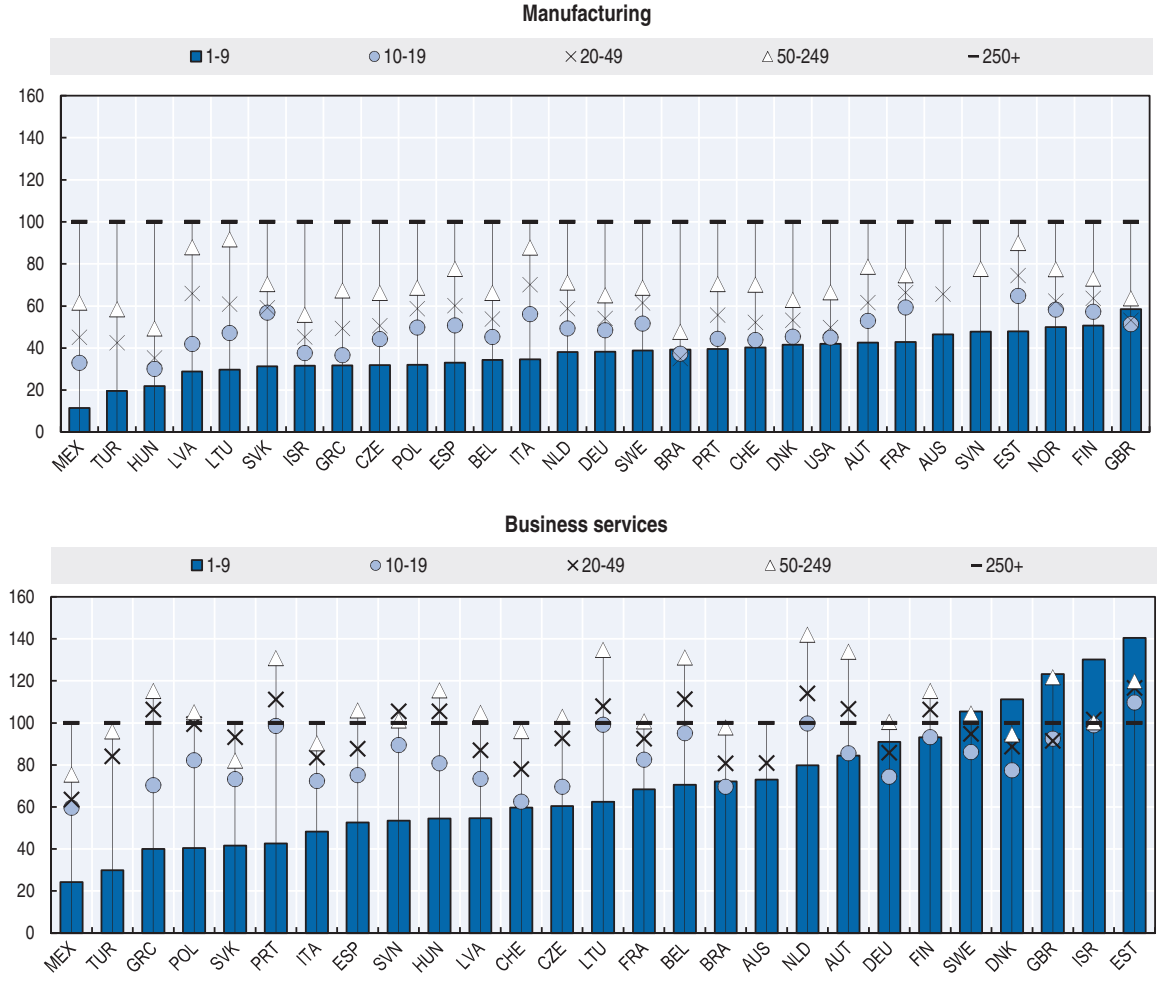
Value added per person employed, thousands of USD, current PPPs, 2014, or latest available year




StatLink http://dx.doi.org/10.1787/888933477384

Figure 3.6. **Labour productivity by firm size, manufacturing and business services**

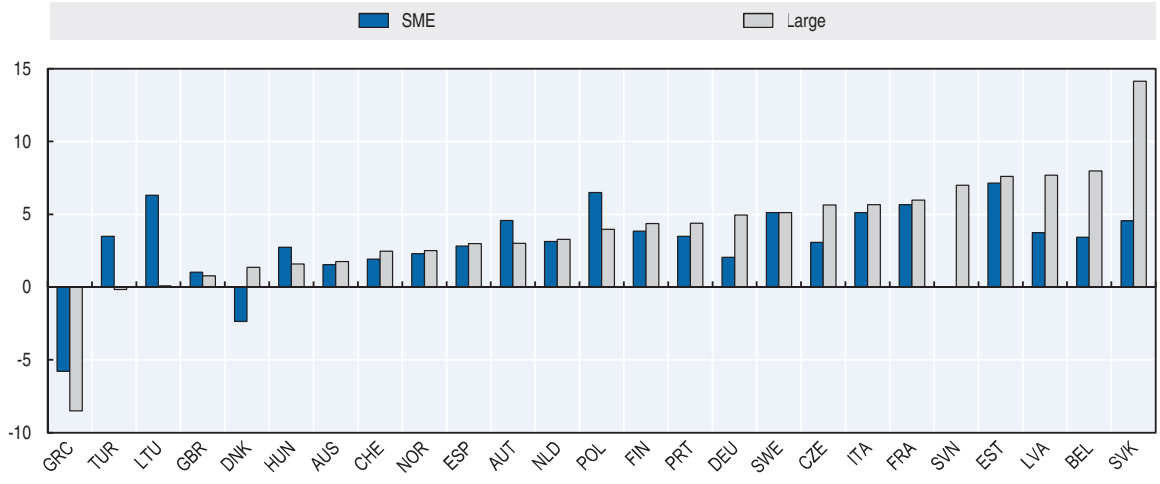
Value added per person employed, index 250+ = 100, 2014, or latest available year




StatLink http://dx.doi.org/10.1787/888933477397

## Figure 3.7. **Labour productivity growth by firm size, manufacturing**

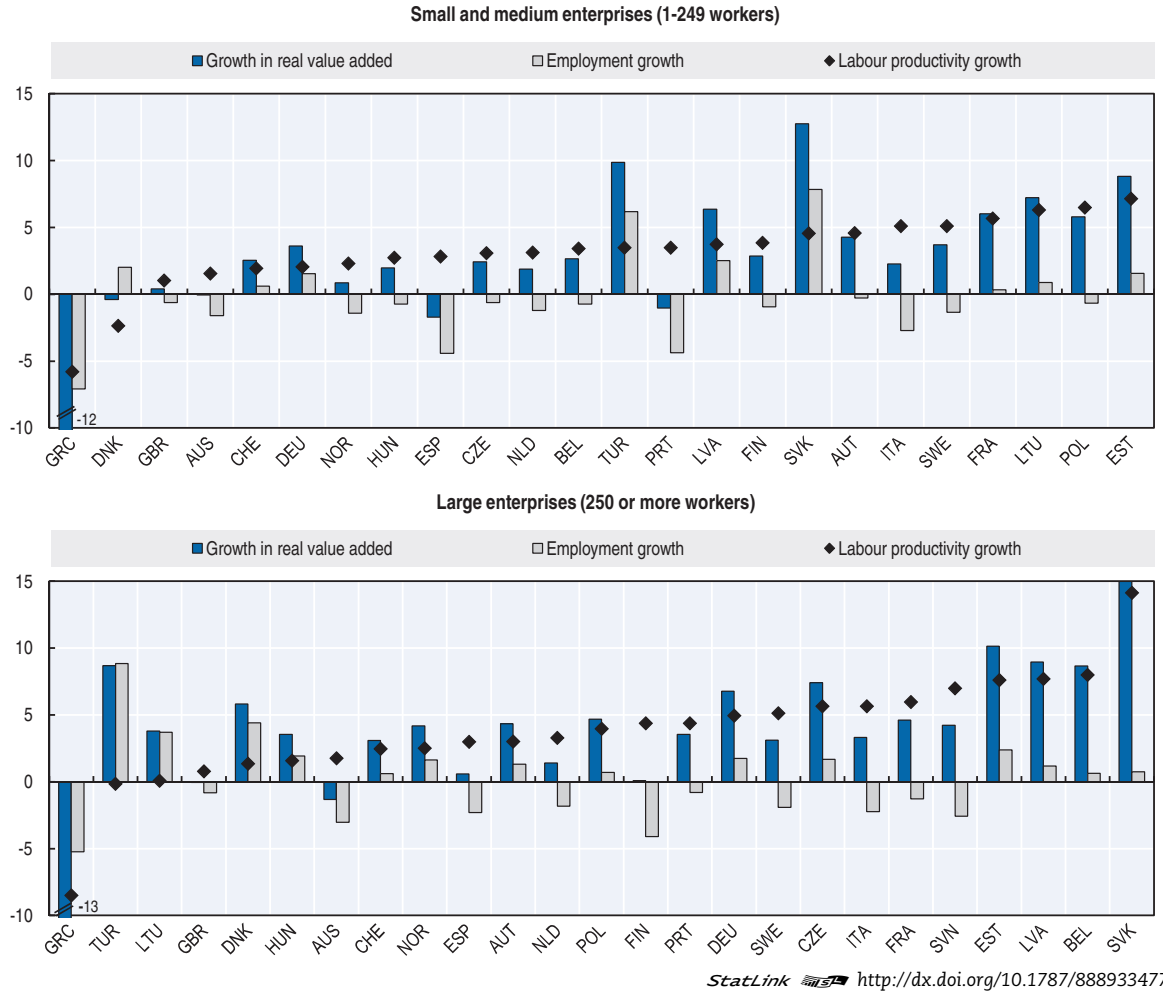
Real value added per person employed, average annual rate, percentage, 2009-14 or latest available year




StatLink http://dx.doi.org/10.1787/888933477407

## Figure 3.8. **Growth in real value added and employment by firm size, manufacturing**

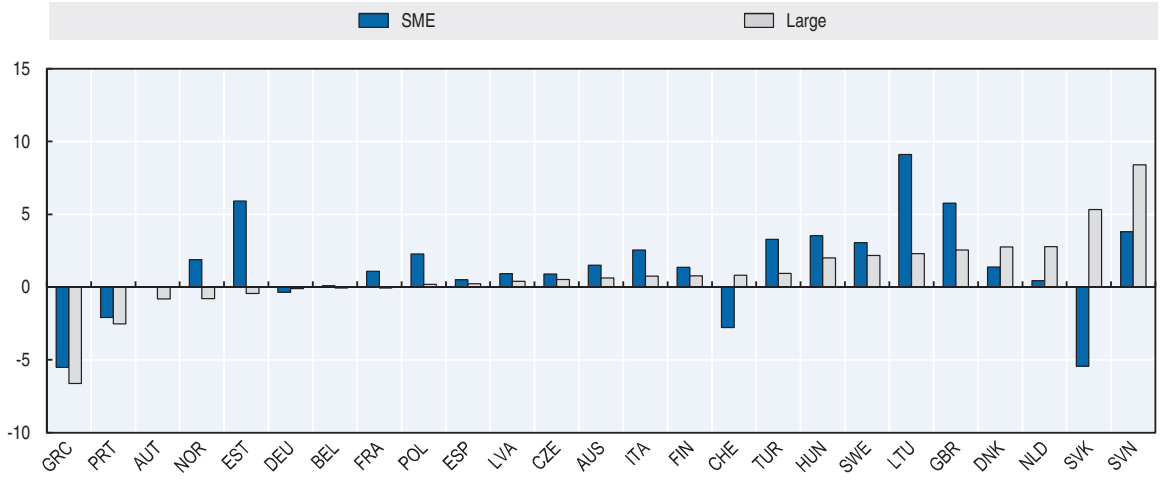
Average annual rate, percentage, 2009-14 or latest available year




StatLink http://dx.doi.org/10.1787/888933477411

Figure 3.9. **Labour productivity growth by firm size, business services**

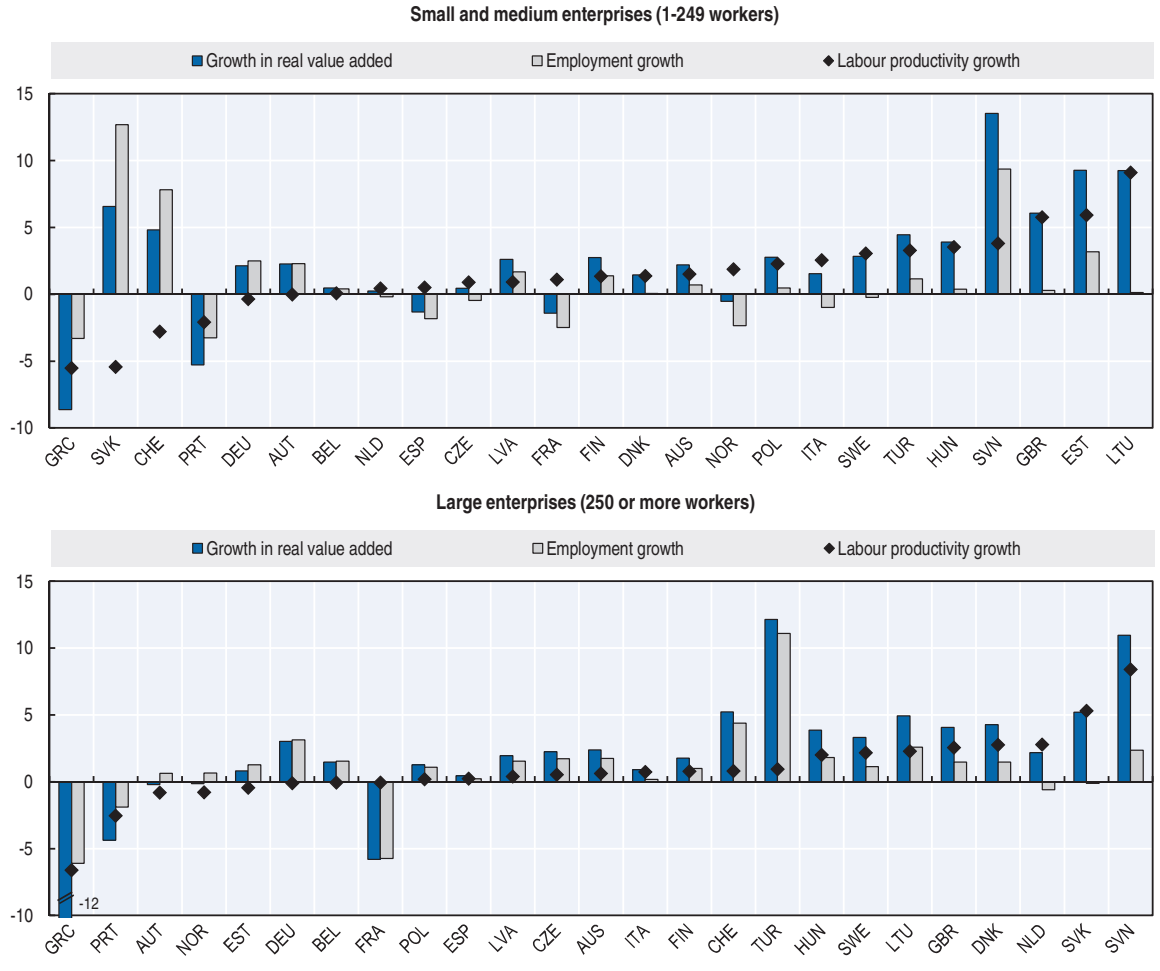
Real value added per person employed, average annual rate, percentage, 2009-14 or latest available year




StatLink http://dx.doi.org/10.1787/888933477421

Figure 3.10. **Growth in real value added and employment by firm size, business services**

Average annual rate, percentage, 2009-14 or latest available year

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*Chapter 4*

# Productivity, trade and international competitiveness

Unit labour costs

International competitiveness

The importance of global value chains

## Unit labour costs

Unit labour costs (ULCs) 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 the international cost competitiveness of firms within a country.

