OECD Compendium of Productivity Indicators 2018

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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 2018 OECD Compendium of Productivity Indicators *was prepared in the OECD Statistics and Data Directorate by Frédéric Parrot and María Belén Zinni, and edited by Nadim Ahmad and Mariarosa Lunati. The contributions of Liliana Suchodolska and Gueram Sargsyan are gratefully acknowledged. The publication has benefited from comments from the OECD Economics Department and the OECD Directorate for Science, Technology and Innovation.*

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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;
- the relationship between wages and productivity;
- 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 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 represents the efficiency of the combined use of labour and capital in the production process and is measured as the residual growth that cannot be explained by changes in labour and capital inputs. 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 (database)

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 7. 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 7.). However, at the time of publication the indicators computed for 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 2010) and 2008 SNA (from 2011 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.[1]

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: 1995-2016; 2001-2016; 2001-2007; and 2010-2016. 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

[1] 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.

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.

This year edition presents indicators for more detailed economic activities according to ISIC Rev. 4.

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Executive summary

Short-term trends

Global economic growth remains solid and broad-based, even though the pace has eased in recent periods. But while the upturn is set to persist into 2018, it has been modest, partly reflecting continued relatively weak labour productivity growth in most countries. Among OECD economies, in the United Kingdom and the United States, and more recently in Mexico, Spain and Italy, the recovery in GDP growth has been largely sustained by increasing employment.

Moreover, in many countries, employment has increased most in recent years in activities with relatively low labour productivity, dragging down overall labour productivity, although this partly reflects a rebound in employment in activities hit hardest by the crisis. In nearly all major OECD economies, the top three sectors generating the largest net employment gains over the period 2010-2016 had below average labour productivity, with restaurants, health and residential care activities featuring highly in most economies.

While the impact of the crisis and the different response mechanisms adopted by countries to mitigate its effects need some care in interpretation, the evidence points to relatively minimal boosts to productivity growth from reallocation effects in most countries, with declining within-sector productivity growth at the origin of declines at the whole economy level.

More jobs in lower labour productivity activities has also meant more jobs with below average wages in most economies, working to weigh down on average salaries in the economy as a whole. Moreover, growth in real wages (compensation per hour worked), adjusted for inflation using the consumer price index (CPI), has also been lagging labour productivity growth in many countries in the post-crisis period. Indeed, real wages, on this basis, declined between 2010 and 2016 in Portugal, Spain and the United Kingdom. However, in some countries, such as Germany and the United States, real wages have begun to rise in line with (albeit slow) labour productivity growth in recent years, helping to reverse pre-crisis decoupling.

But even in countries where decoupling at the whole economy has been less apparent, this is not always true at the sectoral level, which may have implications for inclusive growth. For example most sectors saw lower growth in real wages than labour productivity growth in France, and even in the United States and Germany, about one third of sectors saw real wage growth lag labour productivity growth.

Although investment is beginning to pick up, the recovery remains modest with post-crisis investment rates, in particular in tangible assets, still below pre-crisis levels in many OECD economies. Lower investment rates combined with higher employment resulted in slower capital deepening, compounding the longer term slowdown in labour productivity growth seen before the crisis in many countries.

Long-term trends

Productivity growth in most countries, remains well below historic averages but, notwithstanding care needed in interpreting post-crisis trends, the evidence points to tentative signs of improvement in multifactor productivity growth (from the crisis lows) in Canada, France, Germany and Japan.

The post-crisis period has been characterised by a significant increase in the contribution of labour utilisation to GDP per capita growth, notably in 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.

The post-crisis slowdown in labour productivity growth in manufacturing has been widespread, spanning nearly all sub-sectors of manufacturing from higher-tech, higher skilled activities such as computers and electronics, to those traditionally viewed as lower-tech and lower-skilled, such as textiles. In the former, labour productivity growth slowed significantly in the Czech Republic, Lithuania, Poland, Sweden and the United States, while in the latter, significant slowdowns were observed in the Czech Republic, the Slovak Republic, Slovenia and the United Kingdom.

Productivity growth in manufacturing continues however to outpace productivity growth in services. Within the business services sector, for most OECD countries, labour productivity growth over the past fifteen years was mainly driven by retail trade, hotels and transport services, reflecting their much larger share of overall economic activity and employment. In the pre-crisis period strong productivity growth in finance and insurance activities also acted as a significant contributor, but the contribution of these activities has been weaker post-crisis.

In most countries, gaps in labour productivity levels between large firms and small and medium-sized enterprises (SMEs) are relatively high. This is particularly true for micro firms in both manufacturing and business services sectors, even if in some countries and sectors, smaller enterprises do outperform larger firms, particularly in the business services sector.

Investment in intellectual property products has been increasing over the last fifteen years, often at a faster pace than investment in traditional physical capital, with shares of investment in intellectual property products ranging from 1.1% in Colombia to 30% in Switzerland and 56% in Ireland in 2016.

In sectors less exposed to direct international competition, notably the services sector, unit labour costs (ULC) in some countries outpaced manufacturing ULC. This was particularly the case in the post-crisis period in Austria, Germany, Italy and Portugal and the European Union as a whole. As many of these services are used as upstream inputs to manufacturers, overall international competitiveness could in fact be affected.

Labour income shares have declined in most countries over the last fifteen years, particularly in the manufacturing sector, with the largest declines in Poland (from 66% in 2001 to 48% in 2016), the United States (61% in 2001 to 48% in 2015) and Denmark (64% in 2001 to 52% in 2016). In Ireland, labour income shares in manufacturing declined from 29% in 2001 to 14% in 2016, partly reflecting relocations of firms with high knowledge based assets value in 2015. In business services, the largest declines occurred in Greece (63% in 2001 to 35% in 2016), Ireland (56% in 2001 to 42% in 2016) and Israel (77% in 2001 to 66% in 2016).

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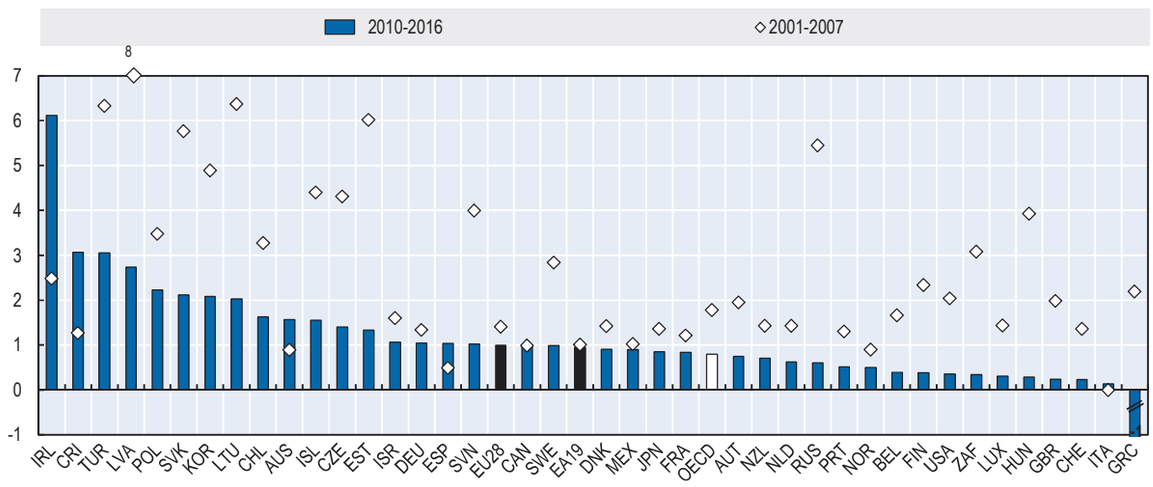
Chapter 1. Recent trends in productivity and employment

Economic growth is picking up but labour productivity growth remains weak

Global economic growth remains solid and broad-based (OECD, 2017b), even though the pace has eased in recent periods. But while the upturn is set to persist into 2018, it has been modest, partly reflecting continued relatively weak labour productivity growth in most countries (Figure 1.1). In the OECD as a whole labour productivity in the post crisis period has grown at about half the rate of the pre-crisis period.

Figure 1.1. Labour productivity growth before and after the crisis

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



Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, February 2018.

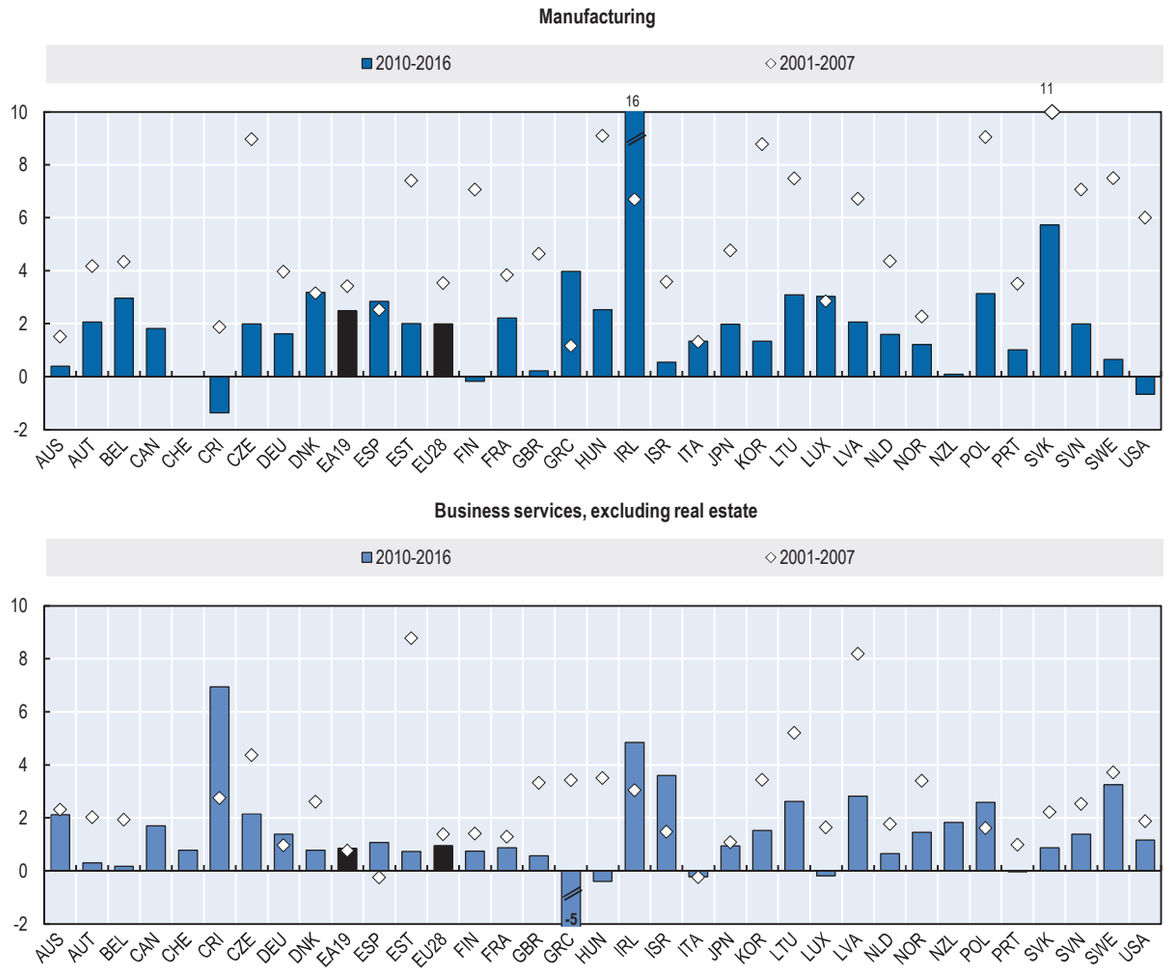
StatLink http://dx.doi.org/10.1787/888933733296

Productivity growth slowed markedly after the crisis in all major sectors, but particularly in manufacturing where productivity growth rates remain well below pre-crisis levels in most countries (Figure 1.2), such as the Czech Republic, Finland, Hungary, Korea, Latvia, Sweden and the United States. Contributions from the business sector services also declined in the post-crisis period, especially in Estonia, Hungary, Greece and the United Kingdom (Figure 1.3).[2]

[2] In this chapter, 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.

Figure 1.2. Labour productivity growth in manufacturing and business services

Gross value added per hour worked, constant prices, percentage change at annual rate

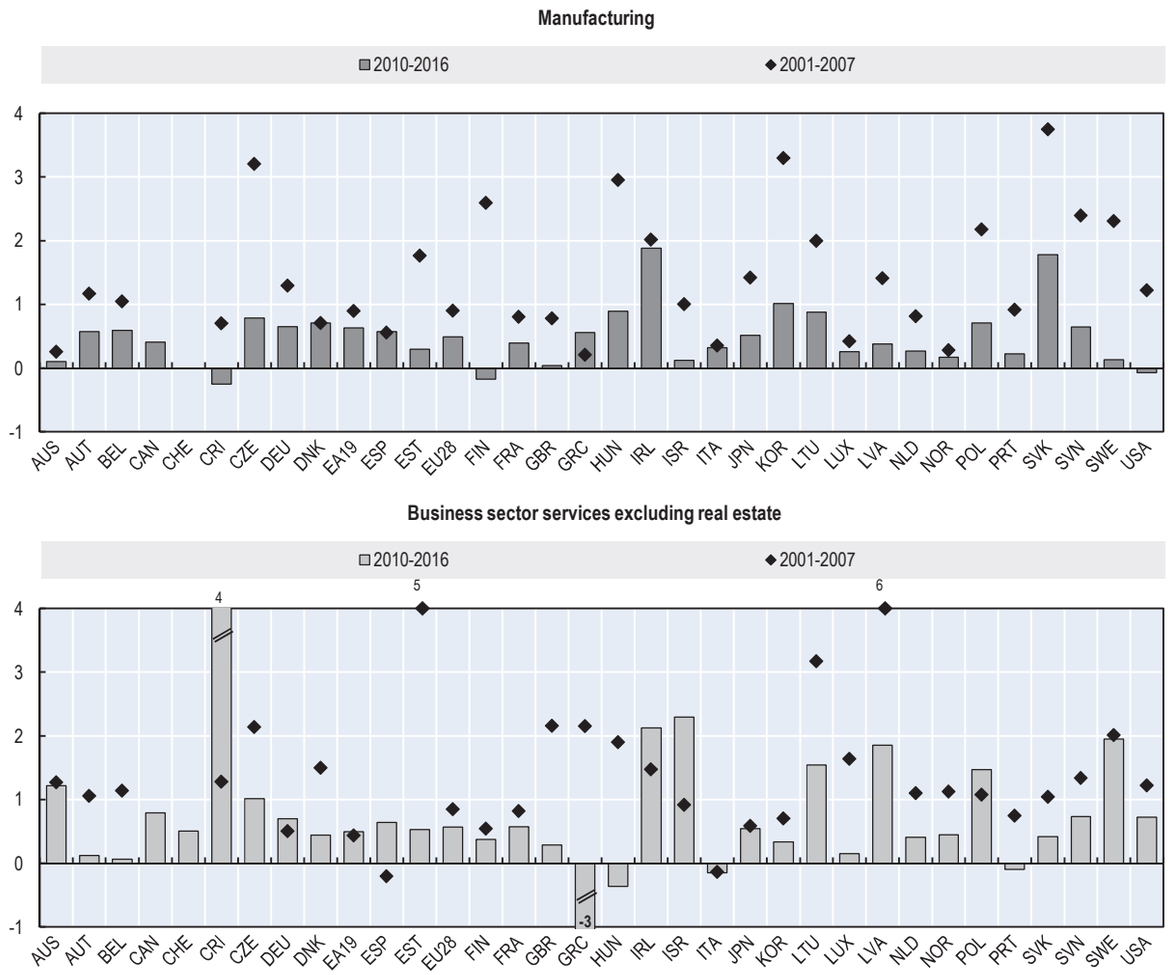


Note: For Japan, Korea and the United States, labour productivity is measured as gross value added per person employed, as national accounts estimates of total hours worked by main economic activity are not currently available.
Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, February 2018.

StatLink http://dx.doi.org/10.1787/888933733315

Figure 1.3. Contributions of manufacturing and business services to labour productivity growth in the business economy

Percentage point contribution at annual rate



Note: For Japan, Korea and the United States, labour productivity is measured as gross value added per person employed, as national accounts estimates of total hours worked by main economic activity are not currently available.
Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, February 2018.

StatLink http://dx.doi.org/10.1787/888933733334

Capital deepening has also been weak

Although there are some signs that investment may be beginning to pick up (OECD 2017b), the recovery remains modest, with capital deepening, i.e. increases in capital per hour worked, from both ICT and non-ICT capital, stalling in many countries in the post-crisis period (up to 2016), compounding the longer term slowdown in productivity growth seen before the crisis in many countries. Indeed, the contribution of capital deepening was negative in Italy and Switzerland between 2014 and 2016, and in Portugal and Spain between 2014 and 2015 (Figure 1.4).

Slower capital deepening rates in part reflect higher employment, but are also in line with lower investment rates, especially in tangible assets, i.e. dwellings, non-residential construction, machinery and equipment and cultivated assets, which in most countries showed only a marginal improvement on the crisis lows and remain below pre-crisis rates (Figure 1.5). However, investment in intellectual property products, where the benefits of the investment may not accrue immediately and are often lagged, has remained more robust, marginally increasing in most countries, which may act as a catalyst for stronger economic growth going forward.

Multifactor productivity growth has also remained weak in many countries

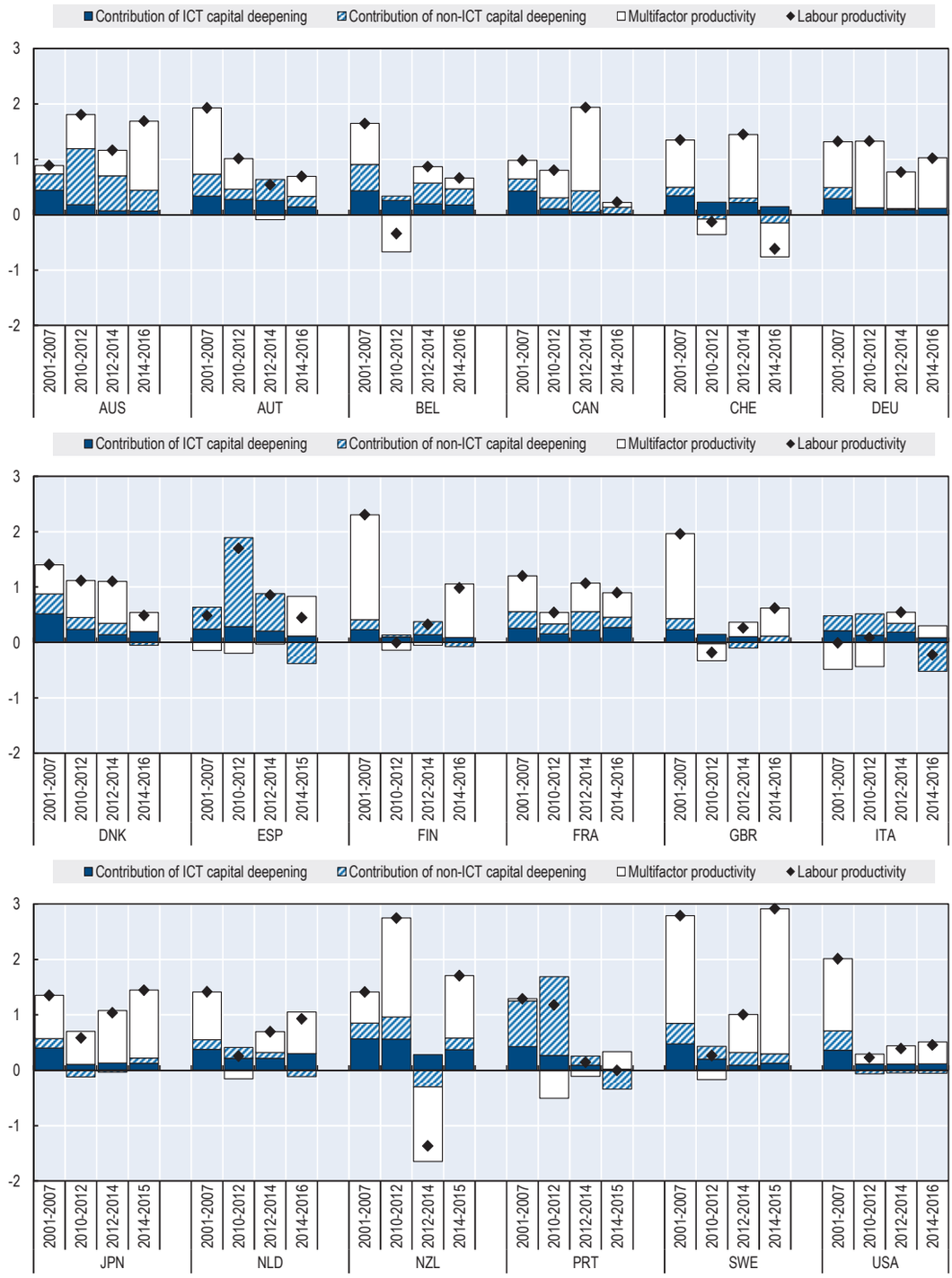
Weak labour productivity growth also reflects continued slowing in multifactor productivity growth (MFP) (Figure 1.4; see Chapter 7. for methodology), notably in Austria, Belgium, the United Kingdom and the United States, lending some weight to the arguments that:

- technological spillovers and diffusions from ICT and other new technologies may be lower than from earlier technology breakthroughs (Cowen, 2011; Gordon, 2012, 2016); and
- the pace of technological progress requires parallel innovation in organisational structures and business models and, as such, the deployment of new technologies is only getting under way (Brynjolfsson and McAfee, 2011; Baily, Manyika and Gupta, 2013).

Other factors may also play a role. Declining MFP growth rates may at least in part reveal the financial crisis after-effects (OECD, 2015) and inefficiencies in the combined utilisation of labour and capital inputs, notably skills mismatches (Adalet McGowan and Andrews, 2015) but also capital misallocation (Adalet McGowan et al., 2017) or a slower pace at which innovations spread throughout the economy from frontier firms to other firms (Andrews et al., 2015).

Figure 1.4. Contributions of capital deepening and MFP to labour productivity growth

Selected OECD countries, total economy, percentage point contribution at annual rate

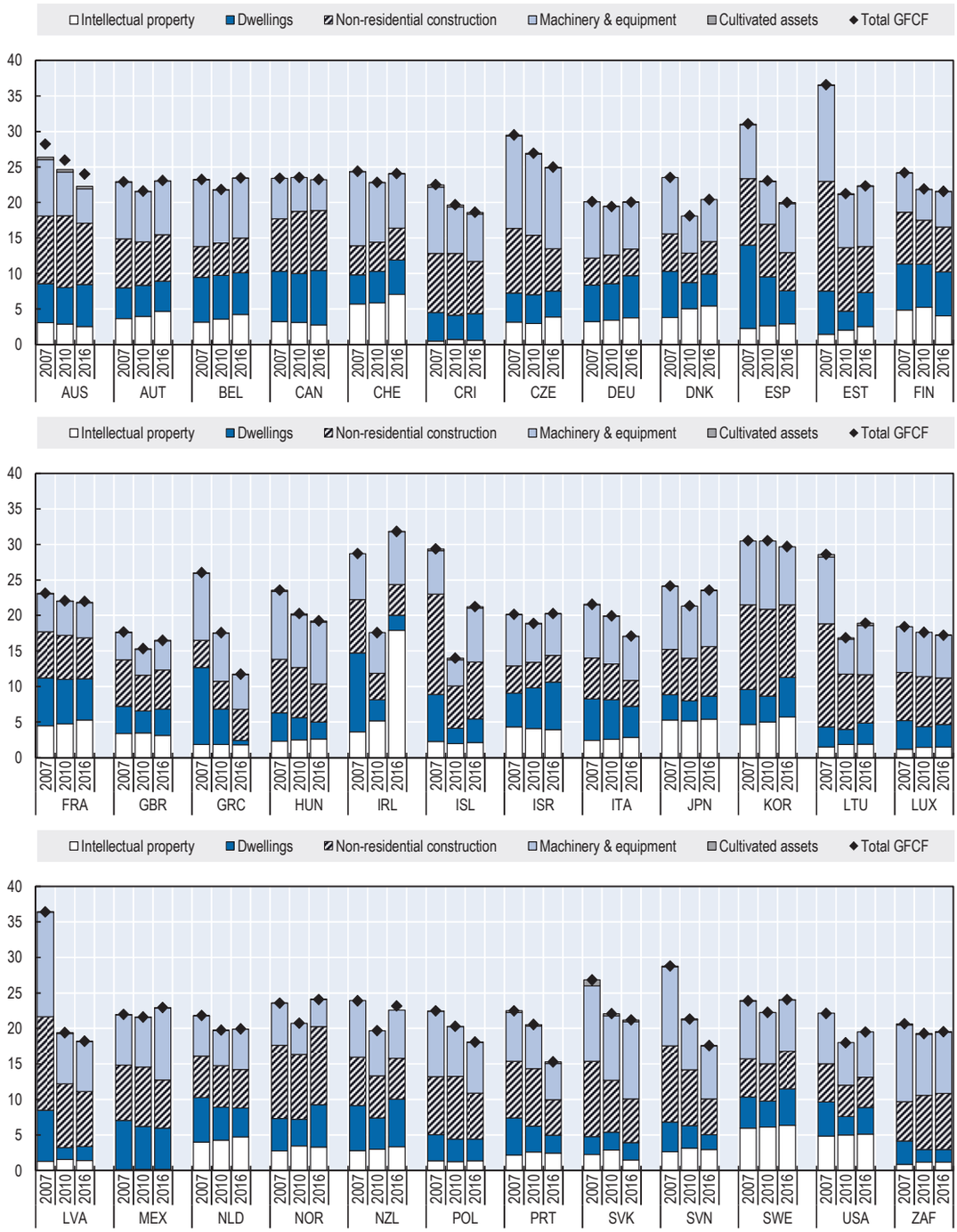


Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, February 2018.

StatLink http://dx.doi.org/10.1787/888933733353

Figure 1.5. Investment rates, total economy

Gross fixed capital formation by asset type as a percentage of GDP



Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, February 2018.

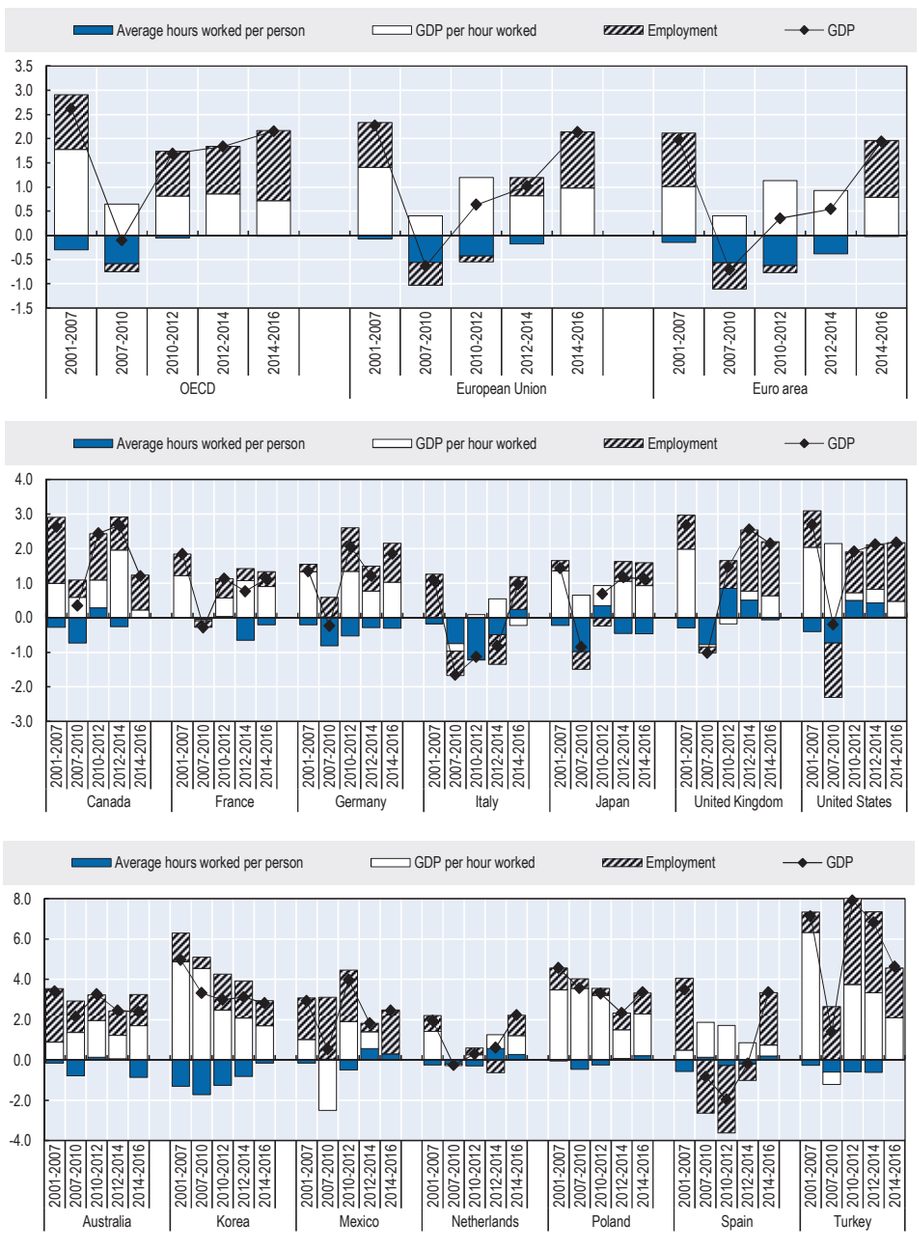
StatLink http://dx.doi.org/10.1787/888933733372

Employment growth has been a key driver of economic growth in many countries

Among advanced economies, in particular, the United Kingdom and the United States, and more recently in Mexico, Spain and Italy, the recovery in GDP growth has been largely sustained by increasing employment gains, making up for limited labour productivity growth (Figure 1.6).

Figure 1.6. Growth in GDP, labour productivity, average hours worked and employment

Selected countries, total economy, percentage change at annual rate



Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, February 2018.

