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Editor's Overview

The 32nd issue of the *International Productivity Monitor* is a special issue produced in collaboration with the OECD. All articles published in this issue were selected from papers presented at the First Annual Conference of the OECD Global Forum on Productivity held in Lisbon, Portugal, July 7-8, 2016.

The Forum was established by a large group of OECD member countries in 2015 to provide a platform for the mutual exchange of information and international cooperation between public bodies with a responsibility for promoting productivity-enhancing policies. The primary purpose of the Forum is to shed light on the structural and policy drivers of productivity, especially in the context of the generalized slowdown in productivity growth affecting OECD countries. It helps generate synergies in policy-oriented research; share data, results and insights; and facilitate the diffusion of best policy practices leveraging on both cross-country analysis and country-specific experiences. To this end, the Forum organizes conferences and workshops connecting policy-makers, academics and other stakeholders and proposes and coordinates research programs in areas related to productivity, notably by encouraging collaboration with national experts, to extend and support work done at the OECD.

The issue contains 11 articles by leading productivity researchers from eight countries on a range of topics: long-term productivity trends, decoupling of wage/productivity growth, productivity in global value chains, insights for productivity analysis from firm-level productivity data, productivity trends and drivers in Portugal, the contribution of agglomeration economies to productivity, public sector productivity measurement issues, and pro-productivity institutions.

Productivity growth is by far the most important source of long-term improvements in living standards, but trend productivity growth has been slowing down markedly over the past decades and especially since the beginning of the century. Trend productivity growth is a long-run phenomenon largely driven by the underlying pace of technological advance. The first article in the issue by Banque de France economists **Antonin Bergeaud**, **Gilbert Cette** and **Rémy Lecat** provides background for the articles that follow by presenting new estimates for long-term total factor productivity (TFP) growth in four advanced economies (United States, Japan, the United Kingdom and the Euro area) over the 1890-2015 period. Based on a long-period productivity database that the authors have constructed, the new TFP estimates take account of the improved quality of inputs: labour, as proxied by educational attainment, and capital, as proxied by the average age of equipment. The role of two General Purpose Technologies (electricity and information and communication technologies (ICT)) in long-term productivity growth is explored. Even after adjustment for changes in the quality of inputs, the authors find that much of TFP remains unaccounted for and confirm the secular trend decline in TFP growth. A third key finding is that the diffusion of ICT in recent decades has had a much weaker impact on TFP than the diffusion of electricity in earlier decades.

While productivity growth creates the conditions for improving real incomes, recent experience shows that productivity gains do not

automatically translate into higher wages for all workers. Indeed, in recent years many OECD countries have seen a decoupling of wage growth from productivity growth, particularly for the median worker. This trend has negative implications for the development of inclusive economies and societies.

The second and third articles in the issue, by **Cyrille Schwellnus**, **Andreas Kappeler** and **Pierre-Alain Pionnier** from the OECD and **Andrew Sharpe** and **James Uguccioni** from the Centre for the Study of Living Standards (CSLS) respectively, examine in depth this decoupling phenomenon from different perspectives.

The OECD authors focus on two factors to account for decoupling - trends in the labour share in GDP and the ratio of median to average wages, a wage inequality measure. They also argue that the most appropriate definition of the aggregate economy for decoupling analysis should exclude the primary, housing and non-market sectors. Based on this definition, they find that median compensation growth lagged labour productivity growth in 15 of 24 OECD countries over the 1995-2013 period. Growing wage inequality was the main reason for this decoupling, as median compensation grew at a slower pace than average compensation in 22 of 24 countries. In contrast, the labour share fell in only 15 countries.

The CSLS authors develop a methodology that decomposes the relationship between productivity and wages into four factors. In addition to the labour share and wage inequality, they add the relationship between consumer and producer wages which they call labour's terms of trade, and changes in the importance of employer contributions to social programs in labour compensation. Data limitations restrict the analysis to 11 countries for the 1986-2013 period. In 9 of the 11 countries median real hourly earnings lagged labour productivity, with the largest gap in the United States. Of the four factors, rising wage inequality was again the most important taking place in 10 countries.

With production of final products increasingly fragmented across countries, global value chains (GVC) represent a new and important feature of the world economy. These new production networks have implications for productivity, a topic addressed in the fourth article by **Chiara Criscuolo** and **Jonathan Timmis** from the OECD. GVCs is a broader concept than offshoring as it also includes indirect linkages along the supply chain network and reflects the destination of firm production, that is whether this production is embodied in the exports of third countries. The authors quantify GVC participation in terms of the share of gross exports comprised by the backward and forward components of GVCs. They calculate that this share varied significantly in OECD countries in 2011, from 70 per cent in Luxembourg to 30 per cent in New Zealand and 32 per cent in the United States. Between 1995 and 2011 all OECD countries saw increased GVC participation in gross exports, with the largest increase taking place in Iceland, Korea, Hungary, Poland and Turkey.

GVCs can foster productivity growth in a number of ways - greater specialization in tasks, increased competition in factor input markets, and knowledge spillovers to local firms from multinational corporations, the main drivers of GVCs. The authors conclude that that the international fragmentation of production as represented by GVCs may have stagnated since 2011, throwing into doubt whether the productivity gains from GVCs will continue to be realized.

Aggregate productivity is the result of a myriad of firm-level productivity outcomes and partly depends on the ability of the highest productivity firms to gain market shares and attract the resources they need to grow. In recent years, productivity studies based on micro-level data have flourished, thanks to the increasing avail-

ability of firm-level datasets. These data can provide important new insights into the behaviour of firms and the determinants of productivity growth.

This issue of the *International Productivity Monitor* contains three articles that uses firm-level datasets to shed light on productivity issues. The first uses transaction data to quantify the integration into the world economy of firms in the Belgium production network. The second uses a unique dataset covering the universe of Italian firms to estimate the role of allocative efficiency in productivity growth. The third highlights the insights on productivity, and especially the increasing dispersion of domestic productivity outcomes, based on the new OECD's firm-level Multifactor Productivity (Multiprod) project.

Exploiting a unique database that captures the domestic and international transactions of nearly 900,000 firms in the Belgium production network, **Emmanuel Dhyne** and **Cédric Duprez** of the National Bank of Belgium provide a detailed account of the participation of these firms in global and local value chains. They find that the number of exporting firms is relatively small, at less than 5 per cent of total firms. But 80 per cent of firms supplied inputs to the rest of the world, either directly or through third companies. They also find that almost all Belgium firms use foreign inputs, either directly or indirectly through importers. Based on an econometric analysis of the dataset, the authors show that the most productive firms are the ones most deeply integrated into the global economy.

Italy has experienced very poor productivity performance in recent years. But this situation does not appear to be due to a lack of dynamism in resource reallocation by Italian firms, **Andrea Linarello** and **Andrea Petrella** from the Bank of Italy use a unique dataset covering the universe of Italian firms to estimate the role of allocative efficiency in productivity growth. They find that that the net entry of firms contributed positively to aggregate labour productivity growth every year from 2005 to 2013. Rather it was the productivity growth of surviving firms that was negative and hence responsible for Italy's fall in labour productivity over the period. The authors also find that reallocation of labour was strongest in industries more exposed to import competition.

A key stylized fact that has emerged in recent years with the increasing availability of firm-level databases is the existence of large differences in multifactor productivity (MFP) levels across firms, a finding with important policy implications. **Giuseppe Berlingieri**, **Sara Calligaris** and **Chiara Criscuolo** from the OECD and **Patrick Blanchenay** from the University of Toronto shed light on productivity heterogeneity using data from the OECD's firm-level Multifactor Productivity (Multiprod) project. This project, implemented in close cooperation with micro data providers in OECD countries, has assembled aggregate indicators drawn from confidential micro data to provide a comprehensive picture of productivity patterns at the firm level over the past two decades. The authors document the high dispersion of MFP levels in both manufacturing and non-financial services in 16 OECD countries and find that this dispersion has been increasing over time, especially in services.

Countries with low productivity levels have the potential to catch-up with countries with high productivity levels if they can successfully adopt the technology of the most advanced countries. This technological convergence process explains the faster productivity growth of many countries in recent years relative to the technology leaders. Portugal experienced this catch up process until the early 1990s, with productivity growth exceeding that in the United States and the EU average. Since then, however, the country's productivity growth has underper-

formed. In the eighth article in this issue, **Ricardo Pinheiro Alves** from the GEE and IADE-UE provides a comprehensive overview of Portugal's productivity performance and drivers. He identifies a number of barriers to productivity growth, including weak business sector R&D, excessive labour market segmentation, a high mortality rate for new firms, a low share of workers in more productive medium-sized and large firms relative to the EU average, and an insufficient level of openness of the economy. The author puts forward a number of policies that can reduce the level of resource misallocation and boost productivity growth, including greater product market competition, the development of a tax system that rewards risk takers, and the establishment of an independent productivity commission to promote pro-productivity policies.

It has long been recognized that urban areas have higher levels of productivity than non-urban areas, with the productivity premium increasing with the size of the city. In the ninth article in this issue, **Rüdiger Ahrend**, **Alexander C. Lembcke** and **Abel Schuman** from the OECD document this relationship using an international harmonized definition of urban areas not based on administrative units. They then explore the mechanisms for the relationship between urbanization and productivity. One obvious reason is that average levels of education are higher in urban areas than in non-urban areas through self-selection. Second, different types of agglomeration economies, including knowledge spillovers, the sharing of infrastructure costs over a larger population base, and better labour market matching due to the larger numbers of workers and jobs, boost productivity. The authors estimate that a 10 per cent increase in the population of an urban area is associated with an increase in productivity of 0.2 to 0.5 per cent. An important new finding of the authors is that a region's closeness to an urban area, as measured by road-based travel distances and travel times, has a significant positive effect on its productivity.

The measurement of productivity in the public or non-market sector has long been a challenge for economists. In the market sector, output is priced and price indexes can then be constructed and used to deflate the nominal value of output to produce a real output series essential for measurement of productivity growth. In the non-market sector, output is not priced and inputs are used as a proxy for real output, often with the assumption of zero productivity growth.

In the tenth article in the issue, **Edwin Lau**, **Zsuzsanna Lonti**, and **Rebecca Schultz** from the OECD provides a comprehensive overview of issues related to public sector productivity measurement. The authors surveyed OECD members to obtain information on their practices related to public sector productivity measurement. They found that only seven countries reported measures of productivity for the whole public sector, indicating much room for improvement. The authors recommend that OECD countries focus attention on improving both public sector productivity measures and performance. They suggest a number of ways forward, including standardization of government inputs and output, benchmarking of government activities relative to best practices, and the development of productivity-enhancing strategies related to human resource management and digitization.

A recent development in OECD countries has been the establishment of organizations with a mandate to promote productivity-enhancing reforms. The Australian Productivity Commission is likely the best known example of such organizations. In the eleventh and final article of this issue, **Sean Dougherty** from the OECD and **Andrea Renda** from the Centre for European Policy Studies and Duke University, ana-

lyze and compare ten of these organizations, which include government advisory councils, standing inquiry bodies, and ad hoc task forces. The authors find that pro-productivity institutions can indeed contribute to productivity growth by facilitating public debate on policy issues and evidence-based policy-making. They identify the characteristics needed for such institutions to be successful, including sufficient resources to fulfill their tasks, a broad mandate oriented toward long-term well-being of the population, and the ability to reach out to the general public.

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Total Factor Productivity in Advanced Countries: A Long-term Perspective

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ABSTRACT

Changes in GDP during the 20th century have been mainly driven by total factor productivity (TFP). This article synthesizes results from our research based on the long period (1890-2015) productivity database we have constructed. In particular, we aim to refine our TFP measure by including the contribution of the improved quality of factor inputs and technology diffusion to TFP growth in four developed areas or countries: the United States, the euro area, the United Kingdom, and Japan. Two types of factor quality are considered: the average level of education and the average age of equipment. Two technological shocks corresponding to two general purpose technologies are investigated: electricity and information and communication technologies (ICT). However, even after these adjustments, long-term patterns of TFP growth do not change, with two major waves appearing over the past century and much of TFP growth remaining unaccounted for by quality-adjusted factors of production and technology diffusion. Our estimates show that the productivity impact of the recent ICT wave remains much smaller than that from the electricity wave, and that the post-1973 and the most recent slowdowns in TFP growth are confirmed.