**Key findings**

Over the last 15 years, many OECD countries improved their relative competitiveness by keeping ULCs in check in both manufacturing and business sector services; as was the case in Germany, Ireland, Israel, Poland and Portugal. In these countries, low increases in ULCs reflected relatively strong labour productivity growth and/or moderate wage increases. In Lithuania, the Slovak Republic, Slovenia and Korea, large productivity gains helped to keep ULCs in check despite significant wage increases.

Within Europe, Greece, Ireland, Portugal and Spain saw strong falls in their ULCs 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 prior to the crisis show signs of being reversed in recent years.

### *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). Total output is measured here as Gross domestic product (GDP) in constant prices for the total economy and as gross value added in constant prices for economic activities; while total labour compensation is expressed in current prices. 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 (i.e. employees and self-employed).

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

The data are presented for the total economy, manufacturing and business sector services (which exclude real estate activities) according to the ISIC Rev. 4 classification. The series used to construct the ULC measures and its components are primarily sourced from the *OECD National Accounts Statistics* (database) and disseminated in the *OECD Productivity Statistics* (database). The figures present the data for those countries for which time series of sectoral hours worked are available in the *OECD National Accounts Statistics* (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 ULCs.

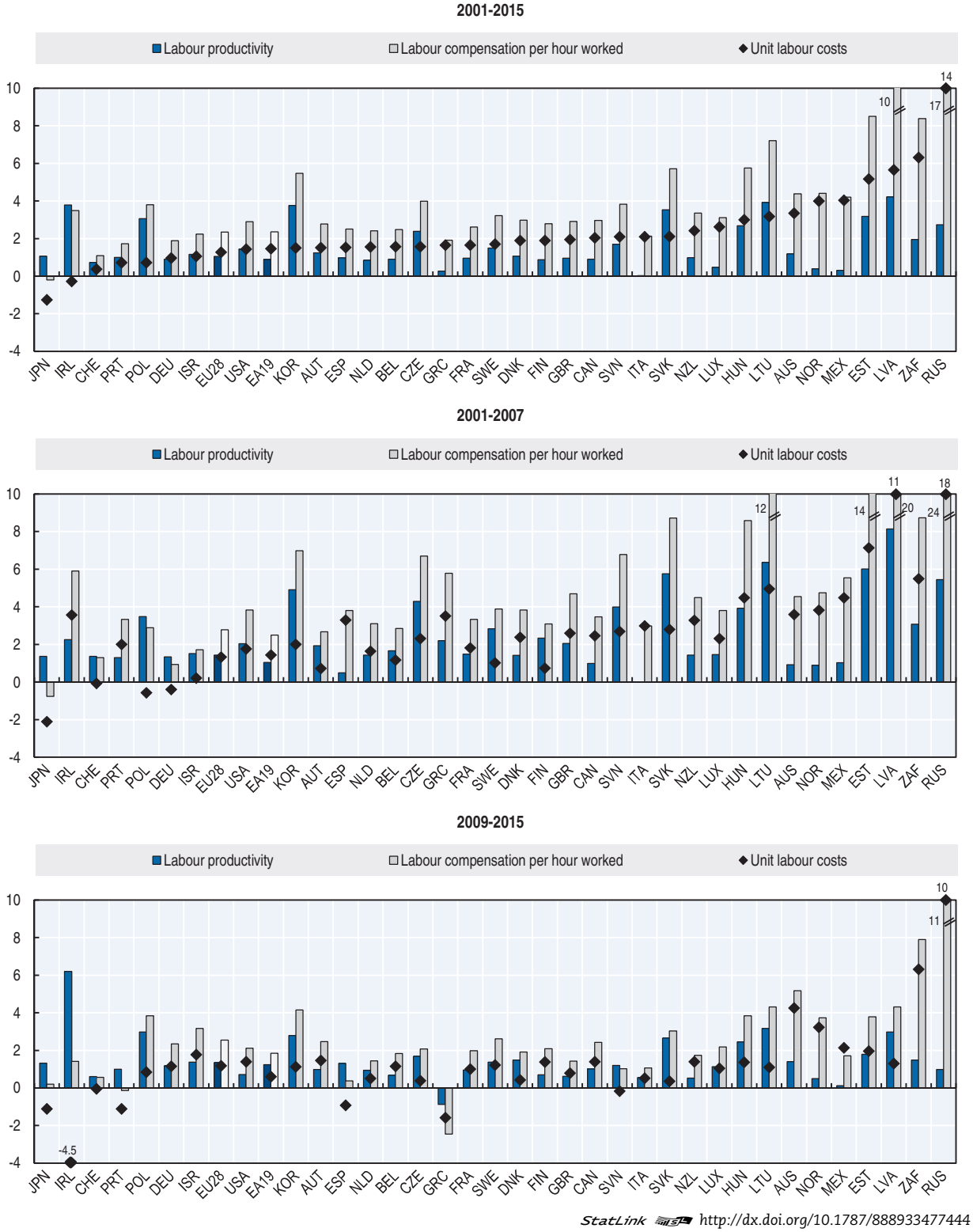
### *Sources/online databases*

*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

Figure 4.1. **Unit labour costs, hourly labour compensation and productivity, total economy**

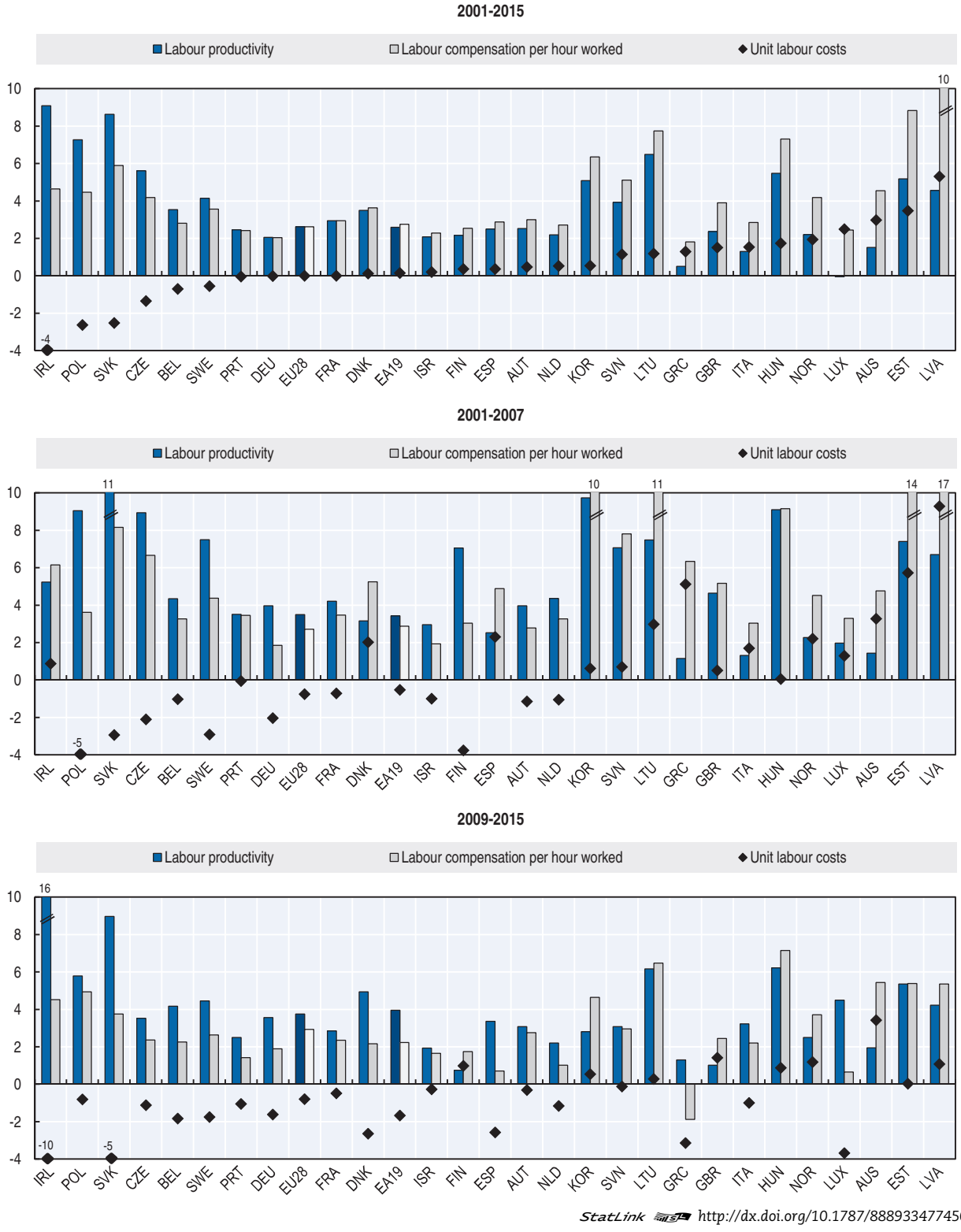
Percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477444

Figure 4.2. **Unit labour costs, hourly labour compensation and productivity, manufacturing**

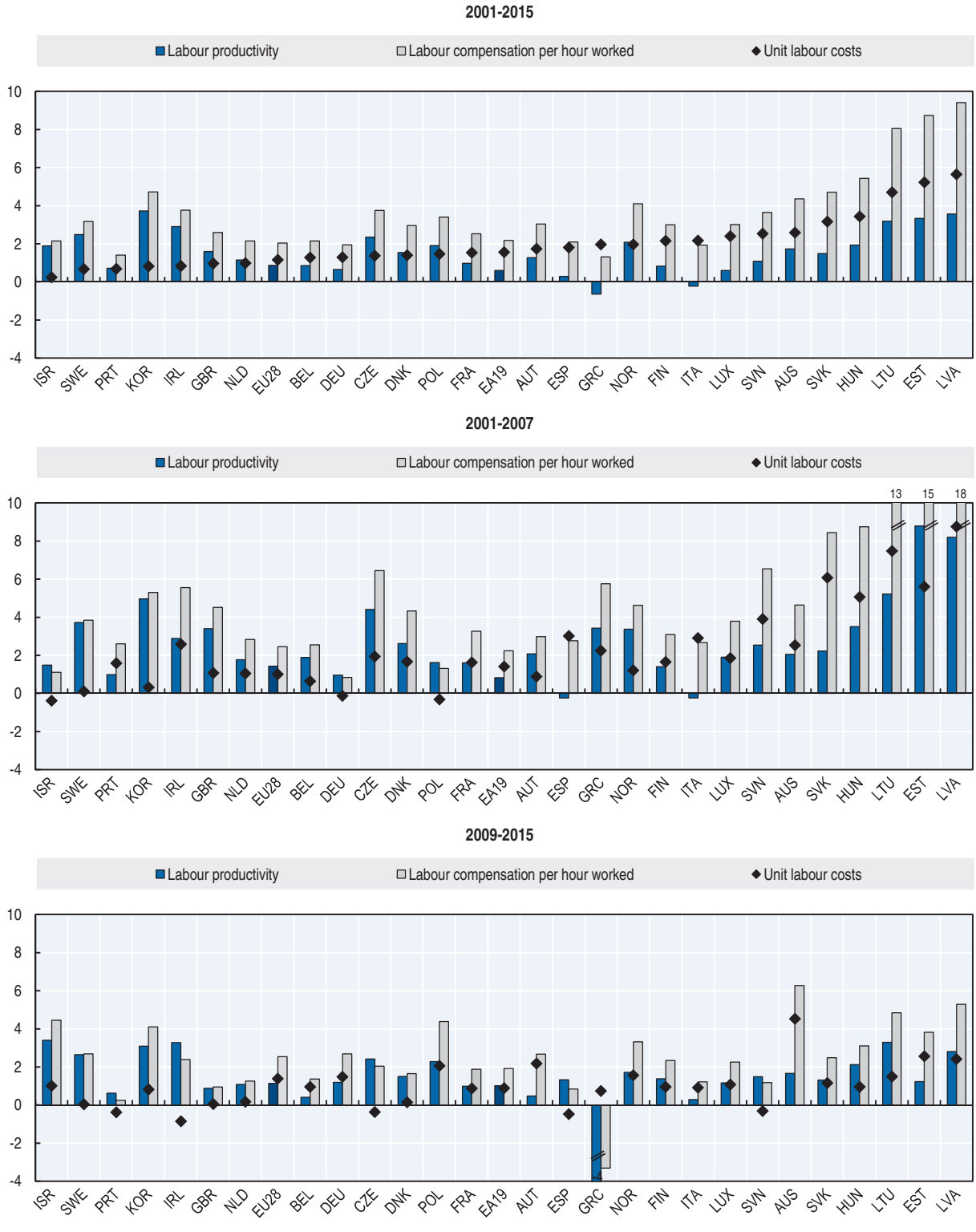
Percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477450

Figure 4.3. **Unit labour costs, 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 (ULCs) are an incomplete measure of international competitiveness, as they deal exclusively with the cost of labour and do not consider changes in the cost of capital or intermediate inputs. For this reason, 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, ULCs as a measure of cost-competitiveness cannot capture the capacity of firms to serve international markets through high quality goods and services and where demand is relatively price inelastic.

**Key findings**

Over the last 15 years, global market shares for all G7 countries have decreased, partly reflecting the growth of emerging economies. But the pace of decline has varied across countries. In Germany, for example, where ULCs have been kept in check compared with other countries, export performance held up well, while the opposite was true for Canada, France, Italy, the United Kingdom and the United States, while Japan's market share fell despite declining ULCs and real effective exchange rates.

### *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 that 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 in goods and services that are typically downstream in global value chains, and so have lower value added to export ratios.

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 ULCs in business sector services. 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 National Accounts Statistics* (database).

### *Sources and further reading*

*OECD Economic Outlook: Statistics and Projections* (database), *http://dx.doi.org/10.1787/eo-data-en*.