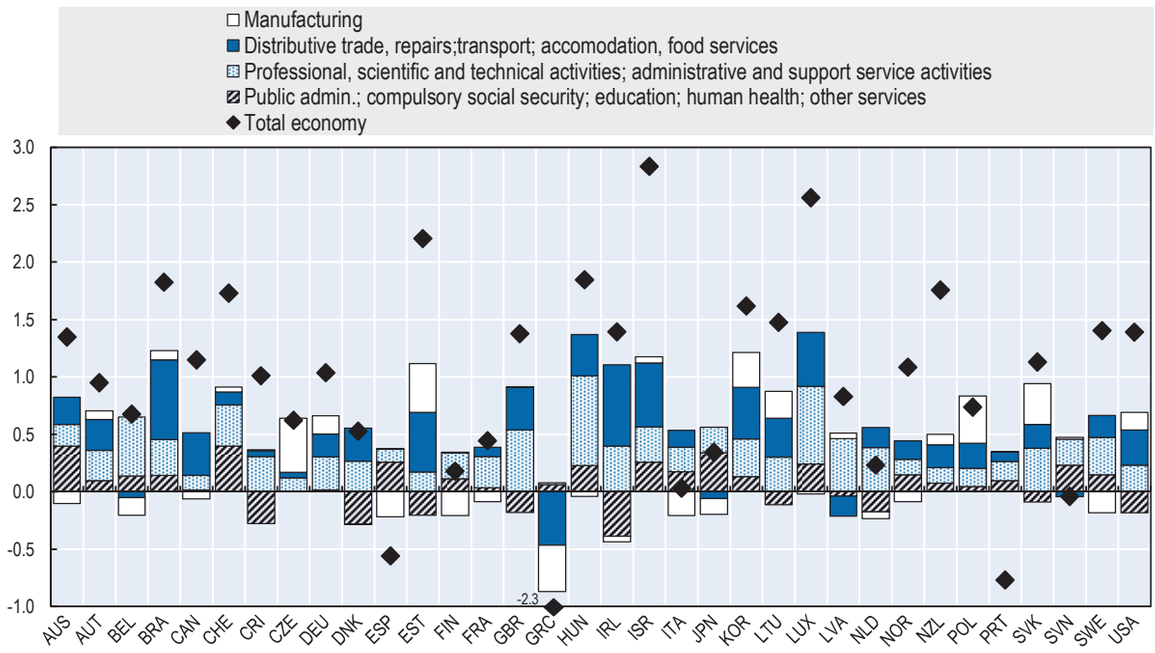
StatLink http://dx.doi.org/10.1787/888933733391

Employment gains have been mainly in low productivity activities

A concern that has emerged in recent years is that many jobs are being created in lower labour productivity activities, dragging down overall labour productivity (Figure 1.7), partly reflecting the on-going decline in manufacturing's share of overall employment (Table 1.1). This also reflects, in part, the outsourcing of some service activities from manufacturing firms to (more specialised) service firms and the fact that more low-skilled jobs were destroyed during the crisis.

Figure 1.7. Contributions to employment growth by main economic activity, 2010-2016

Four largest economic sectors in terms of employment, percentage point contribution at annual rate



Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, February 2018.

StatLink http://dx.doi.org/10.1787/888933733429

Table 1.1. Employment in manufacturing, persons, percentage of total

	Canada	France	Germany	Italy	Japan	United Kingdom	United States
1995	..	14.8%	21.2%	21.2%	20.4%	15.5%	..
2000	14.5%	13.4%	19.6%	19.9%	18.7%	13.7%	14.1%
2005	12.9%	12.0%	18.4%	18.5%	16.6%	10.2%	11.3%
2010	10.0%	10.3%	17.4%	16.8%	16.3%	8.5%	10.0%
2015	9.3%	9.7%	17.5%	15.6%	15.3%	8.0%	10.2%

Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, April 2018.

StatLink http://dx.doi.org/10.1787/888933733410

Across major economies, on average, between 2010 and 2016, increases in employment in activities with below average labour productivity were about two to four times higher than in those with above average labour productivity (Figure 1.8). In the United States, for example, 9.7 million more jobs in activities with below average labour productivity levels existed in 2016 compared to 2010, over four times the additional 2.4 million jobs in above average labour productivity activities. Comparable figures in other major economies were: 0.5 million and 0.2 million in Canada, 0.4 million and 0.2 million in France, 1.5 million and 0.6 million in Germany; minus 0.02 million and minus 0.2 million in Italy; and 1.9 and 0.6 million in the United Kingdom.

In nearly all major OECD economies the top three sectors generating the largest net employment gains over the period 2010 to 2016 had below average labour productivity, with restaurants, health and residential care activities featuring highly in most economies (Table 1.2). Only France saw a sector, namely legal, accountancy, management consultancy, with above average labour productivity in the top three sectors. On the other hand, in sectors that had lost most (net) jobs over the same period, most major economies had at least one above average labour productivity sector in the top three; all three in the case of the United States (Table 1.3).

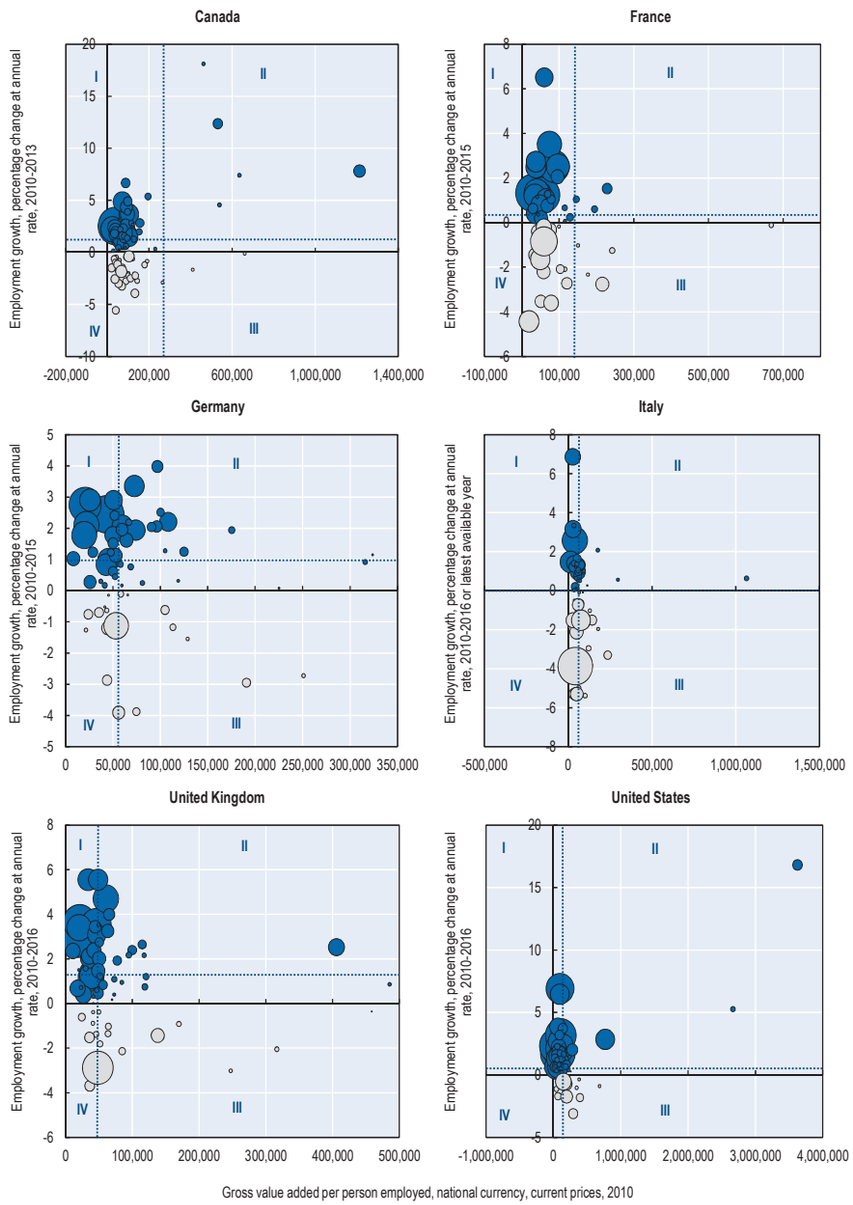
Insights on the contribution of these reallocation and structural effects on overall labour productivity growth can be made using a standard shift-share analysis that decomposes productivity growth into three components: (i) a component that accounts for the within-industry effect: i.e. the sum of industry productivity growth rates, weighted by the initial employment shares, in other words a measure of productivity growth unaffected by actual reallocation effects; (ii) a static structural component that captures the overall effect of changes in employment from low to high labour productivity sectors (or vice versa); and (iii) a dynamic component that captures the overall effect of changes in the shares of labour shifting to higher or lower productivity growth sectors (Box 1.1).

While the impact of the crisis and the different response mechanisms adopted by countries to mitigate its effects need some care in interpretation, the evidence points to relatively minimal boosts to productivity growth from reallocation effects in most countries[3] (Figure 1.9) with declining within-sector productivity growth mirroring declines at the whole economy level. However, in the United Kingdom reallocation effects, which were strong drivers of overall productivity growth in the pre-crisis period, and helped mask a precipitous decline in within-industry productivity growth in the five years leading up to the crisis, petered out in the post-crisis period.

[3] However it should be noted that the industry level decomposition used here (at the one-digit level) may mask reallocation effects within one-digit sectors.

Figure 1.8. Labour productivity in 2010 and employment growth over 2010-2016 (or latest available year)

Selected countries, detailed sectors (ISIC Rev 4), national currency, current prices and percentage change at annual rate



Note: Quadrant I (II) corresponds to sectors with below (above) average – whole economy – labour productivity levels in 2010 and above average employment growth between 2010 and 2016. Quadrant III (IV) corresponds to sectors with above (below) average – whole economy – labour productivity levels in 2010 and below average employment growth between 2010 and 2016. The size of the bubbles increases with the absolute change in employment on a person's count basis in the different sectors. Bubbles in dark blue denote employment creation; bubbles in grey denote employment destruction. Measurement of value added, and hence labour productivity, in the primary sector, real estate services, public administration, health, education and other non-market activities is subject to a number of conceptual and measurement issues (Cho et al., 2017; OECD, 2017a; Schwellnus et al., 2017).

Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, April 2018.

StatLink http://dx.doi.org/10.1787/888933733448

Table 1.2. Net employment creation between 2010 and 2016 (or latest available year)

Three sectors with largest net employment creation, selected countries, thousands of persons

	ISIC Rev.4 code	Activity label	Net employment creation	Labour productivity level of the sector
CAN	G47	Retail trade, except of motor vehicles and motorcycles	141	Below average labour productivity
	I56	Food and beverage service activities	64	Below average labour productivity
	P85	Education	50	Below average labour productivity
FRA	Q_87_88	Residential care activities; social work activities without accommodation	128	Below average labour productivity
	Q86	Human health activities	114	Below average labour productivity
	M_69_70	Legal and account activities; activities of head offices; management consultancy activities	94	Above average labour productivity
DEU	Q86	Human health activities	357	Below average labour productivity
	Q_87_88	Residential care activities; social work activities without accommodation	306	Below average labour productivity
	N_80_82	Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	189	Below average labour productivity
ITA	I_55_56	Accommodation and food service activities	214	Below average labour productivity
	T_97_98	Activities of households as employers; undifferentiated goods- and services-producing activities of private households for own use	135	Below average labour productivity
	Q_87_88	Residential care activities; social work activities without accommodation	86	Below average labour productivity
GBR	I_55_56	Accommodation and food services activities	334	Below average labour productivity
	N_80_82	Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	292	Below average labour productivity
	M_69_70	Legal and account activities; activities of head offices; management consultancy activities	249	Below average labour productivity
USA	Q86	Human health activities	1457	Below average labour productivity
	F_41_42_43	Construction	1251	Below average labour productivity
	I56	Food and beverage service activities	1214	Below average labour productivity

Note: Average labour productivity is measured as gross value added per person employed in the total economy. Data for Canada refer to the period 2010-2013 and shows thousands of *jobs* created over that period. Data for France, Germany and Italy refer to 2010-2015.
Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, April 2018.

StatLink http://dx.doi.org/10.1787/888933733467

Table 1.3. Net employment destruction between 2010 and 2016 (or latest available year)

Three sectors with largest net employment destruction, selected countries, thousands of persons

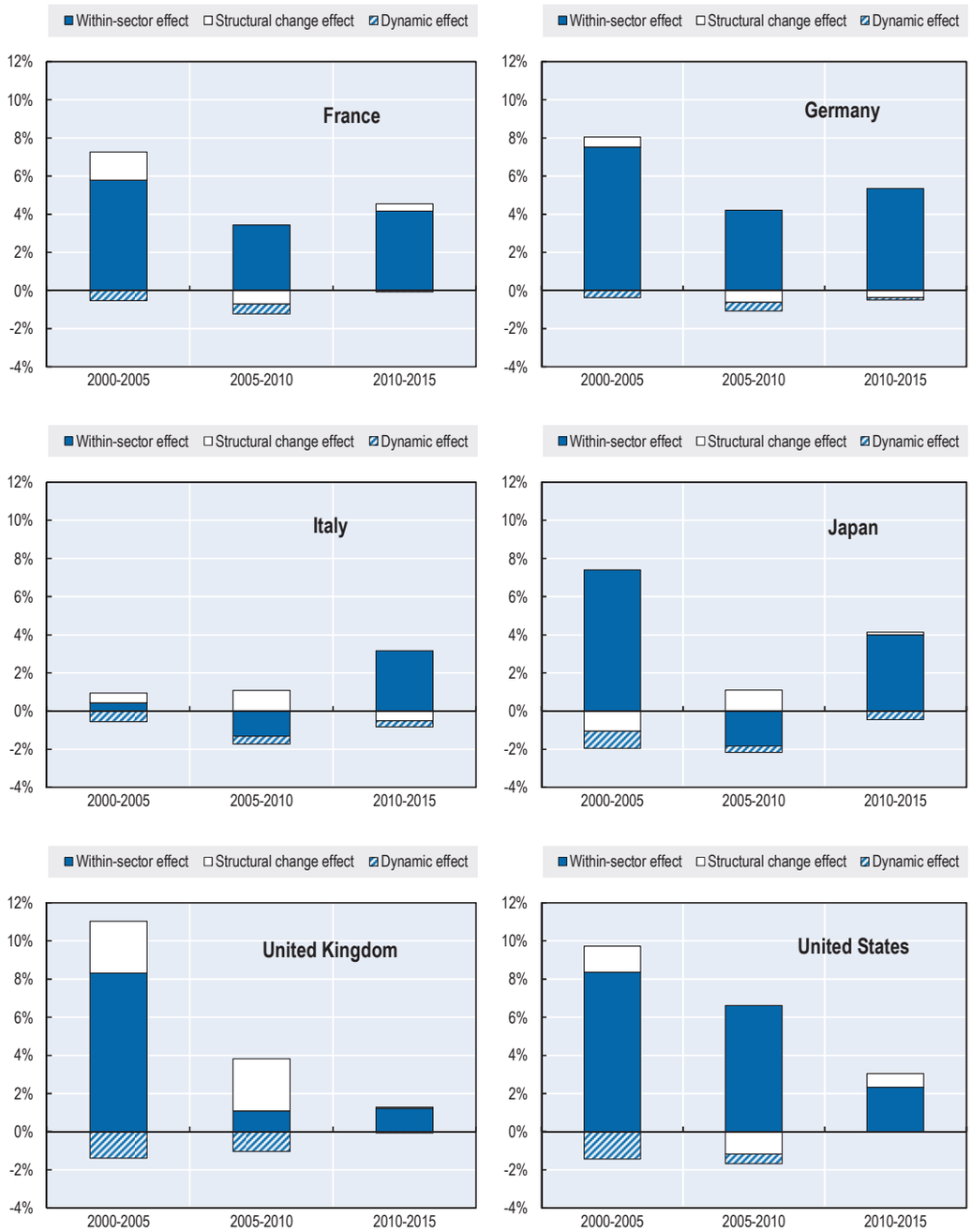
	ISIC Rev.4 code	Activity label	Net employment destruction	Labour productivity level of the sector
CAN	N80	Security and investigation activities	-8	Below average labour productivity
	O84	Public administration and defence; compulsory social security	-12	Above average labour productivity
	N82	Office administrative, office support and other business support activities	-15	Below average labour productivity
FRA	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	-40	Below average labour productivity
	T_97_98	Activities of households as employers; undifferentiated goods- and services-producing activities of private households for own use	-42	Below average labour productivity
	F_41_42_43	Construction	-76	Below average labour productivity
DEU	J58	Publishing activities	-43	Below average labour productivity
	S96	Other personal service activities	-44	Below average labour productivity
	O84	Public administration and defence; compulsory social security	-180	Below average labour productivity
ITA	A01	Crop and animal production, hunting and related service activities	-66	Below average labour productivity
	O84	Public administration and defence; compulsory social security	-120	Above average labour productivity
	F	Construction	-403	Below average labour productivity
GBR	C18	Printing and reproduction of recorded media	-27	Below average labour productivity
	K64	Financial service activities, except insurance and pension funding	-46	Above average labour productivity
	O84	Public administration and defence; compulsory social security	-260	Below average labour productivity
USA	G46	Wholesale trade, except of motor vehicles and motorcycles	-164	Above average labour productivity
	J60	Programming and broadcasting activities	-173	Above average labour productivity
	O84	Public administration and defence; compulsory social security	-296	Above average labour productivity

Note: Average labour productivity is measured as gross value added per person employed in the total economy. Data for Canada refer to the period 2010-2013 and shows thousands of *jobs* created over that period. Data for France, Germany and Italy refer to 2010-2015.
Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, April 2018.

StatLink http://dx.doi.org/10.1787/888933733486

Figure 1.9. Shift-share analysis of labour productivity growth

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



StatLink http://dx.doi.org/10.1787/888933733505

Note: The shift-share analysis is based on information of all one-digit sectors in line with ISIC Rev 4 industrial classification. Labour productivity is measured as gross value added per hour worked in France, Germany, Italy and the United Kingdom, and gross value added per person employed in Japan and the United States.

Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, February 2018.

Box 1.1. Decomposing aggregate labour productivity growth into intra-branch effects and structural changes: the shift-share analysis

Changes in an economy's labour productivity can be due to either changes in labour productivity of the individual industries or structural shifts in resources between contracting and expanding industries. The shift-share analysis is the most commonly used method to analyse these effects, by decomposing aggregate labour productivity growth into the contributions of within-sector productivity gains and structural changes caused by resource reallocation among sectors. In other words, the shift-share analysis assess to which extent changes in aggregate labour productivity growth rates emanate from higher or lower labour productivity growth in the specific industries and shifts in employment to industries with lower or higher labour productivity levels and growth rates.

Under this approach, labour productivity in the total economy is expressed as the sum of labour productivity levels of each sector weighted by the sectoral employment shares, as follows:

$$LP_t = \frac{Y_t}{L_t} = \sum_{i=1}^{n} \frac{Y_{it}}{L_{it}} * \frac{L_{it}}{L_t} = \sum_{i=1}^{n} LP_{it} S_{it}$$

where LP_t, Y_t and L_t represent respectively labour productivity, output and employment in the total economy in period t, LP_{it}, Y_{it} and L_{it} represent respectively labour productivity, output and employment in sector i $(i = 1, \dots, n)$ in period t, and S_{it} represents the employment share of sector i in the total economy in period t.

In a discrete time perspective, the difference in aggregate labour productivity levels at time 0 and time T can be written as follows:

$$LP_T - LP_0 = \sum_{i=1}^{n} (LP_{iT} - LP_{i0}) S_{i0} + \sum_{i=1}^{n} (S_{iT} - S_{i0}) LP_{i0} + \sum_{i=1}^{n} (LP_{iT} - LP_{i0})(S_{iT} - S_{i0})$$

Dividing both sides by LP_0, it follows that aggregate labour productivity growth can be decomposed into intra-branch labour productivity growth, represented by the first term in the right-hand side of the equation, and the effects of structural change in the economy, which consist of a static effect, represented by the second term, and the dynamic effect, represented by the third term.

Within-sector productivity growth effect: also known as intra-branch productivity effect, it captures the effect of productivity growth within the different industries in the absence of structural change, this is, on the assumption that there are no changes in employment shares in specific industries (i.e. the structure of the economy is assumed to remain fixed).

Static shift effect: also known as static shift effect or static structural change, it measures the contribution to aggregate labour productivity growth of a shift of employment resources towards sectors or branches with lower or higher labour productivity levels at the beginning of the period.

Dynamic shift effect: often referred as the interaction effect or the dynamic component of the structural change, it measures the interaction of changes in labour productivity and employment across sectors, this is, to measure the extent to which positive/negative efficiency gains interact with the expansion/contraction of different industries. This term is positive if sectors with higher (lower) productivity growth increase (reduce) their share in total employment, and negative when expanding sectors have below average labour productivity growth or if sectors with higher productivity growth have declining shares in total employment.

The sum of the static and dynamic shift effects is often used a measure of the overall resource reallocation process in the economy.

And, in turn, most growth has been in lower paid jobs

Labour compensation levels correlate highly with labour productivity levels, and, so, more jobs in lower labour productivity activities has also meant more jobs with below average wages in most economies, working to weigh down on average salaries in the economy as a whole. Between 2010 and 2016, for example, close to 90% of all new jobs in France were created in activities with below average wages; close to two-thirds in Germany and the United Kingdom and over three-quarters in the United States (Table 1.4).

Table 1.4. Change in employment over the period 2010-2016, or latest available year

Thousands of persons

Country	Below average labour compensation and below average labour productivity in 2010	Below average labour compensation and above average labour productivity in 2010	Above average labour compensation and below average labour productivity in 2010	Above average labour compensation and above average labour productivity in 2010
CAN	228	-7	245	197
FRA	479	-2	-101	169
DEU	1247	21	157	624
ITA	-99	1	5	-175
GBR	1498	72	414	515
USA	8752	626	1039	1785

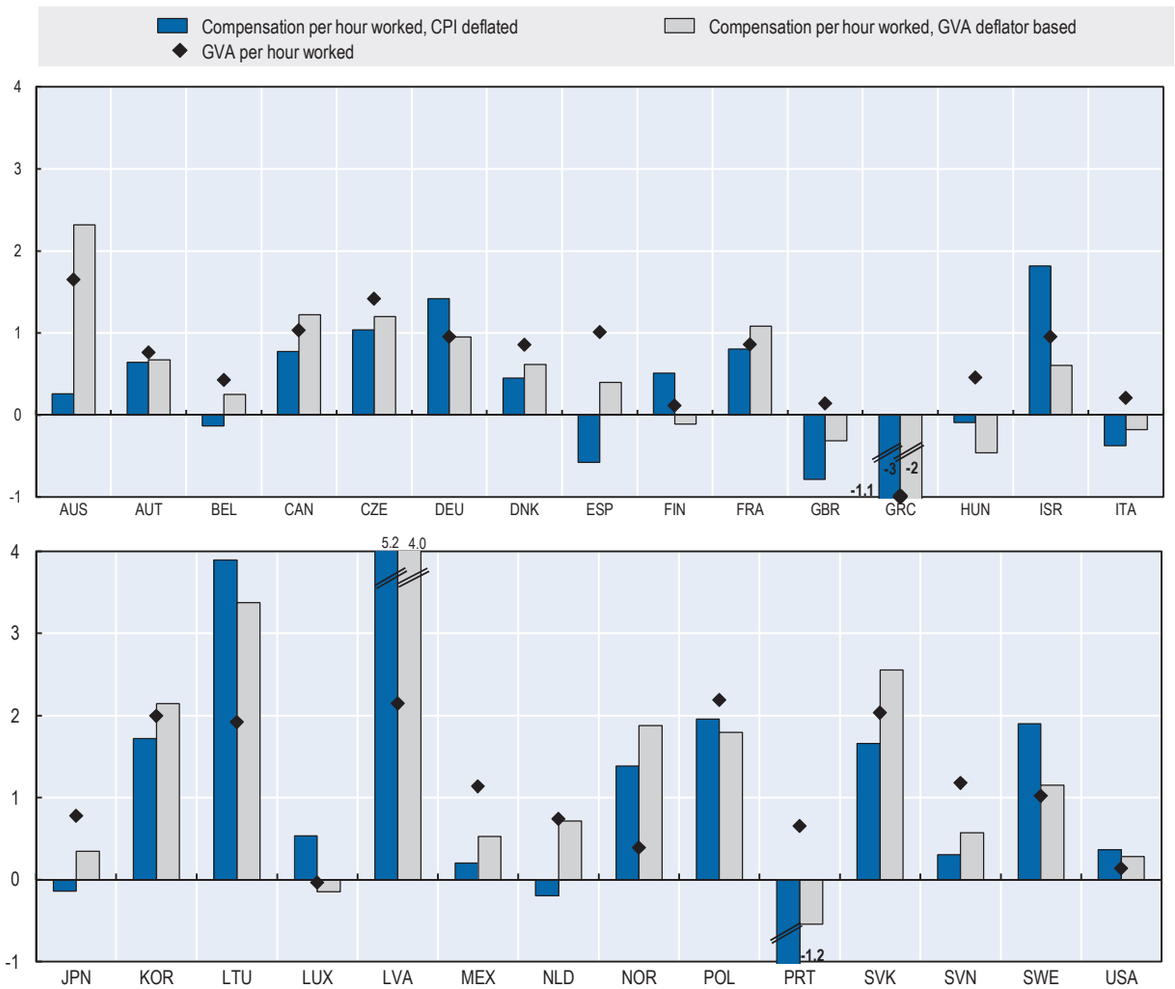
Note: Data for Canada refer to 2010-2013. Data for France, Germany and Italy refer to 2010-2015. At the time of writing this publication, data for the period 2010-2016 in Italy are available only at the whole economy level and show net employment creation equal to 56 thousand of persons.
Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, and OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, February 2018.

StatLink http://dx.doi.org/10.1787/888933733524

Growth in real wages, adjusted for inflation using the consumer price index, has also been lagging labour productivity growth in many countries (Figure 1.10) (OECD, 2017a; Schwellnus et al., 2017). Indeed real labour compensation per hour worked, adjusted for the CPI (which provides for a better measure of real purchasing power from a household perspective, compared to the GDP deflator), declined between 2010 and 2016 in Portugal, Spain and the United Kingdom. However, in some countries, such as Germany and the United States, real labour compensation has begun to rise in line with (albeit slow) labour productivity growth in recent years, helping to reverse pre-crisis decoupling (Figure 5.5).

Figure 1.10. Labour productivity and average labour compensation per hour, total economy, 2010-2016

GVA per hour worked and average hourly employee labour compensation, percentage change at annual rate



Source: OECD Productivity Statistics (database), http://dx.doi.org/10.1787/pdtvy-data-en, and OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, February 2018.

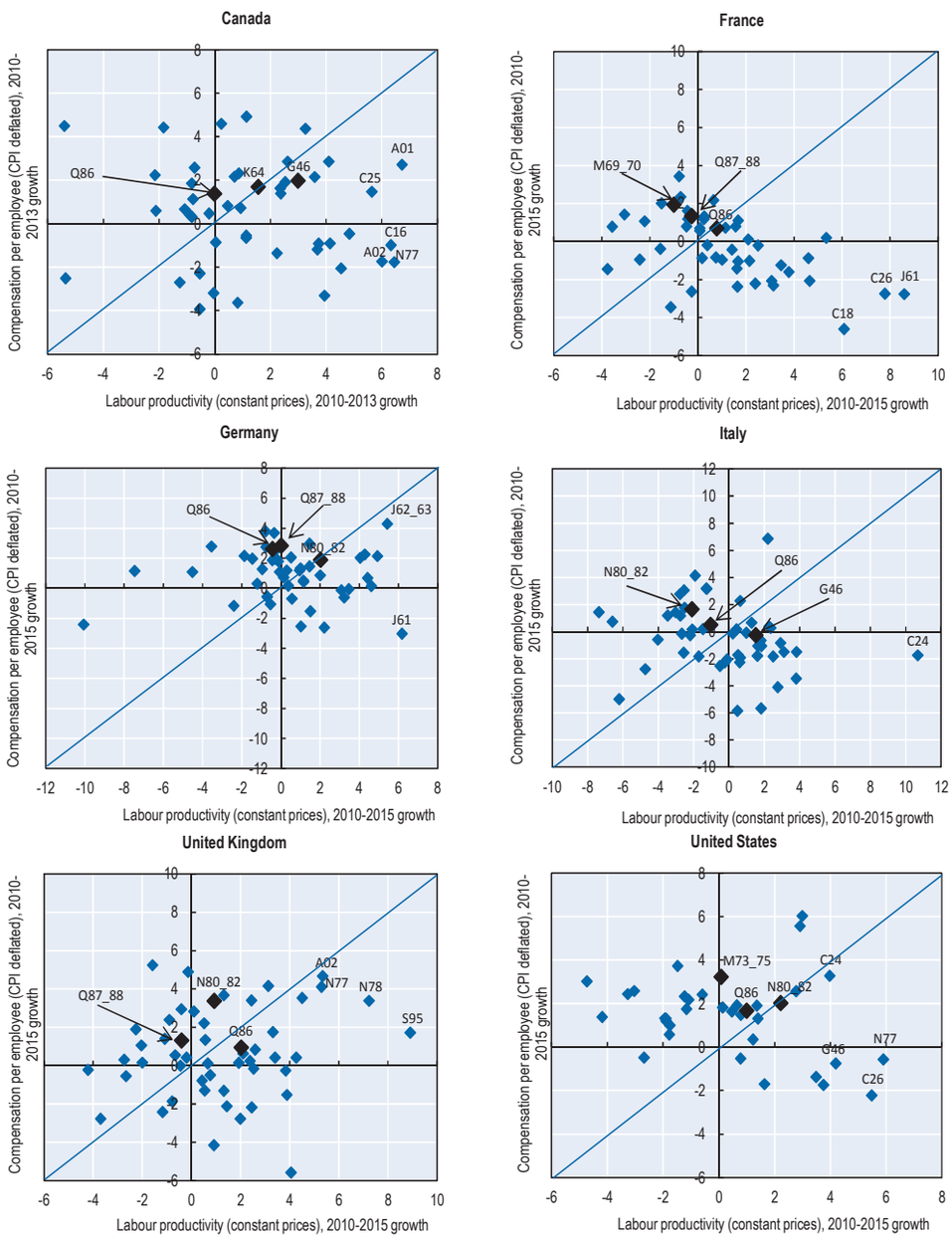
StatLink http://dx.doi.org/10.1787/888933733543

The decoupling of wages from labour productivity growth at whole economy level however can mask divergences within sectors (Figure 1.11). In France, for example, out of 63 sectors, according to the ISIC Rev. 4 classification, 41 saw growth in average real labour compensation lagging labour productivity growth in the post-crisis period; with the largest decoupling occurring in water transport services and telecommunication services. Similarly in the United Kingdom and Italy, just over half of all sectors saw real average labour compensation grow at a slower pace than labour productivity, with the largest gaps in the fishing and aquaculture and education sectors in the United Kingdom and basic metals and non-metallic mineral products in Italy. In the United States and Germany however, mirroring the improvement seen at the whole economy level, most sectors saw real wage growth outpacing productivity growth (40 out of 58 in the United States and 37 out of 63

in Germany). Across all major economies, sectors that saw the highest net increase in employment gains also saw wages outpacing, or keeping pace with, labour productivity growth.

Figure 1.11. Growth in labour productivity and average labour compensation since 2010

GVA per person employed and average compensation per employee, percentage change at annual rate



Note: The three sectors with highest employment change over the period 2010-2015 are denoted in black. ISIC Rev 4 code descriptions can be consulted here: https://unstats.un.org/unsd/publication/SeriesM/seriesm_4rev4e.pdf.
Source: OECD National Accounts Statistics (database), http://dx.doi.org/10.1787/na-data-en, April 2018.

StatLink http://dx.doi.org/10.1787/888933733562

Granularity matters

For ease of exposition past editions of the *OECD Compendium of Productivity Indicators* presented information at a relatively aggregated sectoral level, which can however mask developments at a more detailed level. The analysis presented above shows that more granularity helps to better understand the underlying drivers underpinning whole economy productivity growth, in particular with regards to structural changes and their impact on material well-being and inclusive growth. Indeed, employment growth has been an important driver of overall economic growth in most OECD economies in the post crisis period, but a more granular analysis reveals that in nearly all major economies most net job creation has occurred in activities with below average labour productivity and below average wages.

Future editions of *the Compendium* will work to explore granularity in more detail, capitalising on the *OECD Structural and Demographic Business Statistics* database that provides sectoral data at a 4-digit level of detail.