GDP per capita indicators are often used to analyze standards of living.[2] This measure allows country comparisons that can be made either in terms of levels or growth rates, these two dimensions being linked by convergence processes. The large literature devoted to this topic shows that numerous factors can influence GDP per capita growth and convergence (Bau-

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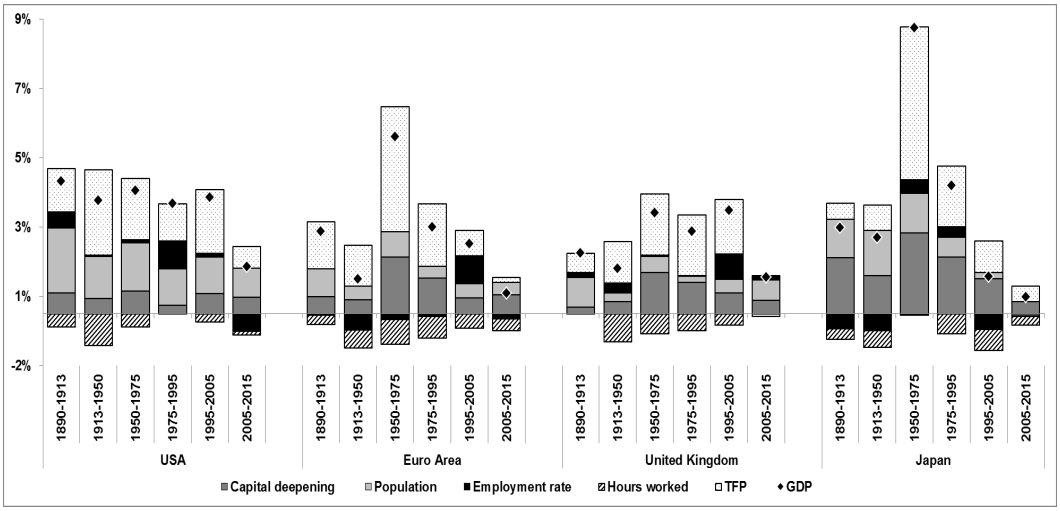
2 This measure is however frequently criticized, notably in the famous Stiglitz, Sen and Fitoussi (2009) report, as it excludes many dimensions that impact the well-being of the population.

Chart 1: Sources of Growth in the United States, the Euro Area, Japan and the United Kingdom - Total Economy, 1890-2015

Average annual contributions (percentage points)



Source: Bergeaud, Cette and Lecat (2015), updated in 2016.

Table 1: Sources of Growth in the United States, the Euro Area, Japan and the United Kingdom - Total Economy, 1890-2015

Average annual contributions (percentage points)

	USA						United Kingdom					
	1890-1913	1913-1950	1950-1975	1975-1995	1995-2005	2005-2015	1890-1913	1913-1950	1950-1975	1975-1995	1995-2005	2005-2015
GDP	3.8	3.3	3.5	3.2	3.4	1.4	1.7	1.3	2.9	2.4	3.0	1.0
Capital deepening	0.6	0.5	0.7	0.2	0.6	0.5	0.2	0.4	1.2	0.9	0.6	0.4
Population	1.9	1.2	1.4	1.1	1.0	0.8	0.9	0.3	0.5	0.2	0.4	0.6
Employment rate	0.5	0.0	0.1	0.8	0.1	-0.5	0.1	0.3	0.0	0.0	0.7	0.1
Hours worked	-0.4	-0.9	-0.4	0.0	-0.2	-0.1	0.0	-0.8	-0.6	-0.5	-0.3	0.0
TFP	1.3	2.5	1.8	1.1	1.8	0.6	0.5	1.2	1.8	1.8	1.6	-0.1
	Euro Area						Japan					
	1890-1913	1913-1950	1950-1975	1975-1995	1995-2005	2005-2015	1890-1913	1913-1950	1950-1975	1975-1995	1995-2005	2005-2015
GDP	2.4	1.0	5.1	2.5	2.0	0.6	2.5	2.2	8.2	3.7	1.1	0.5
Capital deepening	0.5	0.4	1.6	1.0	0.5	0.6	1.6	1.1	2.3	1.6	1.0	0.4
Population	0.8	0.4	0.7	0.3	0.4	0.4	1.1	1.3	1.1	0.6	0.2	-0.1
Employment rate	0.0	-0.5	-0.2	-0.1	0.8	-0.1	-0.4	-0.5	0.4	0.3	-0.4	0.0
Hours worked	-0.3	-0.5	-0.7	-0.6	-0.4	-0.3	-0.3	-0.5	0.0	-0.6	-0.6	-0.3
TFP	1.4	1.2	3.6	1.8	0.7	0.2	0.5	0.7	4.4	1.7	0.9	0.4

Table: Annual growth rate of GDP and its sources in the United States, the Euro Area, Japan and the United Kingdom – Total Economy, 1890-2015.

Box 1: The Long-Term Productivity Database

The database presented in this article (Bergeaud-Cette-Lecat or BCL database) has evolved continuously since its first version in 2013. As soon as the series are improved or new sources enable us to add countries to the database, a new version of the BCL database is constructed. The most recent version of the database can be found at www.longtermproductivity.com. The database currently covers 17 countries: United States, Japan, Germany, France, United Kingdom, Italy, Spain, Canada, Australia, the Netherlands, Belgium, Switzerland, Sweden, Denmark, Norway, Portugal and Finland. It is composed of series for GDP per capita, labour productivity, total factor productivity, average age of equipment, and capital intensity. The underlying series used to construct these measures (GDP, population etc.) are not currently available for download, but can be obtained by request. Data sources are described in a file in the database. The website provides an application that enables users to plot the latest series and to compare several countries. All of the data available on the website can be freely used provided that they are properly acknowledged. The Appendix to the article offers a longer description.

mol, 1986 ; Barro, 1991 being ones of the seminal papers). Numerous factors can influence GDP per capita growth and convergence. The most important appear to be institutions, education, and of course innovation and technological progress, which are in turn linked to education and institutions.[3] In Bergeaud, Cette and Lecat (2015), we have shown that there is an overall convergence process among advanced countries, mainly after WWII, relying mostly on capital intensity and then on TFP, while developments in hours worked and employment rates are more contrasted. But this convergence process is not continuous and slowed down or was even reversed since 1990, as the convergence of the euro zone, the UK, and Japan stopped well before attaining the U.S. level of GDP per capita.

In this article, we review some of the findings from our earlier research based on an original database for 17 developed countries from 1890 to 2015. The construction of this dataset is described in the Appendix, and at length in Bergeaud, Cette and Lecat (2016a, 2016b). All of this can be found in a dedicated website (see Box 1 for more information).[4] In a nutshell, we built capital data from investment series divided into five different assets (structures, communication equipment, computers, software, and other non-ICT equipment) on the assumption of constant depreciation rates for each of the five asset classes (See Appendix). This allows one to account for the shift from structures to equipment that occurred around the 1920s, the emergence of ICT capital, and overall to better measure the stock of capital. For investment, (GDP, labour, and population), we rely on the updating of the estimates of economic historians such as Angus Maddison and others by Bolt and Van Zanden (2014), as described in Bergeaud, Cette and Lecat (2016a).

Chart 1 and corresponding figures in Table 1 show average GDP growth rates for different sub-periods of the whole 1890-2015 period for the three developed countries (United States, Japan and the United Kingdom) and the euro

3 On the role of education and institutions, see for example Barro (1991), Barro and Sala-I-Martin (1997), and, for more recent assessments, Aghion *et al.* (2008); Madsen (2010a and 2010b); Crafts and O'Rourke (2013); and Acemoglu *et al.* (2014). On the impact of institutional and educational factors on innovation and technological progress, see, among others, Aghion and Howitt (1998, 2006 and 2009).

4 www.longtermproductivity.com

zone.[5] Chart 1 also provides an accounting decomposition of GDP growth based on a simple Cobb-Douglas production function.[6] In this decomposition, the three main components of GDP growth are population growth, the growth in the number of hours worked per inhabitant and hourly labour productivity growth. The contribution of the number of hours worked per capita to growth is itself decomposed into two sub-components: the employment rate, here the ratio of employment to the total population, and the number of hours worked per worker. The sum of the population and average working time per worker components corresponds to the overall contribution of the total number of hours worked to growth. And the contribution of hourly labour productivity growth is itself also decomposed into two sub-components: total factor productivity (TFP) and capital deepening.

Formally, $GDP=TFPK^{\alpha}(LH)^{(1-\alpha)}$ with K being the stock of physical capital, L the number of workers, and H the average annual hours worked per worker, so that (LH) represents the total number of hours worked. Denoting the total population as Pop, we have:

$$GDP = TFP \times \left(\frac{K}{LH}\right)^{\alpha} \times \left(\frac{L}{Pop}\right) \times H \times Pop \quad (1)$$

Where capital deepening is represented by $(K/(LH))^{\alpha}$, and the hourly labour productivity is $TFP\times(K/(LH))^{\alpha}$. As well, employment rate is determined by $L/(POP)$, and the number of hours worked per employee is H. Log differentiating this last expression gives the decomposition that is represented in Chart 1.

Chart 1 shows that hourly labour productivity growth is the main contributor to GDP growth in the four economic areas considered. The overall contribution of hours worked (which corresponds to the sum of the contributions made by change in the population, the employment rate and average working time) is generally small, if not nil. Within hourly labour productivity growth, the contribution of the TFP subcomponent is the largest, with that of capital deepening being smaller. The TFP contribution varies considerably from sub-period to subperiod, with these variations generally being the main driver of changes in GDP growth. However, in our accounting we define TFP as a residual encompassing any variation of output that cannot be explained by the aggregation of physical capital and labour. As such, Chart 1 gives no real explanation for these large changes in GDP growth other than the small fluctuations explained by the hours worked component. This is why, as Abramovitz (1956) wrote, TFP is traditionally considered 'a measure of our ignorance.'

GDP growth appears very low during the 2005-2015 sub-period in the four economic areas studied. And the main reason for this low growth is a small contribution from TFP, especially when compared with previous sub-periods. Once again, our accounting framework cannot give any more insight on this slowdown since it is driven almost entirely by a slowdown in TFP growth.

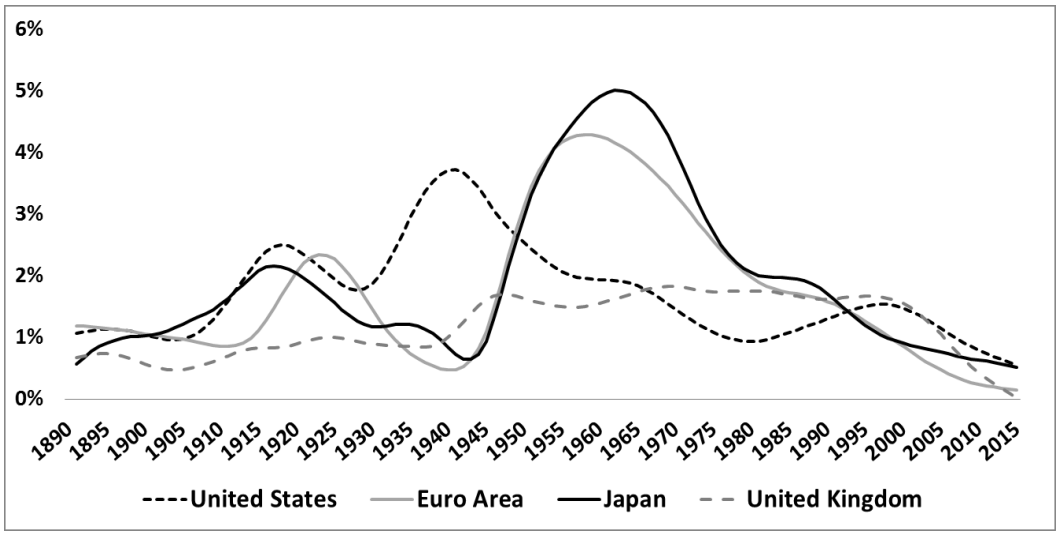
These observations raise important questions: are we facing a risk of 'secular stagnation'? This expression was coined by Hansen (1939) and was

5 The euro area is defined as the aggregation of the zone's eight of the largest countries: Germany, France, Italy, Spain, the Netherlands, Belgium, Portugal and Finland. These countries represent more than 93 per cent of the euro area's 2010 GDP. See Bergeaud, Cette and Lecat (2016a) for more details.