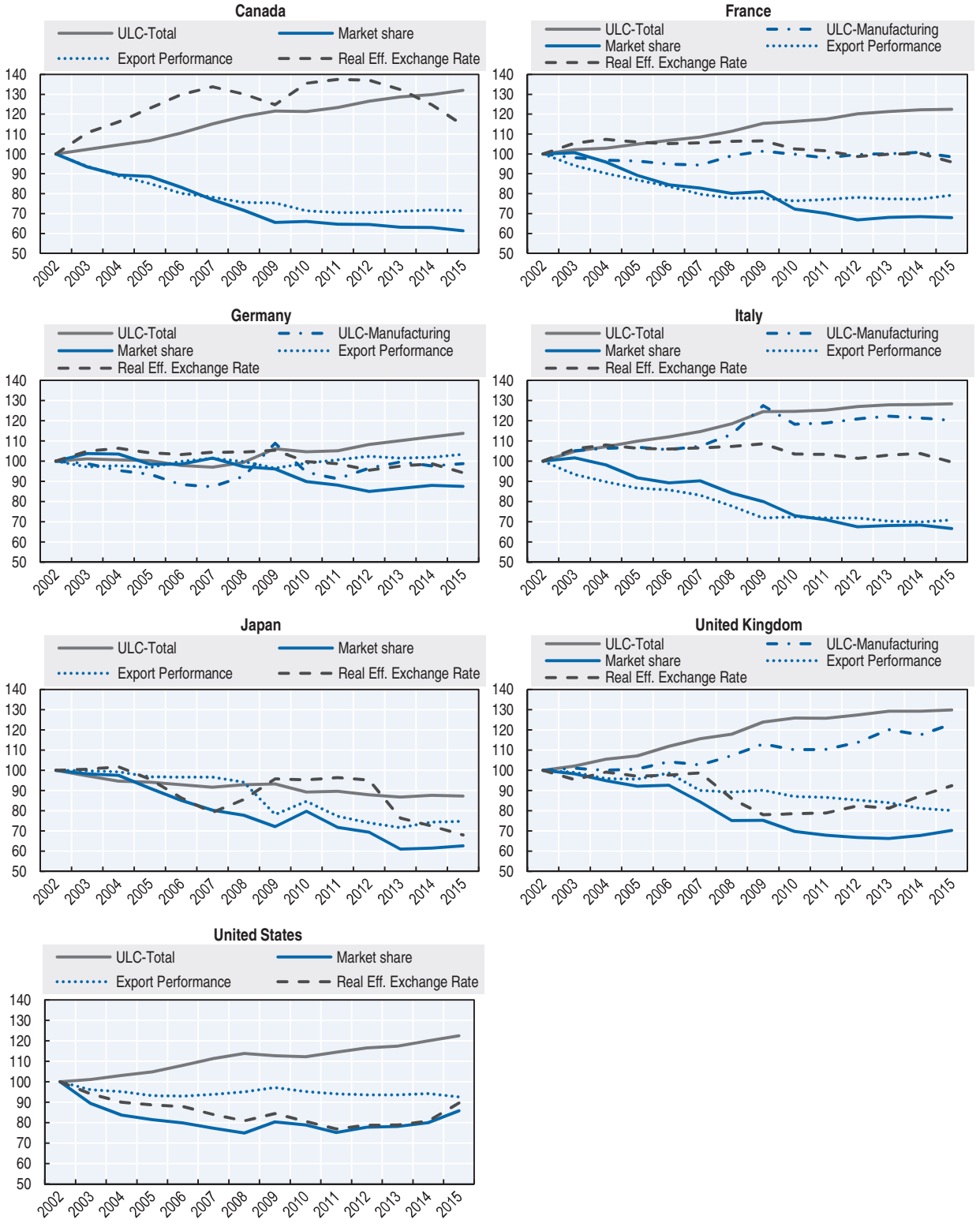
*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

Durand, M., J. Simon 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, 2002 = 100

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## The importance of global value chains

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 in goods and services that can be most efficiently produced in the home country; to sell to larger markets, hence exploiting economies of scale; and to benefit from higher quality and variety of inputs as well as technological spillovers and knowledge exchange. Trade also puts pressure on prices for final goods and intermediate inputs and facilitates international fragmentation of production processes, further reducing costs. Firms exposed to international competition ought to innovate continuously in order to succeed.

### Key findings

The empirical evidence confirms the strong link between trade and growth. More open countries, where trade openness is measured by imports plus exports as a per cent of GDP, typically have a higher level of GDP per capita. Moreover, with the exception of the Russian Federation, countries that have been able to increase their exports-to-GDP ratio over time have also improved labour productivity over the same period. This is particularly the case for catch-up economies such as the Central and Eastern European countries, which suggests that participation in global value chains (GVCs) has contributed to 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. Indeed, the foreign value added share of gross exports has augmented in nearly all countries over the past fifteen years, reflecting growing participation into GVCs. This has amplified the opportunities for higher specialisation, and so increased export driven growth, reflected by the higher ratios of direct domestic value content of gross exports to GDP, possibly contributing to productivity gains.

### *Definition*

Trade openness is measured as the ratio of total trade, i.e. gross exports plus gross imports, to gross domestic product (GDP). 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 the double-counting. Value added embodied in foreign final demand – as represented in the bottom right panel of Figure 4.6 – 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.

Information on data for Israel: *http://dx.doi.org/10.1787/888932315602*.

### *Comparability*

The indicators in the joint *OECD/WTO Statistics on 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. 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.

### *Sources and further reading*

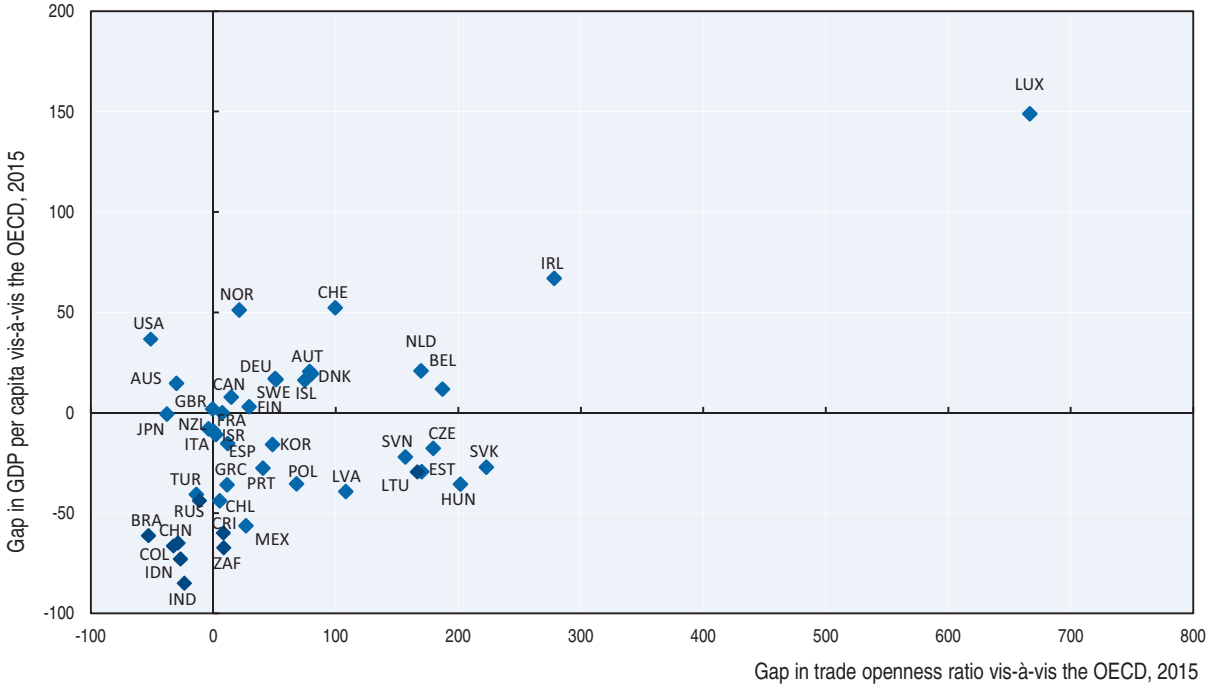
*OECD National Accounts Statistics* (database), *http://dx.doi.org/10.1787/na-data-en*.

*OECD-WTO: Statistics on Trade in Value Added* (database), *http://dx.doi.org/10.1787/data-00648-en*.

OECD-WTO (2012), "Trade in Value Added: Concepts, Methodologies and Challenges" (OECD-WTO, online document), *www.oecd.org/sti/ind/49894138.pdf*.

## Figure 4.5. **Trade openness and GDP per capita vis-à-vis the OECD, 2015**

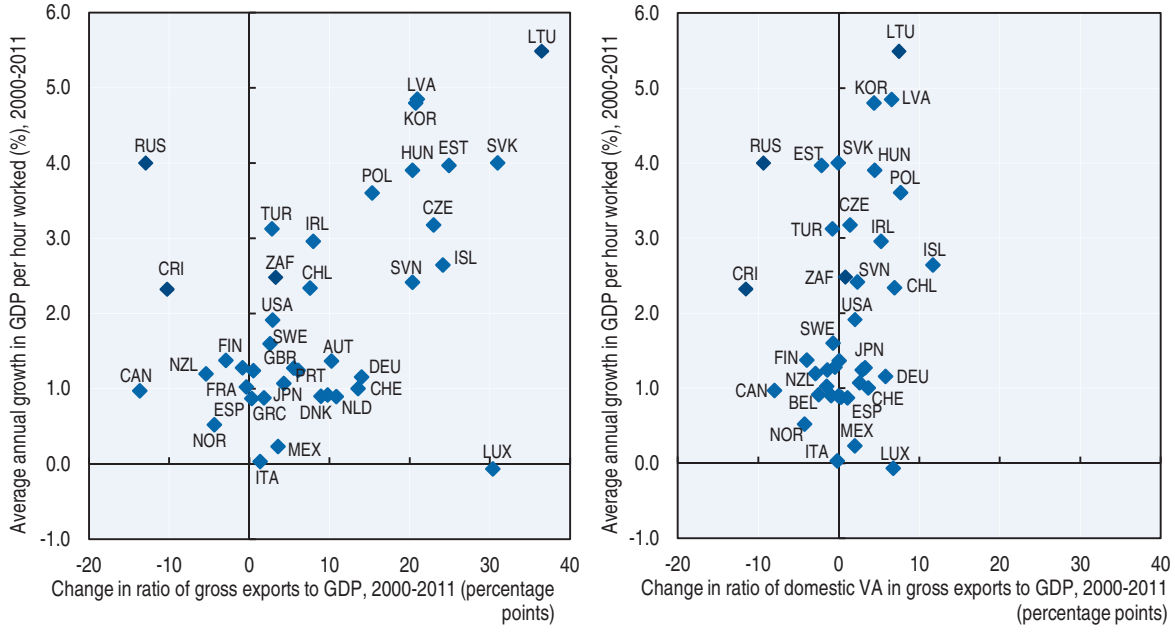
Total economy, percentage point difference from the OECD (OECD = 0), current prices and current PPPs




StatLink http://dx.doi.org/10.1787/888933477489

## Figure 4.6. **Change in exports to GDP ratio and growth in labour productivity**

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

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*Chapter 5*

# Productivity trends in G7 countries

Trends in labour productivity growth

Trends in multifactor productivity and capital deepening

Multifactor productivity over the cycle

## Trends in labour productivity growth

Labour productivity is a key driver of economic growth and living standards. Understanding whether the slowdown in productivity growth has been driven by structural factors and/or by reactions to 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.

**Key findings**

The slowdown in labour productivity growth is a common feature of all major advanced economies and underlying long-term trends suggest that it was underway prior to the crisis. Indeed, over the 10 years preceding the crisis, trend labour productivity growth declined in all G7 countries, particularly in France, Italy and the United Kingdom. In the case of Canada, the United Kingdom and the United States, the decline since the end of the 1990s marked a reversal of growth that coincided with the IT revolution. In other countries, trend labour productivity growth has shown a gradual decline over the past 40 years from relatively high rates. The volatility in the cycle introduced by the crisis necessitates some caution in interpreting recent trends.

### *Definition*

Labour productivity is defined as GDP per hour worked and its growth rate is calculated as its first natural-log difference. The decomposition of labour productivity growth into a trend and a cyclical component is done by applying the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997), where the trend component is meant to capture the long-term growth of the series and the cyclical component is the deviation from that trend. In the HP filter, the smoothness of the trend depends on a parameter usually identified as $\lambda$. The larger the value given to $\lambda$, the smoother is the trend.

### *Comparability*

Like other filters, one limitation of the HP filter is that the estimated trend is more sensitive to transitory shocks or short-term fluctuations at the beginning and at the end of the sample period. This results in a sub-optimal performance of the HP filter at the endpoints of the series (Baxter and King, 1999). In view of this property, trend series are not published for the first and last two years for which data on actual labour productivity growth are available.

An important aspect of the HP filter is the value of the smoothing parameter $\lambda$. While for quarterly data it has been typically assumed a value of $\lambda = 1600$ (as recommended by Hodrick and Prescott, 1997), there is less agreement on the value to be used when the filter is applied to other frequencies (e.g. annual, monthly). The value of $\lambda$ selected here is 54.12 and has been determined by calibrating the Hodrick-Prescott filter in such a way that cycles shorter than 9.5 years are attenuated by 90% or more (Chapter 6).

Official data for Germany after unification are available only from 1991 onwards. Estimates for Germany as a whole back to 1970 have been derived by applying the relevant growth rates for West Germany to 1991 data.

### *Sources and further reading*

Baxter and King (1999), "Measuring business cycles: Approximate band-pass filters for economic time series", *The Review of Economics and Statistics*, Vol. 81, No. 4.

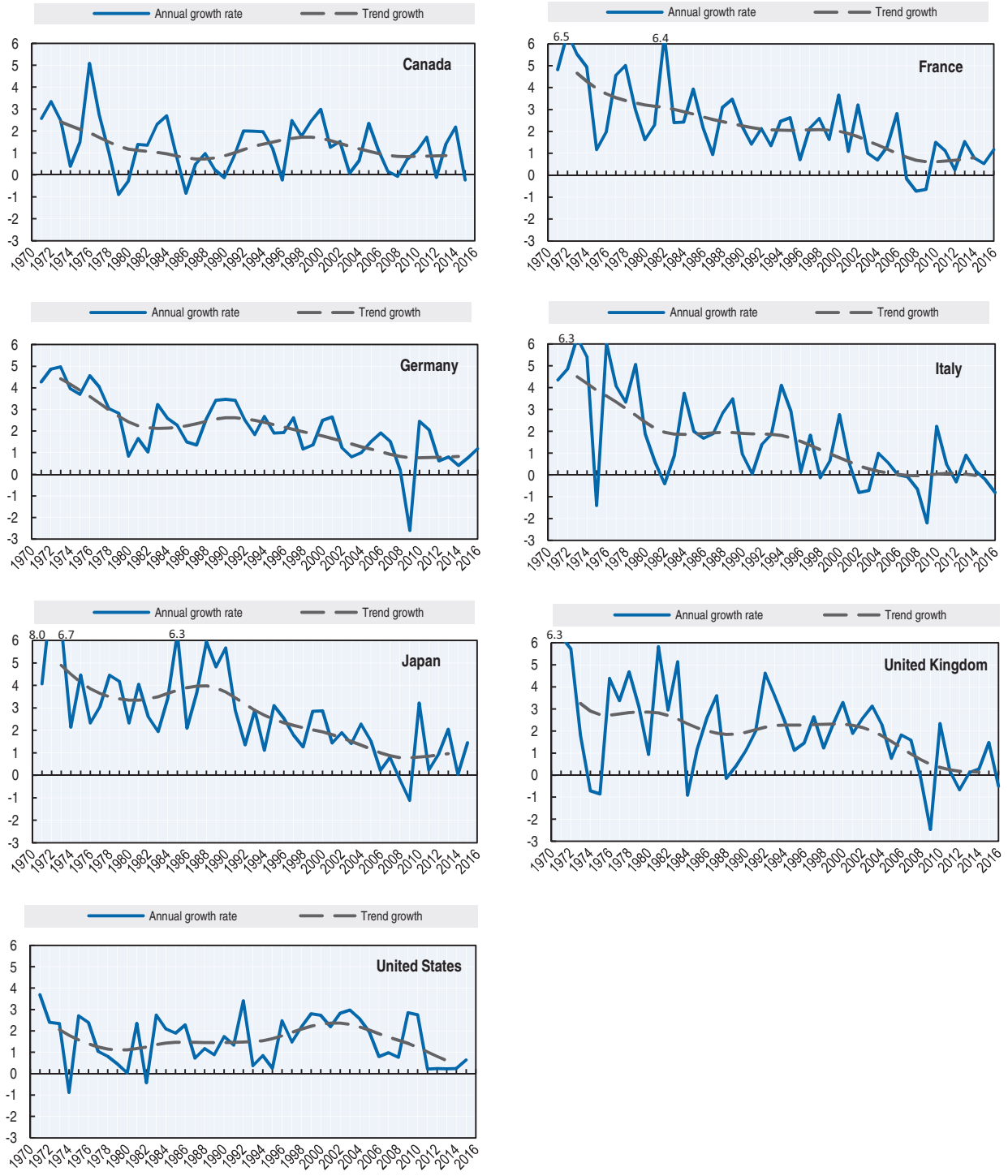
Hodrick, R. and E. Prescott (1997), "Postwar U.S. business cycles: An empirical investigation", *Journal of Money, Credit and Banking*, Vol. 29, No. 1.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

## Figure 5.1. **Trend labour productivity growth in G7 countries**

Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477503

## Trends in multifactor productivity and capital deepening

Policy makers are interested in the structural factors that may have accentuated the recent slowdown in labour productivity growth. The declining trend labour productivity growth may be driven by declining investment in capital relative to hours worked (capital deepening) or could be indicative of factors that hampered growth in multifactor productivity (MFP), such as low innovative activity, skills mismatches and inefficiencies due to barriers to competition. To shed light on these structural factors, one can decompose the time series of labour productivity growth as well as its drivers, i.e. the contribution of capital deepening and MFP, into a trend and a cyclical component.