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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 2016, the size of GDP for the OECD as a whole was USD 54 075 billion based on current PPPs. G7 countries accounted for almost 70% of that total. GDP per capita was on average USD 42 100 for the OECD area and USD 11 450 on average for the BRIICS. However, there are large disparities in GDP per capita across countries. Within the OECD, GDP per capita was above USD 50 000 in Austria, Iceland, Ireland, Luxembourg, the Netherlands, 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 more than twice the BRIICS average and almost four times the average in India.

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

Definition

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 7.).

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 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.

Sources and further reading

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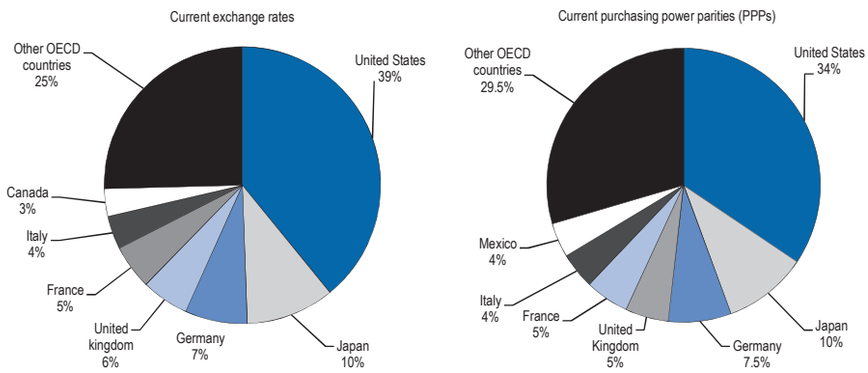
Figure 2.1. Gross domestic product, current PPPs and current exchange rates

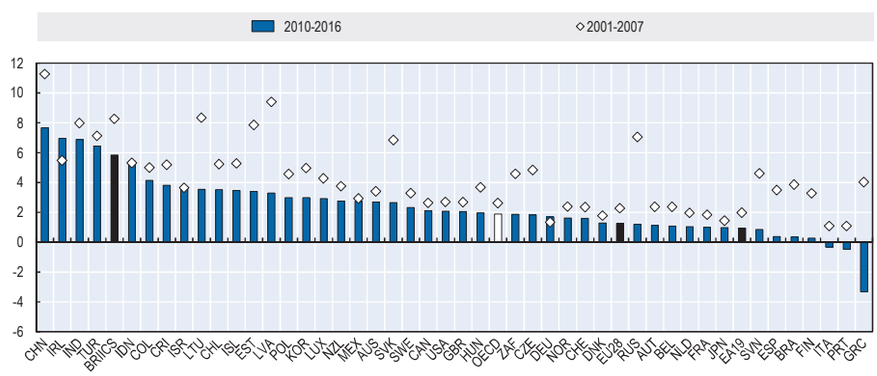
The seven largest economies in the OECD, percentage of OECD total, 2016



StatLink http://dx.doi.org/10.1787/888933733581

Figure 2.2. Growth in gross domestic product

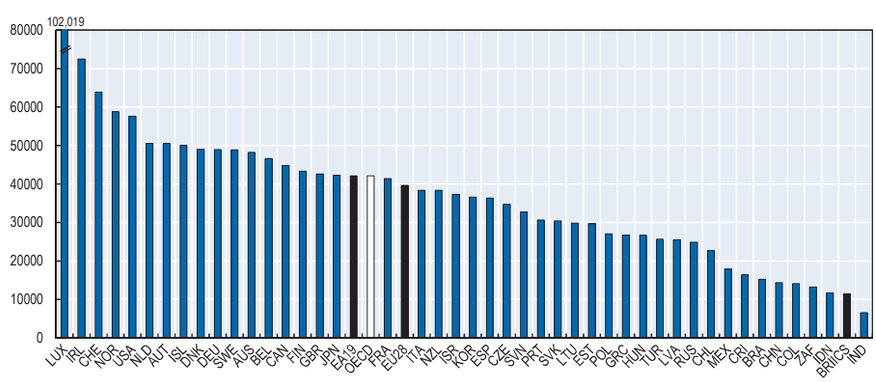
Volume, percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933733600

Figure 2.3. GDP per capita

US dollar per head of population, current prices and current PPPs, 2016



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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 Hungary, Iceland, 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.

Definition

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 7.).

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

Comparability

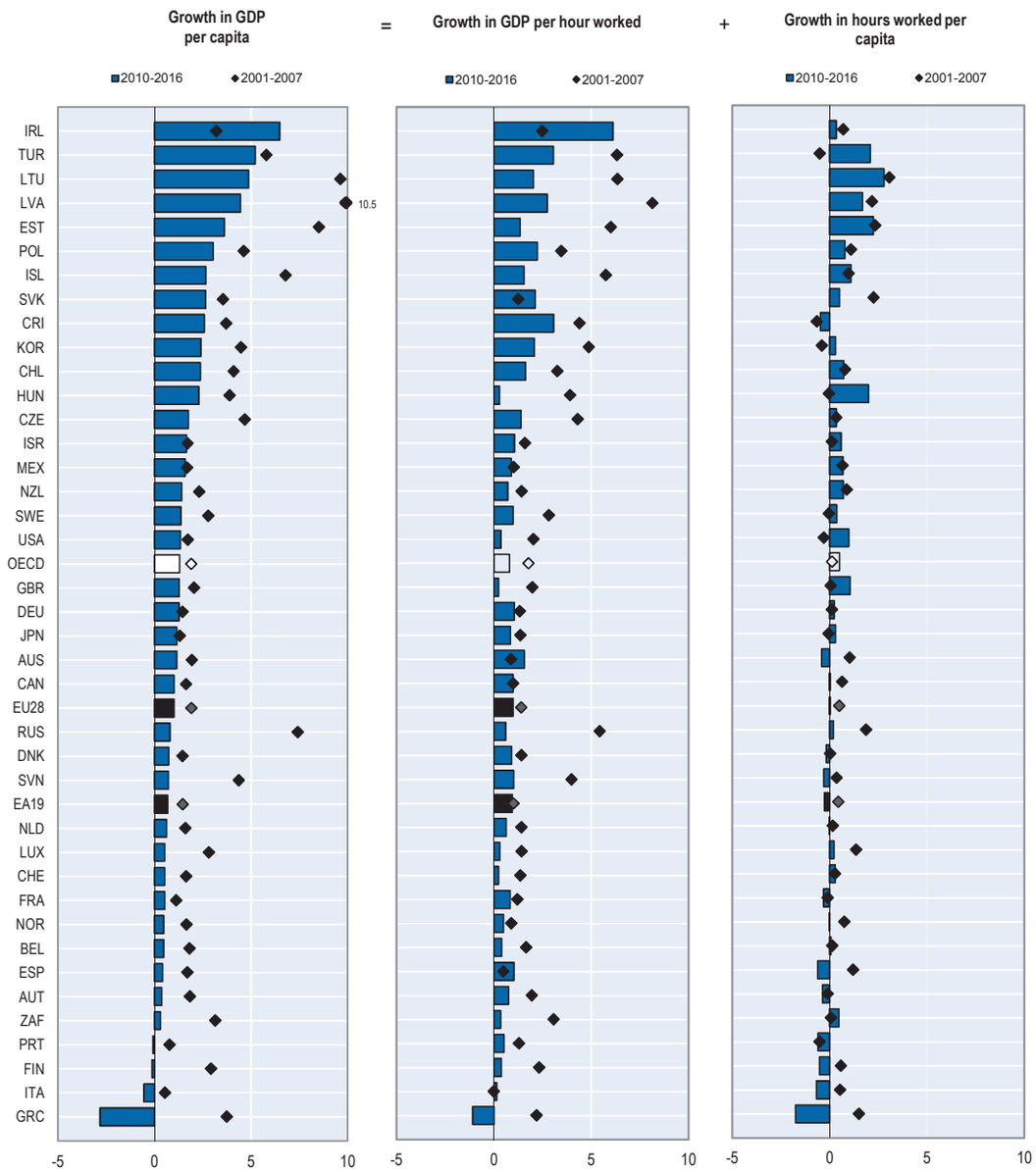
Most countries derive annual estimates of real GDP using annually chain-linked volume indices. However, China, India, Indonesia, Mexico and South Africa currently produce fixed-base volume estimates with the base year updated less periodically. The System of National Accounts 2008 (2008 SNA) recommends 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.
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.
OECD (2001), *Measuring Productivity – OECD Manual*, http://dx.doi.org/10.1787/9789264194519-en.

Figure 2.4. Contributions to growth in GDP per capita

Total economy, percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933733638

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 7.).

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

Comparability

For 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 2010 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 7.).

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

Figure 2.5. GDP per capita convergence, 2001-2007

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

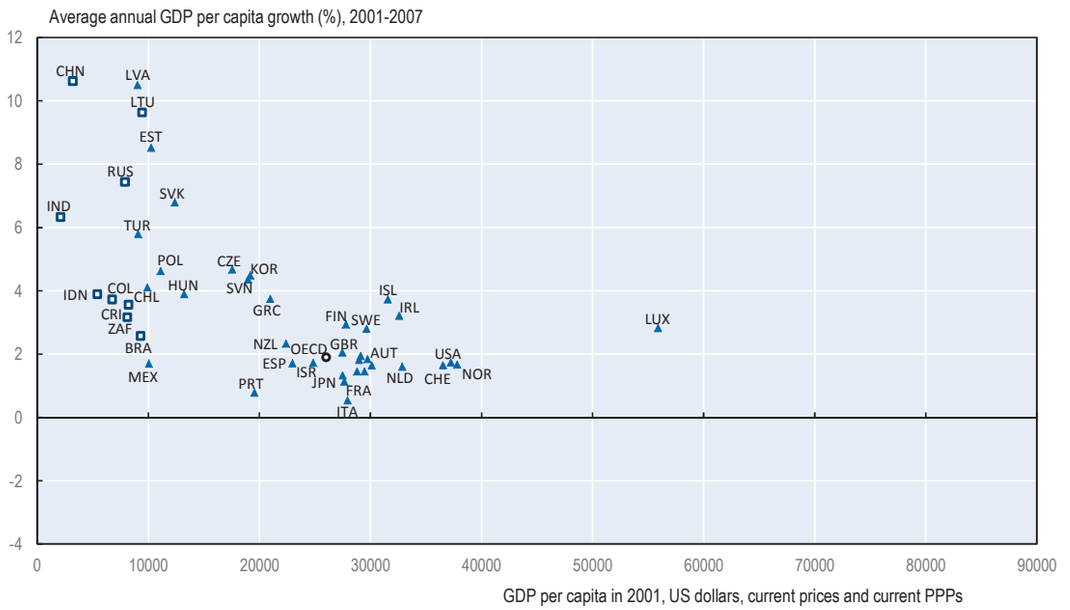


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Figure 2.6. GDP per capita convergence, 2010-2016

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

StatLink http://dx.doi.org/10.1787/888933733676

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, leading to the highest annual post-crisis labour productivity growth rate among OECD member countries (6.2%).

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 7.).

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

Comparability

GDP measures follow the 2008 SNA, except for Colombia, which follows the 1993 SNA, and for the Russian Federation, which follows the 1993 SNA (data up to 2010) and the 2008 SNA (from 2011 onwards) (Chapter 7.).

In most countries, the primary source for measuring hours actually worked is their labour force survey. However, several countries rely – only or in addition – on establishment surveys and administrative sources (Chapter 7.). 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.

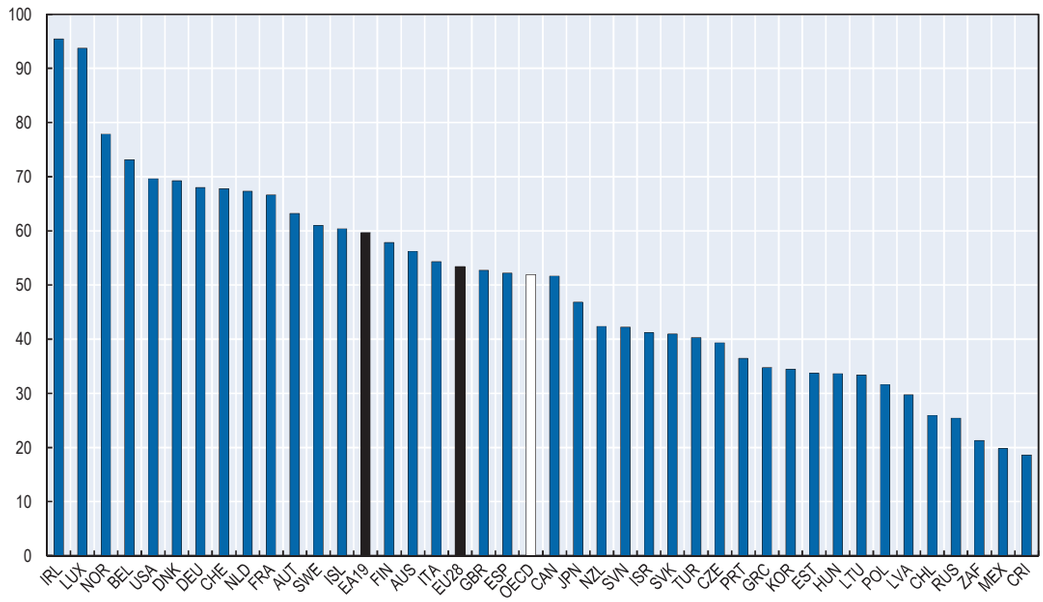
In practice, the effective quantity of labour input depends not only on the total number of hours actually worked but also on the education, working experience, business functions and other worker characteristics. The measure of labour input used in this publication, i.e. total hours worked, does not account for the composition of the labour force and likely underestimates 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, 2016

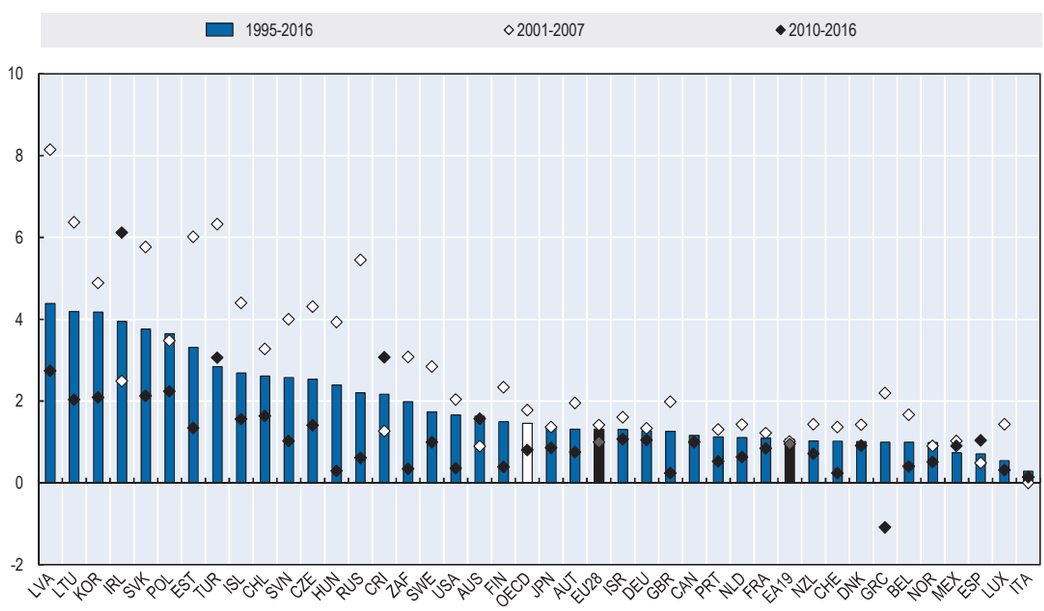
GDP per hour worked, total economy, US dollars, current prices and current PPPs



StatLink http://dx.doi.org/10.1787/888933733695

Figure 2.8. Growth in labour productivity

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



StatLink http://dx.doi.org/10.1787/888933733714

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 2001-2016, 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 average hours worked per person.

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 7.).

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 7.).

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, 2016

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

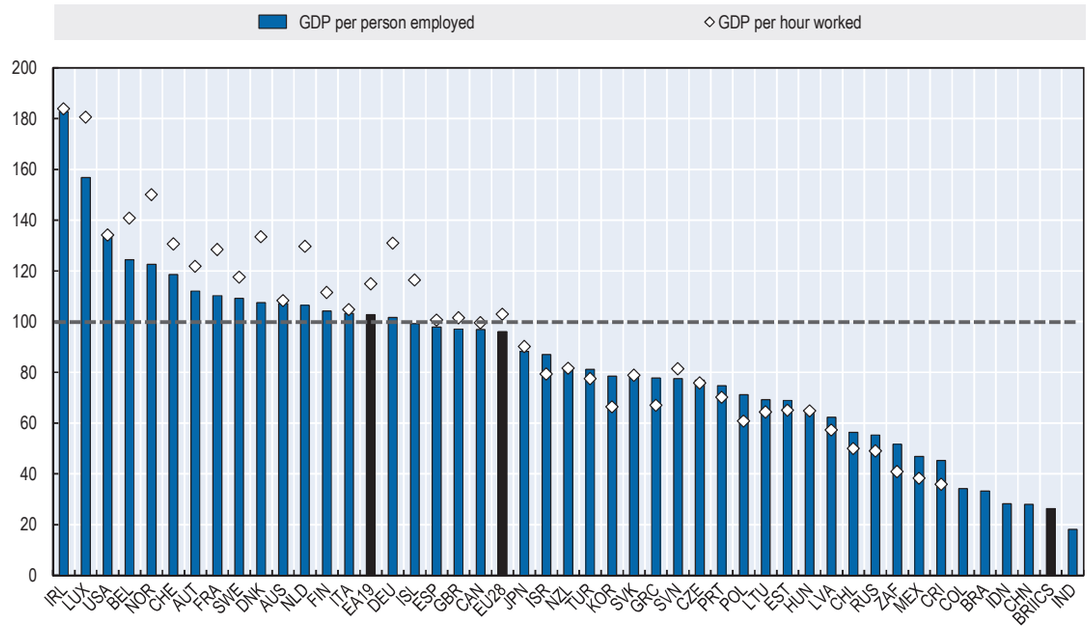


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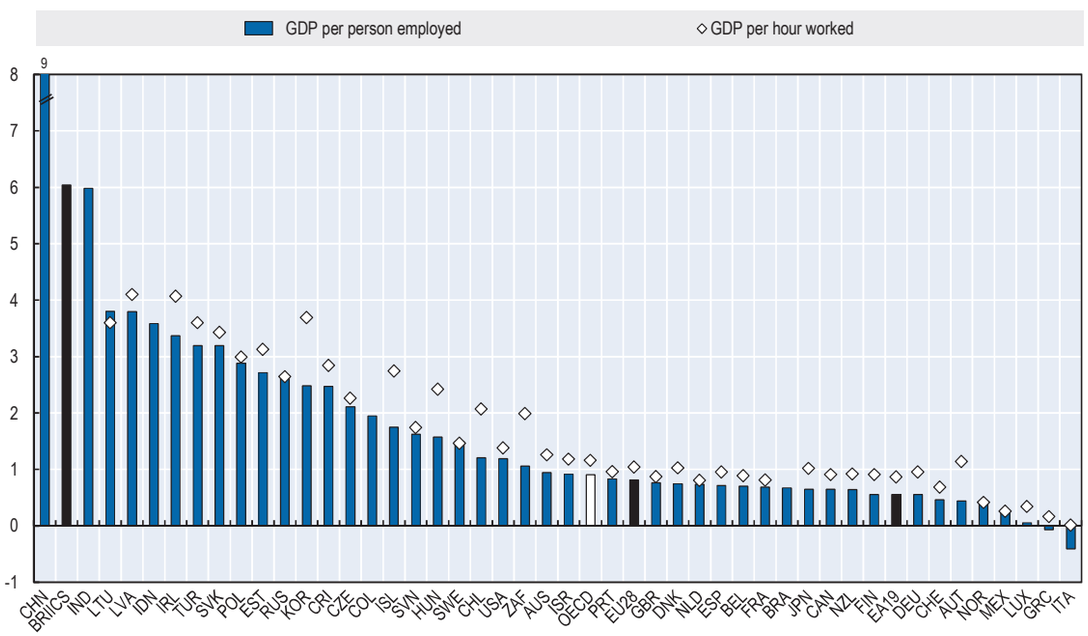
Figure 2.10. Growth in GDP per hour worked and growth in GDP per person employed, 2001-2016

Total economy, percentage change at annual rate



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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 international flows of both compensation of employees and 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, 2016

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

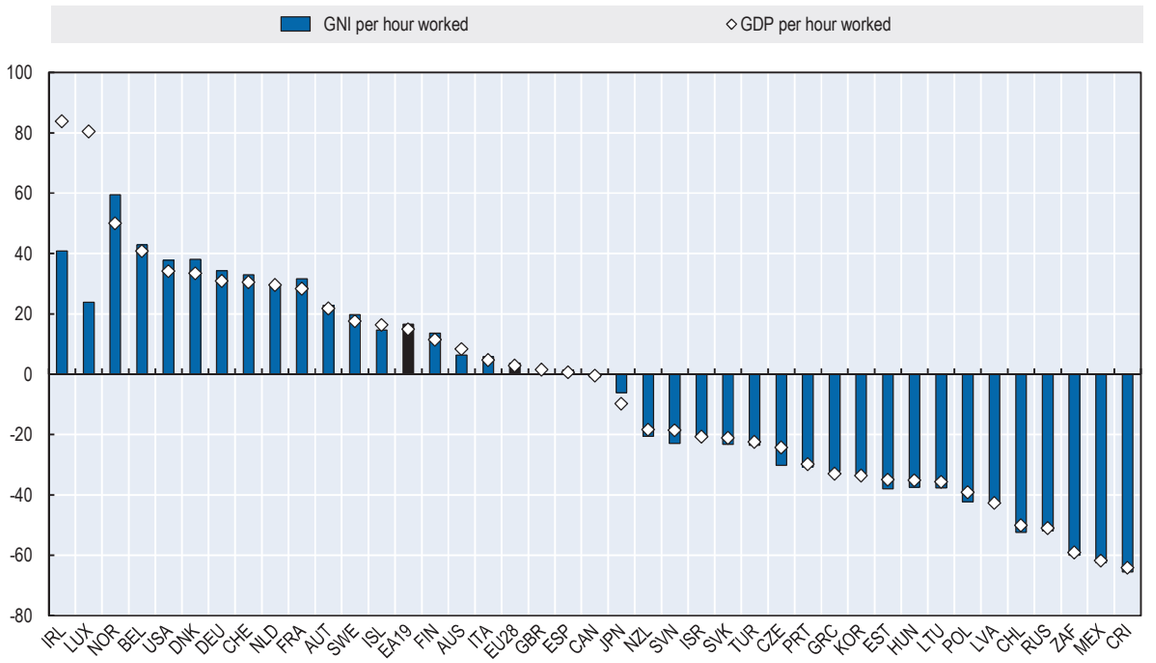

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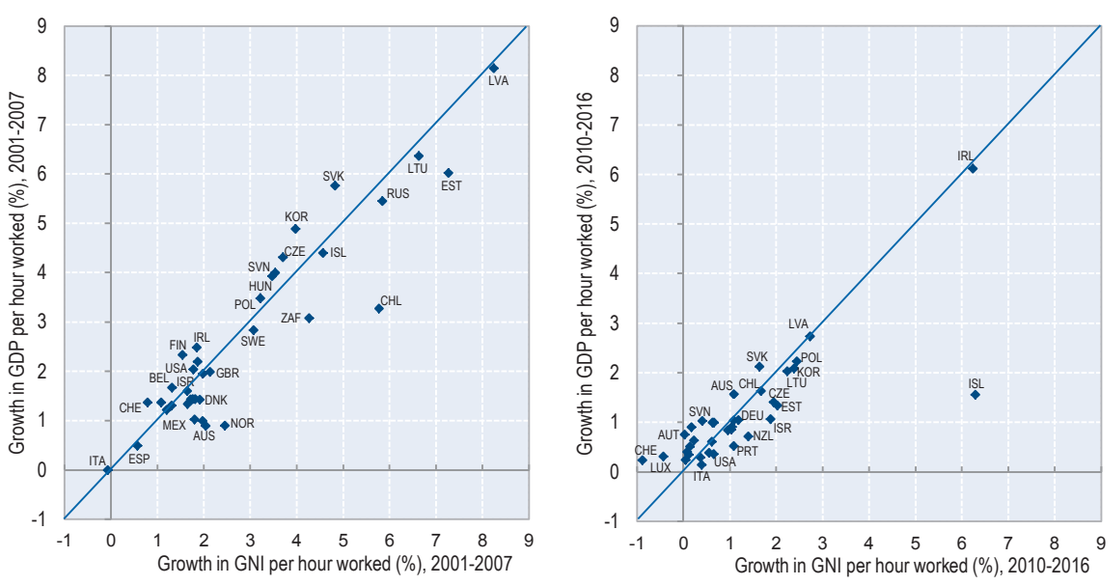
Figure 2.12. Growth in GDP per hour worked and growth in GNI per hour worked

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 contributes 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 pace of decline in capital productivity has been less pronounced since the crisis, partly reflecting the sluggish recovery in investment in tangible assets and rises in labour input rates in some countries, and the possibility that firms have extended the service lives of capital. Investment in intellectual property products has however performed much better; 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 economies 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 7.). 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

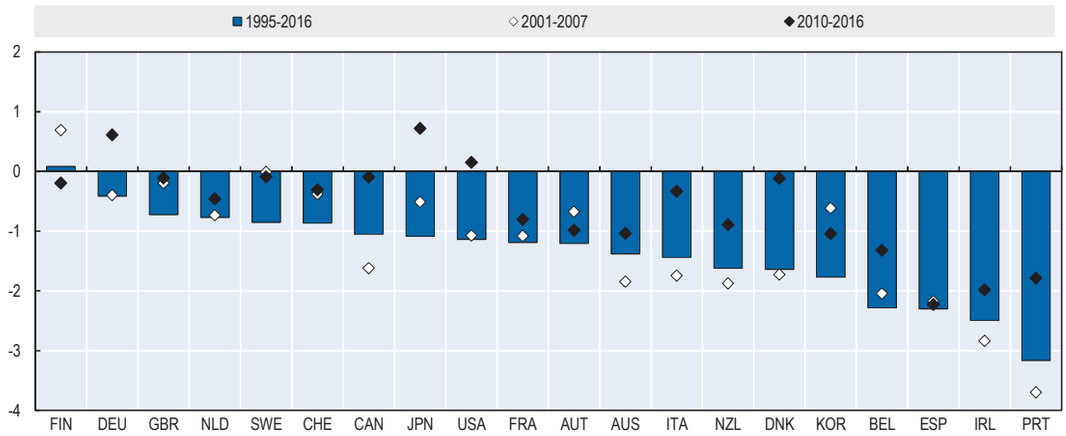

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Figure 2.14. Contributions of ICT and non-ICT capital to total capital services

Total economy, percentage change at annual rate

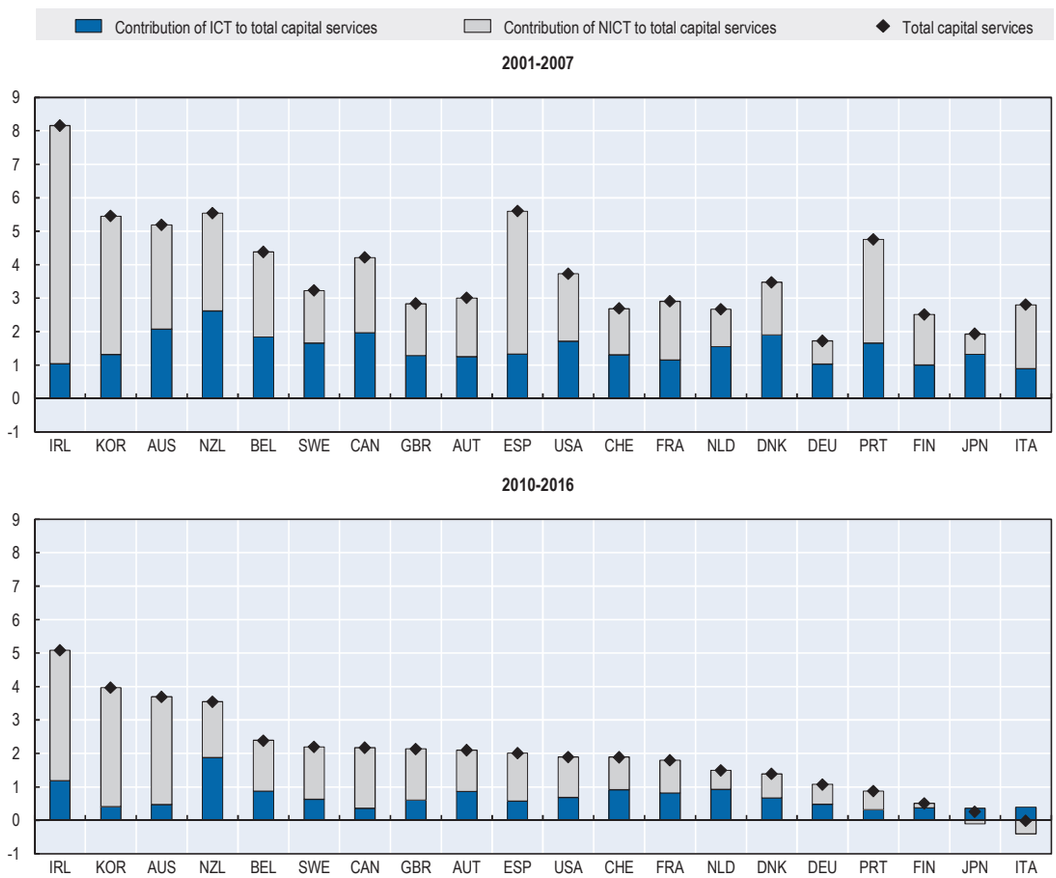

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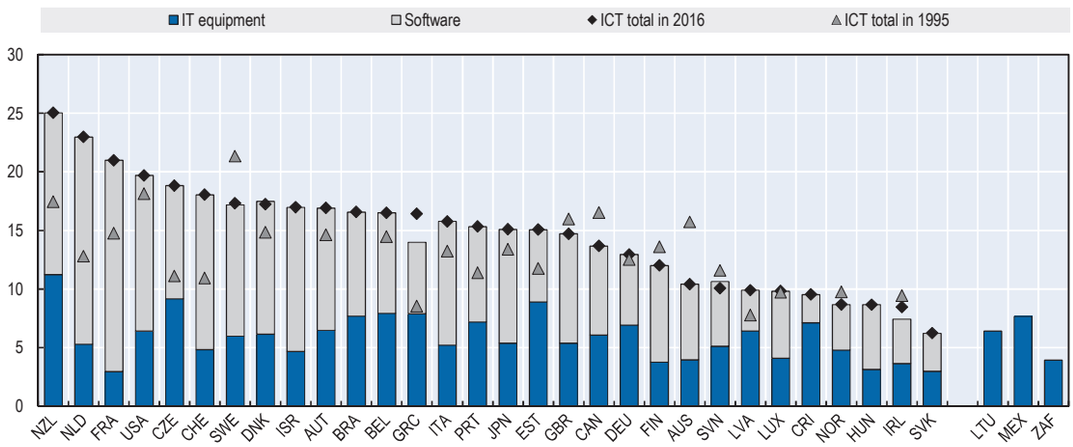
Figure 2.15. Share of ICT investment