6 In this decomposition, we assume constant returns to scale and an elasticity of output to capital that is constant and equal to 0.3 in the four economic areas for the whole period. For more details, see Bergeaud, Cette and Lecat (2015).

Chart 2: Trend TFP Growth in the United States, the Euro Area, United Kingdom and Japan, Total Economy, 1890-2015 (average annual growth rate)

Smoothed indicator (HP filter, λ = 500) - Whole economy



Source: Bergeaud, Cette and Lecat (2016a), updated in 2016.

used again to describe the current situation notably by Summers (2014, 2015) and Eichengreen (2015). This low TFP growth is now well documented and affects most of the advanced economies.[7] In our four areas, the slowdown of TFP can be observed from the end of the 1960s, and intensifies during the 1970s, the 1980s and the 1990s. One notable exception is the UK, which experienced very steady TFP growth from the 1950s to the late 1990s (Broadberry and O'Mahony, 2004) and had more rapid TFP growth during the period 1975-2005 than 1950-1975. As for the United States, we clearly observe from the mid-1990s an acceleration due to faster improvements in the productive performances of information and communication technologies (ICT hereafter). Jorgenson (2001) was the first of numerous economists to stress this point. For some authors such as Gordon (2012, 2013, 2014, 2015), this situation could be the future for long-term productivity.

TFP plays the most important role in explaining GDP dynamism. As shown in Bergeaud, Cette and Lecat (2015), convergence across advanced countries, which took place mostly in the post WWII period, proceeded mostly from TFP convergence, followed by capital deepening. Rapid TFP growth in the euro area and Japan in 1950-1975 represented catching up to the TFP level generated by the rapid TFP growth experienced by the United States over the 1913-50 period.

We now seek to refine our measure of TFP by including factor quality adjustment and technology diffusion indicators over the 1890-2015 period. In other words, we investigate the importance of some potential factors that can improve our measure of TFP growth in order to better understand changes in growth and to give insight into why TFP growth has been low over the 2005-2015 sub-period. We consider two factor quality dimensions: the average level of edu-

7 See for example for the United States, Gordon (2012, 2013, 2014, 2015), or Byrne, Oliner and Sichel (2013), and for other advanced countries, Crafts and O'Rourke (2013), or Bergeaud, Cette and Lecat (2016a).

cation and the average age of equipment. Two technological shocks corresponding to two general purpose technologies are then examined: electricity and ICT. This analysis is performed for our four major economic areas using annual data.

Our main contribution is to show that including the quality of factors of production, especially education and technological shocks, significantly reduce the share of 20th century GDP growth that is unexplained. Nevertheless, still this share remains important, which suggests that there is scope for further analysis to better measure TFP growth.

The article is organized as follows. Section 2 provides a detailed descriptive analysis of TFP growth waves. Section 3 refines our measure of TFP and presents a TFP decomposition, taking into account some factor quality and technological shock aspects. Section 4 comments on two contrasting growth scenarios. Section 5 concludes.

TFP Growth Waves over the Long Period, 1890-2015

In order to establish long-run stylized facts in terms of TFP growth, we follow the analysis of Bergeaud, Cette and Lecat (2016a) and smooth the annual TFP growth rate over the whole period using the Hodrick-Prescott filter (HP). Given the very high volatility of the TFP indicator, the choice of the filter bandwidth, which sets the length of the cycle we capture, is important. We decided to focus on 30-year cycles, which implies a value of 500 for lambda, according to the HP filter transfer function. This values can be rationalized by considering the typical duration between two global statistical breaks in the TFP time series as measured in Bergeaud, Cette and Lecat (2016a) (for example between WWII and the oil crisis). Chart 2 shows smoothed TFP growth, from 1890 to 2015, for the United States, the euro area, the United Kingdom and Japan.

We distinguish five sub-periods from 1890 to 2015.[8]

- From 1890 to WWI, TFP grew moderately. Developed countries were at the end of the very long first Industrial Revolution linked to the spread of the steam engine and the development of the railways. The UK enjoyed the highest level of TFP.
- After the WWI slump, the United States experienced an impressive 'big wave' of TFP growth, interrupted for some years during the Great Depression and identified by Gordon (1999) as the 'one big wave'. Other countries struggled with the legacy of the Great Depression and WWII. This TFP growth wave corresponds to the second Industrial Revolution (Gordon, 2012, 2013, 2014, 2015) linked to the spread of large-scale use of electricity and the internal combustion engine, to the development of chemistry, namely oil-based chemistry and pharmaceuticals, and to the development of communication and information innovations (telephone, radio, cinema), etc. During this sub-period, the US took the lead in terms of TFP, which it has retained up to the present day.[9]
- After WWII, european countries and Japan benefited from the big wave experienced earlier in the United States. During this catch-up process, TFP growth was decelerating in the United States. This TFP slowdown appeared later, from the 1970s onwards, in the other three areas.

8 These sub-periods can be endogenously identified through time series analysis. For more details, in particular regarding TFP levels, see Bergeaud, Cette and Lecat, 2016a.

9 Some countries have a higher TFP level over the period for specific reasons, for example Norway due to its particular sectoral composition.

- After 1995, the post-war convergence process came to an end as US TFP growth overtook that of other countries, although it did not return to the pace observed in the 1930s, 1940s and 1950s. Of more limited duration and less revolutionary than the first wave, a second TFP wave appeared in the United States and, in a less explicit way, in some of the other advanced countries. As documented in numerous studies (e.g. Jorgenson, 2001, van Ark *et al.*, 2008, Timmer *et al.*, 2011, Bergeaud, Cette and Lecat, 2016a), this TFP wave corresponded to the third Industrial Revolution linked to ICT.
- From the mid-2000s, before the beginning of the Great Recession, TFP growth decreased in all countries. The current pace of TFP growth appears very low compared to what was observed previously, except during the world wars. Some analyses regard this slow growth as structural (Gordon 2012, 2013, 2014, 2015); others as a pause before a new acceleration (Pratt, 2015; Mokyr *et al.*, 2015; Brynjolfsson and McAfee, 2014); and still others as at least partly mismeasurement (Byrne et al., 2013).[10] Other explanations of this slowdown are also plausible (for a survey, see Cette, 2014, 2015 and OECD, 2015).

Refining our TFP Measure

We try to better measure TFP growth by accounting for factor quality and technological shocks.[11] Two types of factor quality dimensions are considered: the average level of education and the average age of equipment capital stock. Two technological shocks are considered, corresponding to the two General Purpose Technologies examined: electricity and ICT.

Impact of Education

Regarding education, which is an indicator of labour force quality, we use new series on educational attainment for the population 15 and over developed by van Leeuwen and van Leeuwen-Li (2014) available yearly from 1870 to 2010.[12] The average duration of schooling increases continuously over the period in the four economic areas. At the end of the 19th century, Japan was the area with the lowest level of educational attainment with on average less than 2 years of education among its population. The other three areas recorded about 4 years of education. At the end of our dataset, the euro area has the lowest level of education, with an average duration of 11.5 years, less than the other three areas which had 12.5 to 13 years. 13 years seem to be a maximum for the average duration of schooling, which means that TFP gains from the increase of this duration belong to the past for the United States, the United Kingdom and Japan, and that few gains remain to be obtained from this for the euro area.[13]

The rather low level of education achieved in the euro area hides large disparities among countries. Some countries like the Netherlands,

10 Syverson (2016) and Byrne, Fernald and Reinsdorf (2016) argue that measurement error in the growth of the ICT sector cannot explain the current observed productivity slowdown. Aghion *et al.* (2017) estimate that at most one sixth of the decrease in the productivity growth rate from the 1996-2005 period to the 2005-2013 period could be attributed to mismeasurement.

11 Estimates are all made using instrumental variables approaches on a panel of 17 countries over the period 1890-2010, and 1913-2010 in the case of electricity. See Bergeaud, Cette and Lecat (2016b) for details concerning estimation procedures.

12 The calculation starts with primary school and does not include kindergarten or any other type of education received before 6.

13 Productivity gains from education could now be sought by improving the quality of education and promoting continuous education, with a potential significant impact of ICT in this area. Further improvements in the quality of labour could also stem from on-the-job training and learning.

Germany and France have levels of educational attainment comparable to that of the United States. On the other hand, other countries such as Spain, Portugal and Italy lag behind. For example, the average duration of schooling in Portugal in 2010 was below 8 years.

Many studies, using micro or macro approaches, have focused on estimating the returns on education, corresponding to the wage or productivity gains associated with an average increase of one year in educational attainment. There is a broad empirical consensus in most micro studies on a private return on education of between 4 per cent and 8 per cent in developed countries. The standard equation for the macroeconomic return to education takes the following form (Barro and Lee, 2010):

$$gdp - l - h = (\alpha(k - l - h)) + (1 - \alpha)\theta s + \varepsilon \quad (2)$$

Where a lower case x stands for the logarithm of variable X from equation (1), s is our measure of education attainment, ε is a residual that we will consider to be an improved measure of TFP and $gdp–l–h$ is the log of labour productivity. Finally, θ is a coefficient measuring the impact of education on productivity. Our estimates of this equation indicate a return of education to GDP of 4.9 per cent, which means that an increase of one year in educational attainment would increase labour productivity (or TFP as typically measured) by 4.9 per cent. From this result, and from the fact that education attainment increased by 7 to 11 years in our four areas, we can attribute 16-23 per cent of the cumulative rise in TFP over the 1890-2010 period to rising education; that is, 34.3 percentage points (4.9 per cent x 7 years) to 53.9 percentage points (4.9 per cent x 11 years) over the long period starting in 1890. Of course, this result rests upon the assumption that the elasticity of productivity with respect to education is constant across time and countries. We make this assumption in order to produce estimates comparable with the literature (e.g. Barro and Lee, 2010). It is also consistent with our assumption of constancy for other parameters (e.g. the depreciation rate and the elasticity of substitution between capital and labour).[14]

We have calculated the average age of the capital stock for equipment. This is an indicator of the quality of this factor and should therefore be incorporated into the production function. We estimate the contribution of this factor from a Solow residual regression, as we cannot calibrate directly the quality correction we should apply to the capital stock. This simply corresponds to the intuitive idea of a vintage effect: older capital is expected to be less productive than newer capital, as suggested by Solow (1959, 1962) and developed subsequently by numerous authors (Gittleman *et al.*, 2003; Wolff, 1991, 1996; Greenwood *et al.*, 1997; Mairesse, 1977, 1978; Mairesse and Pescheux, 1980; Cette and Szpiro, 1989). In theory, capital stock series should be constructed using quality-adjusted investment series (through appropriate investment deflators). Changes in average age would then not impact TFP. But national accounts can only partially take into account embodied technical progress, which is not fully included in declines in investment prices and increase in real investment. Consequently, the accounting split between capital deepening and TFP within labour productivity growth is biased in favour of the latter. Using an indicator of the age of equipment is therefore a way to correct this bias and

14 There is evidence that suggests a decline in the marginal return from educational attainment due to the fact that tertiary education yields lower gains in terms of productivity than primary and secondary schooling (Psacharopoulos and Patrinos, 2004).

to consider the impact of embodied technical progress.

It appears that variations in the average age of equipment differ across economic areas: the range of these variations is 5 years for Japan (from a minimum of 4 years to a maximum of 9 years), 4 years for the euro area (from 5.3 years to 9.3 years), and 3 years in the United States (from 5.7 years to 8.7 years) and the United Kingdom (from 6 years to 9 years). The average age increased significantly during the Great Depression in the United States, resulting from low investment; it greatly decreased during WWII due to the war effort, and more modestly during the ICT wave, as investment was needed to incorporate the new technology. In the euro area and the UK, it increased strongly during WWII, as the conflict depressed investment, and decreased in the post-war reconstruction period. It has been on an increasing trend since 1990 in Japan due to the banking crisis, and since the financial crisis in other areas, as credit constraints and low demand prospects weigh on investment. Smaller conter-cyclical fluctuations can be observed.