### Key findings

While nearly all G7 countries show a decline in trend labour productivity growth since the end-1990s or before in some cases, the sources for this decline vary. In Canada, the downward trend of MFP growth contrasted with the flat trend observed in the contribution of capital deepening. In Germany, trend MFP growth has declined continuously since the beginning of the 1990s and flattened after the crisis. In Italy, trend MFP has been negative since the early 2000s and has been coupled in recent years with a declining contribution of capital deepening. Japan saw a drastic decline in trend MFP growth over the second half of the 1980s and the 1990s and has seen a flat trend since then, coupled with a downward trend in the contribution of capital deepening. In France, the United Kingdom and the United States, the downward trend of labour productivity growth since the early 2000s was driven by a slowdown in MFP growth in France, a sharp decline in MFP growth in the United Kingdom and by a combination of declining MFP growth and capital deepening in the United States.

### *Definition*

Labour productivity is defined as GDP per hour worked and its growth rate is calculated as its first natural-log difference. The contribution of capital deepening is constructed as changes in the volume of capital services per hour worked (i.e. capital deepening) weighted by the cost share of the capital input. Growth in multifactor productivity is measured as a residual, i.e. that part of GDP growth that cannot be explained by growth in labour and capital inputs. The decomposition of these series into a trend and a cyclical component is done by applying the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997), where the trend component is meant to capture the long-term growth of the series and the cyclical component is the deviation from that trend (Chapter 6).

### *Comparability*

To ensure cross-country comparability of capital services and MFP data, the OECD applies a common computation method to all countries that uses harmonised ICT investment deflators and assumes the same average service lives for any given asset irrespective of the country.

MFP growth 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. Then, MFP only picks up *disembodied* technical change, e.g. network effects or spillovers from production factors, the effects of better management practices, brand names, organisational change and general knowledge. Moreover, linked to the assumptions of the production function and data constraints hampering a precise measurement of labour and capital inputs, MFP also captures other factors, e.g. adjustment costs, economies of scale, effects from imperfect competition and measurement errors.

Official data for Germany after unification are available only from 1991 onwards. Estimates for Germany as a whole back to 1970 have been derived by applying the relevant growth rates for West Germany to 1991 data.

### *Sources and further reading*

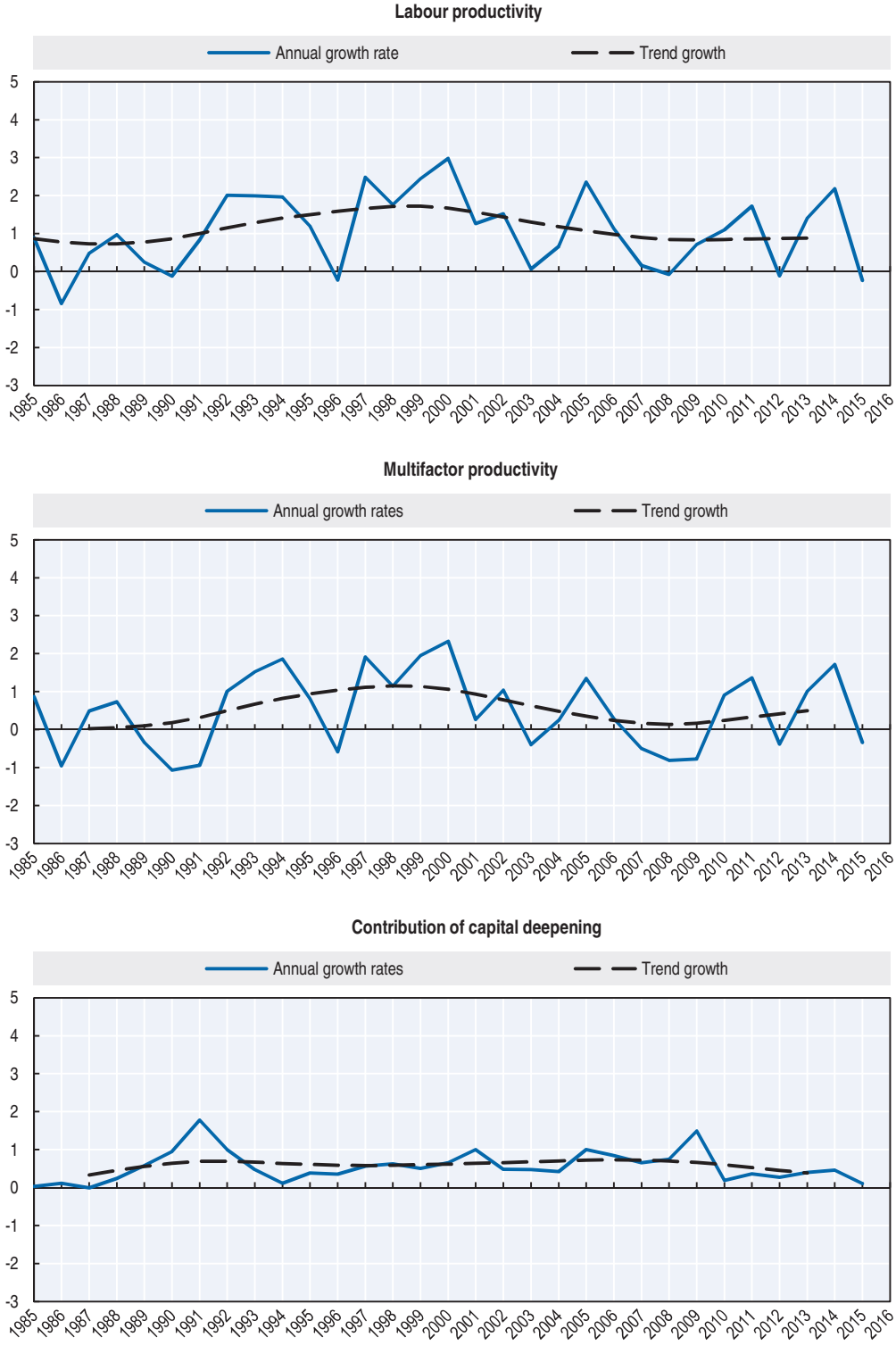
Hodrick, R. and E. Prescott (1997), "Postwar U.S. business cycles: An empirical investigation", *Journal of Money, Credit and Banking*, Vol. 29, No. 1.

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

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

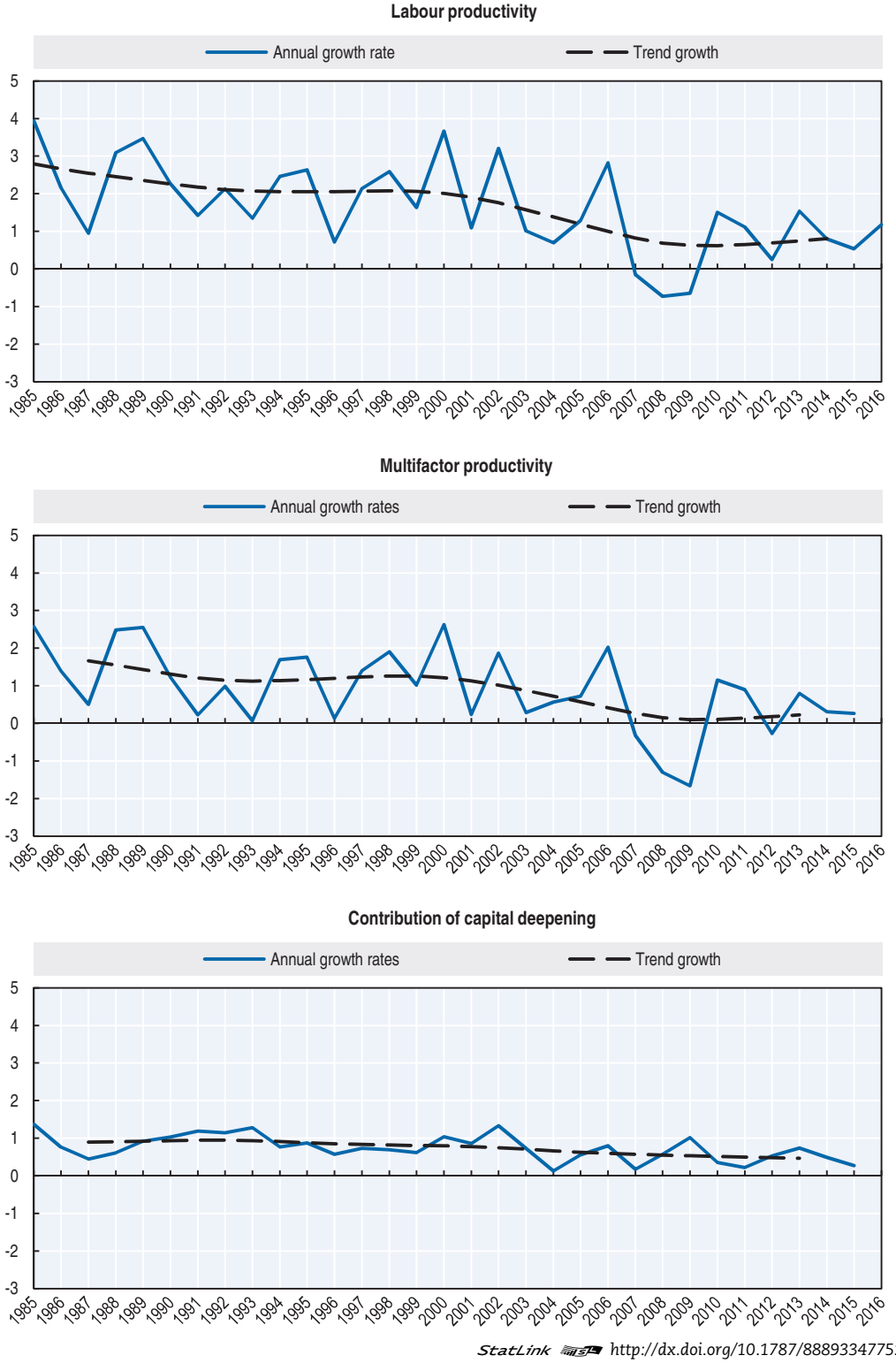
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477513

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

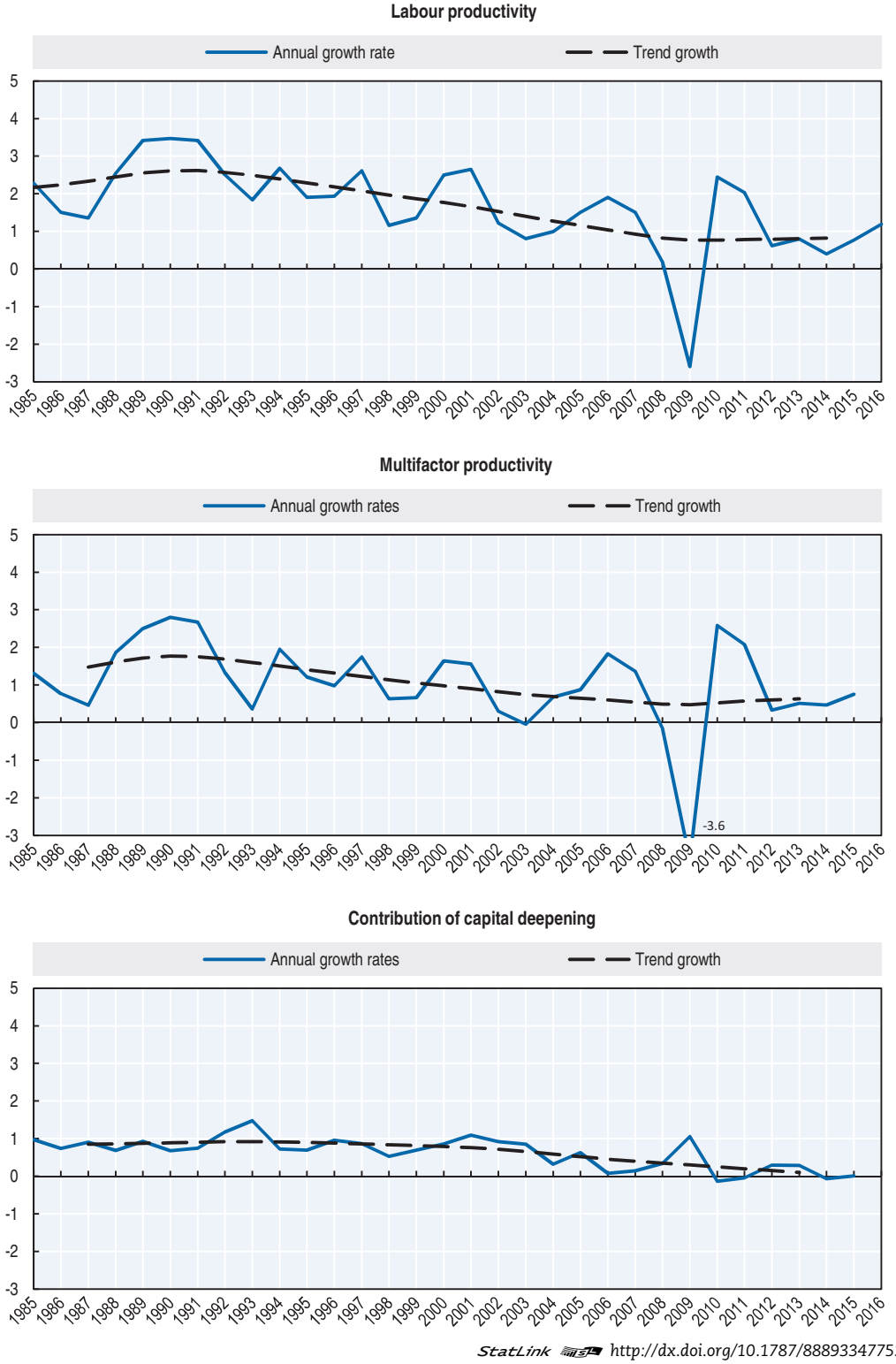
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477529