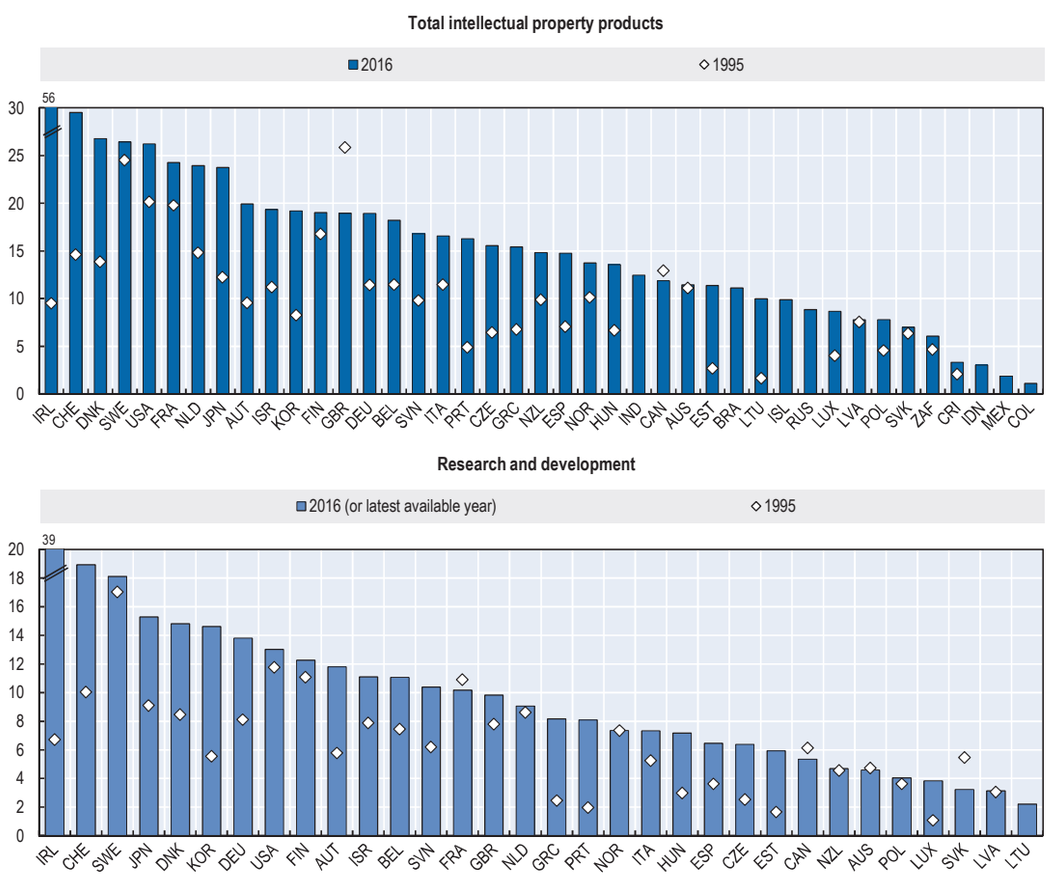
Total economy, current prices, as a percentage of non-residential gross fixed capital formation



StatLink http://dx.doi.org/10.1787/888933733847

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/10.1787/888933733866

Figure 2.17. Investment in tangible assets and intellectual property products

Total economy, constant prices, index 2007=100

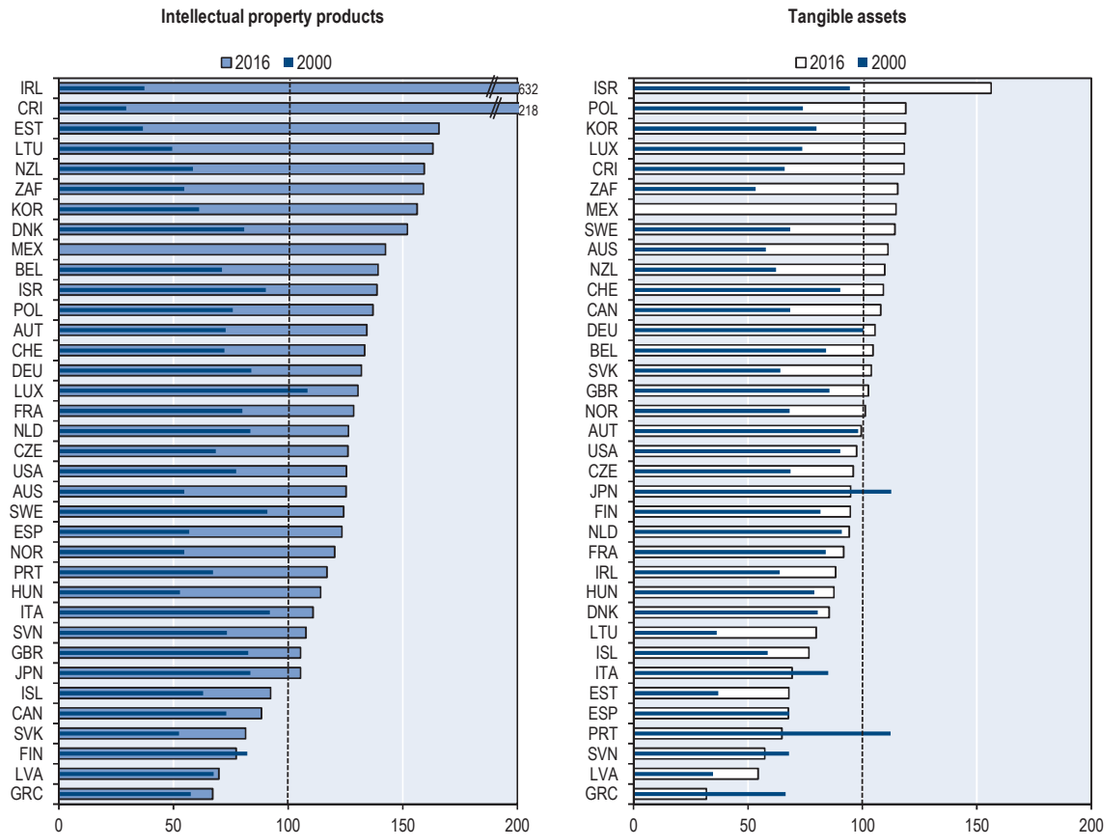


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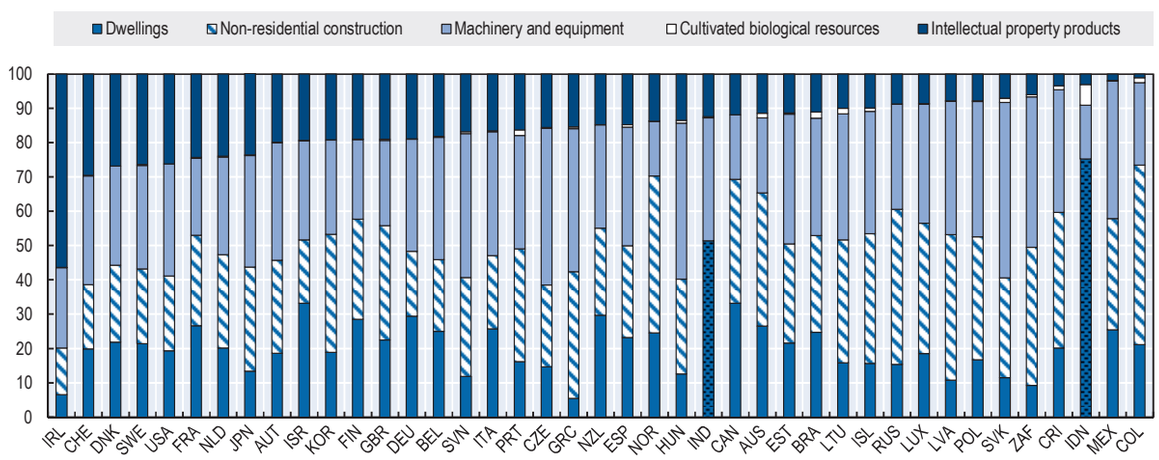
Figure 2.18. Gross fixed capital formation by asset type, 2016 or latest available year

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 20 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 2016, notably Australia, New Zealand and Spain, while non-ICT capital accounted for almost 40% of GDP growth in Spain and 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 2010-2016 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, Sweden, 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, Switzerland, the United Kingdom and the United States, partly reflecting higher employment rates, and by higher MFP growth in Australia, Canada, Ireland, and, to a lesser extent, 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 7.). 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 7.).

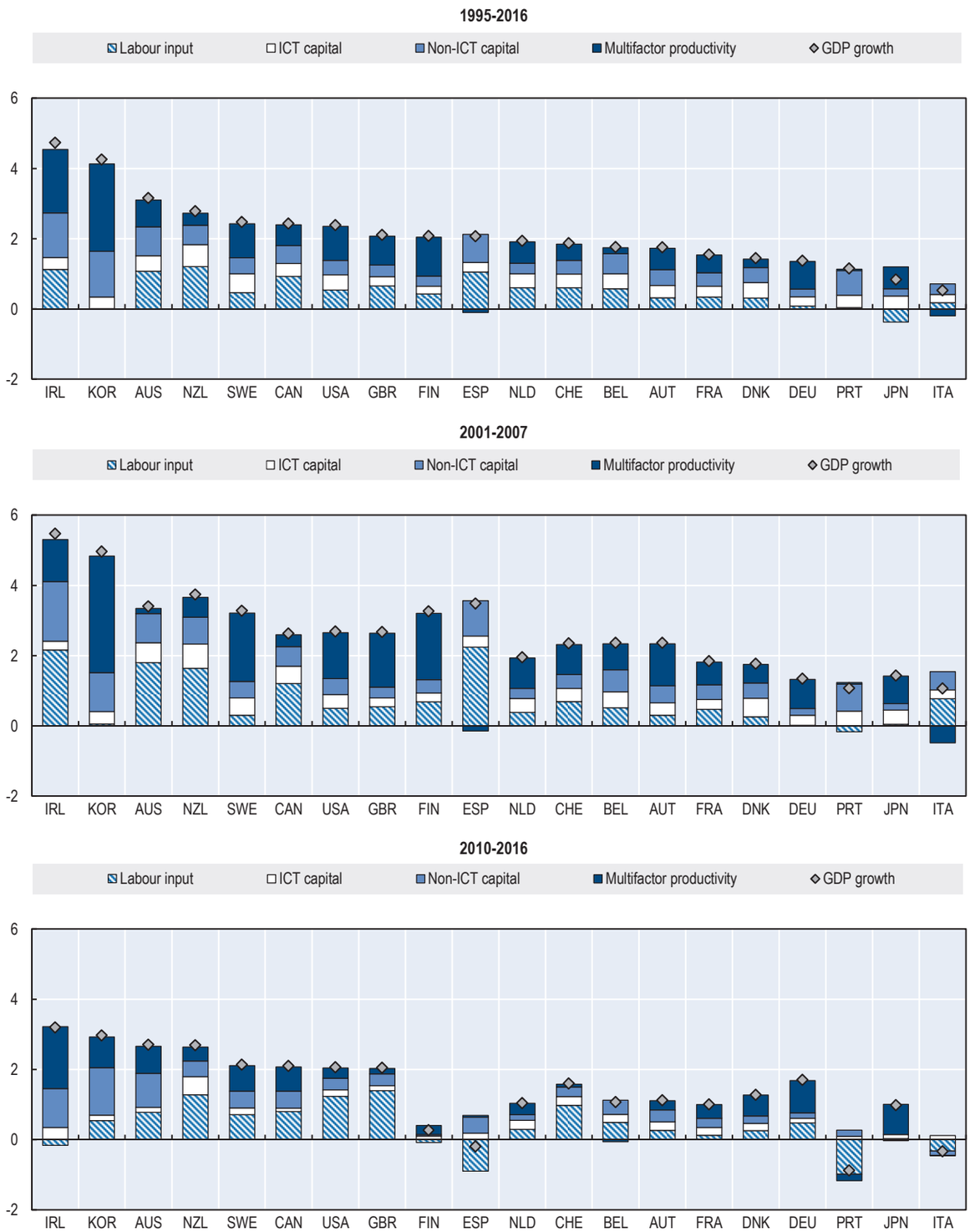
The measure of total hours worked is an incomplete measure of labour input because it does not account for changes in the skill composition of workers, such as those due to higher educational attainment and work experience. In the absence of these adjustments, as is the case in the series presented here, 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 Austria, Belgium, Finland, Korea, Sweden, Switzerland, the United Kingdom and the United States.

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 Austria, Belgium, Finland, Sweden, Switzerland, 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 7.).

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 7.). 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 *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.
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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

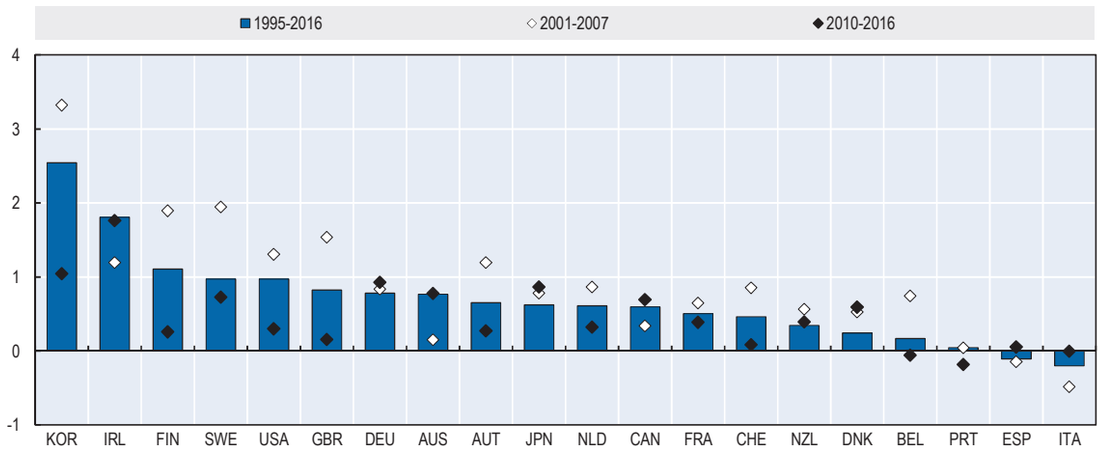

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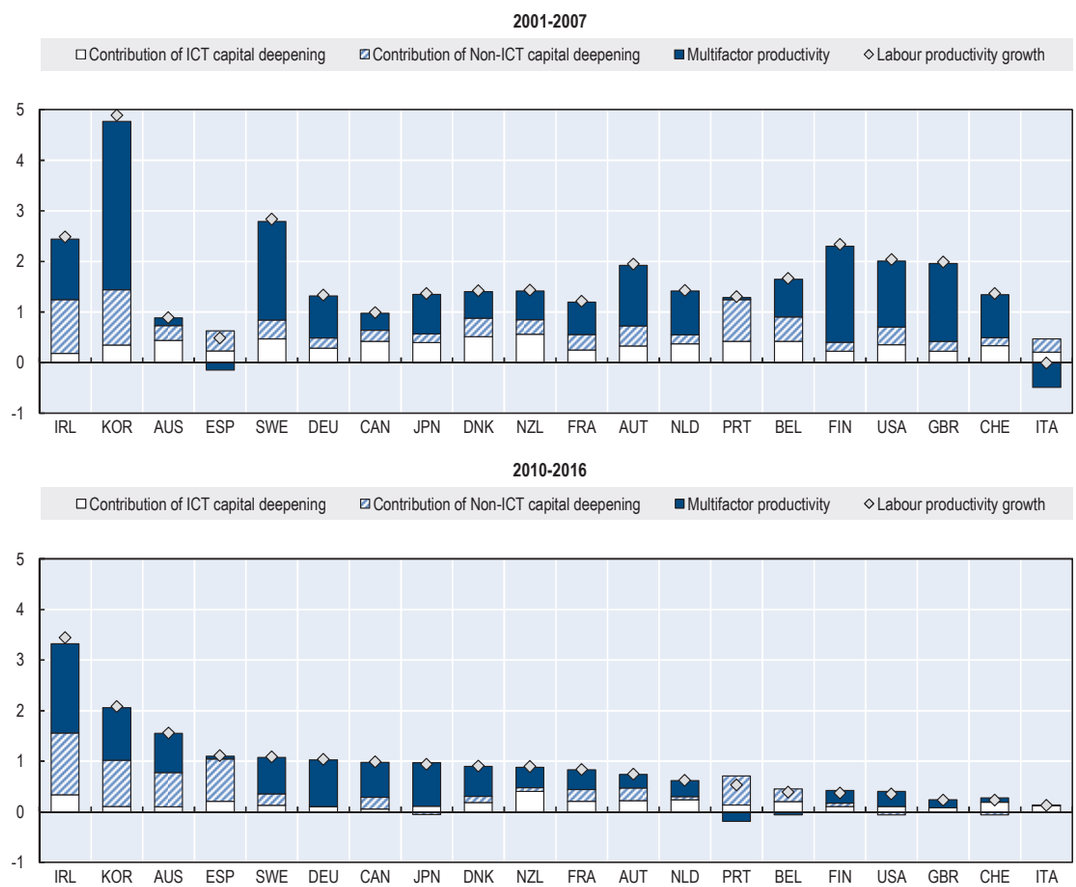
Figure 2.21. Contributions to labour productivity growth

Total economy, annual percentage point contribution



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Chapter 3. Productivity by industry

Labour productivity by main economic activity
Industry contribution to business sector productivity
Labour productivity in manufacturing
Labour productivity in business sector services
Contributions to business sector services' productivity
Productivity by enterprise size

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, growth rates in the manufacturing sector have typically outpaced those in the services sector.

Compared with pre-crisis rates, labour productivity in manufacturing slowed in most OECD countries after the crisis, particularly in the Czech Republic, Finland, Hungary, Korea, Poland, Sweden and the United States. Between 2010 and 2016, labour productivity growth rates in manufacturing ranged from minus 1.4% in Costa Rica to 5.7% 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.

In business sector services, labour productivity also slowed after the crisis, notably in Estonia, Greece, Hungary, Latvia, and, to a lesser extent, the United Kingdom. Growth rates of labour productivity in business sector services ranged from minus 4.5% in Greece to 6.9% in Costa Rica between 2010 and 2016.

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). For Japan, Korea and the United States, in the absence of national accounts data on total hours worked by main ISIC Rev.4 economic activity, the total number of persons employed (employees and self-employed) is used as a measure of labour input.

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

Comparability

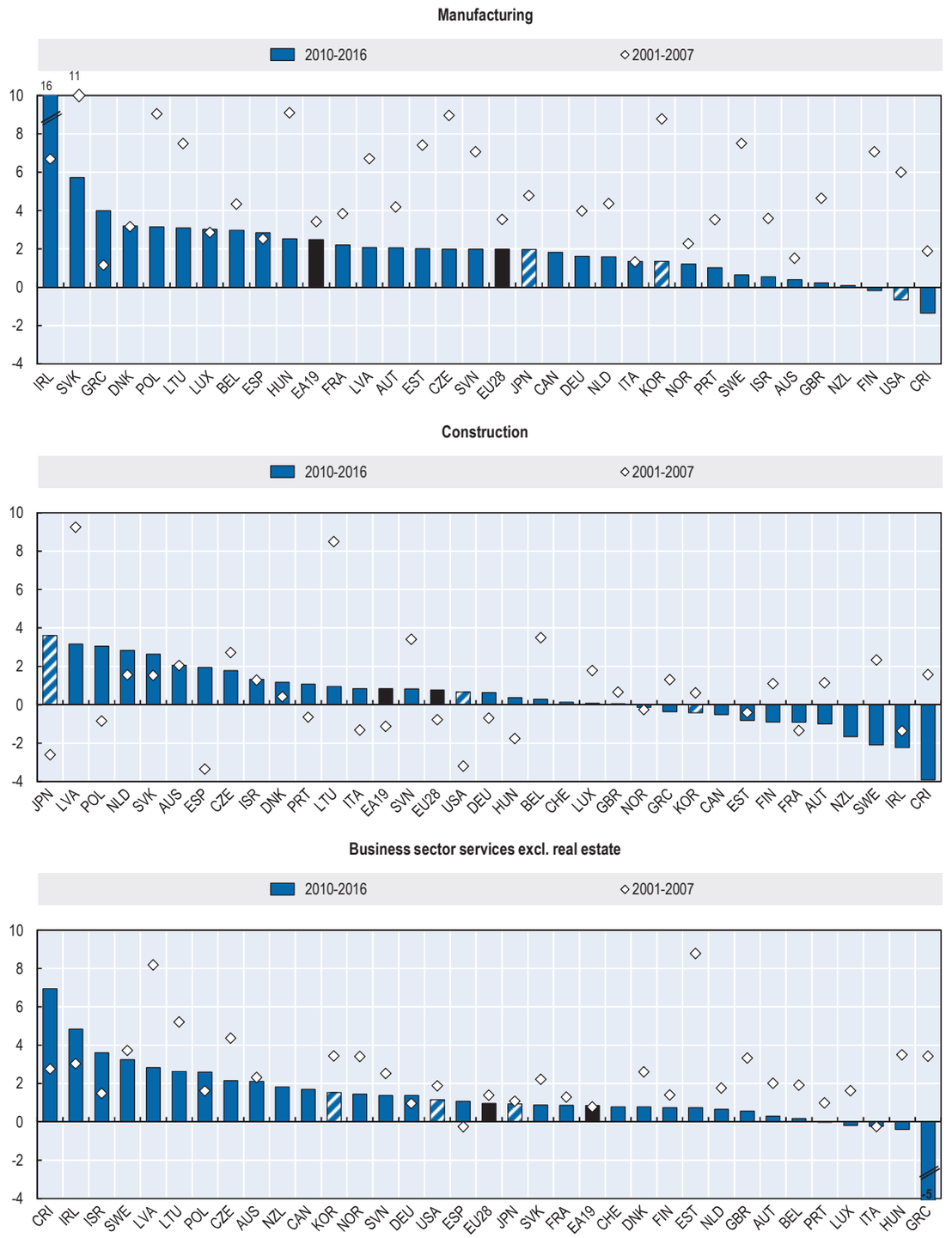
The comparability of productivity growth across industries and countries may be affected by problems in measuring real value added. This is particularly relevant for services, as measurement of price changes is complicated by difficulties in identifying quality changes and the provision of bundled services (Chapter 7.). 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

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



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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, Korea, Slovenia, the Slovak Republic, Sweden and the United States, the productivity slowdown was mainly driven by lower contributions from the manufacturing sector compared with the pre-crisis period. In the Baltic States, Belgium, Greece, Luxembourg 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. For Japan, Korea and the United States, in the absence of national accounts data on total hours worked by main ISIC Rev.4 economic activity, the total number of persons employed (employees and self-employed) is used as the measure of labour input.

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

Inter-Secretariat Working Group on National Accounts (ISWGNA), Task Force on FISIM (2013), *Final Report*.
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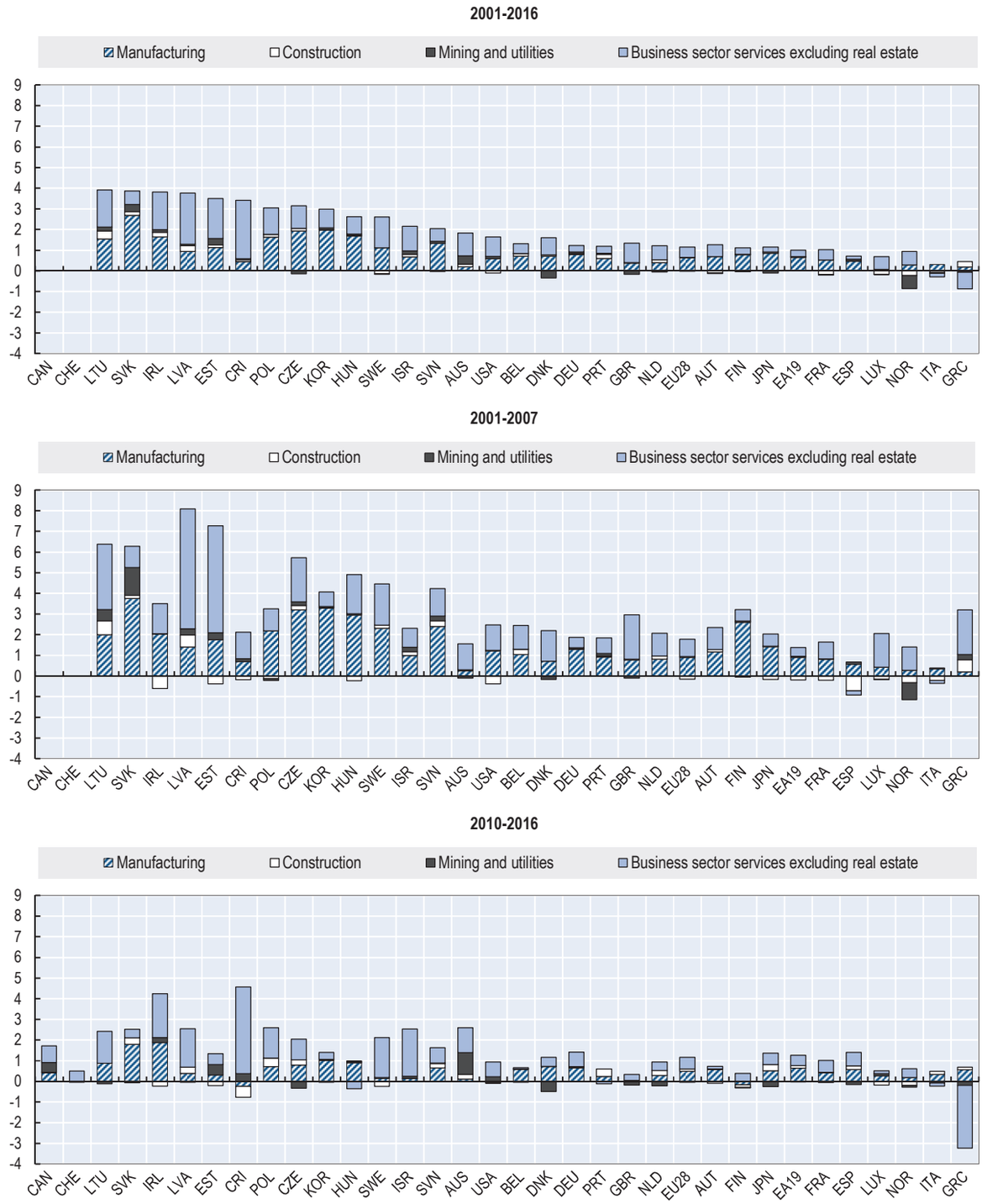
Figure 3.2. Industry contribution to business sector productivity growth

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



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Labour productivity in manufacturing

The manufacturing sector has historically been the main driver of aggregate productivity growth in most economies. While its contribution to aggregate productivity growth has become less important in recent years, it remains a key driver of productivity growth.

Key findings

The post-crisis slowdown in labour productivity growth in manufacturing has been widespread, spanning nearly all sub-sectors of manufacturing from higher-tech, higher skilled activities such as computers and electronics to those traditionally viewed as lower-tech and lower-skilled, such as textiles. In the former, labour productivity growth slowed significantly in the Czech Republic, Lithuania, Poland, Sweden and the United States, while in the latter, an important slowdown was observed in the Czech Republic, the Slovak Republic, Slovenia and the United Kingdom.

Definition

Labour productivity is calculated as the ratio between each sector's value added and the total number of hours worked. For Japan, Latvia, Mexico and the United States, in the absence of national accounts data on total hours worked by manufacturing sector, the total number of persons employed (employees and self-employed) is used as a measure of labour input.

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

Comparability

Volume estimates of value added in ICT-producing sectors (such as manufacturing of computer, electronic and optical products) are complicated by challenges in measuring output prices of the activities, and in particular, how these capture quality improvements associated with technological advances. The use of hedonic deflators is generally considered as the best way to address these problems. However, comparisons of price movements of ICT goods (and also services) point to significant differences in price measurement across countries (Ahmad et. al, 2017), which although not significantly impacting on whole economy productivity estimates can have an impact on more detailed sectoral analyses.

Sources and further reading

Ahmad, N., J. Ribarsky and M. Reinsdorf (2017), *Can potential mismeasurement of the digital economy explain the post-crisis slowdown in GDP and productivity growth?*, OECD Statistics Working Papers, No. 2017/09, OECD Publishing, Paris, http://dx.doi.org/10.1787/a8e751b7-en.

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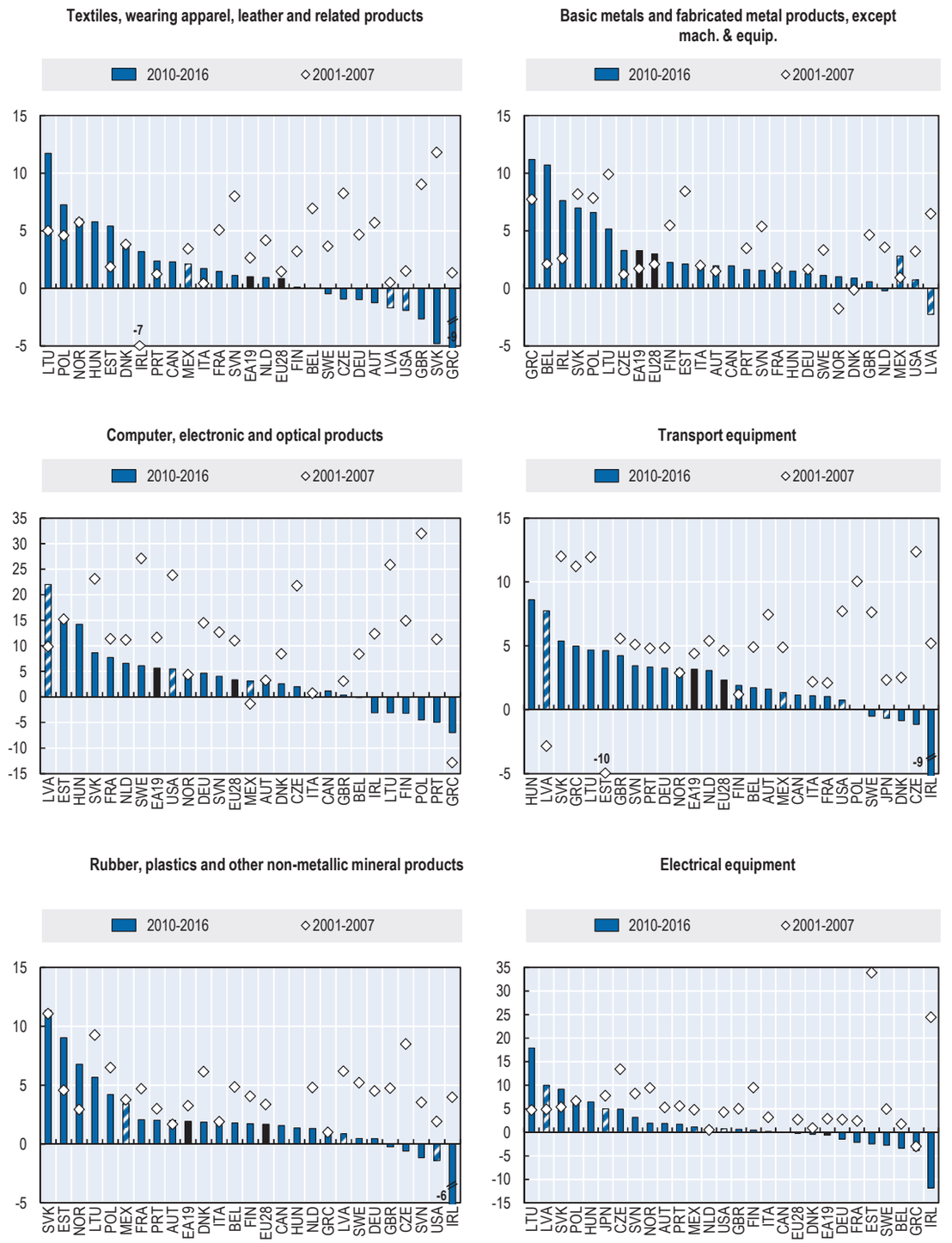
Figure 3.3. Labour productivity in manufacturing, selected sectors

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



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Labour productivity in 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, Hungary, Latvia, the Slovak Republic and the United States. Ireland 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 of IT multinationals.