As with education, many studies, using micro or macro approaches, have estimated the impact of changes in the average age of capital on TFP. The results show that an increase of one year in the average age usually had a negative impact on TFP of -1 per cent to -6.5 per cent, with results concentrated around -4 per cent. Using an equation we include a regressor to capture the effect of the age of capital stock, similar to the one for education. We estimate an impact of -3 per cent, which means that average age variations during the period, from the minimum to the maximum values of capital age, would have changed TFP levels by 15 per cent (3 per cent x 5 years) in Japan, 12 per cent (3 per cent x 4 years) in the euro area, and 9 per cent (3 per cent x 3 years) in the United States and the United Kingdom. On average over the whole period, age plays no role in explaining changes in GDP and only has cyclical effects.

Impact of Electricity

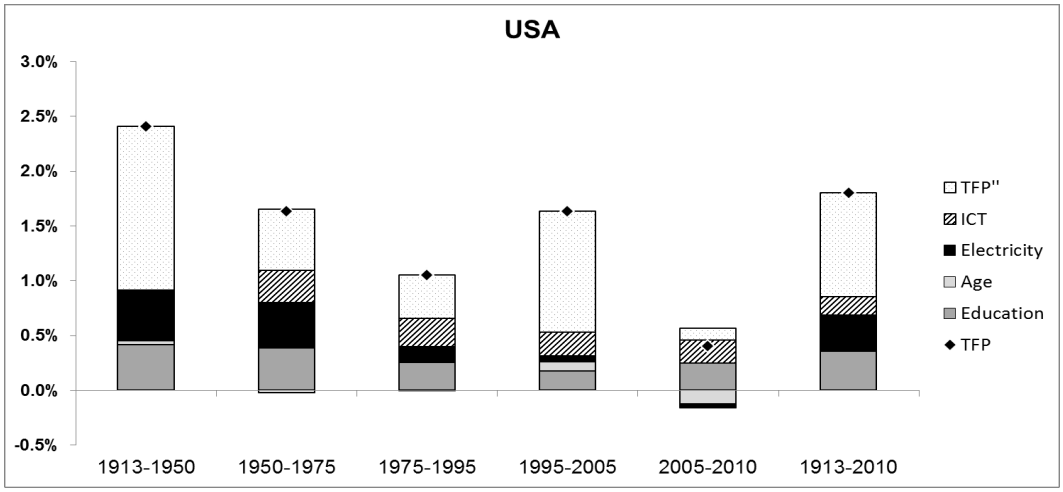
To measure the diffusion of technology over the whole period, we have drawn on the CHAT database constructed by Comin and Hobijn (2009). This database provides annual estimates of the diffusion of more than 100 technologies for a large set of countries. We have selected one technology which is often considered to be representative of the development of technologies during the 20th century, i.e. the production of electricity in kilowatt hours (Comin *et al*., 2006a and 2006b). Data have been completed with series using the World Development Indicators from the World Bank up to 2013 and have been standardized by total population.

This indicator, which we consider as a proxy for the diffusion of electrical machinery and devices, has increased over time in the four economic areas, but this rate of increase has slowed since the 1970s. In line with the literature that focuses on the impact of electricity on US productivity growth (Bakker *et al*., 2015), the take-off of electricity in the United States started at the beginning of the 20th century and accelerated during the 1920s. The UK lags just behind with a take-off that started in the 1930s, while the euro zone and Japan started to massively adopt electricity after WWII. The take-off date depends both on the fall in electricity prices and on a reorganization of the production process to fully benefit from electricity (David, 1990).

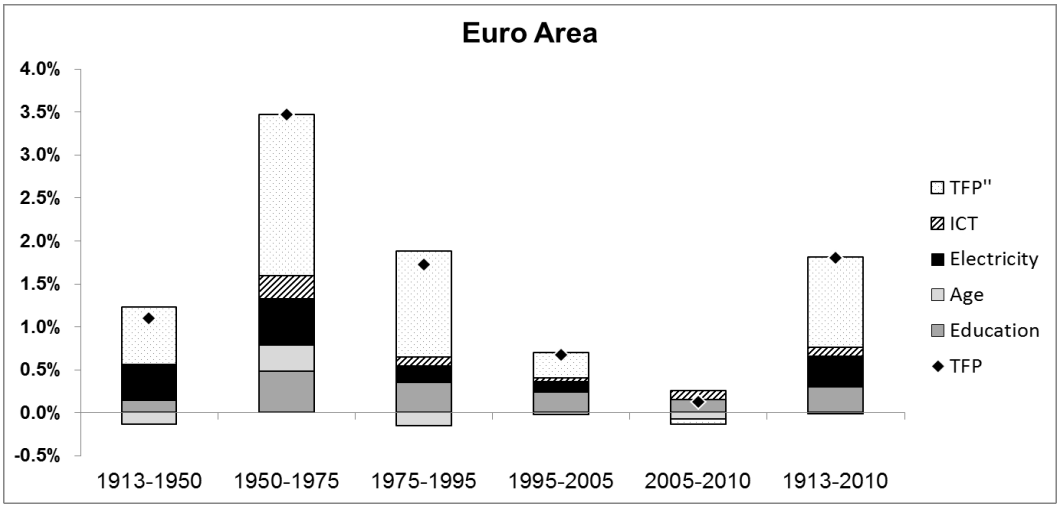
Here again, we make the assumption that the elasticity of TFP to electricity production per inhabitant is constant over time. The constant elasticity assumption, as it has also been used for the impact on productivity of education and capital age, appears preferable to an ad hoc rule.

Chart 3: Factors Affecting TFP Growth, Total Economy, 1913-2010 (contribution in percentage points)

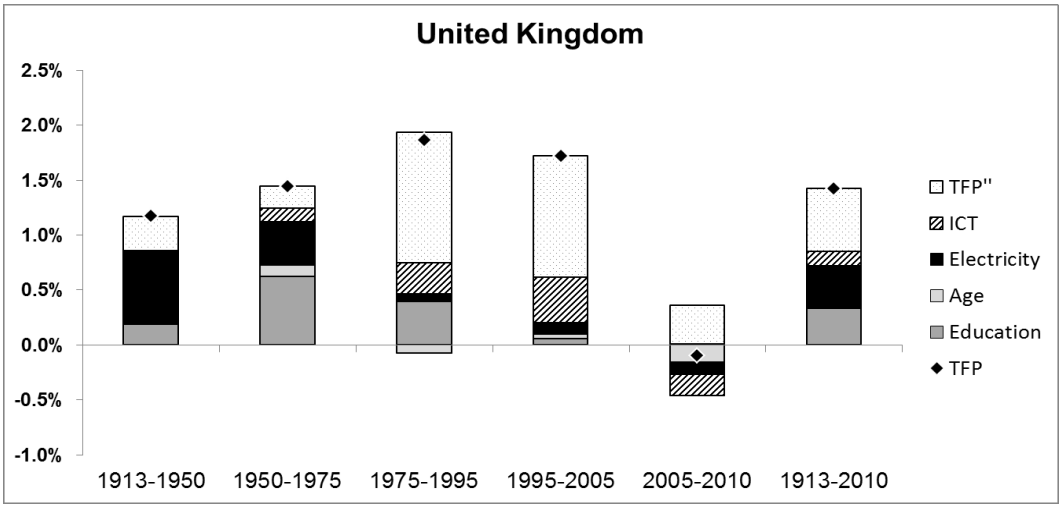
Panel A:



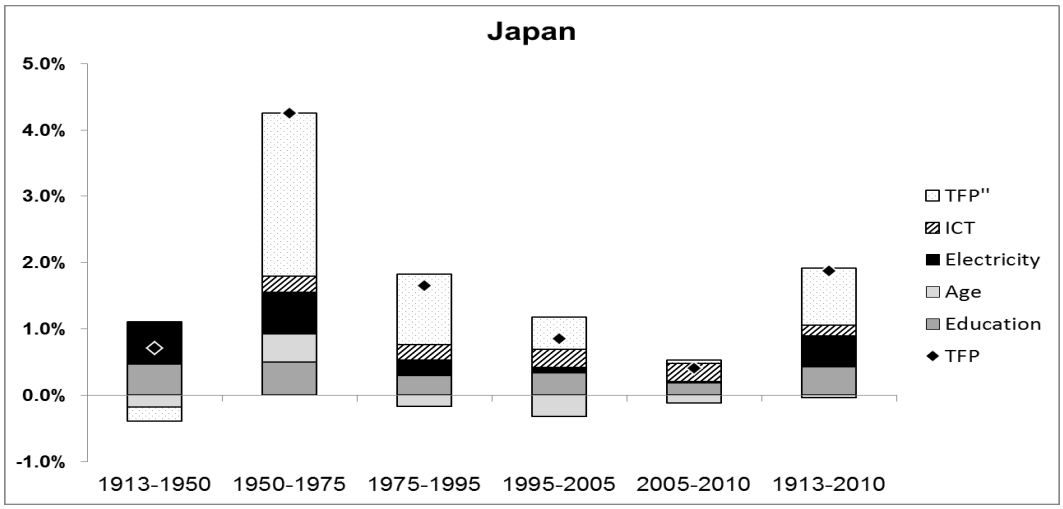
Panel B:



Panel C:



Panel D:



Source: Authors' calculations based on data from Bergeaud, Cette and Lecat (2016b).

Our results indicate that a 1 per cent increase in electricity production per capita explains a 0.079 per cent increase in TFP. With this elasticity, it appears that, from 1913 to 2010, the increase of electricity production and use would have increased the TFP level by 31 percentage points in the United States, 35 points in the euro area, 37 points in the United Kingdom, and 46 points in Japan.

Impact of ICT

Concerning the second measure of technology, we have taken the ratio of the stock of ICT capital to GDP in nominal terms. To compute this ratio, we have drawn on the work of Cette *et al.* (2015) based on investment data provided by the OECD. ICT is split into three components: hardware, software, and communication equipment. The ICT capital stock is computed using a permanent inventory method. Note that for ICT, we have used a stock measure while for electricity we have used a measure of production. However, electricity production should reflect productive capacity, as electricity cannot be stored, electricity imports and exports are low relative to production, and utilization of productive capacities should not create a systematic bias. It appears that the ICT capital stock took off in the 1980s in the United States, peaking at the end of the 1990s. ICT diffusion in the United States settled at a higher level than in the euro area, the United Kingdom and Japan.

Numerous studies provide explanations for these international differences in ICT diffusion.[15] Factors include the level of post-secondary education among the working age population as well as labour and product market rigidities. For example, an efficient use of ICT requires a higher degree of skilled labour than the use of other technologies. The required reorganization of the firm for effective ICT adoption can be constrained by strict labour market regulations. Moreover, low levels of competitive pressure, resulting from product market regulations, can reduce the incentive to exploit the most efficient production techniques. A number of empirical analyses have

15 See Schreyer (2000), Colecchia and Schreyer (2001), Pilat and Lee (2001), Gust and Marquez (2004), Van Ark *et al.* (2008), Timmer *et al.* (2011), and Cette and Lopez (2012).

confirmed the importance of these factors.[16] Among others, Cette and Lopez (2012) show, through an econometric approach, that the United States benefits from the highest level of ICT diffusion because of a higher level of post-secondary education among the working age population and less restrictive product and labour market regulations.

Our estimates indicate that a 1 percentage point increase in the ratio of ICT capital stock to GDP would lead to an increase of 1.56 per cent in the level of TFP. With this elasticity, it appears that, from 1913 to 2010, ICT diffusion as a production factor would have increased TFP by 14 per cent in the United States, 9 per cent in the euro zone, 11 per cent in the United Kingdom and 13 per cent in Japan. This impact is of course concentrated in the post-1950 period.

From these results, we build two new TFP indicators. TFP' is TFP corrected for the impact of the duration of education and changes in average capital equipment age. TFP'' is TFP' corrected for the impact of electricity production per inhabitant and changes in the ICT capital to GDP ratio. In Panels A to D of Chart 3, we present results for the four areas for the same benchmark years as in Chart 1, but starting in 1913 because of the high volatility of electricity production before that period and ending in 2010 because of the availability of education data.