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

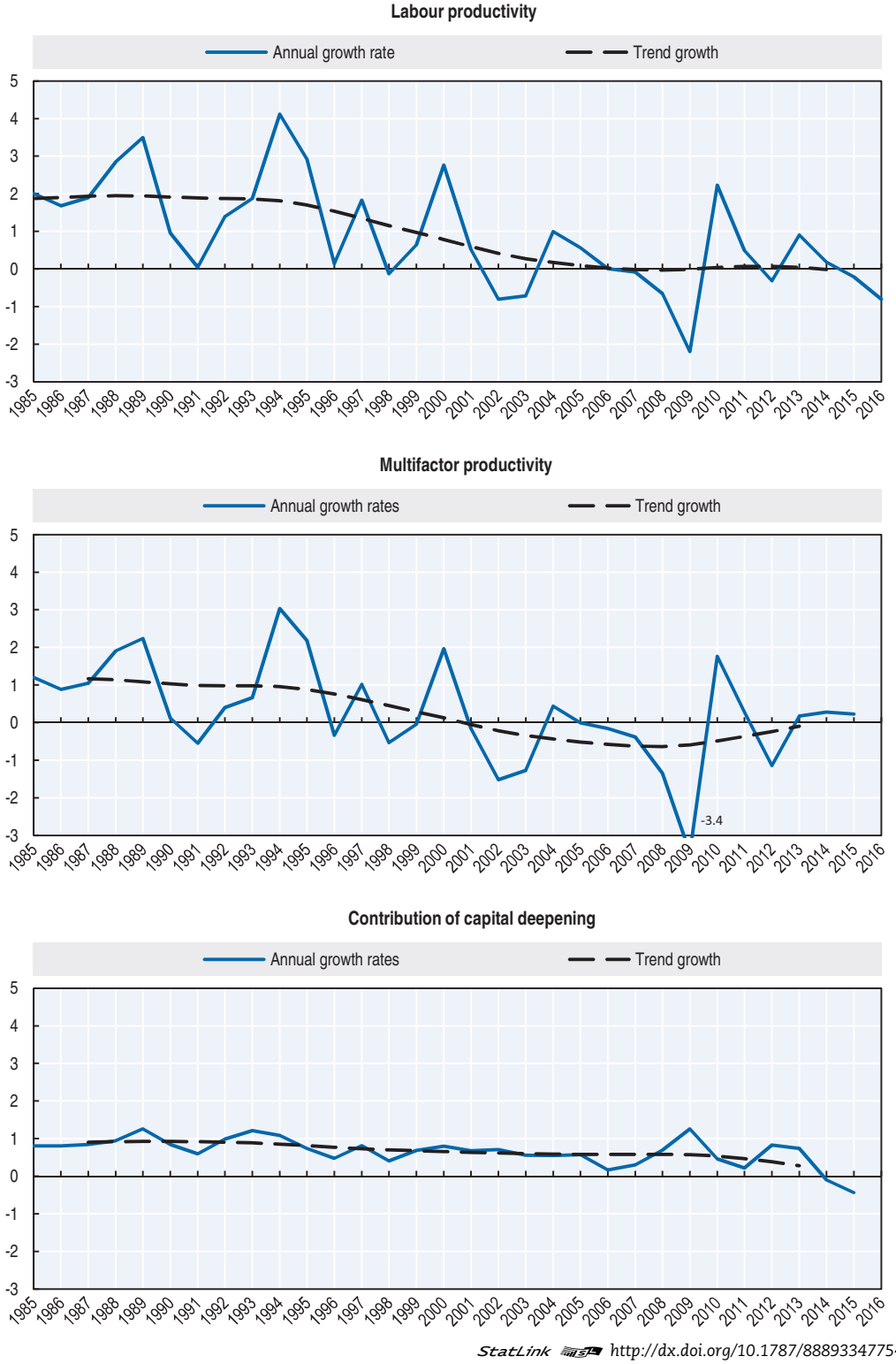
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477532

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

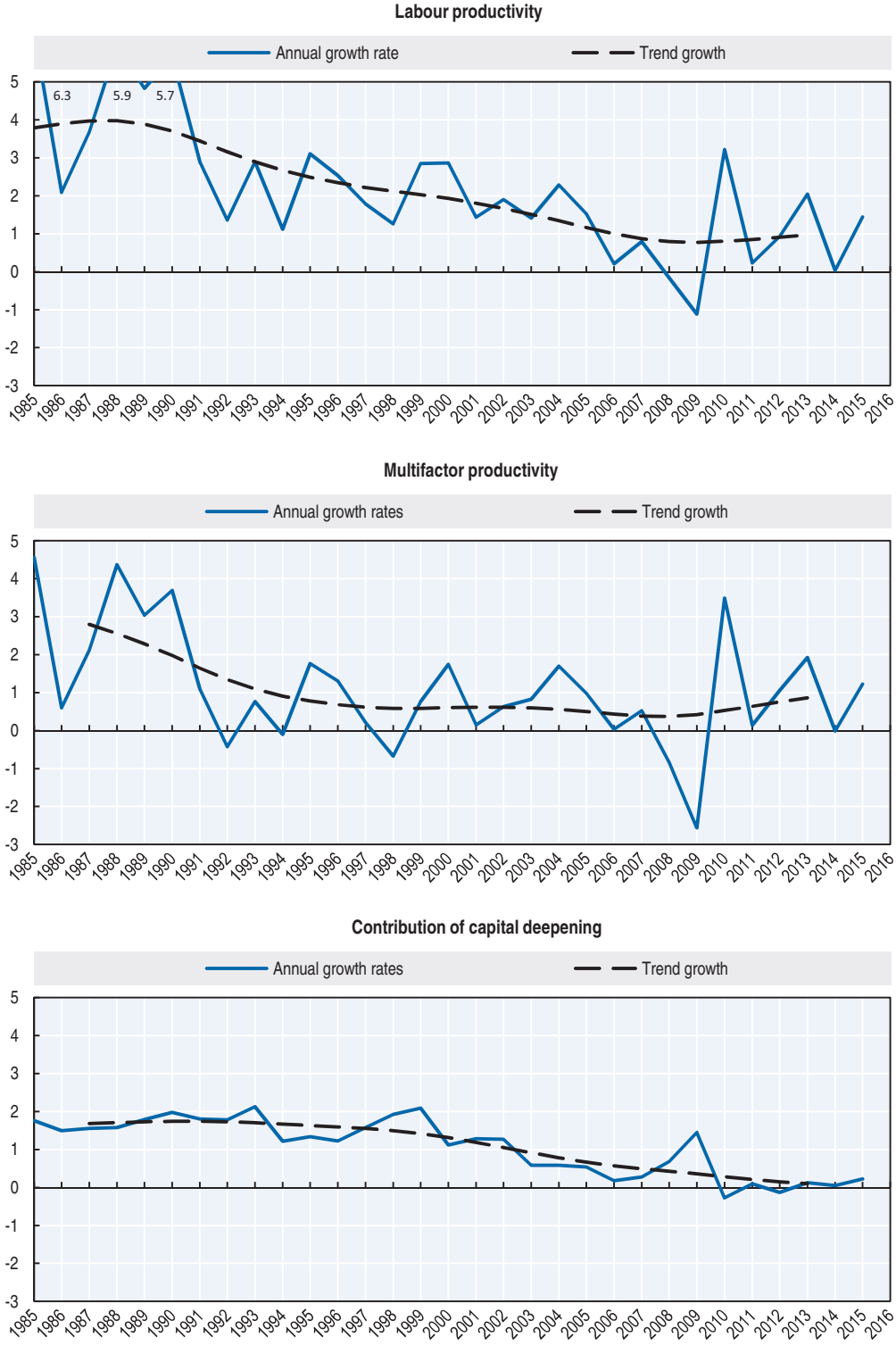
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477545

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

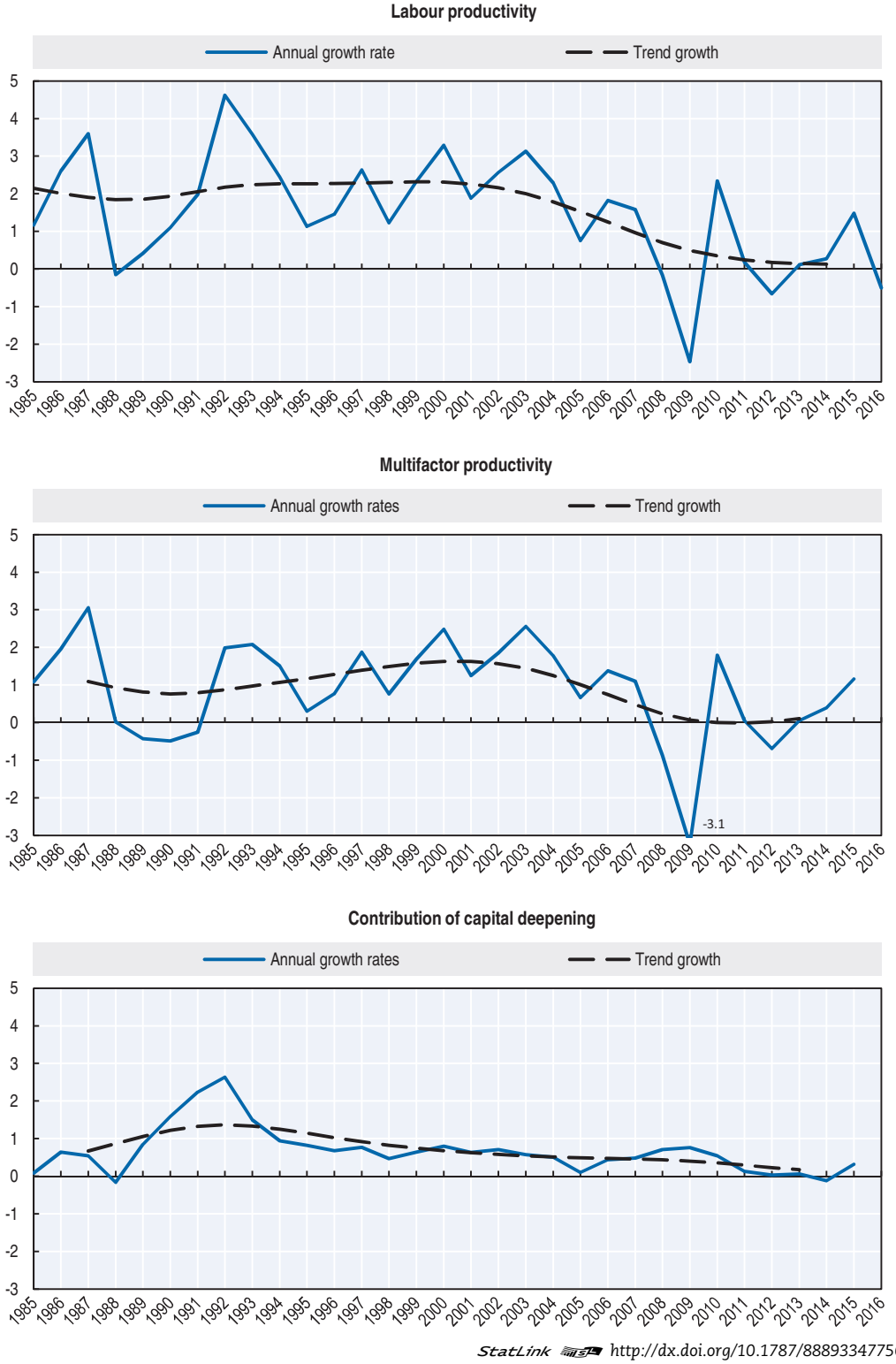
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477552

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

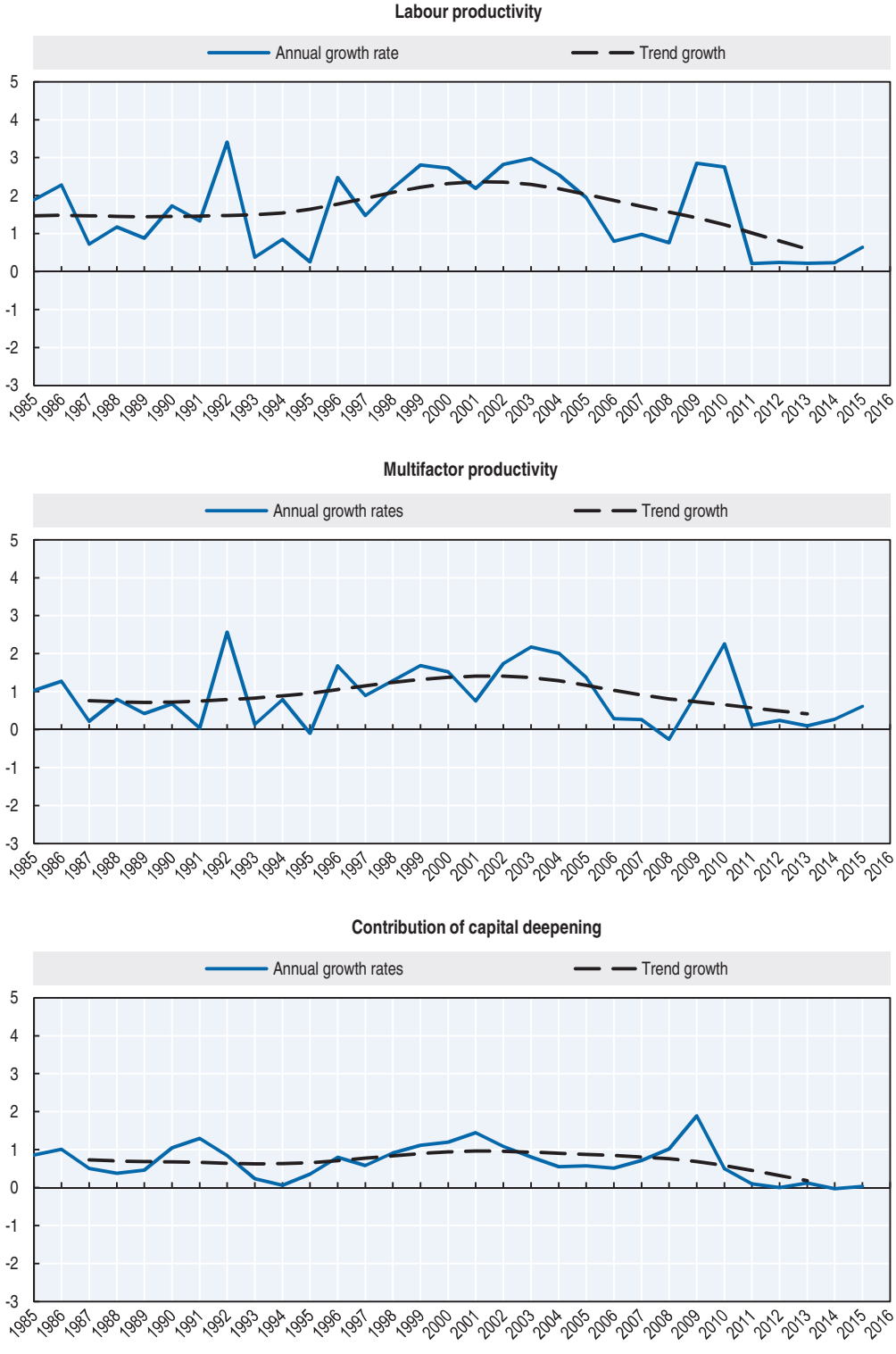
Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477565

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

Total economy, percentage change at annual rate




StatLink http://dx.doi.org/10.1787/888933477571

## Multifactor productivity over the cycle

A number of studies indicate that multifactor productivity growth (MFP) behaves cyclically, i.e. it increases in upturns and declines in downturns. This has sometimes been interpreted as a paradox, as MFP has traditionally been perceived as exogenous technological change, which should typically not behave cyclically.

**Key findings**

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. 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. However, the contribution of capital input to GDP growth declined significantly after the crisis, possibly reflecting the sluggish recovery of investment.

### *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 changes in labour and capital inputs (Chapter 6). 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 (labour hoarding). 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 capital services (Chapter 6). 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 (Chapter 6).

Official data for Germany after unification are available only from 1991 onwards. Estimates for Germany as a whole back to 1970 have been derived by applying the relevant growth rates for West Germany to 1991 data.

### *Sources and further reading*

*OECD Productivity Statistics* (database), *http://dx.doi.org/10.1787/pdtvy-data-en*.