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). For Japan, Korea and the United States, in the absence of national accounts data on total hours worked by main ISIC Rev.4 economic activity, the total number of persons employed (employees and self-employed) is used as a measure of labour input. 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 7.). 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.

Sources and further reading

Ahmad, N., J. Ribarsky and M. Reinsdorf (2017), *Can potential mismeasurement of the digital economy explain the post-crisis slowdown in GDP and productivity growth?,* OECD Statistics Working Papers, No. 2017/09, OECD Publishing, Paris, http://dx.doi.org/10.1787/a8e751b7-en.

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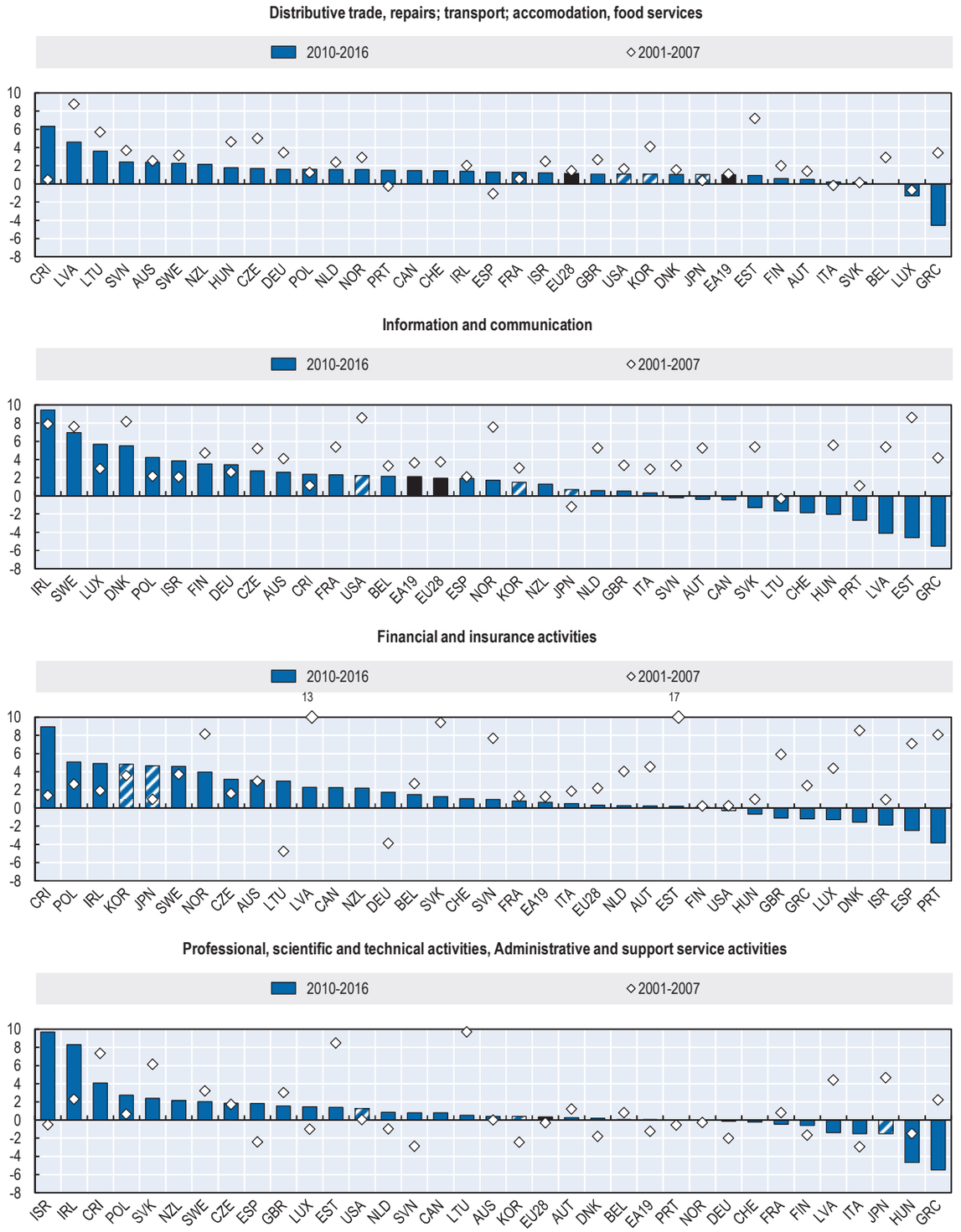
Figure 3.4. Labour productivity in business sector services

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



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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, reflecting their much larger share of overall economic activity and employment. In the pre-crisis period strong productivity growth in finance and insurance activities also acted as a significant contributor, however the post-crisis contribution has been weaker.

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 preferably computed as each individual sector's share in nominal gross value added and total hours worked respectively of total business sector services. For Japan, Korea and the United States, in the absence of national accounts data on total hours worked by main ISIC Rev.4 economic activity, the weights are computed using the total number of persons employed (employees and self-employed). 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 any particular services activity 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.

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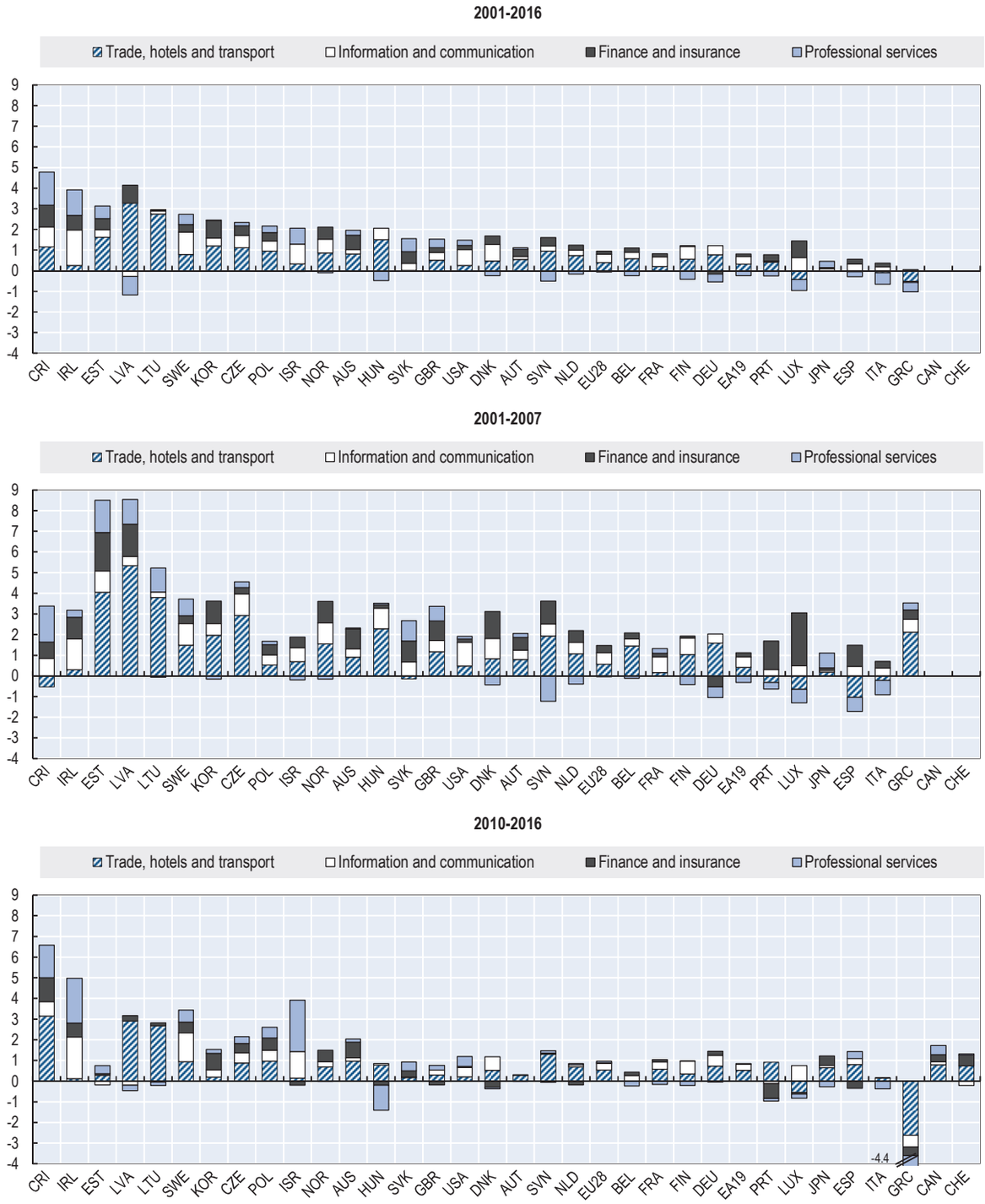
Figure 3.5. Contributions to productivity growth of business sector services excluding real estate

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



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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.

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.

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

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 (2017), *Entrepreneurship at a Glance 2017*, OECD Publishing, Paris. http://dx.doi.org/10.1787/entrepreneur_aag-2017-en.

Figure 3.6. Labour productivity by firm size, business economy

Value added per person employed, thousands of USD, current PPPs, 2015, or latest available year

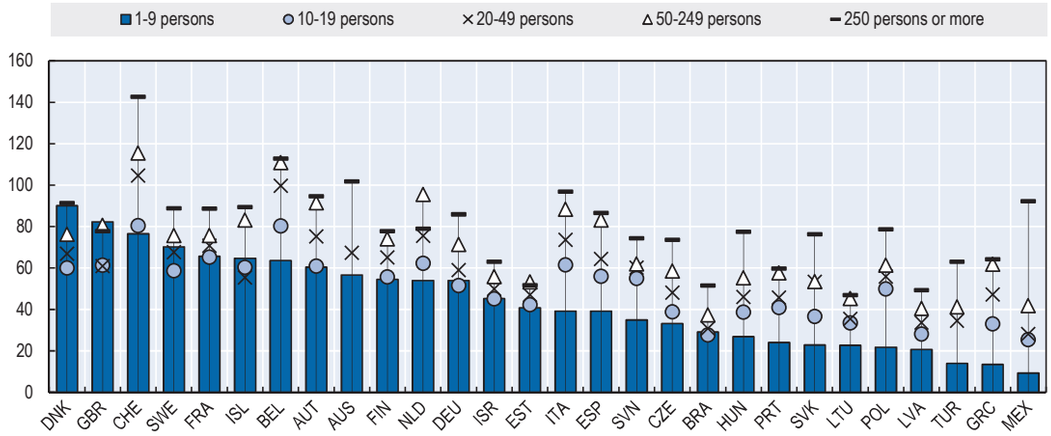

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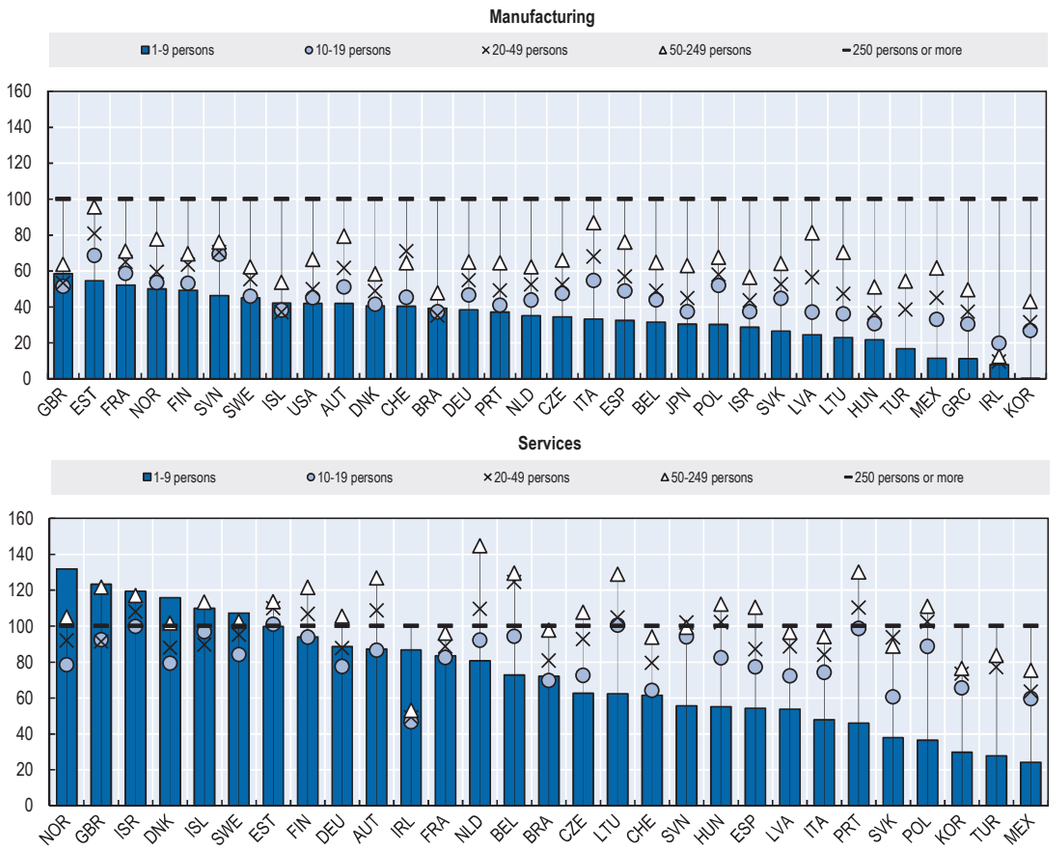
Figure 3.7. Labour productivity by firm size, manufacturing and business services

Value added per person employed, index 250+=100, 2015, 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 Belgium, 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 Hungary, Korea, Lithuania, the Slovak Republic and Slovenia, 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).

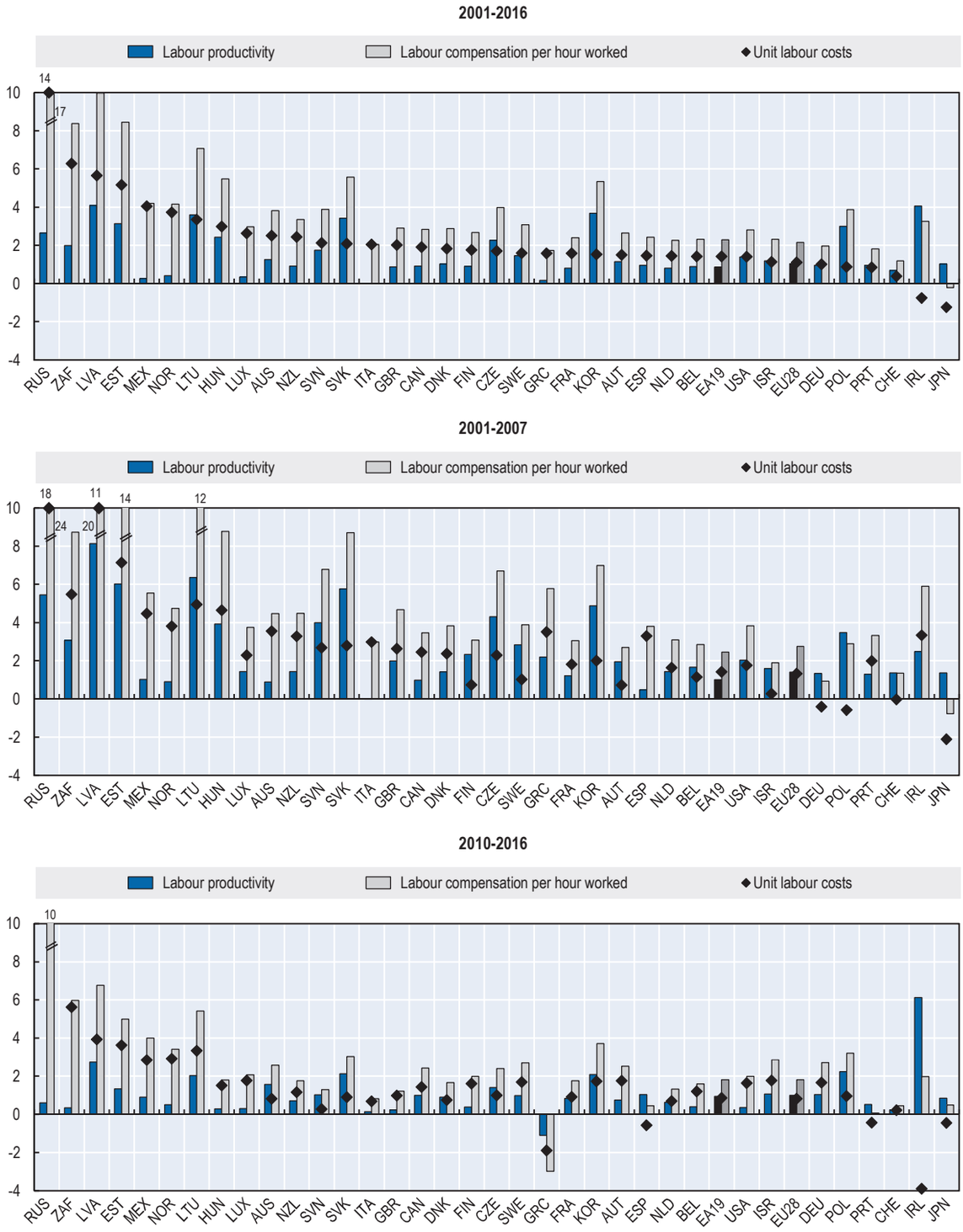
Manufacturing ULCs are often perceived as more representative for assessing competition in tradable products. Services prices are often not very reliable, which may affect the cross-country comparability of measured business sector services ULCs.

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

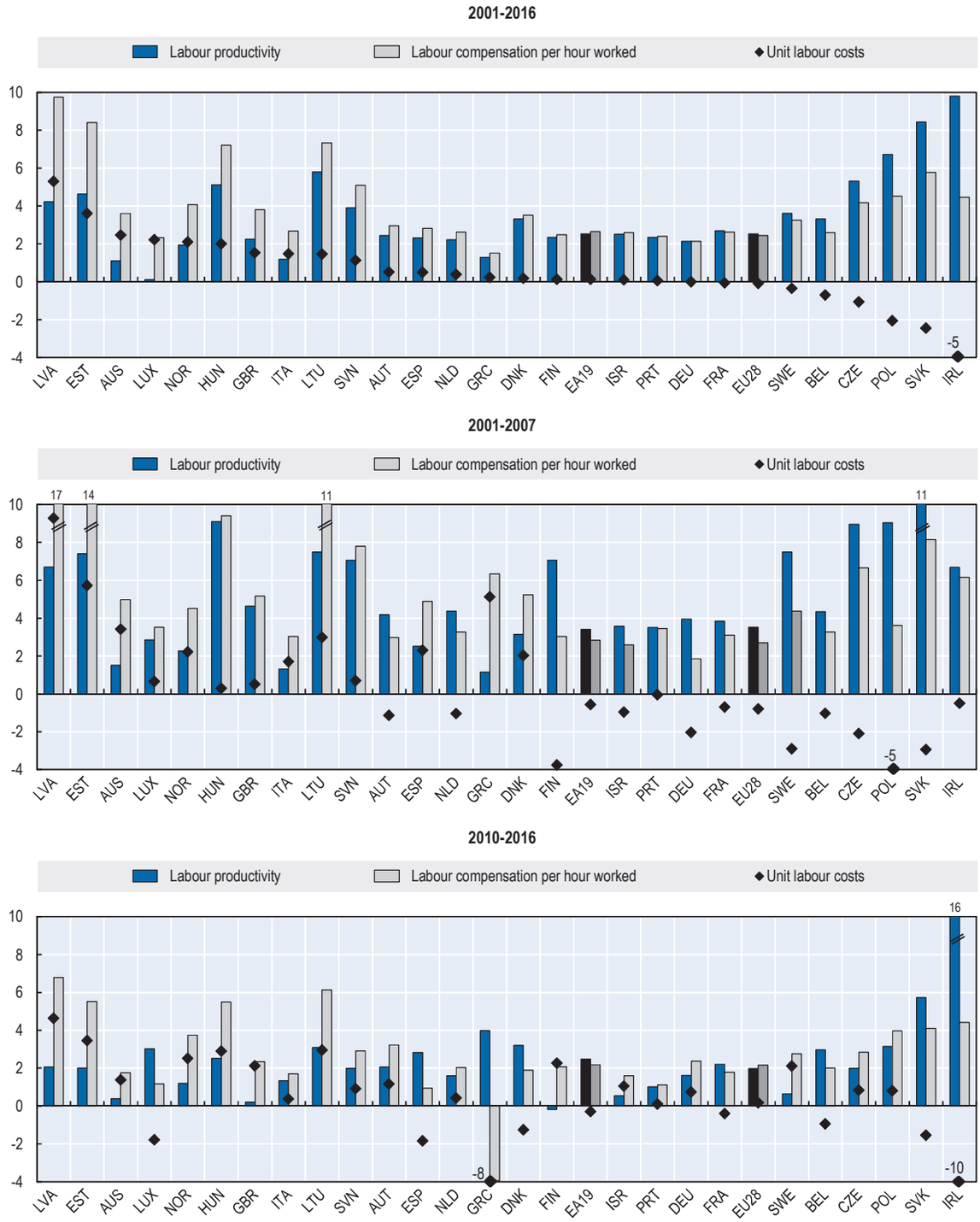
Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734113

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

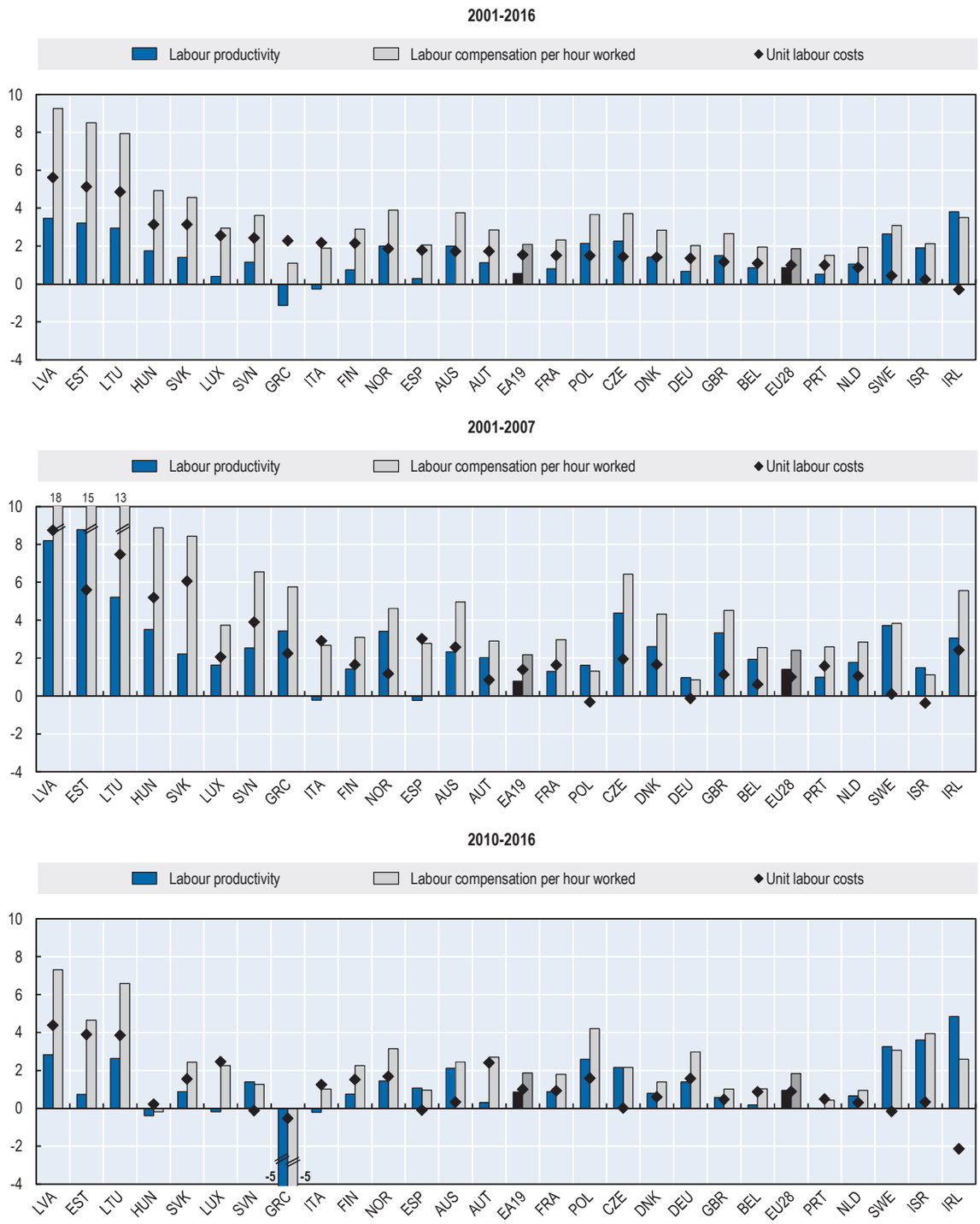
Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734132

Figure 4.3. Unit labour costs, hourly labour compensation and productivity, business sector services

Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734151

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.

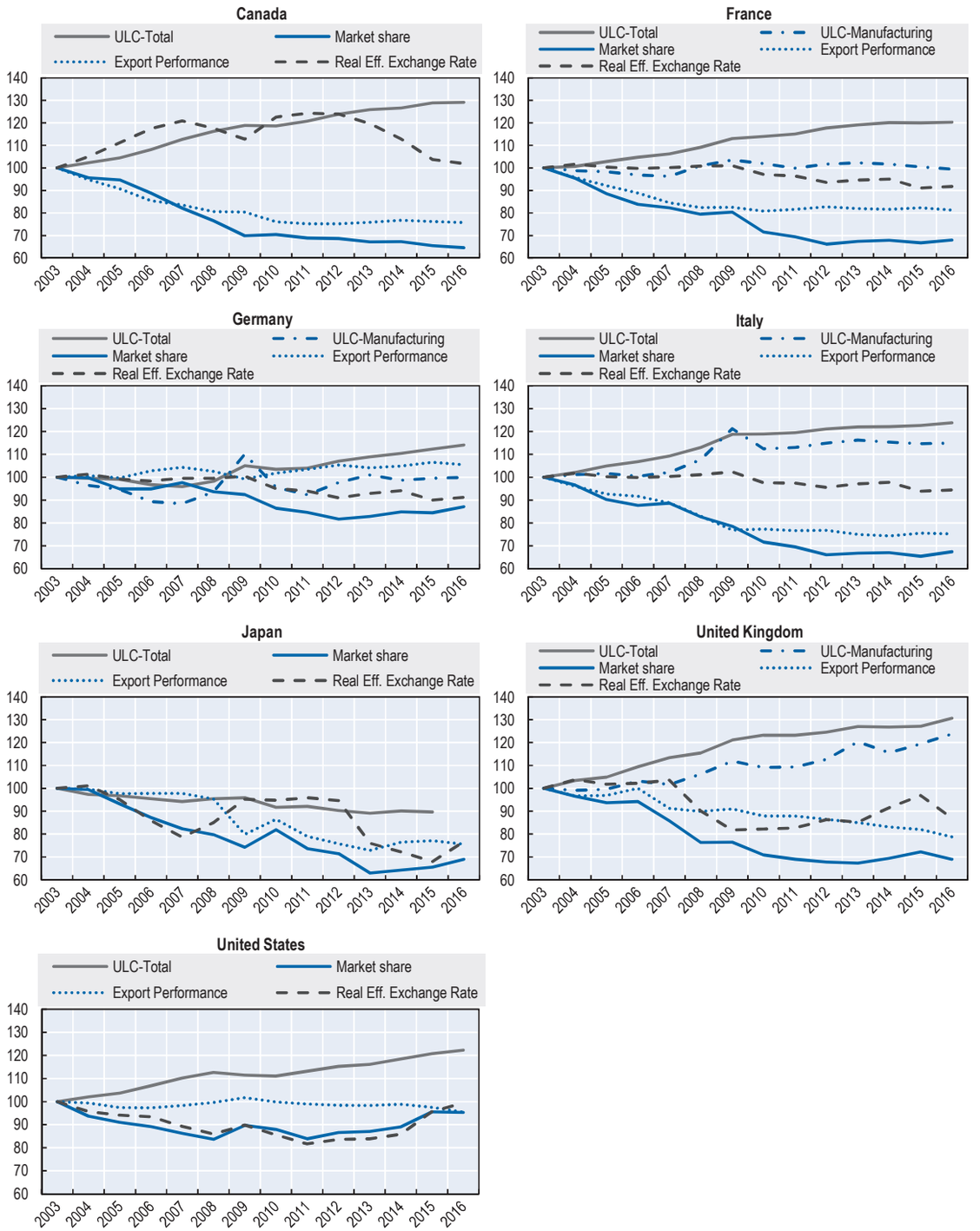
Manufacturing ULCs are often perceived as more representative for competition in tradable products, but they do not account for the increasing trade in services. Services prices are often not very reliable, and therefore may affect cross-country comparability of ULCs in business sector services. Looking 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., Simon, J., and C. Webb (1992), "Indicators of international competitiveness", *OECD Economics Department Working Paper* No. 120, http://dx.doi.org/10.1787/708306180711.