From Chart 3, we see that variations in human capital and the age of capital are significant omitted factors in the estimation of TFP growth. Over the whole 1890-2010 period, human capital and the age of physical capital together account for 21 per cent of US TFP growth, 17 per cent in the euro zone, 25 per cent in the United Kingdom and 26 per cent in Japan. However, it appears that the amplitude of TFP' growth does not differ much from that of TFP. In particular, the 'one big wave' that occurred during the 20th century is still persistent with respect to the United States. This is also the case for the wave in the mid-1990s. This result is robust to different sets of credible values concerning the elasticity of TFP to the duration of education and to the average age of capital.

Nevertheless, education significantly contributed to the first TFP wave in the US, with a contribution of 0.42 percentage point per year during the 1913-1950 period, only slightly decreasing in the following periods (0.38 points in 1950-1974 and 0.34 points in 1974-1990), consistent with findings of Goldin and Katz (2008). Hence, the early opening-up of education to the masses in the US yielded a lasting contribution to productivity and partly explains the American lead. Indeed, the increase in the contribution of education appears one period later, in the 1950s, in the euro zone and the United Kingdom. In Japan, education posts a significant contribution throughout the century due to the initial very low level of education.

The age of capital makes a significant positive contribution mainly during the reconstruction period after World War II in the euro area and Japan, and also in the United Kingdom. Conversely, it has made a significant negative contribution since the 1970s in the euro area and Japan. In the four areas, equipment has aged from the 2000s, with a negative contribution to TFP growth.

The TFP growth waves are still evident in TFP', which is also corrected for the impact of the two General Purpose Technology shocks considered (electricity and ICT), especially as far as the 'one big wave' is concerned. However, the amplitude of this 'one big wave' has been

16 See Gust and Marquez (2004), Aghion *et al.* (2009), Guerrieri *et al.* (2011) and Cette and Lopez (2012) who use country-level panel data, as well as Cette *et al.* (2017) who employ sectoral-level panel data.

reduced and is almost 40 per cent lower for TFP'' than for TFP' in the United States. Although the difference in contribution is not very large across areas, the spread of electricity contributed significantly to the American advance on the euro zone, as its contribution peaked in the 1913-1950 period, while it increased during the 1950-1974 period in the euro zone. The United Kingdom appears not to have lagged in terms of the diffusion of electricity, with a very large contribution in the 1913-1950 period.

Broadberry and Crafts (1990) trace the productivity lead that the United States achieved over the United Kingdom during this period to barriers to competition allowing high-cost producers to remain in business. The contribution of ICT to TFP growth appears to be smaller than that of electricity in all four economic areas. This result seems consistent with results from Crafts (2002) and Jalava and Pohjola (2008). A possible explanation is that the diffusion of electricity was concomitant with the increasing skill of the labour force, robust postwar investments and a young population, which was not necessarily the case with ICT. The low contribution of ICT diffusion to the second productivity wave (the gap between TFP' and TFP'' from ICT diffusion is not large) may be due to an underestimation of the productivity wave itself or of ICT diffusion.

Indeed, due to the price decrease of this type of product, investment in ICT can accelerate the capital deepening process in ICT-using industries, leading to an increase in capital intensity and hence in labour productivity, but not necessarily in TFP. But, as already noted, national accounts take only partially into account the embodied technological progress in ICT investment price indexes, which means that it is not fully included in increases in investment volume and falls in investment prices (see the synthesis by Van Ark, (2016) on these aspects). Consequently, the accounting split between capital deepening and TFP within labour productivity growth is biased, the role of the capital deepening component being undervalued and, conversely, the role of TFP growth being overvalued.

ICT investment data compiled by national accountants (and taken into account here as ICT investment) underestimate productive ICT expenditure. Indeed, spending on ICT is regarded as investment only when the corresponding products are physically isolated. Therefore, generally speaking, ICT that is included in productive investment (for example machine tools or robots) is not counted as ICT investment but as intermediate consumption of companies producing these capital goods. Beretti and Cette (2009) and Cette *et al*. (2016) correct macro ICT investment data by considering intermediate consumption in ICT components integrated in non-ICT productive investment. Their main result is that the amount of 'indirect ICT investment' appears to be significant.

How can we further improve measurement of TFP in order to reduce the share of unexplained GDP growth? A first way would be to include the quality of the labour input in the production function, for example by trying to measure the quality of education. Second, spillovers from both capital and labour that we are not factoring in can be captured. Third, other fundamental innovations that are encompassed by TFP can be identified and estimated.

What to Expect for the Future?

Regarding the productivity slowdown observed during the 2000s, analyses carried out by the OECD at the firm level suggest that this slowdown does not appear to be observed for the most productive firms, in other words, at the productivity frontier (Andrews et al., 2015). The productivity slowdown appears to be a diffusion

problem from the best performances at the frontier to the laggard firms. This diffusion problem seems to hinge on the nature of innovations at the current juncture, with intangible capital being more difficult to replicate, or on a winner-takes-all phenomenon in ICT sectors. The puzzle is why such innovation diffusion difficulties appear to have become worse simultaneously in all developed countries, which are at different stages of development.

Work in progress at the Banque de France on French firms confirms the OECD results but suggests complementary explanations. The cleansing mechanisms may indeed have become weaker. One explanation being tested is that this weaker cleansing mechanism could at least partly be explained by a decline in real interest rates and less expensive capital, which allow low-productivity firms to survive and highly productive firms to thrive. Less expensive capital lowers the return on capital expected from firms and allows innovative firms to take on more risks. But this could also contribute to capital misallocation, as financing becomes less selective on the main innovative projects. Recent researchers have found that such an explanation may be relevant for Southern European countries such as Portugal, Italy and Spain (see for example Reis, 2013; Gopinath *et al.*, 2015; Gorton and Ordonez, 2015; and Cette, Fernald, Mojon, 2016).

Nevertheless, the omitted factors in the estimation of TFP growth continue to remain largely a mystery. For this reason, future productivity and GDP growth is very hard to forecast and different scenarios are credible. Cette, Lecat and Marin (2017) develop a growth model calibrated to test various scenarios over the very long-run (up to 2100). They show how different perspectives on future trends in innovation and its impact on TFP can yield dramatically different outcomes. They stress the need to deepen our knowledge of the main drivers of GDP through examination of past trends.

Conclusions

Long-term explainations for trends in GDP per capita are needed to understand long-term developments in living standards. This article is a synthesis of several previous contributions based on an original database over the long 1890-2015 period for the four main developed areas: the United States, the euro area, the United Kingdom, and Japan. We decompose GDP growth into its main components through an accounting breakdown. These components are TFP, capital intensity, working time, the employment rate, and population. It appears clearly that changes in TFP growth are the main driver of changes in GDP growth. We then go further to explain changes in TFP growth.

We attempt to capture empirically the contribution of factor quality and technology diffusion to TFP growth. In other words, we refine the measurement of TFP to better explain changes in GDP and in particular low growth over the last sub-period 2005-2015. Two types of factor quality are considered: the average level of education and the average age of the capital stock. Two technological shocks corresponding to General Purpose Technologies are considered: electricity and ICT.

Our main contribution is to present estimates of the impact of changes in the quality of labour and capital, and the impact of technological shocks, on the measurement of TFP. But this is still not enough to explain a large part of TFP growth, and the productivity waves remains largely unexplained. This means that we have to go further in future analysis to explain growth. As we do not have complete knowledge and understanding of what drives GDP growth, forecasting the future course of growth is very difficult.

Policies can influence TFP and GDP per capita growth. Relevant policies are ones that support innovation and foster greater productivity benefits from technological shocks. Examples are policies to reduce anti-competitive barriers on the product market, introduce more flexibility into the labour market, and increase the education level of the working age population (see on these aspects Aghion and Howitt, 1998, 2006, 2009, and Aghion *et al*. 2008 for an empirical illustration). The challenge in the coming years for the four economic areas considered in this analysis will be not to miss the opportunities arising from a possible new TFP growth wave linked to a new technology shock. The increase of the participation rate in the euro area over the past two decades illustrates the large role played by policy. But compared to the United States, GDP per capita in the euro area still suffers from lower employment rates, which gives room for new policies.

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Appendix: Construction of the Series

In this appendix, we describe our dataset more in details and explain some of the choices we made regarding the estimation of TFP.

Background

The Bergeaud, Cette and Lecat (BCL) long term productivity database was created in 2013 as part of an effort to update the long-term TFP series used in Cette *et al.* (2009). The database is updated yearly. More countries are added when information becomes available. The latest vintage of the database can be downloaded from the website: www.longtermproductivity.com. In 2016, the current version of the BCL database includes 17 countries: the United States, Japan, Germany, France, the United Kingdom, Italy, Spain, Canada, Australia, the Netherlands, Belgium, Switzerland, Sweden, Denmark, Norway, Portugal and Finland. Series are available for labour productivity, GDP per capita, capital intensity, average age of equipment, and TFP, defined as the Solow residual of a Cobb-Douglas production function with two inputs: capital stock and total hours worked.

Main hypothesis

To calculate our TFP series we need data on real GDP (Y), total hours worked (H), employment (N), population (P) and real capital stock (K). Capital stock estimates are based on long-term information on investment (I). Series for GDP and capital are given in national currencies, expressed in constant 2010 prices, and converted to US dollars by purchasing power parity (PPP) estimates for 2010, with a conversion rate from the Penn World Tables.

The perpetual inventory method (PIM) is used to construct the capital series from data on investment. Equipment and building investment (IE and IB) and capital (KE and KB) are distinguished with different life expectancy. The annual depreciation rates, noted δ, have been chosen according to Cette *et al.* (2009 and 2015) as 10 per cent for non-ICT equipment, 30 per cent for software and computers, 15 per cent for communication equipment and 2.5 per cent for buildings. In addition, for each year, we updated the given capital stock with a war and natural disasters damage coefficient (d_t) (with $0 \leq d_t \geq 1$) in order to take into consideration capital destruction.

The PIM corresponds to the relation $K_{\tau+1}=(K_{\tau}\times(1-\delta)+I_{\tau}\times\sqrt{1-\delta})\times(1-d_{\tau+1})$
This relation assumes that the whole investment

is done in one flow and in the middle of the year which explains that a part of it is slightly depreciated with a coefficient $\sqrt{1-\delta}$ at the end of the year.

In order to calculate K_t for every year, we need to initialize the capital stock at t_o. To do so, we considered that on the long run, the growth of capital follows the average growth of GDP. We calculated the average growth rate from the first year available to the data up to 1913 for each country. Let g be this growth (initial war and natural disasters damage coefficient is assumed to be null):

$$g=\frac{K_{\tau_{o+1}}-K_{\tau_o}}{K_{\tau_o}}=-\delta+\sqrt{1-\delta}\times\frac{I_{\tau_{o+1}}}{K_{\tau_o}}$$

or equivalently:

$$K_{\tau_o}=\frac{\sqrt{1-\delta}}{\delta+g}\times I_{\tau_{o+1}}$$

In the estimation of capital stock, we have made a strong hypothesis by assuming coefficient δ is constant in time over time for each of the two asset types: structures and equipment. This can be criticized, namely regarding the latter, as the increasing share of short-living ICT equipment in total equipment investment has put upward pressures to the depreciation rate of equipment. For this reason, we have used the ICT investment series from Cette *et al.* (2015) and divided series of investment into 5 assets: structures, communication equipment, computers, software, and other non-ICT equipment. Considering depreciation rates within a reasonable range for ICT capital, the differences in the aggregate capital stock growth rate are minor. Indeed, the bias implied by not separating ICT and non-ICT investment is equal to , $\left(K^{ICT}/K_M\right)(\delta^{ICT}-\delta^M)$ where δ^{ICT} is the depreciation rate of ICT and K^{ICT}/K_M is below 5 per cent.

From this PIM, we can derive the average age of equipment by using a recursive rule (see Bergeaud, Cette and Lecat 2016b for more details):

$$A_{\tau+1}=(A_\tau+1)\times\left(1-\frac{I_{\tau+1}}{K_{\tau+1}}\right)$$

Sources

Sources used in the construction of the investment series presented in the BCL database are mostly based on country specific studies that we have compared and updated using national accounts. Examples of such studies are Prados (2003) for Spain, Hjerppe (1996) for Finland, Villa (1994) for France.