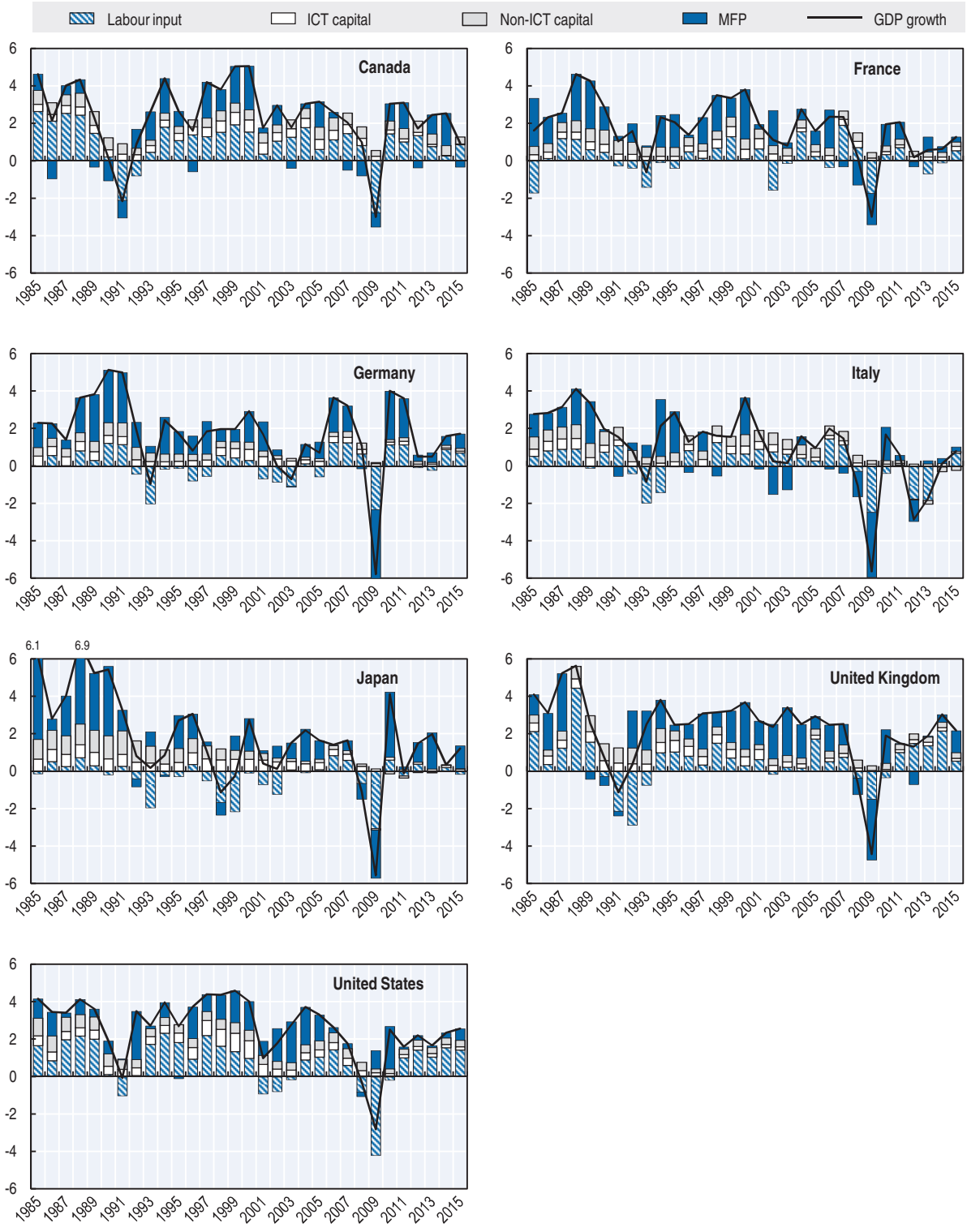
OECD (2001), *Measuring Productivity – OECD Manual*, *http://dx.doi.org/10.1787/9789264194519-en*.

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. **Contributions to GDP growth over time in G7 countries**

Total economy, percentage point contributions at annual rate




StatLink http://dx.doi.org/10.1787/888933477585

*Chapter 6*

# Methodological chapter

*This chapter presents relevant methodological information on the productivity indicators available in this publication and/or disseminated in the OECD Productivity Statistics (database). It discusses the different existing concepts of hours worked and describes the sources used to measure hours worked for the purposes of productivity analysis. It provides a brief description of capital stocks and capital input measures available at the OECD, highlighting the distinction between two key measures of capital: the productive capital stock and the gross (or net) wealth capital stock. The chapter also provides a summary of the major changes introduced by the System of National Accounts 2008 (2008 SNA), with respect to the 1993 SNA. Further, it describes important measurement issues when tracking price changes in the services sector and the potential significance of price measurement for measured productivity growth in services sectors. It presents the concept of Purchasing Power Parities (PPPs), describing the two different approaches for using PPPs in international comparisons of productivity levels: current PPPs and constant PPPs. The chapter ends with a detailed description of the trend estimation method used to compute productivity trends in this publication.*

## 6.1 Productivity measures in the OECD Productivity Database

The *OECD Productivity Statistics* (database) (PDB) contains a consistent set of productivity measures at the total economy and at the industry levels. This section provides detailed information on the measures included in the database. While the PDB and this publication present value added based productivity indicators by relating value added to the labour and capital inputs used, productivity measures can be computed for different representations of the production process. One typical approach is to relate a volume measure of gross output to primary and intermediate inputs, as used in the KLEMS methodology, which measures the contributions of capital (K), labour (L), energy (E), material inputs (M) and services (S) to output growth. This representation is not adopted in the PDB nor in this publication.

### *Productivity measures for the total economy*

#### *Labour input*

Within the PDB, the preferred measure of labour input (L) is the total number of hours worked by all persons engaged in production (i.e. employees plus self-employed). Another measure of labour input, albeit less preferred, is the total number of persons employed (i.e. employees plus self-employed). The preferred source for total hours worked and total employment is the OECD *National Accounts Statistics* (database). However, this database does not provide data on hours worked for all countries, and, so, other sources are necessarily used, e.g. the *OECD Employment and Labour Market Statistics* (database). Estimates of average hours actually worked per year per person employed are also provided within the PDB. Section 6.2 presents detailed information on hours worked.

#### *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 Schreyer et al., 2003 for more details on the computation of capital services in PDB). In the PDB, capital services measures are based on productive capital stocks derived using 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 (see Schreyer, 2002 and Colecchia and Schreyer, 2002 for further information about the calculation of ICT "harmonised" deflators). The investment series by asset type used in the PIM calculations are sourced from national accounts statistics produced by national statistics offices.

From 2015, the classification of assets adopted in the PDB is in line with the SNA 2008. Capital services are computed separately for eight non-residential fixed assets $k = 1, 2, \ldots, 8$, i.e. computer hardware, telecommunications equipment, transport equipment, other machinery and equipment and weapons systems, non-residential construction, computer

software and databases, research and development and other intellectual property products. The volume index of total capital services is computed by aggregating the volume change of capital services of all individual assets using a Törnqvist index that applies asset specific user cost shares as weights:

$$\ln\left(\frac{K^t}{K^{t-1}}\right)=\sum_{k=1}^{8}\frac{1}{2}\left(v_k^t+v_k^{t-1}\right)\ln\left(\frac{K_k^t}{K_k^{t-1}}\right)$$

where:

$$v_k^t=\left(\frac{u_k^tK_k^t}{\sum_{k=1}^{8}u_k^tK_k^t}\right)$$

and $u_k^t$ is the user cost per unit of capital services provided by asset $k$ at time $t$ (see Schreyer et al., 2003). Thereby, $v_k^t$ is the user cost share of asset $k$, $\frac{1}{2}\left(v_k^t+v_k^{t-1}\right)\ln\left(\frac{K_k^t}{K_k^{t-1}}\right)$ is the contribution of asset $k$ to total capital services in year $t$ and $K_k^t$ is the quantity of capital services provided by asset $k$ in year $t$.

Aggregate volume indices of capital services are also computed for ICT assets (computer hardware, telecommunications equipment and computer software and databases) and non-ICT assets (transport equipment, other machinery and equipment and weapons systems, non-residential construction, research and development and other intellectual property products), using the appropriate user costs shares as weights. The aggregate volume indices of ICT and non-ICT capital services are given by:

$$\ln\left(\frac{K_{ict}^t}{K_{ict}^{t-1}}\right)=\sum_{i=1}^{3}\frac{1}{2}\left(\gamma_i^t+\gamma_i^{t-1}\right)\ln\left(\frac{K_i^t}{K_i^{t-1}}\right)$$

where $i$ represents an ICT asset and

$$\gamma_i^t=\left(\frac{u_i^tK_i^t}{\sum_{i=1}^{3}u_i^tK_i^t}\right)$$

$$\ln\left(\frac{K_{nict}^t}{K_{nict}^{t-1}}\right)=\sum_{j=1}^{5}\frac{1}{2}\left(\gamma_j^t+\gamma_j^{t-1}\right)\ln\left(\frac{K_j^t}{K_j^{t-1}}\right)$$

where $j$ represents a non-ICT asset and

$$\gamma_j^t=\left(\frac{u_j^tK_j^t}{\sum_{j=1}^{5}u_j^tK_j^t}\right)$$

### *Cost shares of inputs*

The total cost of inputs is the sum of the labour input cost and the total cost of capital services. The national accounts record the income of the self-employed as *mixed income*. This measure includes the compensation of both labour and capital to the self-employed but separate estimates of the two components are not generally measurable. As such, in the PDB, total labour input costs for total persons employed (employees and self-employed) are computed as the average remuneration per employee multiplied by the total number of persons employed. The preferred source for data on compensation of employees and for the number of employees as well as the number of self-employed is the *OECD National Accounts Statistics* (database).

The labour input cost is calculated as follows:

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

where $w^t L^t$ reflects the total remuneration for labour input in period $t$, $COMP^t$ is the total 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 of the user costs of each capital asset type $k$ given by $u_k^t K_k^t$, where $u_k^t$ is the user cost per unit of capital services provided by asset type $k$.

The total cost of inputs is then given by

$$C^t = w^t L^t + \sum_{k=1}^{8} u_k^t K_k^t$$

and the corresponding cost shares of labour and capital are

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

$s_K^t \equiv \frac{\sum_{k=1}^{8} u_k^t K_k^t}{C^t}$ for total capital input,

$s_{K_{ict}}^t \equiv \frac{\sum_{i=1}^{3} u_i^t K_i^t}{C^t}$ for capital input derived from ICT assets $i$=1,2,3,

$s_{K_{nict}}^t \equiv \frac{\sum_{j=1}^{5} u_j^t K_j^t}{C^t}$ for capital input derived from non-ICT assets $j$=1,…,5.

### *Labour productivity*

At the total economy level, labour productivity is measured as Gross domestic product (GDP) at market prices per hour worked.

### *Multifactor productivity*

In simple terms, growth in multifactor productivity (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 market prices and 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 inputs, with the respective cost shares as weights. Aggregation of these inputs is by way of the Törnqvist index:

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

### *Contributions to GDP growth*

In the growth accounting framework, GDP growth can be decomposed into the contributions of each production factor plus multifactor productivity:

$$\ln\left(\frac{Q^t}{Q^{t-1}}\right)=\frac{1}{2}\left(s_L^t+s_L^{t-1}\right)\ln\left(\frac{L^t}{L^{t-1}}\right)+\frac{1}{2}\left(s_{K_{ict}}^t+s_{K_{ict}}^{t-1}\right)\ln\left(\frac{K_{ict}^t}{K_{ict}^{t-1}}\right)+\frac{1}{2}\left(s_{K_{nict}}^t+s_{K_{nict}}^{t-1}\right)\ln\left(\frac{K_{nict}^t}{K_{nict}^{t-1}}\right)+\ln\left(\frac{MFP^t}{MFP^{t-1}}\right)$$

where:

$\frac{1}{2}\left(s_L^t+s_L^{t-1}\right)\ln\left(\frac{L^t}{L^{t-1}}\right)$ is the contribution of labour input to GDP growth,

$\frac{1}{2}\left(s_{K_{ict}}^t+s_{K_{ict}}^{t-1}\right)\ln\left(\frac{K_{ict}^t}{K_{ict}^{t-1}}\right)$ is the contribution of ICT capital input to GDP growth,

$\frac{1}{2}\left(s_{K_{nict}}^t+s_{K_{nict}}^{t-1}\right)\ln\left(\frac{K_{nict}^t}{K_{nict}^{t-1}}\right)$ is the contribution of non-ICT capital input to GDP growth.

### *Contributions to labour productivity growth*

By reformulating the decomposition of output growth presented above, it is possible to decompose labour productivity growth into the contribution of capital deepening and MFP.

$$\ln\left(\frac{LP^t}{LP^{t-1}}\right)=\frac{1}{2}\left(s_K^t+s_K^{t-1}\right)\left[\ln\left(\frac{K^t}{K^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)\right]+\ln\left(\frac{MFP^t}{MFP^{t-1}}\right)$$

where:

$\ln\left(\frac{LP^t}{LP^{t-1}}\right)=\ln\left(\frac{Q^t}{Q^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)$ is labour productivity growth,

$\ln\left(\frac{K^t}{K^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)$ is capital deepening (i.e. growth in capital services per hour worked),

$\frac{1}{2}\left(s_K^t+s_K^{t-1}\right)\left[\ln\left(\frac{K^t}{K^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)\right]$ is the contribution of capital deepening to labour productivity growth.

It is also possible to reformulate the decomposition of labour productivity growth to show the contributions of ICT capital and non-ICT capital:

$$\ln\left(\frac{LP^t}{LP^{t-1}}\right)=\frac{1}{2}\left(s_{K_{ict}}^t+s_{K_{ict}}^{t-1}\right)\left[\ln\left(\frac{K_{ict}^t}{K_{ict}^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)\right]+\frac{1}{2}\left(s_{K_{nict}}^t+s_{K_{nict}}^{t-1}\right)\left[\ln\left(\frac{K_{nict}^t}{K_{nict}^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)\right]+\ln\left(\frac{MFP^t}{MFP^{t-1}}\right)$$

where:

$\frac{1}{2}\left(s_{K_{ict}}^t+s_{K_{ict}}^{t-1}\right)\left[\ln\left(\frac{K_{ict}^t}{K_{ict}^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)\right]$ is the contribution of ICT capital to labour productivity growth,

$\frac{1}{2}\left(s_{K_{nict}}^t+s_{K_{nict}}^{t-1}\right)\left[\ln\left(\frac{K_{nict}^t}{K_{nict}^{t-1}}\right)-\ln\left(\frac{L^t}{L^{t-1}}\right)\right]$ is the contribution of non-ICT capital to labour productivity growth.

### *Unit labour costs and their components*

Unit labour costs (ULCs) measure the average cost of labour per unit of output produced. They are calculated as the ratio of total labour costs (in national currency,

current prices) to real output (in national currency, constant prices). At the total economy level, real output is measured as GDP at market prices and constant prices. Equivalently, ULCs may be expressed as the ratio of total labour costs per hour worked in current prices to real GDP per hour worked in constant prices, i.e. labour productivity.

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, 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 excludes labour compensation for the self-employed which is covered in the item *mixed income*. Estimates of the compensation component (per hour worked) of mixed income are set as compensation of employees per hour worked. This assumption may be more or less valid across different countries.

Unit labour costs are therefore compiled as follows:

$$\frac{COMP^t \frac{H^t}{HE^t}}{Q^t}$$

where $COMP^t$ reflects the total compensation of employees in period t, $H^t$ is the total number of hours worked by all persons employed in period t, $HE^t$ is the total number of hours worked by employees in period t and $Q^t$ is GDP at market prices and constant prices in period t.

### *Productivity measures at industry level*

The conceptual approach used to estimate productivity at industry level follows that for the total economy. However the same quantity (and quality) of data that is available for the whole economy estimates is not always available at the detailed industry level. Hence some approximations are necessary and, so, some differences may prevail between the whole economy estimates and those at industry level.

Productivity measures at industry level are computed for 14 economic activities, each defined in accordance with the International Standard Industrial Classification of All Economic Activities (ISIC) Rev.4.

#### *Labour input*

Labour input is measured as total hours worked by all persons engaged in production, i.e. employees plus self-employed, broken down by industry. Another measure of labour input presented in the database is total number of persons employed (i.e. number of employees plus numbers of self-employed).

#### *Labour productivity*

At the industry level, labour productivity is measured as gross value added at basic prices per hour worked and growth rates are determined using constant price estimates of gross value added. Comparable measures are also derived per person employed.