Figure 4.4. Indicators of international competitiveness

Indices, 2003=100



StatLink http://dx.doi.org/10.1787/888933734170

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

Typically, 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

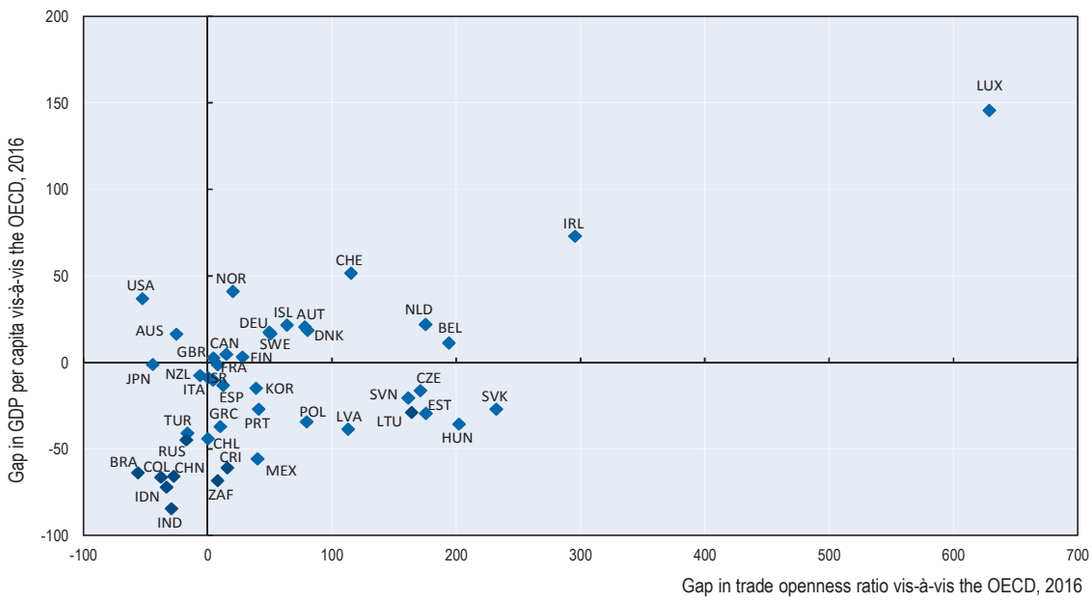
The indicators in the joint *OECD/WTO Statistics on Trade in Value Added (TiVA)* (database) are derived from OECD Input Output Tables linked together using bilateral trade flows in goods and services. Some assumptions are necessary to create the TiVA indicators, implying that some care is needed in interpreting 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 *Trade in Value Added Nowcast Estimates*, http://dx.doi.org/10.1787/c25a117e-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, 2016

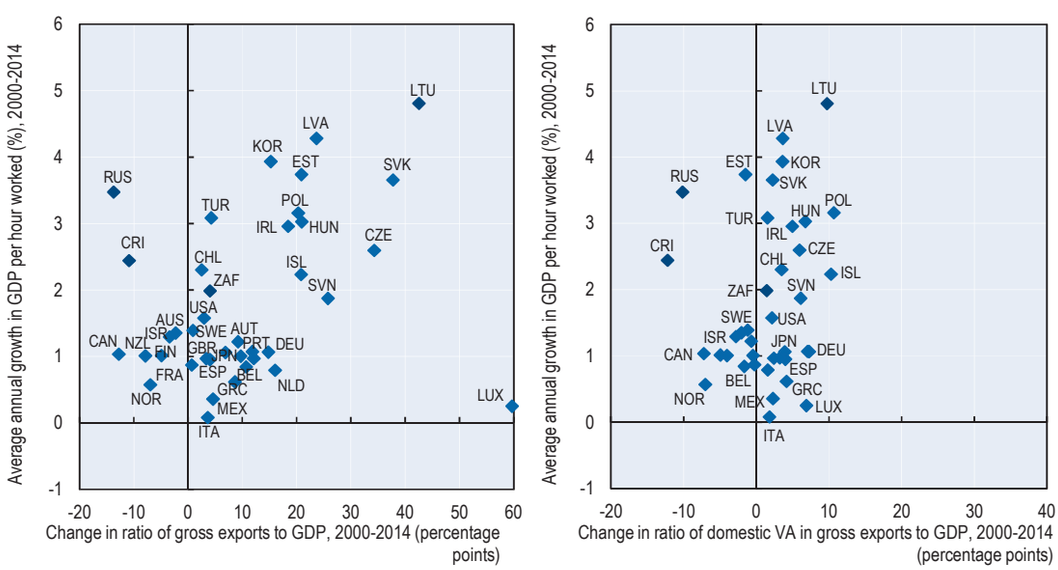
Total economy, percentage point difference from the OECD (OECD=0), current prices and current PPPs



StatLink http://dx.doi.org/10.1787/888933734189

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)



StatLink http://dx.doi.org/10.1787/888933734208

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Chapter 5. Productivity and inclusiveness

Growth in labour income
Labour income shares
Productivity and real wages over time
Productivity and wage gaps across main economic sectors and firms

Growth in labour income

Productivity growth has continued to slow in the post-crisis period, limiting the scope for improvements in material well-being, and the impact of the slowdown has been exacerbated by a decoupling in wage and productivity growth in many countries, which may also be driving inequalities in income and wealth.

Key findings

Recent years have seen a slowdown in real average and median compensation growth compared with the pre-crisis period. In some countries, such as Greece, Italy, Portugal, Spain and the United Kingdom, real average compensation fell over the period 2010-2016. In Canada, Korea, Luxembourg, Poland and the United States, growth in median compensation has lagged that of average compensation over the last 15 years, partly explaining increases in income inequalities.

Definition

Compensation of employees is made up of two components: wages and salaries, and social contributions payable by employers. Wages and salaries are payable in cash or in kind and include the values of any social contributions, income taxes, etc., payable by the employee even if they are actually withheld by the employer and paid on behalf of the employee. The value of social contributions payable by employers include actual social contributions payable by employers to social security schemes or to private funded social insurance schemes and imputed social contributions to unfunded schemes.

Compensation of employees is not payable in respect of unpaid work undertaken voluntarily, including work done by members of a household within an unincorporated enterprise owned by the same household. Any income generated through these activities is recorded as mixed income in the national accounts, which also includes income earned by the self-employed.

Median compensation is estimated using the ratios of minimum to median and minimum to mean wages of full-time employees available in the OECD *Employment and Labour Market Statistics* (database).

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

Comparability

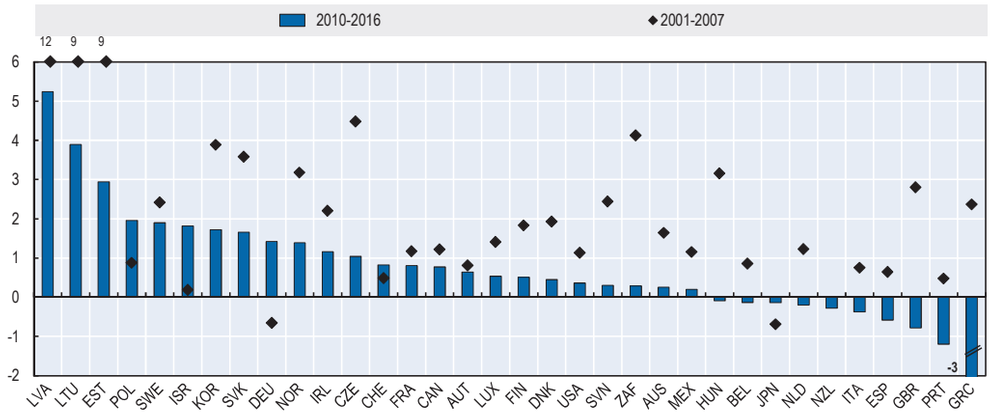
Compensation of employees does not represent the entire value of the contribution of labour to production. Mixed income also reflects a labour income component. In some countries, and notably in some sectors, the shares of self-employed in the labour force may be significant and, so, differences in the shares of compensation of employees across countries may reflect institutional differences, for example tax incentives, to be self-employed or otherwise. This can also have implications in a temporal context. For example increases in average compensation per employee at the total economy level may merely reflect compositional effects, for example if employees in lower paid activities shift to self-employed status.

Sources and further reading

OECD *Employment and Labour Market Statistics* (database), http://dx.doi.org/10.1787/data-00313-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.
OECD (2017), *OECD Compendium of Productivity Indicators 2017*, OECD Publishing, Paris, http://dx.doi.org/10.1787/pdtvy-2017-en.

Figure 5.1. Growth in real average compensation per hour (employees)

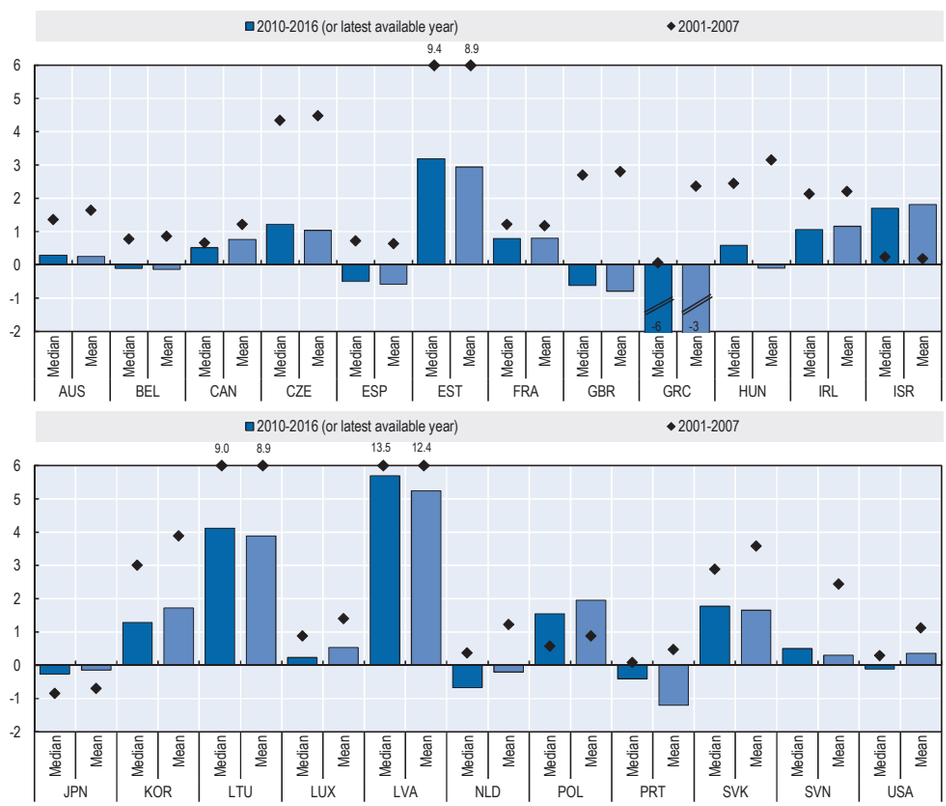
Total economy, CPI all items-deflated, percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734227

Figure 5.2. Growth in real average and median compensation per hour (employees)

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



StatLink http://dx.doi.org/10.1787/888933734246

Labour income shares

The distribution of income between labour and capital has gained considerable attention in recent years in light of declining labour income share in many countries. As labour income tends to play a larger role as a source of income among lower-income households than among higher-income households, a decline in the labour income share may also translate into a widening in income inequalities.

Key findings

Labour income shares have declined in most countries over the last fifteen years, with the largest falls in Ireland, Poland and Portugal (about 10 percentage points), followed by Hungary, Israel and Mexico (about 5 percentage points). Labour income shares in 2016 were particularly low in these economies, ranging from 36% in Ireland to 52% in Portugal.

In most countries, the decline has been more significant in manufacturing than in business services, increasing the gap between labour income shares in business services and those in manufacturing, reflecting the more capital-intensive nature of manufacturing activities.

Definition

The labour income share is calculated as the ratio of total labour compensation to GDP. The labour component of income earned by the self-employed is not separately identifiable. To estimate this, a simple assumption is used, namely that the self-employed and employees earn the same average hourly compensation for labour. Total labour compensation is therefore calculated as compensation of employees multiplied by the number of hours worked by all persons (employees and self-employed), divided by the hours worked by employees.

For Chile, Japan, Korea and the United States, as total hours worked by main ISIC Rev.4 economic activity are not available, the number of persons employed by sector is used, and so, Figure 5.4 necessarily assumes that the average labour compensation of the self-employed is the same as that of employees for these countries.

Note that the decline in labour income shares can be decomposed into a labour productivity component and a real labour compensation per hour component, when labour compensation costs are adjusted for inflation using the same price index as that used to deflate value added. In other words, declining labour income shares are consistent with productivity-wage decoupling.

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

Comparability

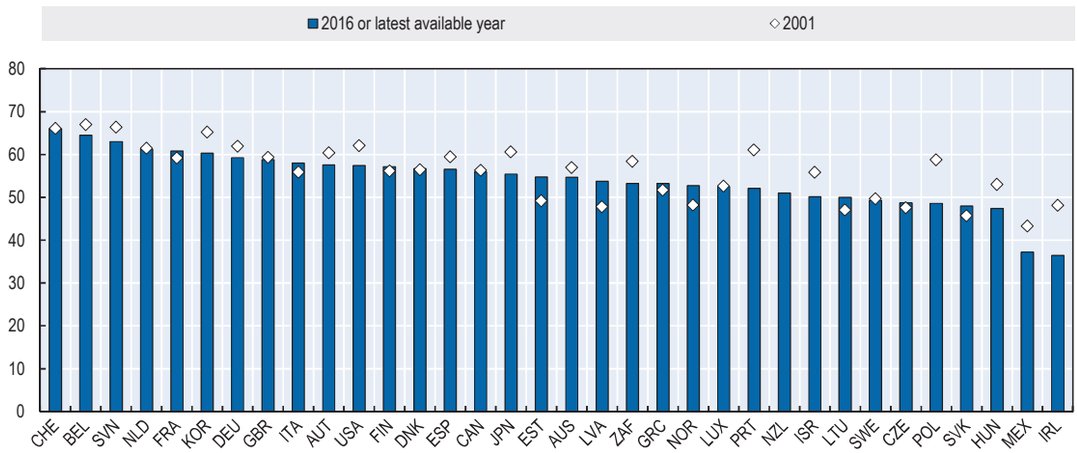
Total labour income represents the compensation received by both employees and self-employed for their labour. The compensation received by employees is readily available in the national accounts. However, total income received by the self-employed is recorded only as mixed income, with no distinction between the returns on their labour and the returns on their capital. Therefore, as described above, self-employed labour compensation is necessarily imputed. These imputations necessarily assume that either the average labour compensation per hour worked of the self-employed and employees or the average labour compensation per self-employed and per employee is the same, within a given sector. To what extent these assumptions (and in particular the latter) are true is likely to differ across countries.

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

Figure 5.3. Labour income shares in the total economy

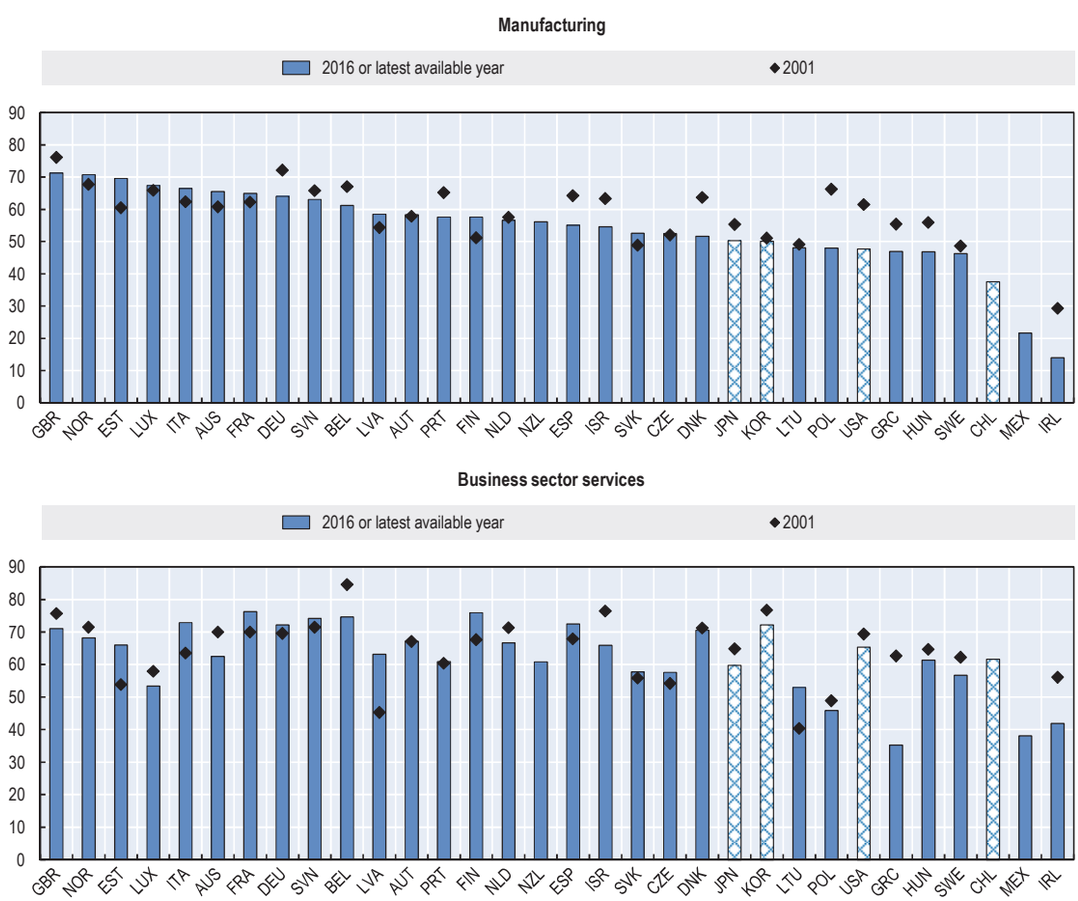
Total compensation as a share of GDP, percentage



StatLink http://dx.doi.org/10.1787/888933734265

Figure 5.4. Labour income shares in manufacturing and business services

Total compensation as a share of gross value added, percentage



StatLink http://dx.doi.org/10.1787/888933734284

Productivity and real wages over time

Real wages are the most direct mechanism through which the benefits of economic growth, and therefore, productivity gains, are transferred to workers. Employers' ability to raise wages and other forms of labour compensation is greatly dependent on increases in labour productivity.

Key findings

Decline in labour income shares observed in most countries can be reformulated as a decoupling between growth in labour productivity growth and real labour compensation, when labour compensation costs are adjusted for inflation using the same price index applied to deflate value added (and so productivity). The impact of a decoupling on material well-being is further exacerbated given the widespread slowdown in productivity growth and even more so when real labour compensation is adjusted for inflation using the consumer price index – i.e. from a consumer/worker perspective – as changes in value-added inflation at the sector level and general inflation can differ significantly, which has been particularly the case in activities, such as manufacturing and information and communications services that have been more exposed to globalisation and technological change.

Definition

The labour component of income earned by the self-employed is not separately identifiable, as such it is assumed that the self-employed and employees earn the same average hourly compensation for their labour, with total labour compensation calculated as compensation of employees multiplied by the number of hours worked by all persons (employees and self-employed), divided by the hours worked by employees. For Chile, Japan, Korea and the United States, as total hours worked by main ISIC Rev.4 economic activity are not available, the number of persons employed by sector is used, and so, Figure 5.6, Figure 5.7 and Figure 5.8 necessarily assume that the average labour compensation of the self-employed is the same as that of employees for these countries.

Measures of value-added follow the definition in the 2008 SNA. Of note in this regard is the impact that relocations of headquarters or indeed intellectual property can have on recorded measures of economic activity. The latter in particular can be an important source of observed decoupling and so some care is necessarily needed in interpreting movements across countries and their implications on material well-being, as is the case in Ireland for example, where GDP grew by 26% in 2015.

Real measures of compensation can be calculated from the a producer's perspective, where real average hourly labour compensation growth is deflated using the same price index as that used for value added, or from a worker's perspective, where compensation is adjusted for general price inflation (in this case the consumer price index, CPI), which is a better reflection of the real purchasing power of households and so more appropriate for analyses of material well-being and inequalities (OECD, 2017).

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

Comparability

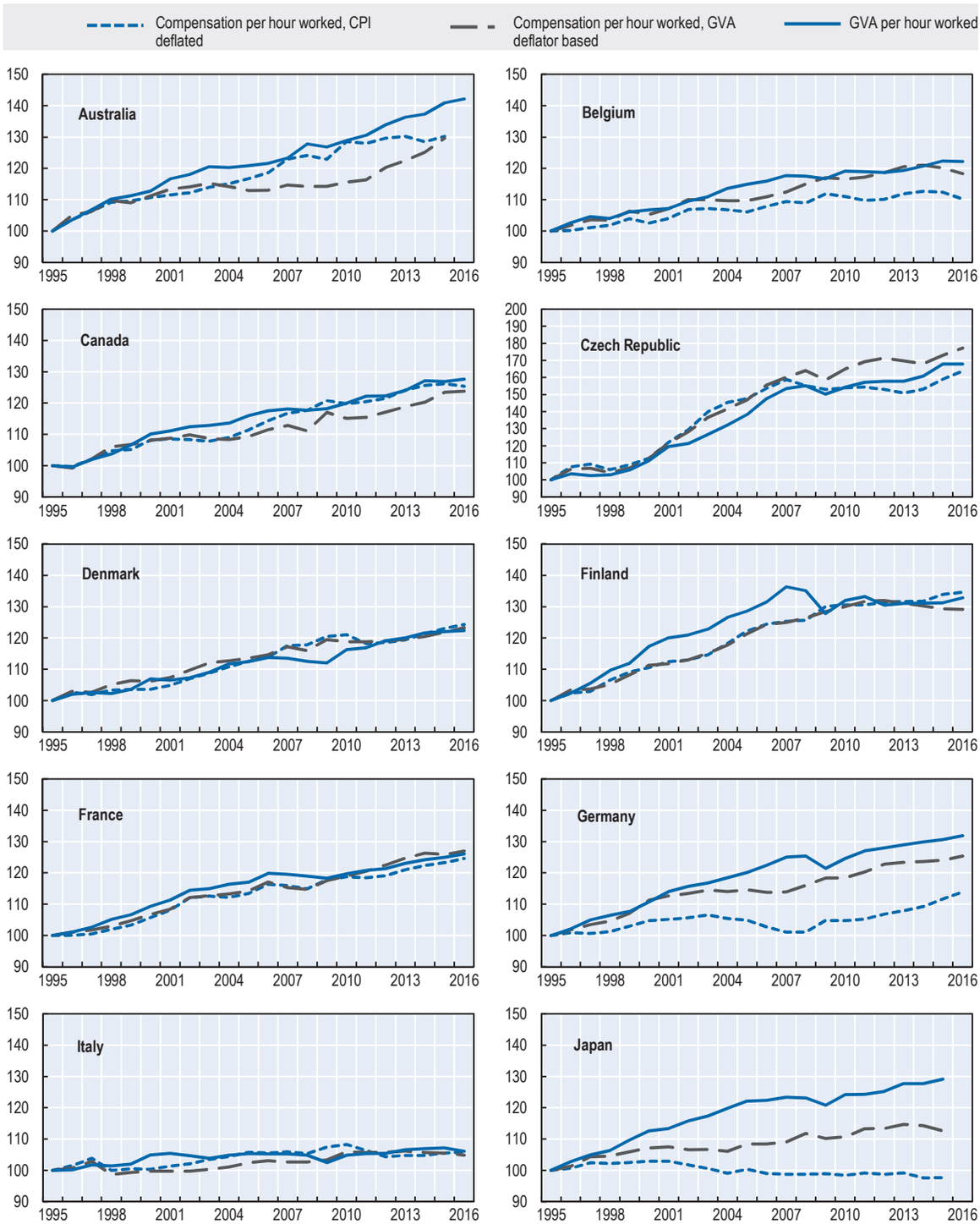
Total labour income represents the compensation received by both employees and self-employed for their labour. The compensation received by employees is readily available in the national accounts. However, total income received by the self-employed is recorded only as mixed income, with no distinction between the returns on their labour and the returns on their capital. Therefore, as described above, self-employed labour compensation is necessarily imputed. These imputations necessarily assume that either the average labour compensation per hour worked of the self-employed and employees or the average labour compensation per self-employed and per employee is the same, within a given sector. To what extent these assumptions (and in particular the latter) are true is likely to differ across countries.

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

Figure 5.5. Labour productivity and average labour compensation per hour, total economy

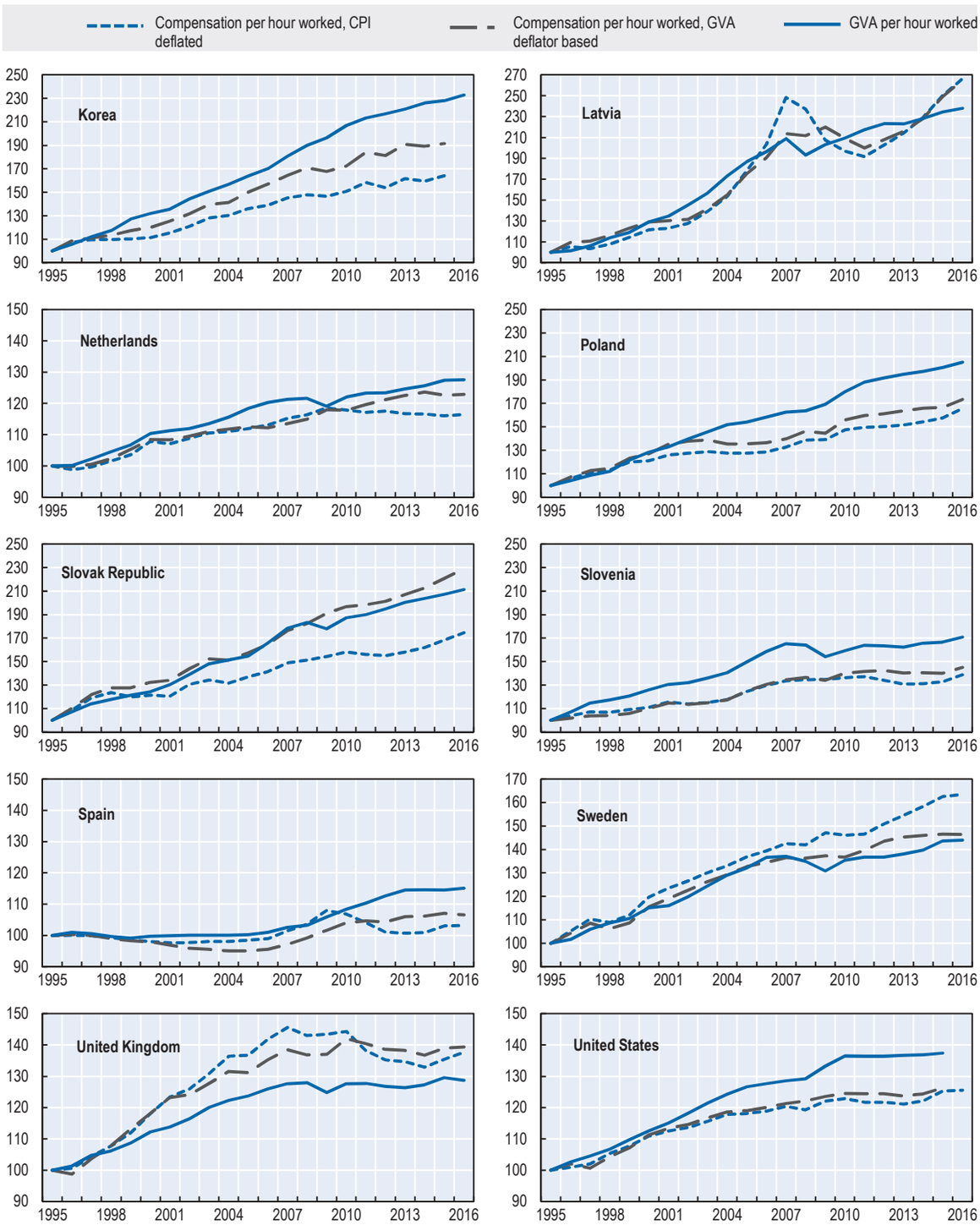
Selected OECD countries, GVA per hour worked and average hourly labour compensation, indices 1995=100



StatLink http://dx.doi.org/10.1787/888933734303

Figure 5.5. Labour productivity and average labour compensation per hour, total economy (cont.)

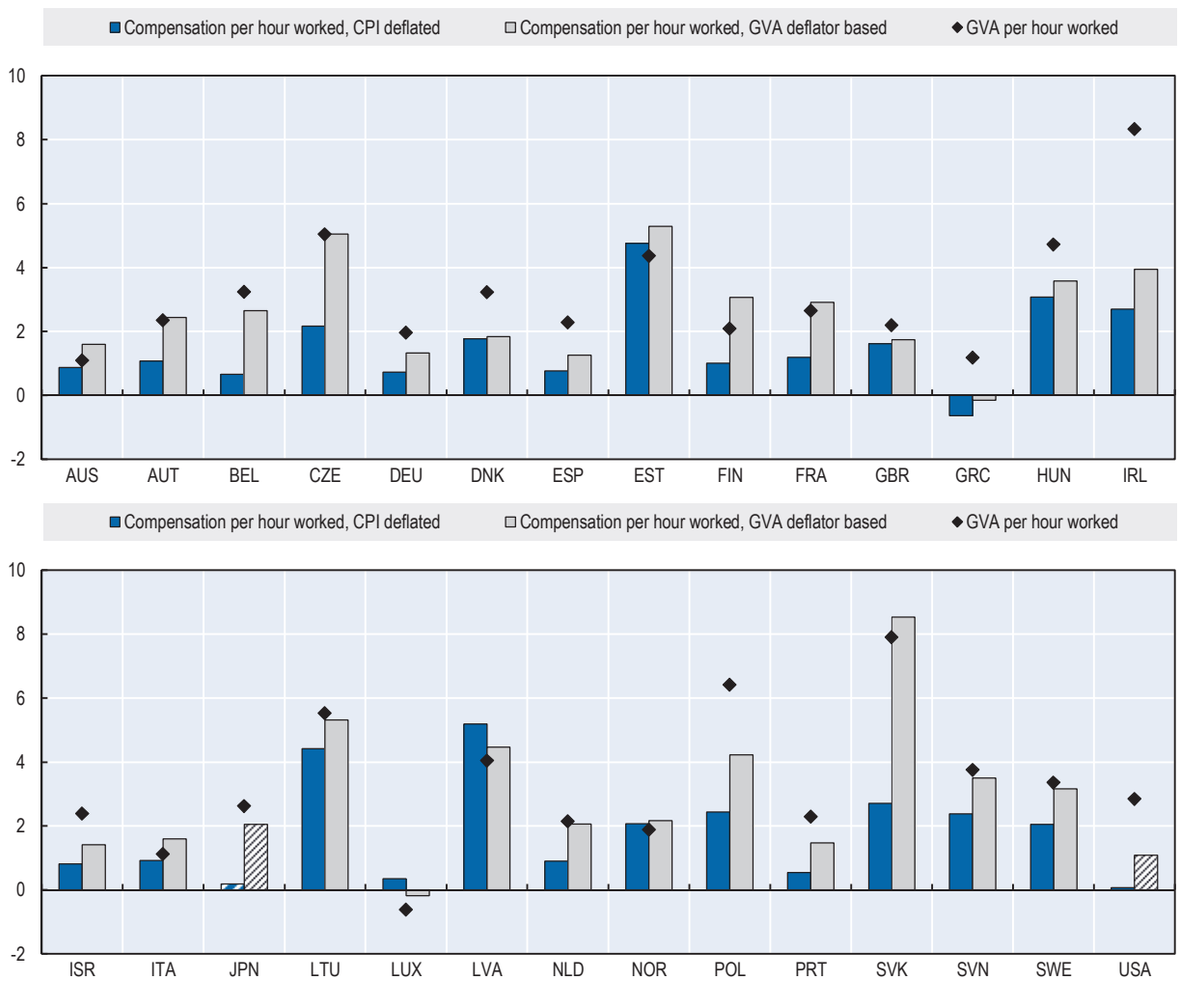
Selected OECD countries, GVA per hour worked and average hourly labour compensation, indices 1995=100



StatLink http://dx.doi.org/10.1787/888933734303

Figure 5.6. Growth in labour productivity and average labour compensation per hour, manufacturing, 2001-2016