GDP and population data mostly comes from Bolt and Van Zanden (2014) that have updated the seminal work of Maddison (2001).

Hours data comes from Huberman and Minns (2007), Clark (1957) and Maddison (2001) and employment series come from various sources.

The complete description can be found in www.longtermproductivity.com by downloading the latest version of the excel file

Education data have been kindly provided by Van Leeuwen and Van Leeuwen-Li (2014).

Decomposing the Productivity-Wage Nexus in Selected OECD Countries, 1986-2013

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ABSTRACT

Standard economic theory predicts that in the long run, productivity growth ought to drive aggregate real wage growth. We consider this prediction in the case of 11 OECD countries, and find that eight of the 11 experienced slower median real wage growth than labour productivity growth over the 1986-2013 period. We decompose the gap between labour productivity growth and median real wage growth into four components: wage inequality, changes in the importance of employer contributions to social insurance programs, differences between the prices of output and consumption, and changes to labour's share of income. The decompositions ultimately show that there is no common cause for the productivity-wage gap, though most countries did see wage inequality grow and labour's share of income fall to some degree over our period of study.

In the face of growing inequality in advanced economies, the OECD (2014) has initiated a significant research effort aimed at understanding and promoting inclusive growth. The aim is to advance policies to ensure that the benefits of growth are broadly shared. Across OECD countries, governments are searching for ways to ensure that subsets of society are not left behind by economic growth. For example, the Canadian government has installed a Cabinet Committee on Inclusive Growth, Opportunities and Innovation with the mandate to "[consider] strategies designed to promote inclusive economic growth, opportunity, employment and social security" in Canada.

These efforts are timely because evidence on wage growth suggests that economic growth has not been broadly shared in recent decades. In eight of the 11 OECD countries examined in this article, median real wage growth since the mid-1980s has not kept pace with labour productivity growth. The size of the growth gap between labour productivity and median real wages differs across countries, but the qualitative pattern is consistent: workers are growing more productive, but those productivity gains are not being matched by growth in the typical worker's wage.

Economic history and economic theory suggest that labour productivity growth should

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generate rising living standards for workers over time, so the apparent disconnect between labour productivity growth and wage growth is puzzling. What factors account for it? In this article, we show that the gap between labour productivity growth and median hourly earnings growth can be decomposed into contributions from the following four sources:

- rising earnings inequality;
- changes in the importance of employer contributions to social insurance programs as a form of labour compensation;
- rising relative prices for consumer goods; and
- a decline in labour's share of aggregate income.

Each of these components has its own implications for the welfare of workers. To the extent that the productivity-earnings gap simply reflects a rising share of labour compensation being paid in the form of employer contributions to social insurance plans, for example, it is not obvious that workers are any worse off. On the other hand, rising earnings inequality or a decline in labour's share of income might represent more serious obstacles to broad-based prosperity.

We perform the decomposition for 11 OECD countries: Canada, Denmark, France, Finland, Germany, Ireland, the Netherlands, Norway, Spain, the United Kingdom, and the United States. The decompositions show that the productivity-wage growth gap has no single common cause across the countries, but most countries did experience rising earnings inequality and a decline in labour's share of income over our period of study. The decompositions typically run from the mid to late 1980s through to 2010 or 2013, depending on the availability of household survey data for a given country.

The article is comprised of five sections. The first discusses literature that provides context for our analysis. The second section describes our framework for decomposing the gap between labour productivity growth and median real hourly wage growth. Section three presents the results of the decomposition. The fourth section discusses wage growth throughout the wage distribution in more detail. Section five concludes.

Literature Review

The failure of real wages to keep pace with labour productivity is not a new observation. Fisher and Hostland (2002) observe that labour productivity outstripped real wage growth in Canada from 1994 to 2001. Bartlett and Tapp (2012) found that labour productivity growth outpaced labour compensation growth from the mid-1990s through to 2012 in Canada. The gap, however, is not limited to Canada. The International Labour Organization (2015) observed that labour productivity growth exceeded real wage growth from 1999 to 2013 in developed countries across the board.

Decompositions allow analysts to identify the proximate sources of the gap between labour productivity growth and real wage growth. In a study of the American non-farm business sector from 1970 to 2006, Feldstein (2008) found that average real wage growth was indeed lower than labour productivity growth. The difference was a matter of prices. When he adjusted wages for inflation using the non-farm business sector output price index (rather than the consumer price index), he found that wages grew at approximately the same rate as labour productivity.

For research that relates the growth of wages and labour productivity, Feldstein stresses the importance of accounting for differences in price indexes and the importance of using total compensation (i.e. including supplementary labour income and fringe benefits) instead of only wages and salaries when calculating a wage for comparison with labour productivity. We

heed both of Feldstein's concerns in our analysis.

While Feldstein's decomposition provides a framework for relating labour productivity growth to average wage growth, he fails to consider how wage growth was actually experienced by the workers near the median - a better measure of the wage of the typical 'middle class' worker. Sharpe *et al*. (2008a; 2008b) consider how wage growth was experienced by the median worker, decomposing the gap between labour productivity growth and real median wage growth in Canada into four contributing factors: rising inequality, poor terms of trade for labour, a decrease in labour's share of income, and measurement inconsistencies.[2] They find that from 1980 to 2005, labour productivity grew 1.26 percentage points per year faster than median real earnings. They decompose the gap into their four factors, attributing 0.35 percentage points per year to inequality, 0.42 percentage points per year to terms of trade for labour, 0.25 percentage points per year to labour's share of income, and 0.25 percentage points per year to measurement issues. This report follows the method of Sharpe *et al*. but extends the analysis to ten additional OECD countries.

Pessoa and Van Reenen (2012) perform a decomposition of median wage growth and productivity growth similar to the one presented in Sharpe *et al*. (2008b) for the United Kingdom and the United States. They propose that there are two different types of measurements for the divergence - "gross decoupling" and "net decoupling". The former measures differences in growth between labour productivity and median hourly real earnings, while the latter measures differences in growth between labour productivity and average labour compensation per hour (deflated with the same deflator). Gross decoupling accounts for changes to labour's share of income, labour's terms of trade, changes median and mean hourly earnings, and the wedge between labour compensation and earnings, while net decoupling only accounts for changes to labour's share of income. Ultimately, Pessoa and Van Reenen (2012) find little evidence of net decoupling in the UK, but significant gross decoupling in the United States and the UK. In the UK, gross decoupling was driven by differences between mean and median earnings and the wedge between earnings and labour compensation.

Pessoa and Van Reenen (2012) recognize that both gross decoupling and net decoupling are important policy indicators. Gross decoupling relates the "true middle" of the earnings distribution to labour productivity. It also deflates earnings with the CPI and labour productivity with the GDP deflator, capturing any difference in the prices faced by firms and workers. This is an important distinction to make because firms and consumers can at times face very different prices. Changes in capital equipment prices affect firms more than consumers, for example.

Net decoupling, on the other hand, is important because it challenges one of the main stylized facts cited by economists - labour's stable share of income. Pessoa and Van Reenen observe that net decoupling could occur for many reasons, including shocks which disturb the long run equilibrium, technological bias against labour, changes to the level of competition in the market (in the product market it results in setting higher prices, while in the labour market it results in setting lower wages), and finally changes to labour supply due to structural phenomena like globalization.

Mishel and Gee (2012) use the methodology developed by Sharpe *et al* (2008b) to compare

2 The term "measurement inconsistencies" refers to the combined effect of employer social contributions and changes in hours of work per worker.

the growth of median real wage in the United States with labour productivity. Like most of the literature, they also find a significant gap between growth in labour productivity and median real wages: 1.56 percentage points between 1973 and 2011. Rising wage inequality accounted for 0.61 percentage points, while labour's terms of trade accounted for another 0.44 percentage points. They specifically point to the erosion of labour standards, globalization, high trade deficits, and the rising share of capital depreciation in GDP to explain both growing inequality and the changes in the distribution of income towards capital.

A recent OECD study by Schwellnus *et al.* (2017) provides an analysis of the decoupling of median wages from productivity in OECD countries for the 1995-2013 period based on trends in labour's share and the ratio of median to average wages. It finds that labour productivity grew faster than median wages in 15 of 24 countries.

Empirical Framework

Our decomposition of the gap between labour productivity growth and median real hourly earnings growth follows the approach developed in Sharpe *et al.* (2008a). In this section, we formally describe this approach.

Decomposition Method

The starting point for the decomposition is the following accounting identity:

$$\frac{Y_L}{P_C \times L} = \frac{Y_L}{P_Y \times L} \times \frac{Y_L}{Y} \times \frac{P_Y}{P_C} \qquad (1)$$

Here, Y_L is total nominal labour compensation, P_C is the price of consumption goods, and L is total hours worked. Y is total nominal output (or income) in the economy and P_Y is the price of output.

Thus, the ratio $Y_L/(P_C \times L)$ denotes average real hourly labour compensation in units of consumption goods (i.e. the "consumer wage"). On the right-hand side, the ratio $Y/(P_Y \times L)$ denotes real output per hour in units of output goods; that is, labour productivity. Y_L/Y is labour's share of total income in the economy. The remaining term P_Y/P_C is the relative price of output goods in terms of consumption goods; following the literature, we will refer to this as "labour's terms of trade."

For any variable X, let the notation $\Delta\%X$ denote the per cent growth rate of X. Then expressing equation (1) in growth rates, we obtain:

$$\begin{aligned}&\Delta\%\text{Average Real Hourly Compensation} = \\ &\Delta\%\text{ Labour Productivity} + \Delta\%\text{ Labour Share} \\ &\Delta\%\text{ Labour Terms of Trade}\end{aligned} \qquad (2)$$

Our goal is to explain changes in the gap between labour productivity and median real hourly earnings. Let $\Delta\%$ Gap denote the productivity-earnings growth gap. Formally, it is defined by:

$$\begin{aligned}&\Delta\%\text{ Gap} = \Delta\%\text{ Labour Productivity} \\ &-\Delta\%\text{ Median Real Hourly Earnings}\end{aligned} \qquad (3)$$

Rearranging (2) and using (3) to eliminate labour productivity growth, we obtain:

$$\begin{aligned}&\Delta\%\text{ Gap} = \Delta\%\text{ Average Real Hourly} \\ &\text{Compensation} - \\ &\Delta\%\text{ Median Real Hourly Earnings} - \\ &\Delta\%\text{ Labour Share}-\Delta\%\text{ Labour Terms of Trade}\end{aligned} \qquad (4)$$

Now, the change in average real hourly earnings relative to median real hourly earnings is an indicator of the change in earnings inequality over time. Thus, we define the change in inequality as:

$$\begin{aligned}&\Delta\%\text{ Inequality} = \\ &\Delta\%\text{ Average Real Hourly Earnings} - \\ &\Delta\%\text{ Median Real Hourly Earnings}\end{aligned} \qquad (5)$$

Finally, we need to relate average real hourly compensation to average real hourly earnings.

The difference between these two measures reflects the impact of changes in employer contributions to social insurance programs:

$$\Delta\% \text{ Average Real Hourly Compensation} - \Delta\% \text{ Average Real Hourly Earnings} = \Delta\% \text{ Employer Social Contributions} \quad (6)$$

Substituting (5) and (6) into (4) yields the overall decomposition:

$$\Delta\% \text{ Gap} = \Delta\% \text{ Inequality} + \Delta\% \text{ Employer Social Contributions} - \Delta\% \text{ Labour Terms of Trade} - \Delta\% \text{ Labour Share} \quad (7)$$

equation (7) is the final decomposition formula.

We find the accounting approach very useful. It draws our attention to the relationships between the productivity earnings gap and several other economic phenomena such as: rising earnings inequality, the changing impact of laws governing employer contributions to social insurance programs. It lends a disciplined, quantitative characterization to those relationships. It suggests areas for future research that might clarify the causal mechanisms at play.

The decomposition in equation (7) does not, on its own, justify any statements about cause and effect and does not explain the trends observed. To address such questions would require a structural model that explains why each of the components change the way it did.