#### *Contributions to labour productivity growth*

The contribution of an economic activity to labour productivity growth of a group of economic activities (e.g. total business sector, total services) is compiled using a Törnqvist index as follows:

$$Cont(i,t) = \frac{1}{2}\left[\left(\frac{Q_{cur,i,t}}{Q_{cur,tot,t}} + \frac{Q_{cur,i,t-1}}{Q_{cur,tot,t-1}}\right)\theta_t\left(Q_{con,i}\right) - \left(\frac{L_{i,t}}{L_{tot,t}} + \frac{L_{i,t-1}}{L_{tot,t-1}}\right)\theta_t\left(L_i\right)\right]$$

where:

*i* is an economic activity,

*tot* is an aggregate of economic activities including economic activity *i*,

$Q_{cur}$ is gross value added at current prices,

$Q_{con}$ is gross value added at constant prices,

L is the number of hours worked,

$\theta_t(x)$ is the annual growth rate of *x* between time t-1 and t.

The database also presents contributions to labour productivity growth by economic activity on an employment (persons) basis.

### *Unit labour costs and their components*

Unit labour costs (ULCs) measure the average cost of labour per unit of output produced. They are calculated as the ratio of total labour costs (in national currency, current prices) to real output (in national currency, constant prices). For main economic activities, real output is measured as gross value added at basic prices and constant prices. Equivalently, ULCs may be expressed as the ratio of total labour costs per hour worked in current prices to real gross value added per hour worked, i.e. labour productivity.

Total labour costs used for the calculations of ULCs by economic activity are computed as described above for the total economy. ULCs by economic activity are compiled as follows:

$$\frac{COMP^{i,t}\,\dfrac{H^{i,t}}{HE^{i,t}}}{Q^{i,t}}$$

where i reflects the economic activity, $COMP^t$ reflects the total compensation of employees in period t, $H^t$ is the total number of hours worked by all persons employed in period t, $HE^t$ is the total number of hours worked by employees in period t and $Q^t$ is gross value added at basic and constant prices in period t. The database presents ULCs by economic activity on an employment (persons) basis.

## *Further reading*

OECD (2001), *Measuring Productivity – OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264194519-en*.

OECD (2009), *Measuring Capital – OECD Manual, Second edition*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264068476-en*.

Colecchia, A. and P. Schreyer (2002), "The contribution of information and communication technologies to economic growth in nine OECD countries", *OECD Economic Studies*, Vol. 2002/1, *http://dx.doi.org/10.1787/eco_studies-v2002-art5-en*.

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Schreyer, P., P. Bignon and J. Dupont (2003), "OECD Capital Services Estimates: Methodology and a First Set of Results", *OECD Statistics Working Papers*, No. 2003/06, OECD Publishing, Paris, *http://dx.doi.org/10.1787/658687860232*.

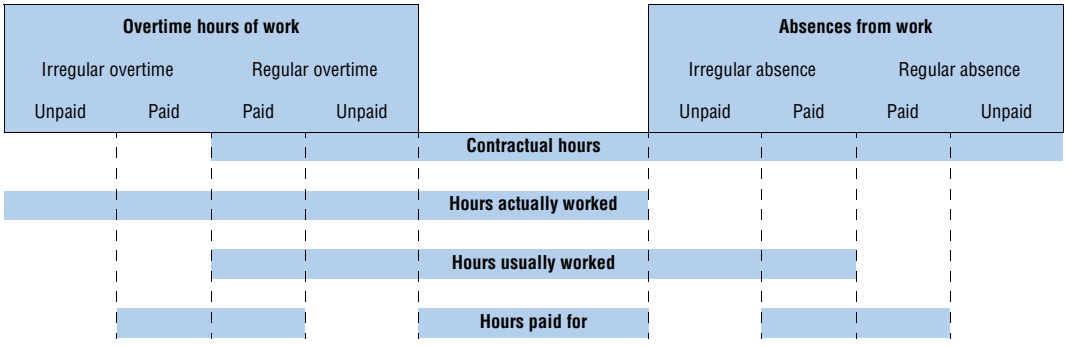
## 6.2 Measuring hours worked

### *Hours worked for productivity analysis – main definitions*

Within the *OECD Productivity Statistics* (database)(PDB), 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 (Table 6.1):

- *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 number of hours 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.

Table 6.1. **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.

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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 for total hours worked estimates in *National Accounts* – the main source ultimately used in the *OECD Productivity Statistics* (database). LFS include questions on the number of hours actually and usually worked in the reference period, i.e. 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 throughout 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 week of the year, effectively taking into account all types of absences from work and overtime.

However, when LFS are not continuous, 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 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.
- *Population census*. These cover the whole population and are often used as a benchmark for most household surveys including LFS. The main disadvantage is the low frequency of data collection (normally carried out every 5 or 10 years).
- *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 with estimates from time use surveys.

For the purposes of productivity analysis, consistency of LFS based data on hours worked with *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: for example, 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.
- Table 6.2 describes the main strengths and limitations of the primary sources typically used to compute hours worked and employment estimates in national accounts.
- In practice, the effective quantity of labour input depends not only on the total number of hours actually worked but also on the characteristics of those performing the work, like education, working experience, business function and sex. The measure of labour input used in this publication, i.e. total number of hours worked, does not account for the composition or heterogeneity of the labour force, thus ignoring changes in the quality of labour (i.e. human capital). This implies treating workers as perfect substitutes: an hour worked by a highly-experienced surgeon and an hour worked by an eighteen-year old student employed in a fast-food are treated as equal amounts of labour. Unadjusted measures of labour input, i.e. total number of hours worked, underestimate the effective use of labour in production affecting cross-country comparability.

### *Hours worked data in the OECD Productivity Statistics (database) (PDB)*

In the *PDB*, the main requirement is that the most internationally comparable hours worked data are used (OECD, 2007). The preferred source for total hours worked is *National Accounts*, which are presented in the *OECD National Accounts Statistics* (database), both for the total economy and for aggregate economic activities. However, long time series of hours worked are not available for a number of countries; in which case, the Secretariat estimates hours worked using the *OECD Employment and Labour Market Statistics* (database). Total economy estimates of average hours actually worked per year and per person employed are currently available on an annual basis, for all 35 OECD member countries and some key partner economies as follows:

- Actual hours worked are primarily sourced from the OECD *National Accounts Statistics* (database) for Australia, Austria, Belgium, Canada, Costa Rica, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Korea,

Table 6.2. **Primary sources used to compute national accounts estimates of hours worked and employment**

| Primary data source | Main strenghts | Main limitations |
|---|---|---|
| **Labour force survey** | • Covers employees, self-employed, unpaid family workers, government and NPISH workers<br>• Includes inormation on the characteristics of employment: age, gender, education, industry, occupation<br>• Provides information on hours actually worked<br>• Harmonised concepts across countries (ILO concepts)<br>• Typically counts the number of persons | • It is a household survey and so may have limited consistency with output and value added measures collected in business surveys, especially by industry<br>• National concept of employment<br>• There may be reporting biases in reported hours worked<br>• Excludes people living in collective households, although this is unlikely to significantly affect numbers of persons employed |
| **Business survey** (e.g. establishment surveys) | • Information consistent with output data<br>• Covers production units operating in the territory: domestic concept of employment | • Typically excludes information on agriculture and government sector - although these are covered in comparable surveys<br>• May exlcude small enterprises below a certain employment or turnover threshold and certain categories of firms, such as unincorporated, self-employed and informal.<br>• Information on hours paid or contractual hours, excludes absences and unpaid overtime<br>• Not necessarily harmonised across countries, although when presented as structural business statistics comparability is generally improved |
| **Population census** | • Can be used as a benchmark | • Low frequency of data collection (typically every 10 years) |
| **Administrative sources** (e.g. social security registers, tax registers) | • To complement data on employment and labour income/compensation | • There is often restricted access (micro data)<br>• Difficult to capture the informal economy |
| **Time use surveys** | • To complement and compare data on hours worked | • Low frequency data<br>• Limited international comparability |

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Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, the United Kingdom and the United States.

- Actual hours worked are sourced from the *OECD Employment and Labour Market Statistics* (database) for Chile, Iceland, Japan, New Zealand, the Russian Federation and Turkey.
- For some countries, longer time series and/or more recent estimates of total hours worked are derived from the *OECD Economic Outlook: Statistics and Projections (database)* and national sources.

## *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*.

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

OECD (2007), "Factors explaining differences in hours worked across OECD countries", *Document prepared for the Working Party No. 1 on Macroeconomic and Structural Policy Analysis*, September 2007.

OECD (2009), "Comparability of labour input measures for productivity analysis", *Document prepared for the OECD Working Party on National Accounts*, November 2009, *www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=std/cstat/wpna(2009)11*.

Ypma, G. and B. van Ark (2006), "Employment and Hours Worked in National Accounts: A Producer's View on Methods and a User's View on Applicability", *EU KLEMS Working Paper* No. 10.

## 6.3 Capital input measures at the OECD

### *Introduction*

Two key measures of capital stock exist. The first is the *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 section provides supplementary information on these two measures, on the approaches used to estimate them and on capital measures available 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 profile 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 with 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 measures of productive capital stock weigh 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, i.e. capital services.

#### *Net and gross (wealth) 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 System of National Accounts (SNA). These provide measures of wealth but they are not conceptually appropriate for productivity analysis. Unlike the productive capital stock, the purpose of wealth capital stocks measures is not to track the role of capital as a factor of production but to track the role of capital as a set of assets with market value – wealth capital stocks appear on the balance sheets in the SNA. This reflects the fact that the implicit weighting for the different assets used in building up wealth measures of total capital stock is based on the market prices 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. In common with most measures presented in the national accounts, they are estimated by national statistics institutes using available data on gross fixed capital formation (investment) with local methodology and assumptions – although there is increasing convergence towards international standards. There are heavy data requirements for the estimation of capital stocks 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.

### *Capital measures in OECD statistics*

Several OECD databases, described below, contain capital stock data. 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 *OECD Productivity Statistics* (database), 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 6.3 below, some databases are confined to aggregate statistics, such as the *OECD Economic Outlook: Statistics and Projections* (database) or *OECD Productivity Statistics* (database). Others provide a break-down by industry, such as the *OECD Structural Analysis Statistics* (database) and the OECD *National Accounts Statistics* (database).
- *The capital stock variable*. The *OECD Productivity Statistics* (database) measures productive capital stocks (and therefore, capital services) whereas the *OECD Structural Analysis Statistics* (database) and OECD *National Accounts Statistics* (database) contain measures of net and/or gross (wealth) capital stocks.

Table 6.3. **Asset and industry breakdown of capital stock data in OECD databases**

| | | Asset breakdown | |
|---|---|---|---|
| | | Yes | No |
| Industry breakdown | Yes | *OECD National Accounts Statistics* (database) | *OECD Structural Analysis Statistics* (database) |
| | No | *OECD Productivity Statistics* (database) | *OECD Economic Outlook: Statistics and Projections* (database) |

StatLink http://dx.doi.org/10.1787/888933477619

### *Capital services for the total economy, 8-way asset break down*

Estimates of capital services in the *OECD Productivity Statistics* (database) are based on a common computation method for all countries (Schreyer et al., 2003). This approach estimates productive capital stocks for all countries on the assumption that the same service lives are applicable for any given asset irrespective of the country.[2] The approach further uses harmonised deflators for computer hardware, telecommunications equipment and computer software and databases, for all countries, to sort out comparability problems that exist in national practices for deflation for this group of assets (Schreyer, 2002; Colecchia and Schreyer, 2002).

From 2015, the classification of assets adopted in the *OECD Productivity Statistics* (database) is in line with the SNA 2008 asset boundary. Productive capital stocks and the respective flows of capital services are computed separately for eight non-residential fixed assets: computer hardware, telecommunications equipment, transport equipment, other machinery and equipment and weapons systems, non-residential construction, computer

software and databases, research and development and other intellectual property 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. The aggregate volume of capital services (i.e. capital input) is then computed by aggregating the volume change of capital services of all individual assets applying asset specific *user cost* shares as weights. No conceptual distinction is made between user costs of capital and rental prices of capital. In principle, the rental price is that price that 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: *the user costs of capital*. In other words, the user cost of capital reflects the amount that the owner of a capital good would charge if they rented out the capital good under competitive conditions.

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

The *OECD National Accounts Statistics* (database) database brings together a large number of national accounts series for OECD and non-OECD countries. This includes data on net and gross capital stocks broken down by main economic activity and by nine types of assets: dwellings, other buildings and structures, transport equipment, other machinery and equipment and weapons systems, of which computer hardware and telecommunications equipment; cultivated biological resources; intellectual property products, of which computer software and databases and research and development. The data are transmitted by OECD member countries in reply to an official questionnaire and are provided in current prices 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 Structural Analysis Statistics* (database) provides data on volume measures of *gross and net capital stock* by industry. The *OECD Structural Analysis Statistics* (database) covers all ISIC Rev.4 aggregations used for national accounts, some additional 2- and 3-digit ISIC Rev.4 detail, as well as specific aggregates**.** The level of industry detail and the time period covered varies across countries. A detailed overview of available data in the *OECD Structural Analysis Statistics* (database) can be found at *www.oecd.org/sti/stan*.

### *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 and key partner economies. One of the series available is the volume measure for non-residential capital services for the total economy (productive capital stocks).

### *How to access OECD capital input measures*

- Aggregate capital services series in the *OECD Productivity Statistics* (database), along with methodological information and analytical papers and publications can be found on the *OECD Productivity Statistics* website on *www.oecd.org/std/productivity-stats/* or on the *OECD Productivity Statistics* (database) on OECD.Stat, within the theme *Productivity*, then selecting *Growth in GDP per capita, productivity and ULC*, and then *Growth in capital input*;
- Data on gross/net capital stocks by industry can be found in the *OECD Structural Analysis Statistics* (database) on: *www.oecd.org/sti/stan*;
- Gross/net capital stocks in the *OECD National Accounts Statistics* (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 *OECD Economic Outlook*, such as the total economy productive 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/*).

### *Notes*

1. For more information on capital measures and their uses see OECD (2001, 2009) and Schreyer (2004).
2. In the PDB, the following average service lives are currently assumed for the different assets: 7 years for computer hardware, 15 years for telecommunications equipment, other machinery and equipment and weapons systems and transport equipment, 40 years for non-residential construction, 3 years for computer software and databases, 10 years for research and development and 7 years for other intellectual property products.

### *Further reading*

OECD (2001), *Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264194519-en*.

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## 6.4 The System of National Accounts 2008

### *The 2008 SNA – changes from the 1993 SNA*

In 2009, The United Nations Statistical Commission endorsed a revised set of international standards for the compilation of national accounts: the System of National Accounts (SNA) 2008, replacing the 1993 version of the SNA. For Chile and Colombia, the indicators presented in this publication are in line with the 1993 SNA. For the Russian Federation, the indicators are in line with the 1993 SNA until 2013 and with the 2008 SNA from 2014 onwards. For all the other countries, the indicators are based on 2008 SNA. The 2008 SNA includes a number of changes from the 1993 SNA and was adopted by most OECD countries at the end of 2014.

### *Changes affecting whole economy levels of income*

For the United States, the adoption of the 2008 SNA in 2013 raised the level of GDP by 3.6 per cent, mainly due to the recognition of new forms of gross fixed capital formation (GFCF), notably Research and Development (R&D). The revision was also an opportunity for countries to implement some additional changes made in the 1993 SNA, which recognised entertainment originals as fixed assets. In addition changes were also made for the 2008 SNA recommendations on ownership transfer costs (see below). Current consumption expenditures of government in recent years were also revised downwards, reflecting 2008 SNA recommendations on defined benefit pensions plans as well as the net (of depreciation) effects of removing R&D expenditures from current consumption (see also below).

#### *Research and experimental development*

R&D is recognised for the first time as a produced asset. This also means that payments for the acquisition of patents, treated as acquisition or disposal of non-produced, non-financial assets in the 1993 SNA, are treated as transactions in produced assets. This also has implications for sectoral gross value added as the 2008 SNA also recommends that a separate establishment be distinguished for R&D producers when possible. See also the OECD Handbook on Deriving Capital Measures of Intellectual Property Products. Under the 1993 SNA, expenditure on R&D by government already adds to government output (which is estimated on a sum of costs basis) and subsequently as general government final consumption. So, for government the direct impact of the capitalisation mainly involves a reclassification of expenditure from government final consumption to government GFCF. Indirectly however government output and, so GDP, will increase as part of the costs of government is an imputation for depreciation; which now includes a component for the capital stock of R&D by government.