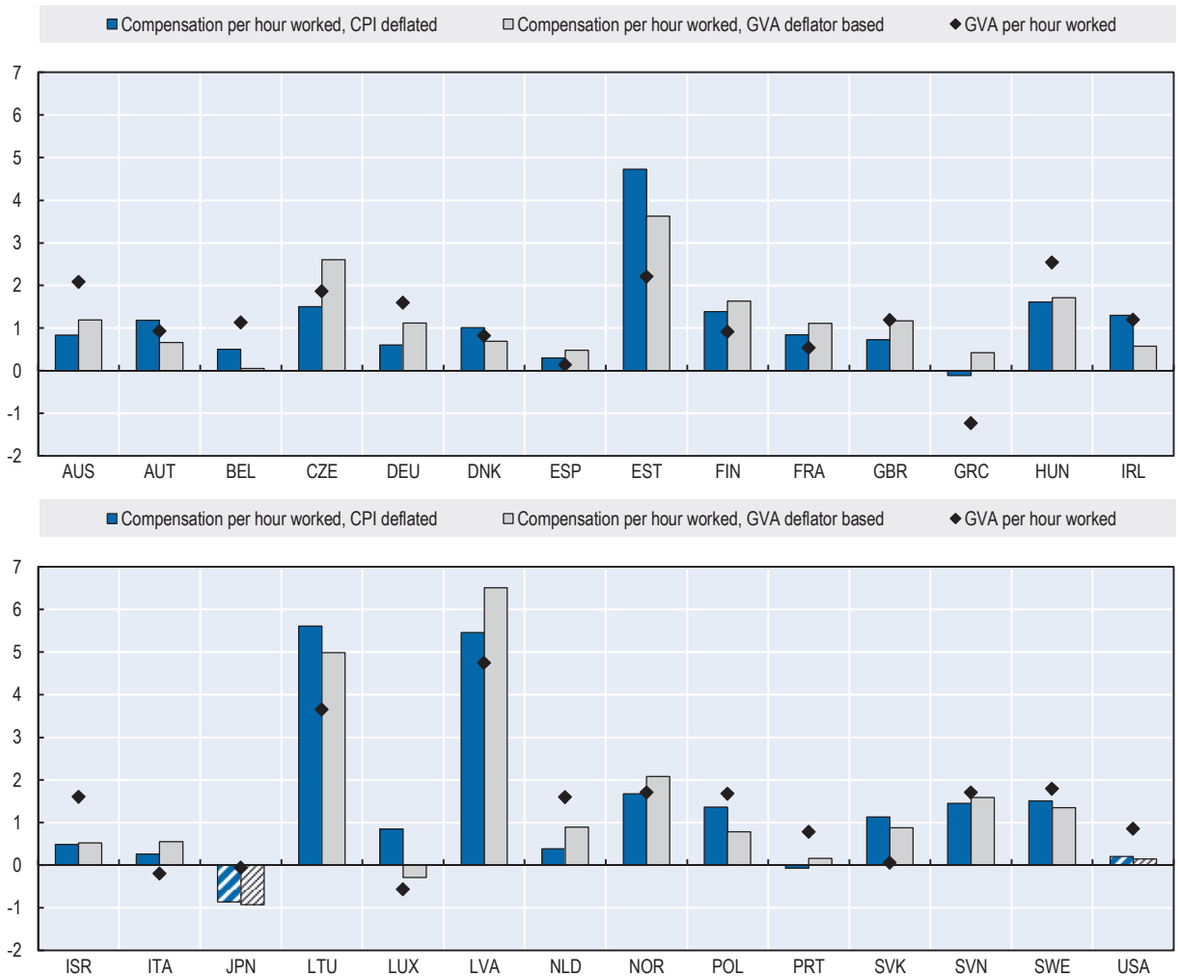
Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734322

Figure 5.7. Growth in labour productivity and average labour compensation per hour, trade, transport, food and accommodation services, 2001-2016

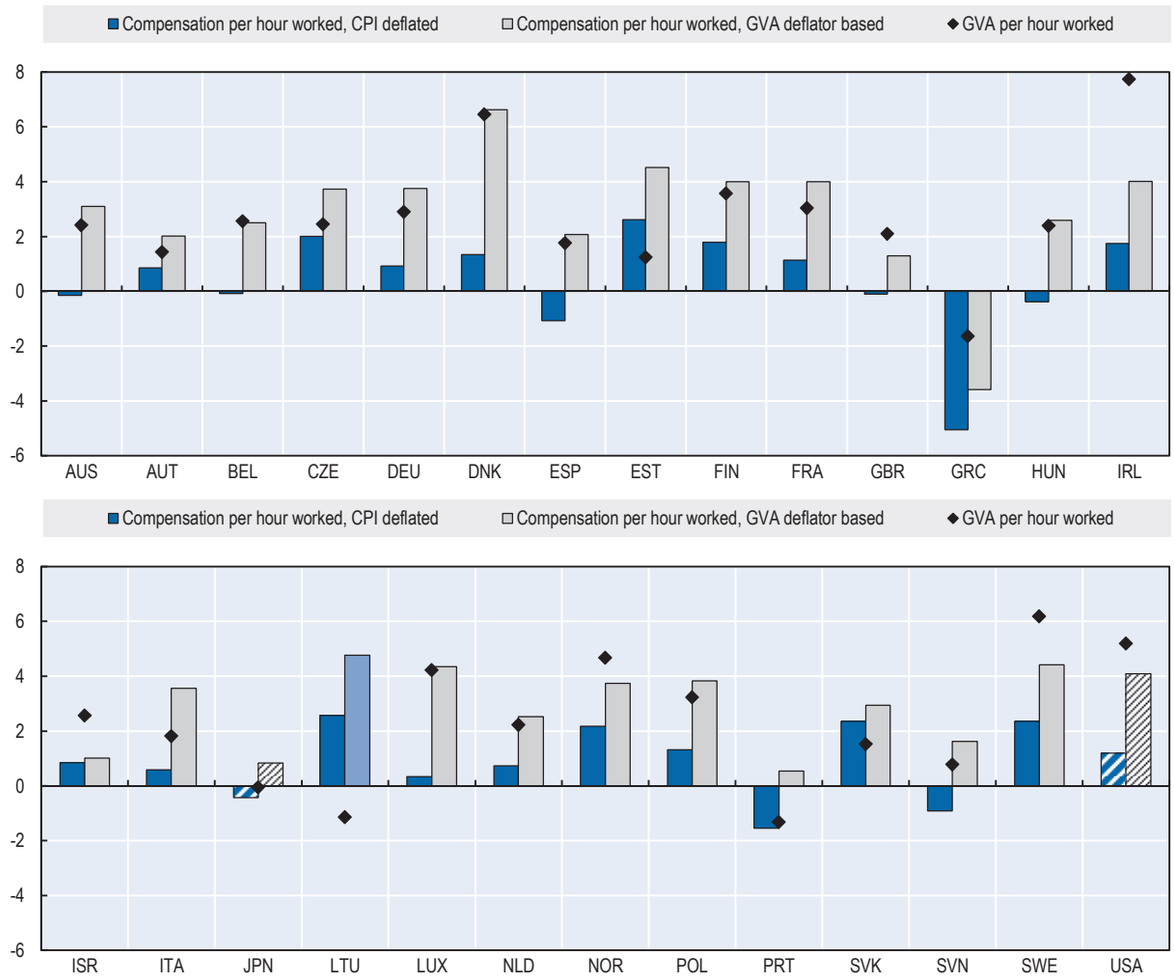
Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734341

Figure 5.8. Growth in labour productivity and average labour compensation per hour, information and communication services, 2001-2016

Percentage change at annual rate



StatLink http://dx.doi.org/10.1787/888933734360

Productivity and wage gaps across main economic sectors and firms

Recent years have seen growing concerns about rising inequalities of income within countries. Weaker productivity growth in some economic sectors and small and medium enterprises (SME) in the post-crisis period has exacerbated longstanding productivity gaps within many countries, with consequential impacts on measures of inequality.

Key findings

Compensation received by employees differs significantly across economic sectors. In trade, transport and food and accommodation services, a sector where SMEs account for a significant share of the enterprise population and value added, the average compensation per employee is generally lower than the total economy average compensation. However, in information and communication services and, in particular, in finance and insurance activities, the average compensation received by an employee is on average 50% and 70% higher than the total economy average compensation.

Wage differentials across firms typically align with labour productivity differentials. Large firms in the manufacturing sector are on average more productive and tend to pay higher wages than SMEs. In Germany, for example, large firms paid a wage premium of over 50% of the wage of medium-size firms and over double the wage paid by smaller and micro enterprises. Large differentials are also observed in Austria, Belgium and the Netherlands, while they are significantly smaller in some other countries, such as in Czech Republic, Finland and Slovenia.

Definition

Compensation of employees is made up of two components: wages and salaries, and social contributions payable by employers. Wages and salaries are payable in cash or in kind and include the values of any social contributions, income taxes, etc., payable by the employee even if they are actually withheld by the employer and paid on behalf of the employee. The value of social contributions payable by employers include actual social contributions payable by employers to social security schemes or to private funded social insurance schemes and imputed social contributions to unfunded schemes. Compensation of employees is not payable in respect of unpaid work undertaken voluntarily, including work done by members of a household within an unincorporated enterprise owned by the same household. Any income generated through these activities is recorded as mixed income in the national accounts, which also includes income earned by the self-employed. Compensation per employee statistics by firm size in national currency are converted to US dollars using purchasing power parities (PPPs) for actual individual consumption and as such reflect average labour compensation per employee from a worker/consumer's perspective. Labour productivity by firm size is measured as gross value added in current prices per person employed.

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

Comparability

Value added data by firm size refer to value added at factor costs in European countries and value added at basic prices for other countries. Estimates of value added and employment presented by size class are based on the *OECD Structural and Demographic Business Statistics* (database) and will not usually align with estimates produced according to the System of National Accounts. The latter includes a number of adjustments to reflect businesses and activities that may not be measured in structural business statistics, such as the inclusion of very small units that may be below operational thresholds used in structural business statistics or those made to reflect the non-observed economy.

Comparability across firm size classes, industries and countries, may be affected by differences in the shares of part-time employment. Measures of compensation of employees or labour productivity per hour worked can overcome cross-country differences in part-time employment but these data are only available for a limited number of countries when broken down by firm size class. As such the indicators presented in Figure 5.15 and Figure 5.16 are based on headcounts and not hours worked and so some care is needed in interpretation.

Sources and further reading

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

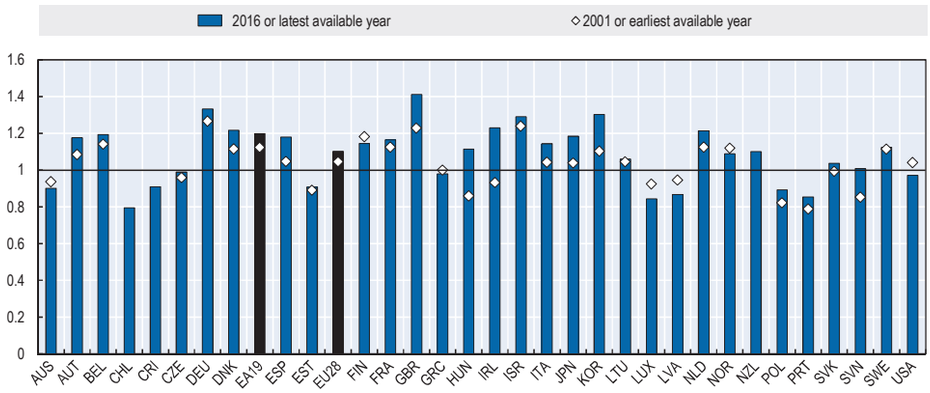
OECD Structural and Demographic Business Statistics (SDBS) (database), www.oecd.org/std/industry-services.

OECD (2017), *Entrepreneurship at a Glance 2017*, OECD Publishing, Paris. http://dx.doi.org/10.1787/entrepreneur_aag-2017-en.

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

Figure 5.9. Compensation per employee, manufacturing

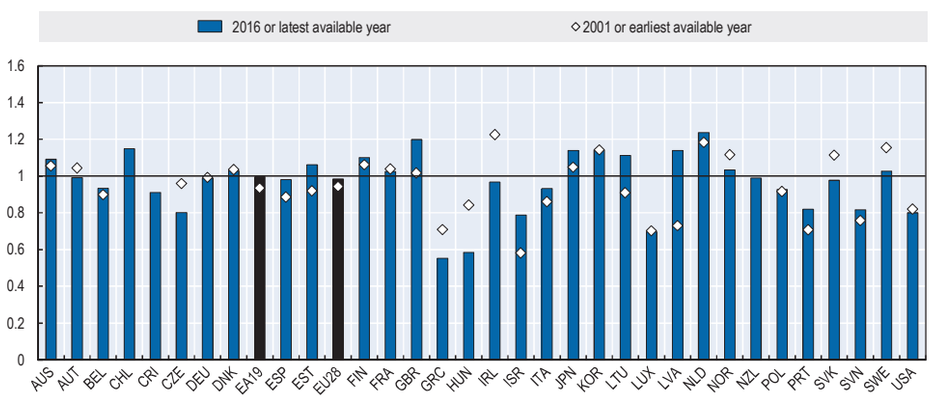
As a ratio of compensation per employee in the total economy



StatLink http://dx.doi.org/10.1787/888933734379

Figure 5.10. Compensation per employee, construction

As a ratio of compensation per employee in the total economy



StatLink http://dx.doi.org/10.1787/888933734398

Figure 5.11. Compensation per employee, trade, transport, accommodation and food services

As a ratio of compensation per employee in the total economy

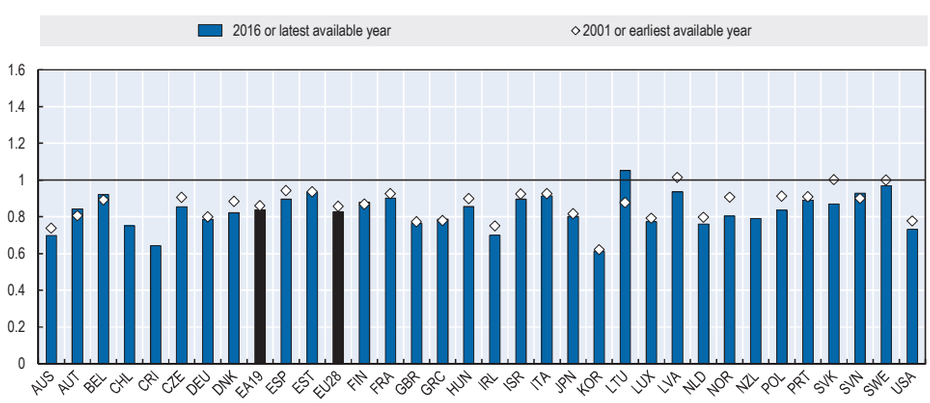


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Figure 5.12. Compensation per employee, information and communication services

As a ratio of compensation per employee in the total economy

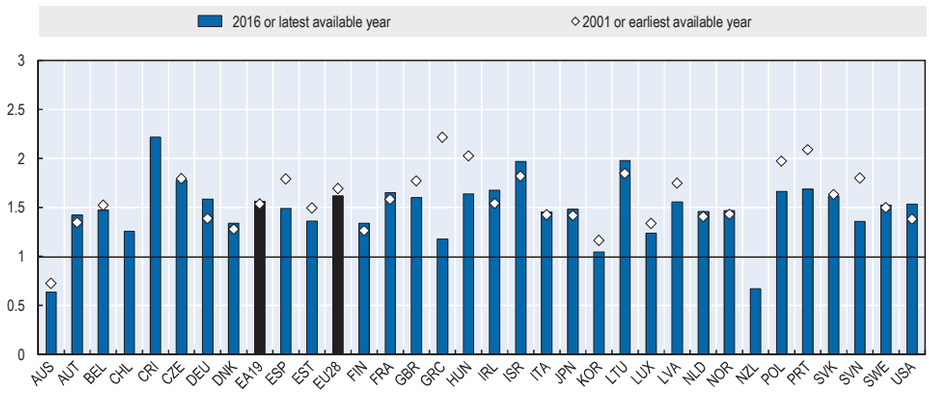

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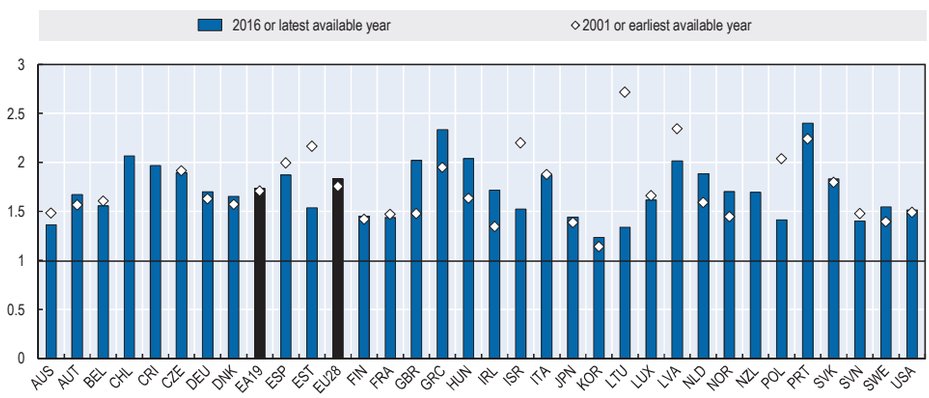
Figure 5.13. Compensation per employee, finance and insurance

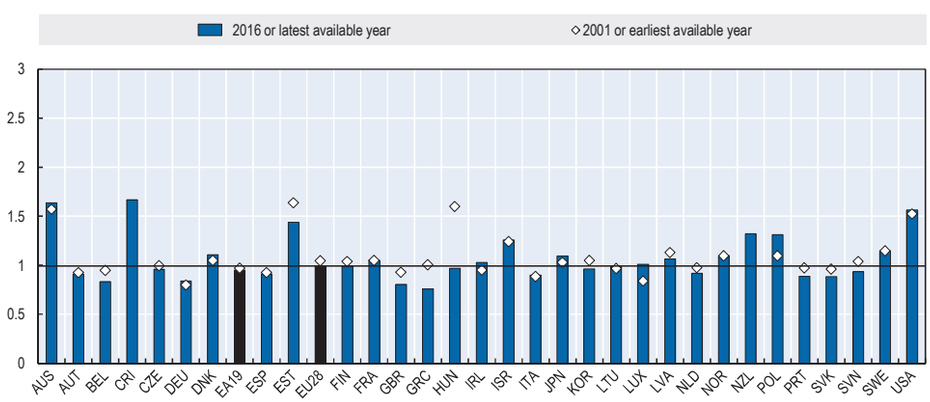
As a ratio of compensation per employee in the total economy



StatLink http://dx.doi.org/10.1787/888933734455

Figure 5.14. Compensation per employee, professional, scientific and administrative services

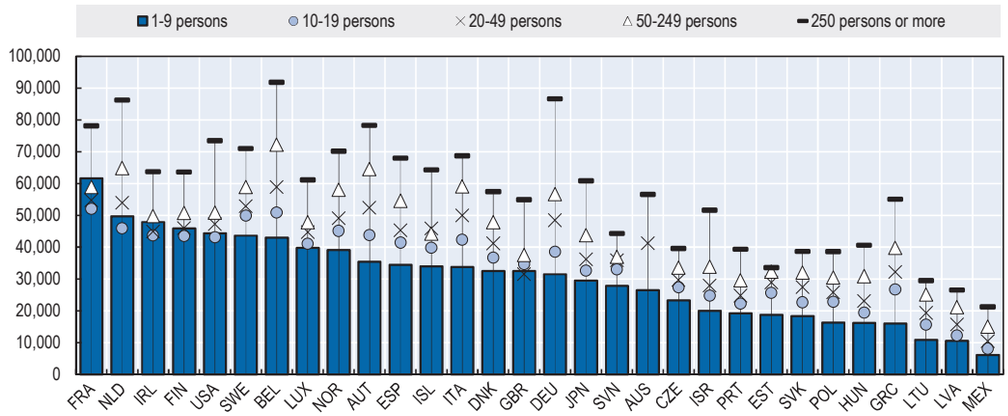
As a ratio of compensation per employee in the total economy



StatLink http://dx.doi.org/10.1787/888933734474

Figure 5.15. Average compensation per employee by firm size, manufacturing

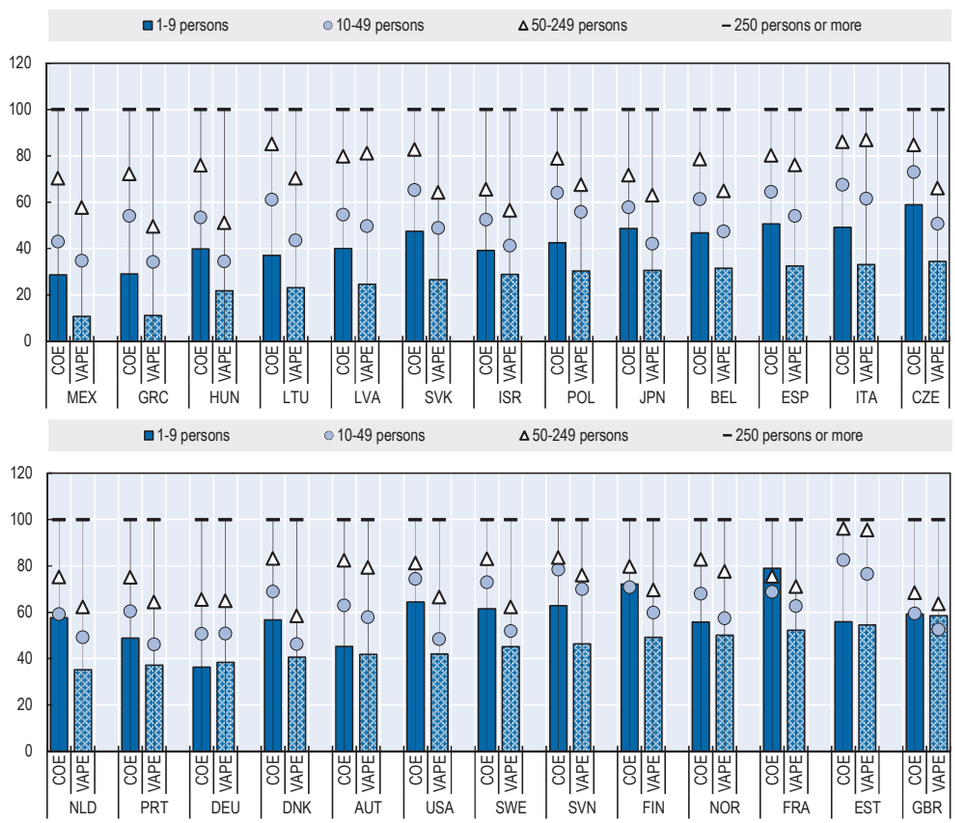
US dollars, current PPP for actual individual consumption, 2015 or latest available year



StatLink http://dx.doi.org/10.1787/888933734493

Figure 5.16. Labour productivity and compensation per employee by enterprise size, manufacturing

Value added per person employed (VAPE) and compensation per employee (COE), index 250+ = 100, 2015, or latest available year



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Chapter 6. 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 45 years from relatively high rates. While the volatility in the cycle introduced by the crisis necessitates some caution in interpreting recent trends, tentative signs of improvement are emerging in France and Germany.

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 λ. The larger the value given to λ, 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 λ. While for quarterly data it has been typically assumed a value of λ=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 λ 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 7.).

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.

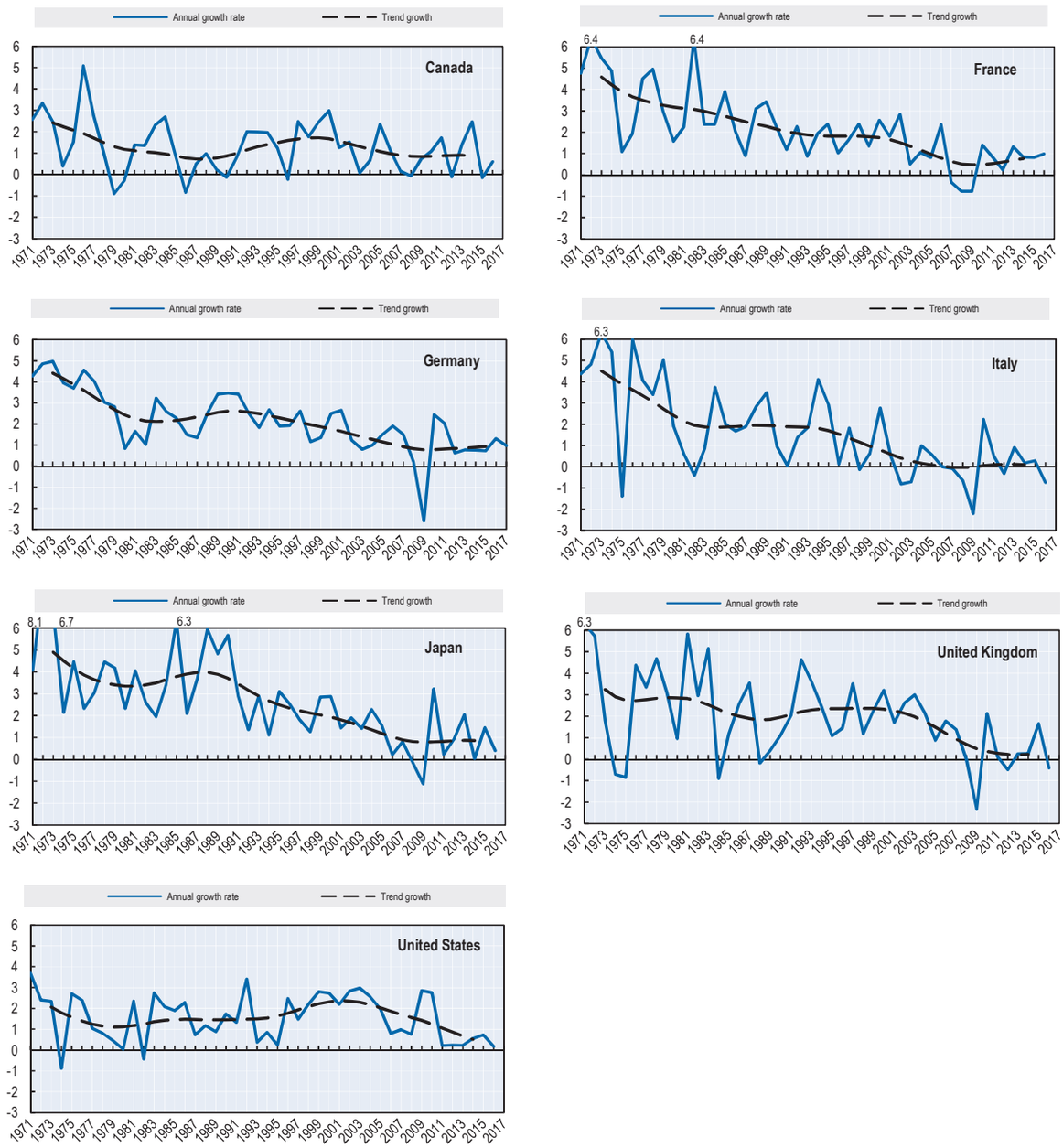
Hodrick R. and E. Prescott (1997), "Postwar U.S. business cycles: an empirical investigation", *Journal of Money, Credit and Banking*, Vol. 29, No. 1.

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 6.1. Trend labour productivity growth in G7 countries

Total economy, percentage change at annual rate



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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 since the mid-1990s contrasted with the relatively flat trend observed in the contribution of capital deepening. In Germany, trend MFP growth declined continuously since the beginning of the 1990s until the crisis, with tentative signs of an improvement emerging in recent years. In Italy, trend MFP growth 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 coupled with a downward trend in the contribution of capital deepening. In the United Kingdom and the United States, the downward trends in labour productivity growth since the early 2000s were driven by a sharp decline in MFP growth in the United Kingdom up to the crisis and a flat-lining since, and by a combination of declining MFP growth and capital deepening in the United States; the downward trends look to have continued in recent years. While some caution is needed in analysing trends in the most recent years, the evidence is beginning to point to tentative improvements from the crisis lows in trend MFP growth in Canada, France, Germany and Japan.

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 7.).