Data Sources

Our analysis relies on two data sources: national accounts and household surveys.[3] For estimates based on national accounts data, we employ the OECD National Accounts from the OECD Stat public-use database. For estimates that rely on household surveys (median and average earnings from household surveys), we rely on the micro-datasets made available by the Luxembourg Income Study. Table 1 details the specific survey(s) used for each country. The length of our time series varies by country with household survey availability. Generally, the series span from 1986 or 1987 to 2010 or 2013. Germany and Ireland are the two exceptions to the rule, with our time series for the two countries spanning 1994 to 2010.[4]

To create our median and average wage series for each country, we used the annual labour income for both part-time and full-time employees from the relevant household survey. We excluded self-employed from our sample when generating the distribution of annual labour income in a given country because of data issues in differentiating labour income from returns to capital.[5] In order to create average hourly real wage and median hourly real wage estimates, we then divided through by the average hours worked per person employed and deflated each series with the CPI.[6]

3 The data series used in this article can be found at http://csls.ca/reports/csls2016-16-DataAppendix.pdf.

4 Ireland began in 1994 simply due to data availability. We opted to begin our German series in 1994 because it was the first household survey after East and West Germany were reunited, and we lack micro-data from East Germany prior to the Wall coming down.

5 The primary difficulty with self-employed data is that their annual income comes both from the labour the self-employed put in their business and the return on the capital they have invested. Most countries have tax systems set up in such a way that dividends from a business are treated differently than salaries paid out from the business. As such, the self-employed will naturally take into account tax implications when deciding how they will be remunerated in a given year. By excluding the self-employed, we avoid any changes to labour income which are the result of changes to the tax treatment of dividends. Moreover, as our decomposition is an exercise in growth, so long as "true" self-employed labour income did not grow faster or slower than labour income did for employees, we do not lose any information by dropping the self-employed.

Table 1: Household Survey Microdata Sources

Country	Survey(s) Used by LIS
Canada	Survey of Consumer Finance (1987, 1991, 1994, 1997), Survey of Labour and Income Dynamics (1998, 2000, 2004, 2007, 2010)
Denmark	Law Model (1987, 1992, 1995, 2000, 2004, 2007, 2010)
Finland	Income Distribution Survey (1987, 1991, 1995, 2000, 2004), Survey on Income and Living Conditions (2007, 2010, 2013)
France	Family Budget Survey (1984, 1989, 1994, 2000, 2005, 2010)
Germany	German Social Economic Panel Study (1994, 2000, 2004, 2007, 2010)
Ireland	Living in Ireland Survey (1994, 1995, 1996, 2000), Survey on Income and Living Conditions (2004, 2007, 2010)
Netherlands	Additional Enquiry on the Use of (Public) Services (1983, 1987, 1990), Socio-Economic Panel Survey (1993, 1999), Survey on Income and Living Conditions (2004, 2007, 2010)
Norway	Income Distribution Survey (1986, 1991, 1995, 2000, 2004), Household Income Statistics (2007, 2010)
Spain	Family Expenditure Survey (1980, 1990), Spanish European Community Household Panel (1995, 2000), Survey on Income and Living Conditions (2004, 2007, 2010, 2013)
United Kingdom	Family Expenditure Survey (1986, 1991, 1995), Family Resources Survey (1994, 1999, 2004, 2007, 2010, 2013)
United States	Current Population Survey – March Supplement (1986, 1991, 1994, 1997, 2000), Current Population Survey – Annual Social and Economic Supplement (2004, 2007, 2010, 2013)

Source: Luxembourg Income Study

Decomposition Results

This section presents and discusses the decomposition results. We begin with an overall summary of the results. We then devote one subsection to detailed analysis of each of the four components: earnings inequality, employer social contributions, labour's terms of trade, and labour's share of income.

Summary of Results

The decomposition results are summarized in Table 2. Overall, eight out of the 11 OECD countries studied saw labour productivity grow faster than median real hourly wages (Chart 1). The gap was largest in the United States, at 1.47 per cent per year from 1986 to 2013. On the other end of the spectrum, Spain, Norway, and Ireland all experienced faster median hourly real wage growth than labour productivity growth, resulting in a shrinking productivity-wage gap over their respective time periods.

The importance of the four components of the gap varied significantly by country. In Canada and the United Kingdom, rising inequality was the largest contributor to the gap. In Germany, the United States, and Norway, labour's terms of trade had the largest absolute effect on the gap. In Finland and the Netherlands, labour's falling share of income was the largest contributor to the gap.

The size of a component of the gap within a country can give some indication to policymakers where action may need to be taken to reduce the productivity-wage gap.

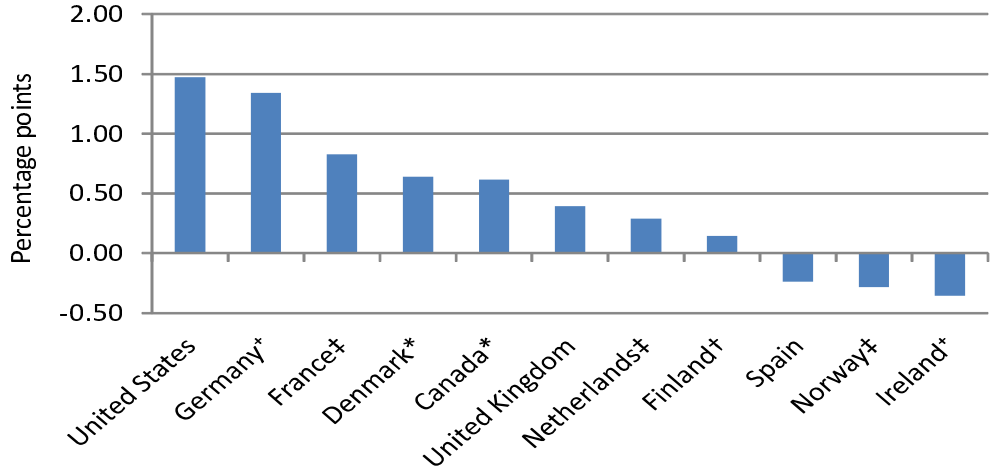
6 Admittedly, using average hours worked in an economy to generate an hourly wage series from the micro-data is not ideal. Ideally, the household surveys would also include a weekly or annual hours worked variable, from which we could create hourly wage (more recent surveys do tend to include such variables, but changes over short periods are less informative for productivity research). However, as average hours worked is driven by full-time workers, we can interpret the general decline of average hours worked as a representative trend for all full-time workers. As our decomposition deals in growth rates rather than levels, our use of average hours worked to generate hourly wages should not introduce bias into our results, particularly for wages levels in the middle of the distribution (i.e. median and average). Bick *et al*. (2016) present a more detailed breakdown of the decline of hours across high income countries.

Table 2: Decomposition of the Gap between Labour Productivity and Median Real Hourly Earnings Growth into Four Components, Selected OECD Countries, 1986-2013 (average annual rate of change)

	Labour Productivity	Median Real Hourly Earnings	Gap	Inequality	Employer Social Contributions	Labour Terms of Trade	Labour Share
	Growth (per cent per year)			Percentage Point Contributions to the Gap			
United States	1.63	0.15	1.47	0.52	0.24	0.57	0.16
Germany+	1.39	0.05	1.34	0.38	-0.07	0.59	0.44
France‡	1.71	0.88	0.83	-0.06	0.71	0.18	0.01
Denmark*	1.61	0.97	0.64	0.01	0.67	0.02	-0.06
Canada*	1.18	0.57	0.62	0.36	0.15	-0.02	0.12
United Kingdom	1.65	1.26	0.39	0.49	0.10	-0.32	0.11
Netherlands‡	1.27	0.98	0.29	0.09	-0.13	0.06	0.26
Finland†	2.20	2.06	0.14	0.11	-0.22	-0.04	0.29
Spain	1.05	1.29	-0.24	0.23	-0.27	-0.01	-0.18
Norway‡	1.80	2.09	-0.28	0.22	0.26	-1.16	0.38
Ireland+	3.75	4.11	-0.36	0.88	-2.03	0.20	0.57
				Per Cent Contributions to the Gap			
United States	--	--	--	35.0	16.0	38.4	10.9
Germany+	--	--	--	28.4	-5.0	43.7	32.7
France‡	--	--	--	-7.7	85.1	21.5	1.1
Denmark*	--	--	--	1.9	104.5	3.4	-9.7
Canada*	--	--	--	58.3	23.9	-2.5	20.0
United Kingdom	--	--	--	125.4	25.9	-81.0	28.2
Netherlands‡	--	--	--	31.4	-44.5	22.2	90.0
Finland†	--	--	--	79.3	-152.6	-29.2	198.0
Spain	--	--	--	-94.9	113.7	4.6	75.9
Norway‡	--	--	--	-78.3	-90.5	410.5	-133.7
Ireland+	--	--	--	-248.2	569.9	-55.6	-159.7

Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010. All others are 1986-2013.
Source: CSLS calculations from OECD National Accounts data and household survey microdata from the Luxembourg income Study: http://csls.ca/reports/csls2016-16-DataAppendix.pdf

Chart 1: Gap between Labour Productivity and Median Real Hourly Wages Growth, Selected OECD Countries, 1986-2013 (percentage points per year)



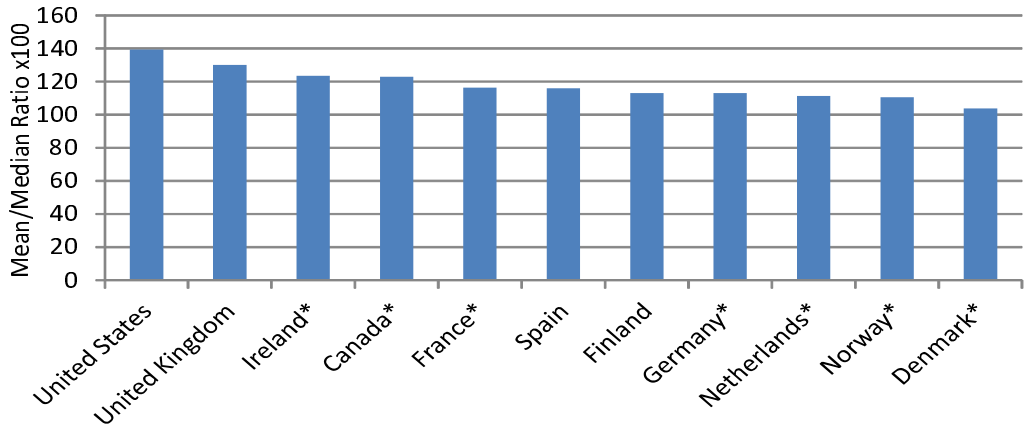
Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010. All others are 1986-2013.
Source: Table 2

Table 3: Average and Median Real Hourly Earnings, Selected OECD Countries, 1986 - 2013 (average annual rate of change)

	Average Real Hourly Earnings	Median Real Hourly Earnings	Inequality Component
	A	B	C = A - B
United States	0.67	0.15	0.52
Germany+	0.43	0.05	0.38
France‡	0.81	0.88	-0.06
Denmark*	0.98	0.97	0.01
Canada*	0.93	0.57	0.36
United Kingdom	1.75	1.26	0.49
Netherlands‡	1.07	0.98	0.09
Finland†	2.17	2.06	0.11
Spain	1.52	1.29	0.23
Norway‡	2.31	2.09	0.22
Ireland+	4.99	4.11	0.88

Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010. All others are 1986-2013.
Source: Household Survey Microdata from the Luxembourg Income Survey

Chart 2: Ratio of Average to Median Hourly Real Wage, Selected OECD Countries, 2013



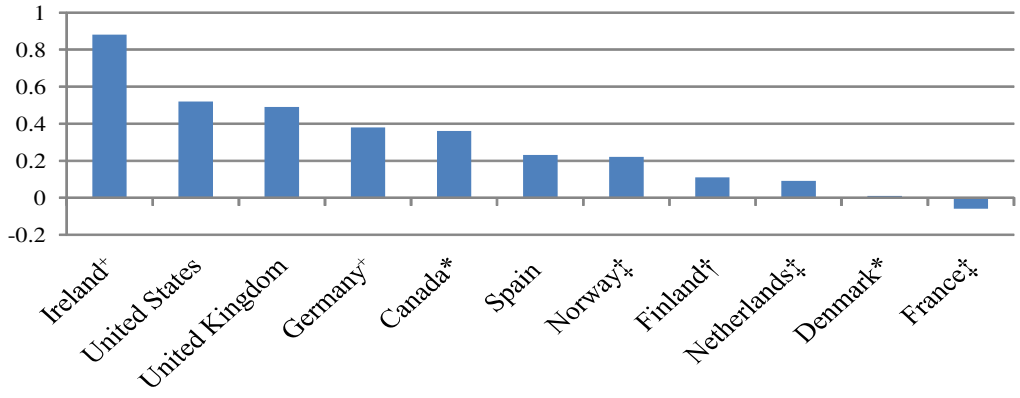
Note: *2010
Source: Household Survey Microdata from the Luxembourg Income Survey

Wage Inequality

The wage inequality component is the gap between the growth rates of average and median real hourly earnings. Empirically, earnings distributions within OECD countries are positively skewed; the mean is greater than the median because the mean is dragged upward by very high earners. When earnings at the top of the distribution grow more quickly than those in the middle of the distribution, the mean rises relative to the median and earnings inequality rises. This would imply that the gains from labour productivity are flowing disproportionately to workers who were already high earners relative to the median worker, so Δ% Inequality contributes positively to Δ% Gap.