#### *Weapons systems*

Military weapons systems such as vehicles, warships, etc. used continuously in the production of defence (and deterrence) services are recognised as fixed assets in the 2008 SNA (the 1993 SNA recorded these as fixed assets only if they had dual civilian use and as intermediate consumption otherwise). Some single-use items such as certain types of ballistic missiles with a highly destructive capability, but which provide ongoing deterrence services, are also recognised as fixed assets in the 2008 SNA. Because most if not all of these expenditures are carried out by government (whose output is typically valued by summing costs) GDP will only increase by the related new consumption of fixed capital.

### *Financial Intermediation Services Indirectly Measured (FISIM)*

The method recommended in the 2008 SNA for the calculation of FISIM implies several changes from that in the 1993 SNA. For example it explicitly recommends that FISIM only apply to loans and deposits provided by/deposited with financial institutions, and that for financial intermediaries all loans and deposits are included, not just those of intermediated funds. In addition, the 2008 SNA no longer allows countries to record FISIM as a notional industry.

### *Financial services*

The 2008 SNA defines financial services more explicitly to ensure that services such as financial risk management and liquidity transformation, are captured.

### *Output of Central Banks*

The 2008 SNA has provided further clarification on the calculation of FISIM in calculating the output of Centrals Banks. Where Central Banks lend or borrow at rates above or below the effective market lending/borrowing rate, the 2008 SNA recommends the recording of a tax or subsidy from the counterpart lender/borrower to/from government to reflect the difference between the two rates. Correspondingly a current transfer (the counterpart to the tax/subsidy) is recorded between government and the Central Bank. These flows will have an impact on the distribution of income in national income compared with the 1993 SNA treatment.

### *Output of non-life insurance services*

The methodology used to indirectly estimate this activity in the 1993 SNA (premiums plus premium supplements minus claims) could lead to extremely volatile (and negative) series in cases of catastrophic losses. The 2008 SNA recommends a different indirect approach to measurement that better reflects the pricing structures used by insurance companies and the underlying provision of insurance services per se. The approach can be simply described as an ex ante expectation approach. Output is equal to premiums plus expected premium supplements minus expected claims. The 2008 SNA also recommends that exceptionally large claims, following a catastrophe, be recorded as capital, rather than current, transfers which will have an impact on (particularly sectoral) estimates of disposable income.

### *Valuation of output for own final use*

The 2008 SNA recommends that estimates of output for own final use should include a component for the return to capital as part of the sum of costs approach when comparable market prices are not available. However no return to capital should be included for non-market producers.

### *Costs of ownership transfer*

The 1993 SNA recommended that these costs (treated as GFCF in the accounts) should be written off over the life of the related asset. The 2008 SNA instead recommends that these costs be written off over the period the asset is expected to be held by the purchaser. This will impact on measures of net income and only marginally on gross measures, reflecting the calculation of output for own final use and government output (which is calculated as the sum of costs including depreciation).

### *Re-allocating income across categories*

#### *Goods sent abroad for processing*

The 2008 SNA recommends that imports and exports be recorded on a strict ownership basis. This means that the values of a flow of goods moving from one country (that retains ownership of the goods) to another providing processing services should not be recorded. Only the charge for the processing service should be recorded in the trade statistics. The 1993 SNA imputed an effective change of ownership.

#### *Merchanting*

Under the 1993 SNA merchanting – the purchase and subsequent resale of goods abroad without substantial transformation and without the goods entering or exiting the territory of the merchant – was classified as a services transaction. This treatment caused global imbalances in goods and services because while the merchant records an export of a service the country acquiring the good records an import of a good. Therefore, the 2008 SNA recommends classifying merchanting as a component of trade in goods. The acquisition of goods by the merchant are recorded as negative exports of the merchant's economy and the subsequent resale of goods by the merchant are recorded as a positive exports. The difference between sales and purchases of merchanted goods is recorded under a new category "Net exports of goods under merchanting" of the merchant's economy.

#### *Defined benefit pension schemes*

The 1993 SNA stated that actual social contributions by employers and employees should reflect the amounts actually paid. The 2008 SNA differs, recognising that the amounts actually set aside may not match the liability to the employees. As such, the 2008 SNA recommends that the employer's contribution should reflect the increase in the net present value of the pension entitlement plus costs charged by the pension fund minus the employee's own contributions. This change will result in a shift of income between gross operating surplus and compensation of employees and between institutional sectors (corporations/government and households).

In some cases, a defined benefit pension plan may be underfunded implying the pension plan has insufficient financial assets to earn the returns that are necessary to meet promised future benefits. The promised future benefits are assets of the household sector and liabilities of the pension schemes, or the employer if there is no autonomous scheme. According to the 1993 SNA, only the funded component of pension plans should be reflected in liabilities. However, the new 2008 SNA recognises the importance of the liabilities of employers' pension schemes, regardless of whether they are funded or unfunded. For pensions provided by government to their employees, countries have some flexibility in the recording of the unfunded liabilities in the set of core tables. However, the full range of information is required in a new standard table (SNA Table 17.10) that shows the liabilities and associated flows of all private and public pension schemes, whether funded or unfunded, including social security.

#### *Ancillary activities*

The 2008 SNA recommends that if the activity of a unit undertaking purely ancillary activities is statistically observable (separate accounts, separate location) it should be recognised as a separate establishment.

### *Holding companies*

The 2008 SNA recommends that holding companies should always be allocated to the financial corporations sector even if all their subsidiary corporations are non-financial corporations. The 1993 SNA recommended that they be assigned to the institutional sector in which the main group of subsidiaries was concentrated.

### *Exceptional payments from public corporations*

The 2008 SNA recommends that these should be recorded as withdrawals from equity when made from accumulated reserves or sales of assets. The 1993 SNA treated such transactions as dividends.

### *Exceptional payments from governments to quasi-public corporations*

The 2008 SNA recommends that these should be treated as capital transfers to cover accumulated losses and as additions to equity when a valid expectation of a return in the form of property income exists. The 1993 SNA treated all such payments as additions to equity.

## *Further reading*

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## 6.5 Measuring producer prices and productivity growth in services

### *The price index-productivity link*

Empirical evidence presented in this publication 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 services producer price indices (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 10 years, much progress has been made by OECD countries in measuring 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 10 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 are:

1. **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.
2. **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.
3. **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 the way firms in a given sector charge for their products can impact considerably on the reliability of measured price indices 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 6.4 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.[1] These services provide two interesting examples of how price index measurement could impact

on measured productivity growth.[2] 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.

Table 6.4. **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 | Telecommunications services | 2000-10 | 6.37 | 0.55 | 2.71 | 6.32 | |
| | | 2005-10 | 4.73 | -2.01 | 0.22 | 4.92 | 8.60 |
| | Legal and accounting services | 2000-10 | -0.24 | | 1.17 | 1.02 | |
| | | 2005-10 | -1.18 | -3.26 | -0.88 | -1.58 | -2.70 |
| United States | Broadcasting & telecommunication | 2000-10 | 6.82 | 2.28 | 1.88 | 7.41 | 6.00 |
| | | 2005-10 | 5.64 | 0.40 | 0.85 | 5.67 | 3.12 |
| | Legal services | 2000-10 | -1.60 | -0.28 | 0.53 | -1.65 | -2.68 |
| | | 2005-10 | -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 Structural Analysis Statistics (database), INSEE, Bureau of Labour Statistics.
StatLink http://dx.doi.org/10.1787/888933477626

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:

- *Services Producer Price Indices (SPPI)*. From a methodological point of view, using SPPIs, 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.

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 2000-11 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.

## Notes

1. This exercise is of a purely hypothetical nature. Its aim is merely to illustrate the sensitivity of value added volume series and hence productivity growth to price index methods.
2. In the empirical results presented in Table 6.4, 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.

## Further reading

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## 6.6 Purchasing Power Parities for cross-country productivity comparisons

### *Definition*

Purchasing power parities (PPPs) are the rates of currency conversion that equalise the purchasing power of different currencies by eliminating the differences in price levels between countries. In their simplest form, PPPs are price relatives which show the ratio of the prices in national currencies of the same good or service in different countries. In this sense, they are spatial price comparisons.

Levels of GDP in a given year, when converted with PPPs, measure the size of economies in volume terms and so provide a more meaningful measure of the relative size of countries than simple exchange-rate based comparisons. Indeed, exchange rates reflect so many more influences than the direct price comparisons that are required to make volume comparisons. Furthermore, they tend to exhibit large movements over short periods of time, implying rapid changes in living standards which cannot have possibly occurred.

GDP and its components, converted using PPPs, provide a snapshot of relative volumes in a particular year. For many analytical purposes, the interest is in the evolution of GDP volumes between countries and over time. There are at least two ways of setting up such a comparison, each with its specific interpretation and use.

### *Current PPPs and expenditures (comparison at current international prices)*

One approach for combining spatial and temporal observations is to use a sequence of current PPPs, i.e., a new set of price data for every period, compiled, weighted and aggregated to yield rates of currency conversion for total GDP and its expenditure components. With current PPPs, prices and price structures are allowed to vary over time. Volume levels of GDP are then obtained by applying these current PPPs, for every period, to GDP measures at current national prices. *For a given year*, (spatial) comparisons between countries are straightforward – volumes are measured with the same price structure. Comparisons of the resulting series over time, however, incorporate several effects: relative volume changes, changes in relative prices between countries and, possibly, changes in definitions and methodologies. The approach can also be described as comparisons at **current international prices or current PPPs**.

### *Constant PPPs and expenditures (comparison at constant international prices)*

A second approach is to generate time series at constant prices and constant PPPs. With constant PPPs, a single year is chosen for the comparison of GDP levels and all other observations are obtained by applying relative rates of GDP growth, consistent with those derived in national currencies. This procedure ensures transitivity over space and time. The approach can also be described as comparisons at **constant international prices or at constant PPPs**. The key conceptual difference between using current and constant PPPs is that the former capture changes in volume as well as changes in weights, whereas the latter only capture volume changes. Put differently, even if the volumes of goods and services remain identical over time, a GDP comparison based on current PPPs may change over time if prices and price structures shift. Ignoring such shifts over longer periods can generate a biased picture of economic developments. This factor comes into play when some countries are large producers and exporters of products with marked price changes, for example Norway, which is an important oil exporter. Another consequence of fixing price structures to a base year is the sensitivity of results to the choice of the base year.

### *How are PPPs calculated?*

PPPs are calculated in three stages:

- first for individual products,
- then for groups of products or basic headings and,
- finally, for groups of basic headings or aggregates.

The PPPs for basic headings are un-weighted averages of the PPPs for individual products. The PPPs for aggregates are weighted averages of the PPPs for basic headings.

The weights used are the expenditures on the basic headings. PPPs at all stages are price relatives. They show how many units of currency A need to be spent in country A to obtain the same volume of a product or a basic heading or an aggregate that X units of currency B purchases in country B.

In the case of a single product, the "same volume" means "identical volume". But in the case of the complex assortment of goods and services that make up an aggregate such as GDP, the "same volume" does not mean an "identical basket of goods and services".

The composition of the basket will vary between countries according to their economic, social and cultural differences, but each basket will provide equivalent satisfaction or utility.

- Values at constant international prices of period $t_0$ (at PPPs of period $t_0$)

Values at constant international prices of period t0 (at PPPs of period t0) are series at current domestic prices converted to a common currency by way of constant PPPs of a given year.

Constant PPPs capture volume changes only.

A value index of this kind corresponds to a weighted average of the value changes in domestic prices, as PPPs are held fixed.

- Values at constant international prices of period $t_{-1}$ (at PPPs of period $t_{-1}$)

Values at constant international prices of period $t_{-1}$ (at PPPs of period $t_{-1}$) are series at current domestic prices converted to a common currency by way of PPPs of year $t_{-1}$.

A value index of this kind corresponds to a weighted average of the value changes in domestic prices, as PPPs are held fixed at their previous year's value. However, weights are continuously updated.

- Values at current international prices (at current PPPs)

Values at current international prices (at current PPPs) are series at current domestic prices converted to a common currency by way of current PPPs. Because PPPs are price relatives of goods and services, this implies substituting the set of domestic prices by a set of international prices.

Current PPPs capture changes in volumes and in relative prices.

PPPs produced at the OECD are intended for *whole economy* cross-country comparisons of GDP and consumption across countries. They are derived through a collection of prices of final demand components and, as such, while they provide a sound basis for whole economy comparisons, they should not be used for comparisons across industries, especially for sectors whose prices are determined internationally.

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## 6.7 Trend estimation method

Understanding to which extent productivity growth is driven by structural factors and affected by short-term economic fluctuations is of utmost importance for policy makers. To shed light on this distinction, one can decompose the series into a trend and a cyclical component, where the trend is meant to capture the long-term growth of the series and the cyclical component is the deviation of the series from that trend. In the OECD Compendium of Productivity Indicators 2017, the method used to extract the trend component is the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997).

### *The Hodrick-Prescott filter*

The HP filter is the best known and most widely used method to separate the trend from the cycle (Hodrick and Prescott, 1997). The method has been first presented in a working paper in 1981 (Hodrick and Prescott, 1981). The filter is defined as the solution to the following optimisation problem:

$$y_t = \tau_t + c_t$$

$$min_{\{\tau_t\}} \left\{ \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} \left[ (\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}) \right]^2 \right\}$$

where $y_t$ is the original series, $\tau_t$ is the trend component and $c_t$ is the cyclical component. The method consists in minimising the deviation of the original series from the trend (the first term of the equation) as well as the curvature of the estimated trend (the second term). The trade-off between the two goals is governed by the smoothing parameter λ. The higher the value of λ, the smoother is the estimated trend.

For quarterly data it has been typically assumed a value of λ = 1600, as recommended by Hodrick and Prescott (1997). However, there is less agreement on the value to be used when the filter is applied to other frequencies (e.g. annual, monthly). Backus and Kehoe (1992) used λ = 100 for annual data, while Ravn and Uhlig (2002) propose an adjustment of the standard value of 1600 that consists of multiplying that value by the fourth power of the frequency of observations relative to quarterly data. The latter results in a value of λ equal to 6.25 (= 1600*(1/4)$^4$) for annual data.[1]

The HP-filter can be interpreted in the frequency domain. In this formulation the λ parameter can be associated with the cut-off frequency of the filter – the frequency at which it halves the impact of the original cyclical component. It can be shown that the Ravn-Uhlig rule for selecting the value of λ corresponds to a cut-off frequency of approximately 10 years, assuming annual data (Maravall and Del Río 2001). Nonetheless, Nilsson and Gyomai (2011) point out that the HP-filter has strong leakages (i.e. letting cyclical components from the stop band appear in the filtered series), and this feature may affect the choice of the filter parameter depending on the goal of the study and sensitivity to filter leakage.

In this publication, the target frequency for trend estimation was no different than in the above studies (10 years and beyond). However an additional objective is to minimize the leakage from shorter business-cycle frequencies into the estimated trend. Accordingly, the value of the smoothing parameter selected here is λ = 54.12. This value has been determined by calibrating the Hodrick-Prescott filter in such a way that the frequency response at 9.5 years is equal to 0.10. This means that with λ = 54.12, cycles with a wavelength lower than 9.5 years would be attenuated by 90% or more.

In comparison with other ideal filters, the trend estimated with the HP filter is more sensitive to transitory shocks or short-term fluctuations at the end of the sample period. This results in a sub-optimal performance of the HP filter at the endpoints of the series (Baxter and King, 1999). In view of this property, in order to lessen revisions of the published estimates, trend series are not published for the first two years and the last two years for which data on the original series are available. Even though, the choice of the HP filter is based on its interpretability and widespread use in the literature.

### *Note*

1. The frequency of observations relative to quarterly data is 1/4 for annual data and of 3 for monthly data.

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