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 6.2. Labour productivity growth trend and its components, Canada

Total economy, percentage change at annual rate

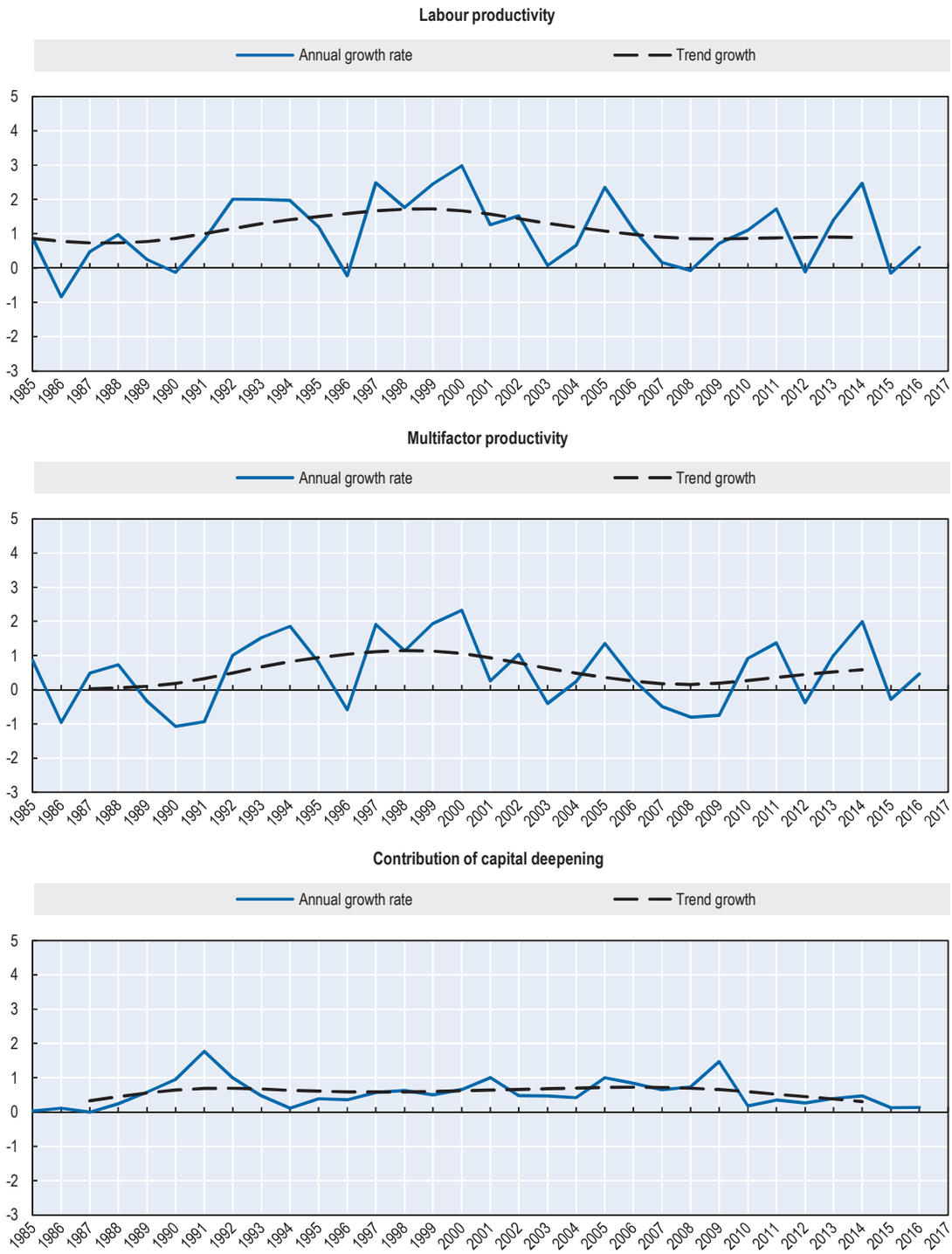

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Figure 6.3. Labour productivity growth trend and its components, France

Total economy, percentage change at annual rate

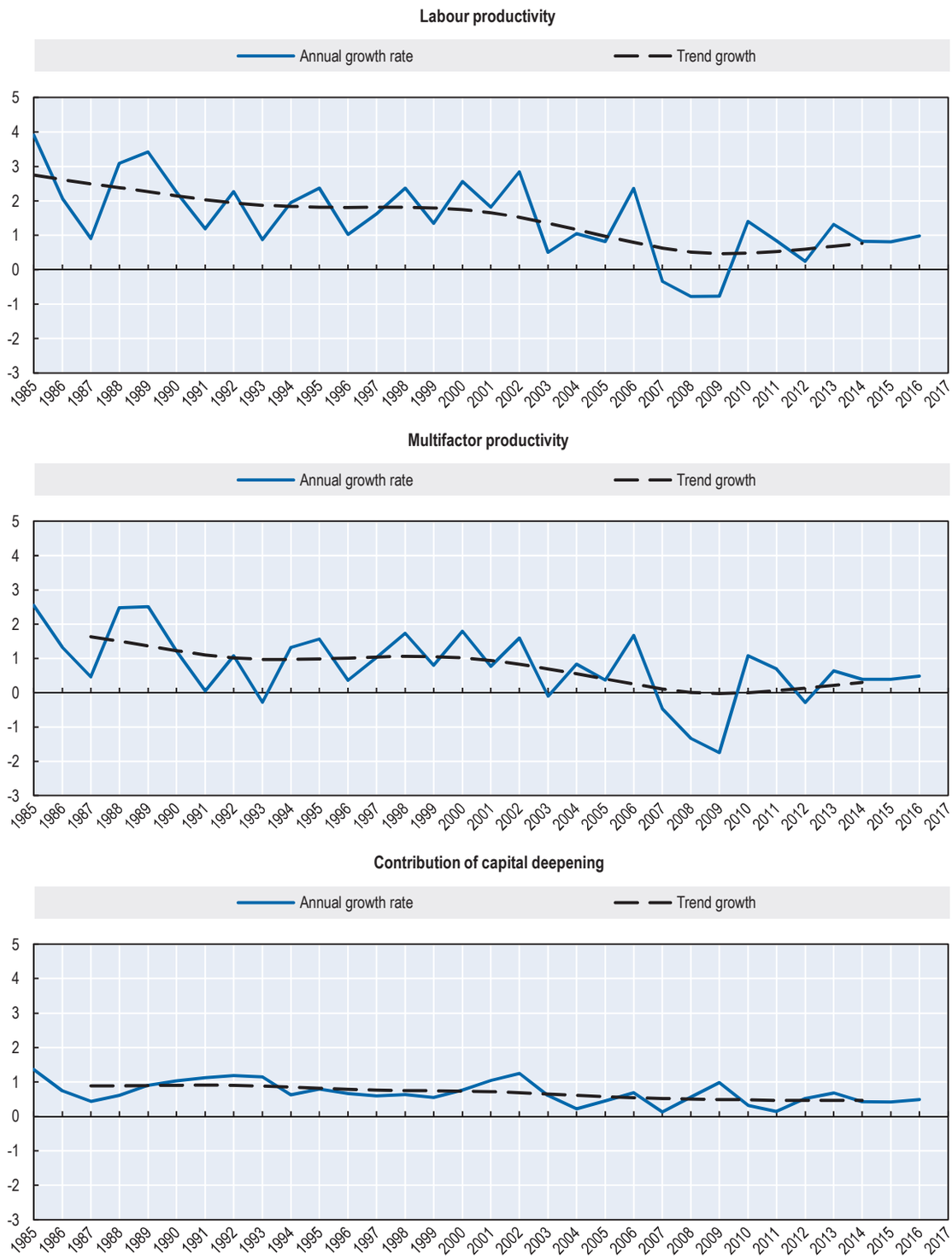

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Figure 6.4. Labour productivity growth trend and its components, Germany

Total economy, percentage change at annual rate

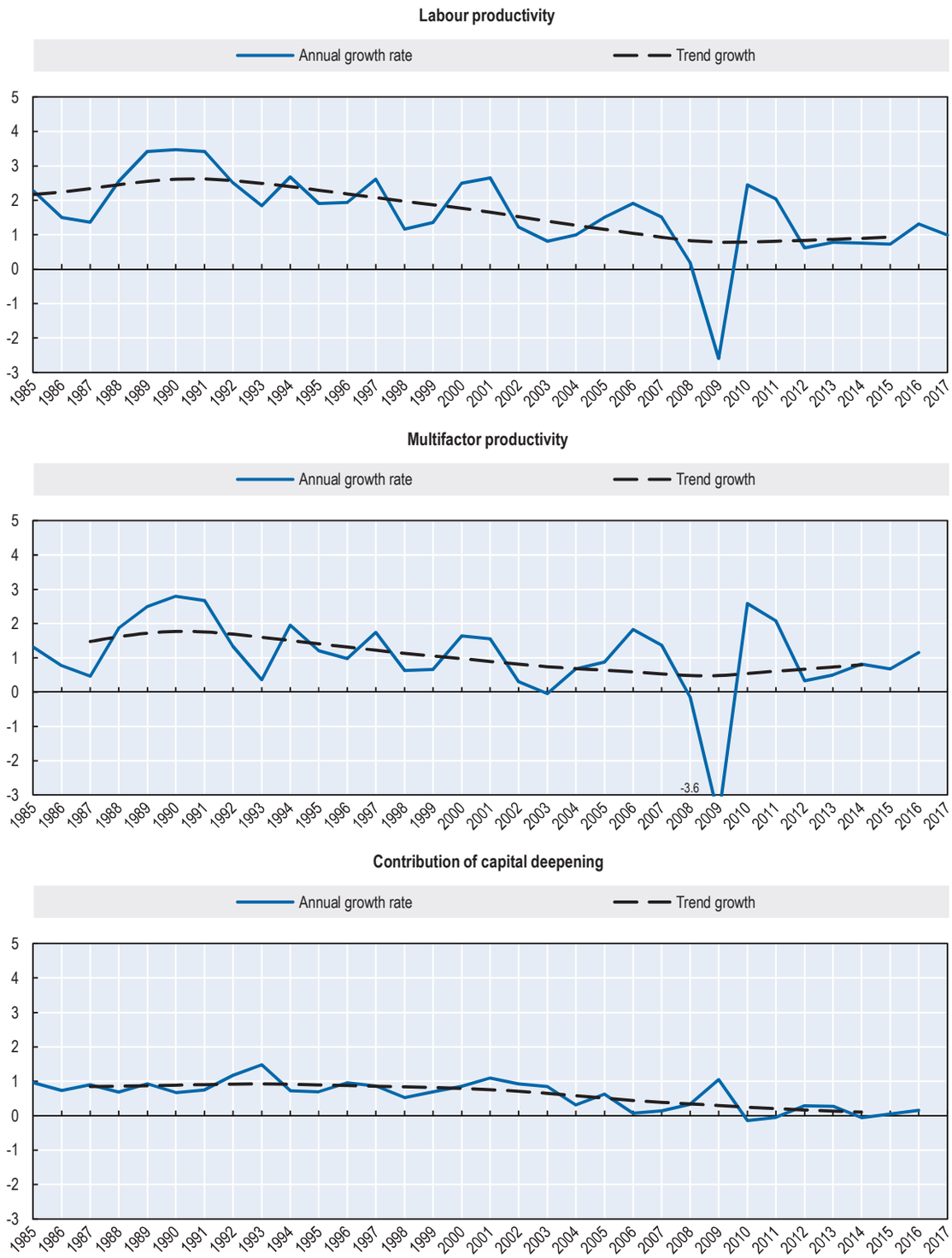

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Figure 6.5. Labour productivity growth trend and its components, Italy

Total economy, percentage change at annual rate

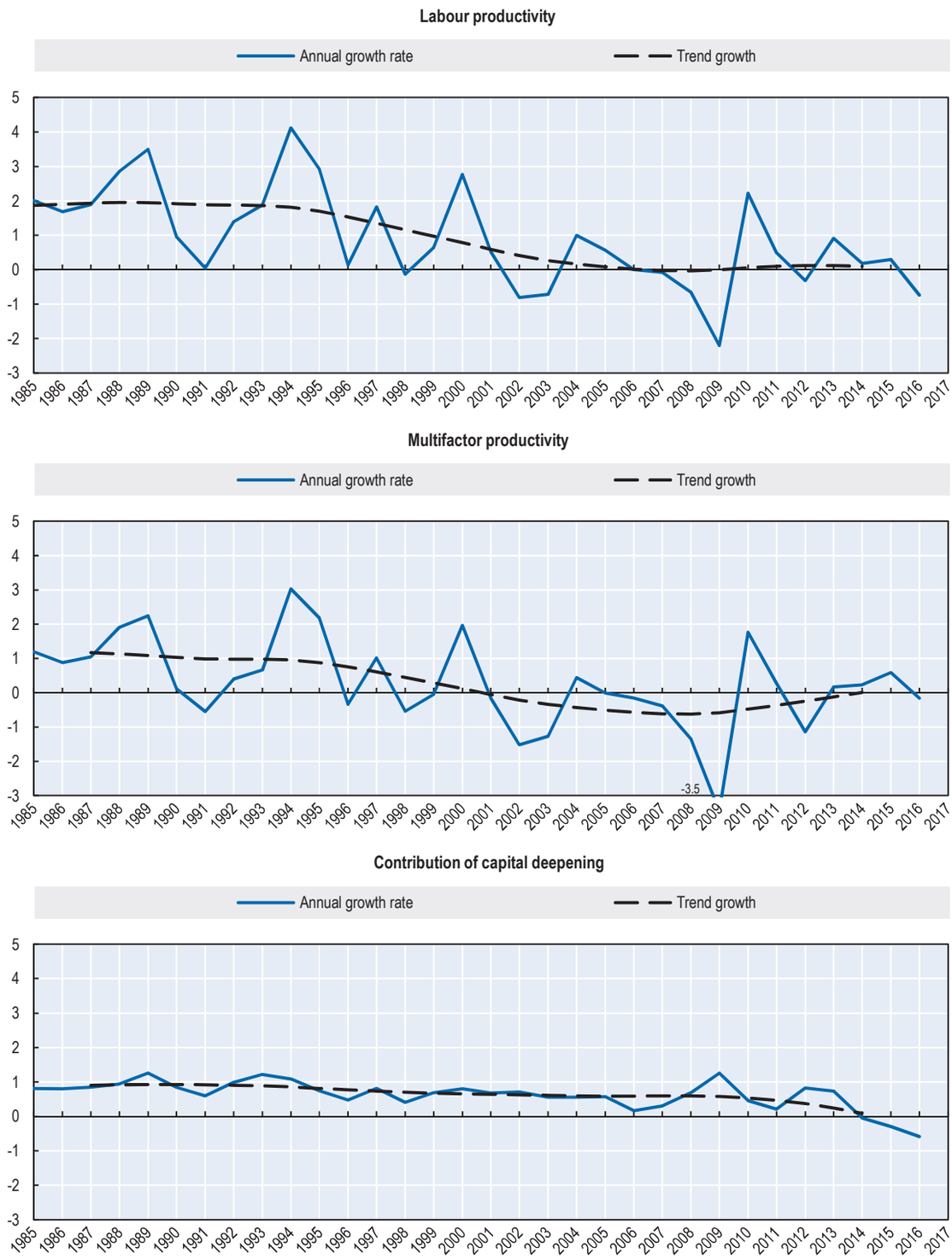

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Figure 6.6. Labour productivity growth trend and its components, Japan

Total economy, percentage change at annual rate

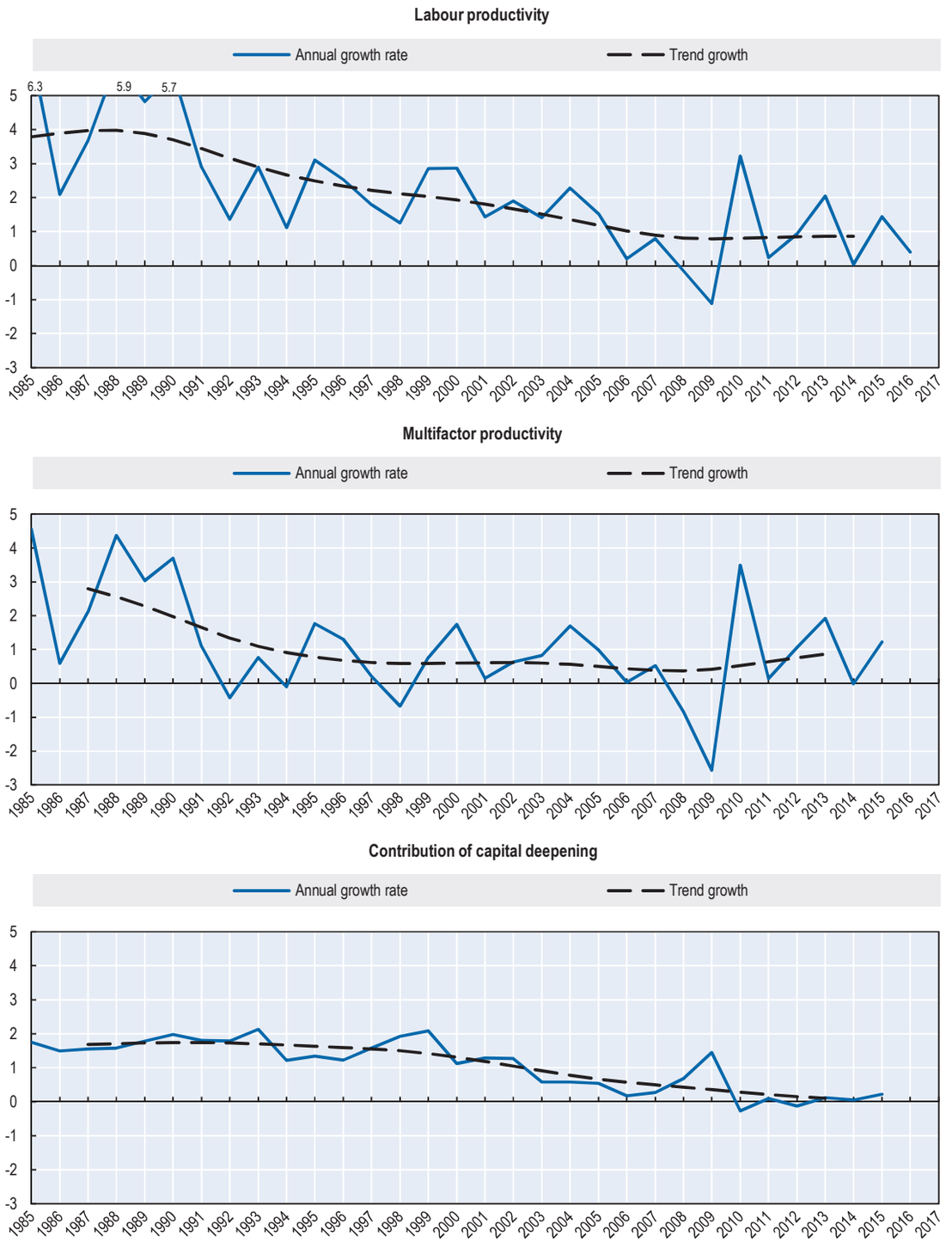

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Figure 6.7. Labour productivity growth trend and its components, United Kingdom

Total economy, percentage change at annual rate

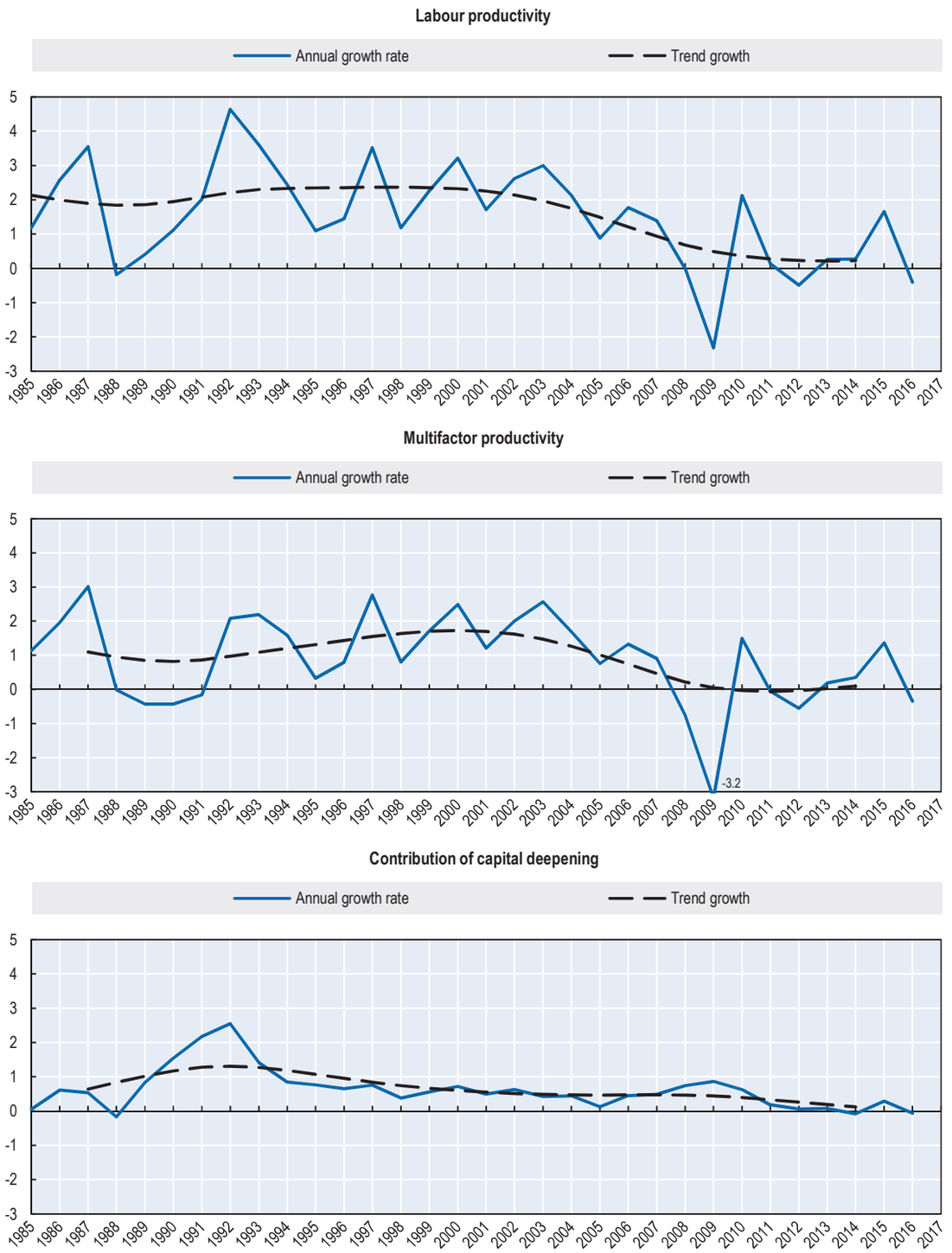

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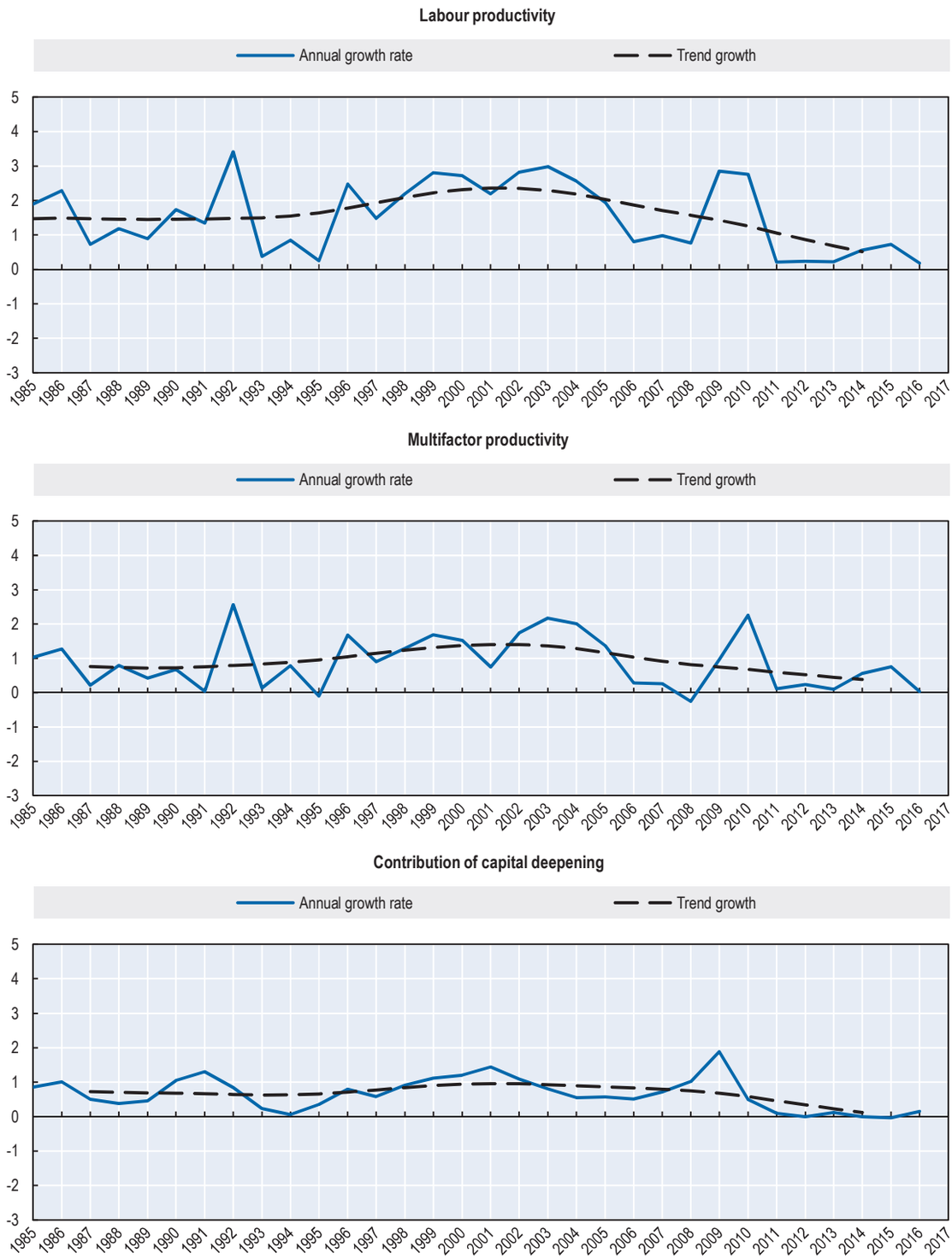
Figure 6.8. Labour productivity growth trend and its components, United States

Total economy, percentage change at annual rate



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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.

Definition

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 7.). 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 7.). 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 7.).

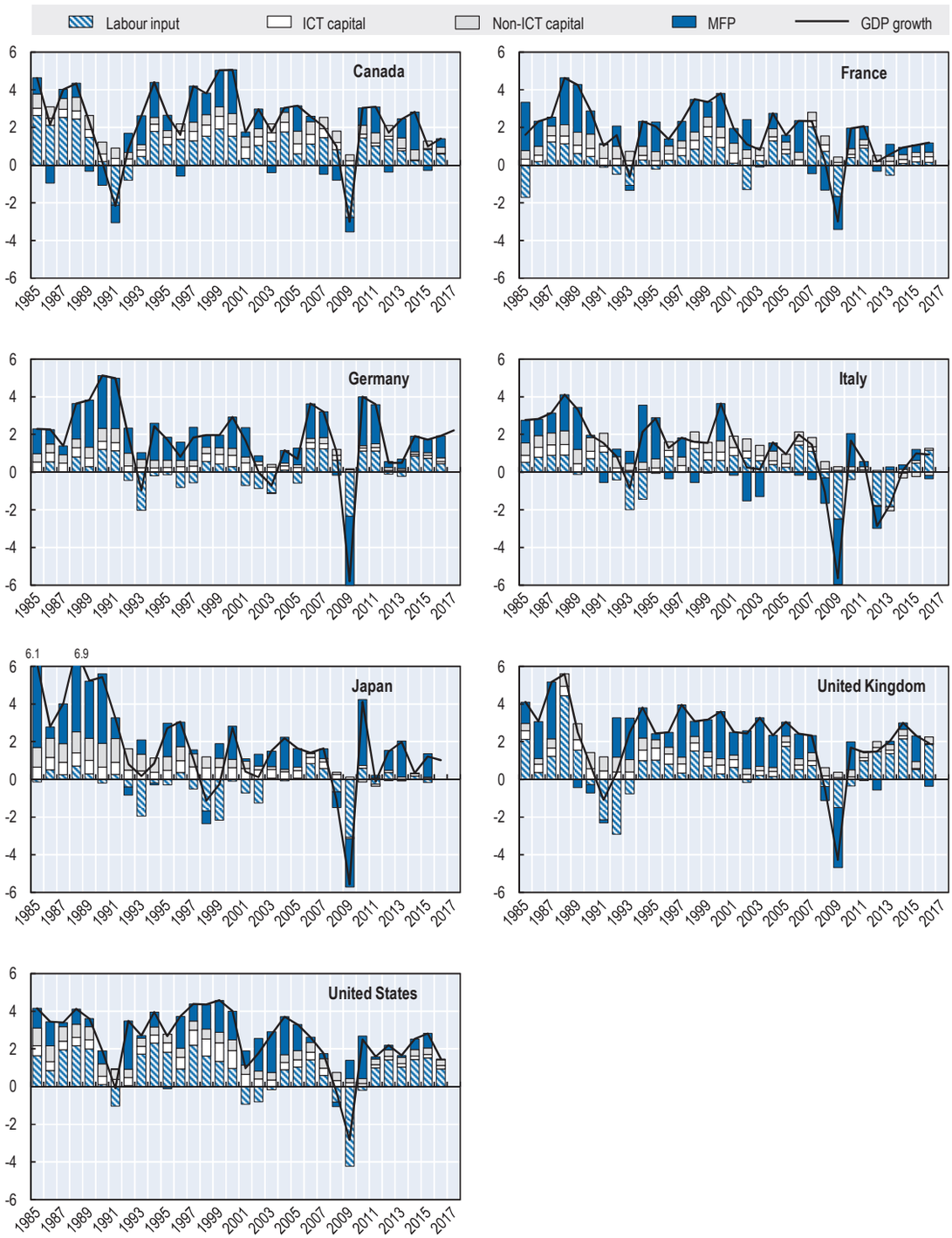
Official data for Germany after unification are available only from 1991 onwards. Estimates for Germany as a whole back to 1970 have been derived by applying the relevant growth rates for West Germany to 1991 data.

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 6.9. Contributions to GDP growth over time in G7 countries

Total economy, percentage point contributions at annual rate



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Chapter 7. 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.

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 neither 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 2008 SNA. 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:

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

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

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

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

where j represents a non-ICT asset and

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

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 (i.e. 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

The underlying production function assumes "Hicks neutral" technical change, as it is represented as an outward shift of the production function that affects all factors of production proportionately:

$$Q = A\, f(L, K)$$

Differentiating this expression with respect to time and using a logarithmic rate of change, multifactor productivity growth (the rate of change of the variable A) is measured as the rate of change of volume output (Q) minus the weighted rates of change of inputs (X). 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 MFP growth is then measured 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:

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

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 and 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:

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

where:

i is an economic activity,

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

$Qcur$ is gross value added at current prices,

$Qcon$ 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:

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

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

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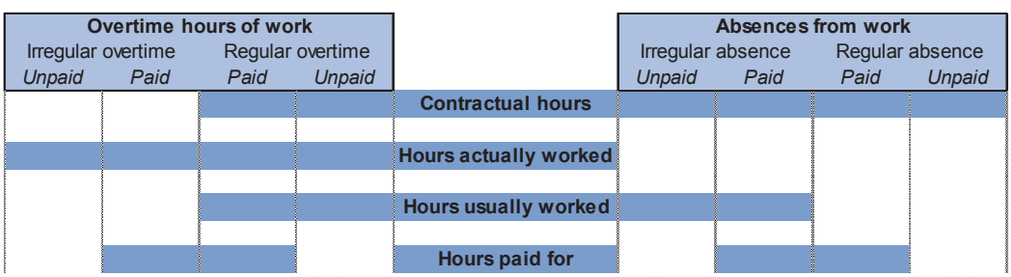
Measuring hours worked

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 7.1):

- *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 7.1. 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 national accounts

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 7.2 describes the main strengths and limitations of the primary sources typically used to compute hours worked and employment estimates in national accounts.

Table 7.2. Primary sources used to compute national accounts estimates of hours worked and employment

Primary data source	Main strengths	Main limitations
Labour force survey	• Covers employees, self-employed, unpaid family workers, government and NPISH workers • Includes information on the characteristics of employment: age, gender, education, industry, occupation • Provides information on hours actually worked • Harmonised concepts across countries (ILO concepts) • 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 • Concept of employment typically not be in line with the resident (domestic) concept in national accounts • There may be reporting biases in reported hours worked • Excludes people living in collective households, although this is unlikely to significantly affect numbers of persons employed
Business statistics (establishment surveys, business census, labour cost surveys)	• Information consistent with output data • Covers production units operating in the territory: domestic concept of employment	• Typically excludes information on agriculture and government sectors - although these are covered in comparable surveys • May exclude small enterprises below a certain employment or turnover threshold and certain categories of firms, such as unincorporated, self-employed and informal. • Information on hours paid or contractual hours, excludes absences and unpaid overtime • 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) • Difficult to capture the informal economy
Time use surveys	• To complement and compare data on hours worked	• Low frequency data • Limited international comparability

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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, Iceland, Ireland, Israel, Italy, Korea, 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, 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 using the *OECD Economic Outlook: Statistics and Projections* (database), the *OECD Main Economic Indicators* (database) and national sources.

Further reading

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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 (OECD, 2001; Schreyer, 2004; OECD, 2009). 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 7.3 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 7.3. 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)

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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. In the *OECD Productivity Statistics (database)*, 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. 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 2008 SNA 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) 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 http://www.oecd.org/sti/ind/stanstructuralanalysisdatabase.htm.

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 http://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: http://www.oecd.org/sti/ind/stanstructuralanalysisdatabase.htm;

- 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/).

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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 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 2010 and with the 2008 SNA from 2011 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.

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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 7.4 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.[4] These services provide two interesting

[4] 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.

examples of how price index measurement could impact on measured productivity growth.[5] 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 7.4 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.

Table 7.4. 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	2000-2010	6.37	0.55	2.71	6.32	
		2005-2010	4.73	-2.01	0.22	4.92	8.60
	Legal and accounting services	2000-2010	-0.24		1.17	1.02	
		2005-2010	-1.18	-3.26	-0.88	-1.58	-2.70
United States	Broadcasting & telecommunication	2000-2010	6.82	2.28	1.88	7.41	6.00
		2005-2010	5.64	0.40	0.85	5.67	3.12
	Legal services	2000-2010	-1.60	-0.28	0.53	-1.65	-2.68
		2005-2010	-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/10.1787/888933734759

[5] In the empirical results presented in Table 7.4, 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.

Table 7.4 suggests that the choice of the implicit value added deflator, or the pricing method for computing producer price indices, may matter significantly for measured labour productivity growth. For instance, in telecommunication services, average annual labour productivity growth rates over the 2000-2011 period would differ by between 5 percentage points (United States, both periods) and 10 percentage points (France, 2005-2011) using different deflators. In the case of legal services, the overall variation is with 1 to 4 percentage points lower, but still significant, especially given the generally lower level of productivity growth in this services activity.

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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 t0 (at PPPs of period t0)

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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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 this publication, 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:

$$y_t = \tau_t + c_t$$

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

Where y_t is the original series, τ_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.[6]

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-

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

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.

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