The 11 OECD countries in our sample had different experiences with inequality growth over their respective periods. Generally in line with the wage inequality literature, most coun-

Chart 3: Inequality Component, Percentage Point Contribution to the Gap, 1986-2013 (per year)



Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010.

tries experienced rising inequality in recent decades according to our measure. As shown in Table 3, only France saw wage inequality fall overall, though median hourly real wage growth only outpaced average hourly real wage growth by 0.06 percentage points per year.

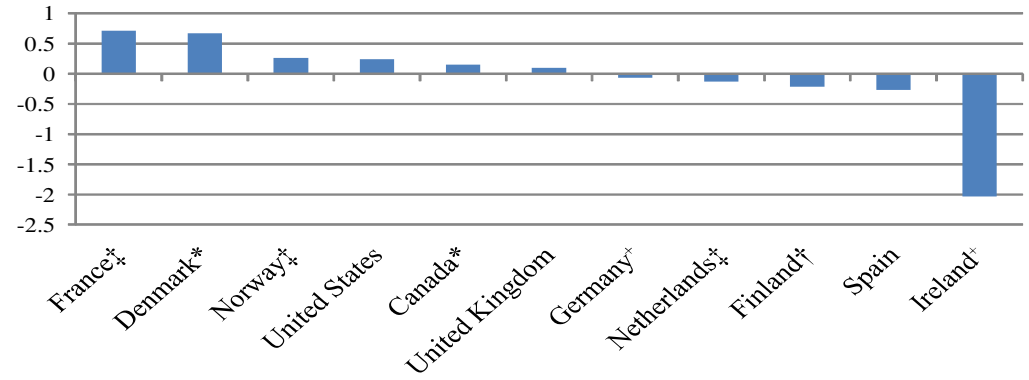
As Chart 2 demonstrates, the level of wage inequality also varied significantly across countries: in 2013 in the United States the average real hourly wage was 139.5 per cent of the median hourly real wage, while in 2010 in Denmark the proportion was only 103.9 per cent. The level of wage inequality in a country is very much the result of how the median and mean have grown relative to one another over time.

Chart 3 illustrates the percentage-point contributions of the wage inequality component to the gap in the 11 OECD countries. Inequality made the largest contribution in Ireland, where the average hourly real wage grew faster than the median hourly real wage by 0.88 percentage points per year. Inequality made large contributions to the gap in both the United States and the United Kingdom as well, contributing 0.52 and 0.49 percentage points per year, respectively.

While evaluating the absolute percentage point contribution of equality to a country's overall gap is important, Table 2 adds the dimension of what proportion of a country's gap is due to inequality. For example, despite inequality in Ireland making a large positive contribution to the gap, it was more than offset by the other three contributors. Contrarily, in the Netherlands and Canada inequality contributed more than 50 per cent of the gap, and in the United Kingdom it accounted for more than 100 per cent of the gap.

Overall, there is no doubt that wage inequality has been growing across the OECD for decades. In most cases, the average hourly real wage grew around 0.10 to 0.50 percentage points per year faster than the median hourly real wage — equivalent to somewhere between 2 and 10 percentage points more cumulative growth over a 20 year period. Evidently, these minor differences in growth can have major ramifications on the overall income distribution in the long run. It is, however, important to bear in mind that differences in growth between the median and the mean may fail to capture some important changes in the earnings distribution. In Section V, we discuss alternative measures of inequality to learn about wage growth throughout the wage distribution.

Chart 4: Employer Social Contributions Component, Percentage Point Contribution to the Gap, Selected OECD Countries, 1986-2013 (per year)



Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010.
Source: Table 2

Employer social contributions

In principle, the difference between average hourly earnings and average total labour compensation is that the latter captures employer social contributions (also called supplementary labour income) while the former may not.[7] It is possible that part of the gap between labour productivity growth and median hourly earnings growth is accounted for by workers receiving a growing share of their compensation in the form of employer contributions to social insurance programs rather than cash or in-kind earnings.[8] Whether this makes workers worse off depends on how much they value the social programs.

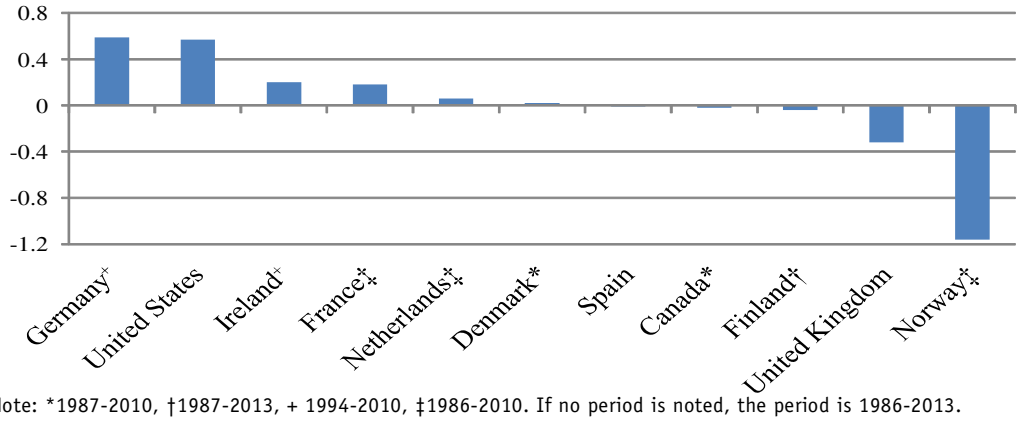
Employer social contributions as a share of labour compensation have been growing throughout the OECD over recent decades. In Canada, for example, employer social contributions as a share of labour compensation grew by about five percentage points from 1987 to 2010. This means that employer social contributions grew about 1.76 percentage points per year faster than wages and salaries over the period (Uguccioni, Murray and Sharpe, 2016).

In practice, we draw average hourly earnings from household surveys and average hourly labour compensation from the National Accounts. We believe that employer social contributions are the main source of the growth discrepancy between the two series (and that is why we have named this component of the gap 'employer social contributions'), but it is likely that other measurement discrepancies between the two data sources are captured here as well. The definitions of labour income used in household surveys may differ across countries in subtle but important ways (e.g. in their treatment of bonuses or of non-cash income such as stock options). Sampling error in the surveys is another potential source of measurement discrepancies. (It is well known, for example, that the top per cent of earners is difficult to capture in household surveys).

7 Supplementary labour income includes contributions employers make on behalf of employees to state-run schemes such as national pension plans, unemployment insurance, and workplace injury insurance, as well as health and dental insurance plans provided by the employer, sickness and life insurance, and retirement allowances.

8 It can be noted that definitional differences between the data sources for earnings and labour compensation, and changes in these differences over time, may also lead to different growth rates for earnings and labour compensation.

Chart 5: Labour's Terms of Trade, Percentage Point Contribution Per Year to the Gap, Selected OECD Countries, 1986-2013 (per year)



Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010. If no period is noted, the period is 1986-2013.
Source: Table 2

As shown in Chart 4, this component's contribution to the gap in Ireland, France, and Denmark exceeded 0.50 percentage points per year in absolute value. This indicates that there are significant differences between the labour compensation component of the SNA and the hourly earnings from the household surveys produced by the national statistics agencies in these countries, but further research is needed before a definitive conclusion is reached.

In per cent terms, employer social contributions (plus other measurement discrepancies) make considerable contributions to the gap in Ireland, Denmark, and France (Table 2). In Finland, Norway, and Spain employer social contributions make up a large share of the gap in relative terms.

Labour's terms of trade

The accounting identity in equation (1) includes two prices: the consumption goods price P_C and the output goods price P_Y. These average prices differ because, in general, the bundle of goods consumed by consumers is not the same as the bundle of goods produced in the domestic economy.[9]

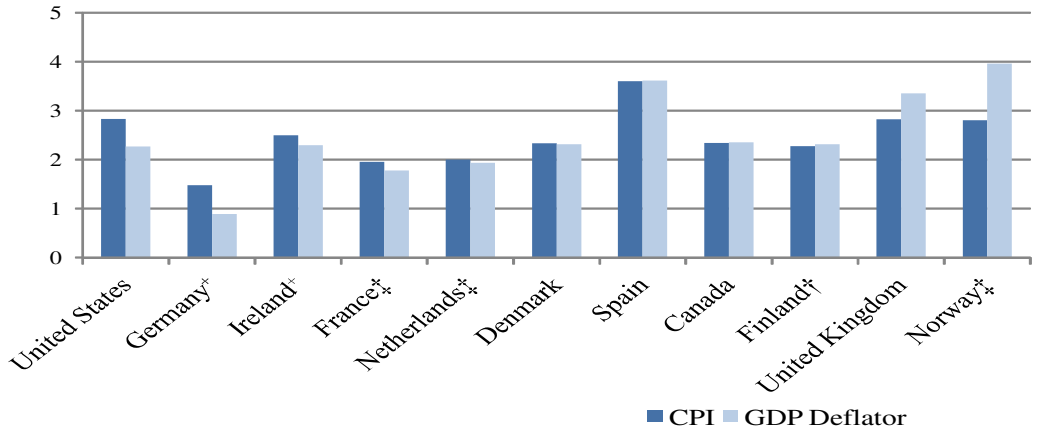
Labour productivity is defined as the volume of output produced per hour of work, so the relevant price is P_Y. Workers ultimately want to use their wages to buy consumption goods, so the relevant price for measuring real labour compensation is P_C. The discrepancy between labour productivity and real labour compensation is therefore influenced by the ratio P_Y/P_C . Following the literature, we refer to this ratio as "labour's terms of trade."[10]

When Δ% Labour Terms of Trade > 0, consumer prices are falling relative to output prices. Everything else being equal, this increases workers' purchasing power relative to labour productivity, and hence reduces the gap between labour productivity growth and real earnings growth. That is why labour's terms of trade enter equation (7) with a negative sign.

9 For example, countries produce goods that are exported to other countries rather than purchased by domestic consumers. The prices of those exports are included in the output price P_Y but not in the consumer price P_C.

10 Clearly, an analogy is being drawn between P_Y/P_C and the more common notion of "terms of trade," which is the ratio of a country's export prices to its import prices. Intuitively, P_C is the price of the goods workers buy and P_Y is the price of the goods workers produce. It is to workers' advantage when the price of what they sell increases relative to the price of what they buy, just as it is to a country's advantage when the price of what it sells (its exports) increases relative to the price of what it buys (its imports).

Chart 6: CPI and GDP Deflator Growth, Per cent Per Year, Selected OECD Countries, 1986-2013



Source: OECD

Labour's terms of trade made a sizeable contribution to the gap in six of the 11 countries (Chart 5). Labour's terms of trade in Norway contributed -1.16 percentage points per year. Norway was the sole country where the GDP deflator outpaced the CPI by such a wide margin (3.96 per cent per year versus 2.80 per cent per year) (Chart 6). This is explained by much faster growth in export prices than consumption prices, driven by the commodity boom and large share of offshore oil and gas production in GDP.

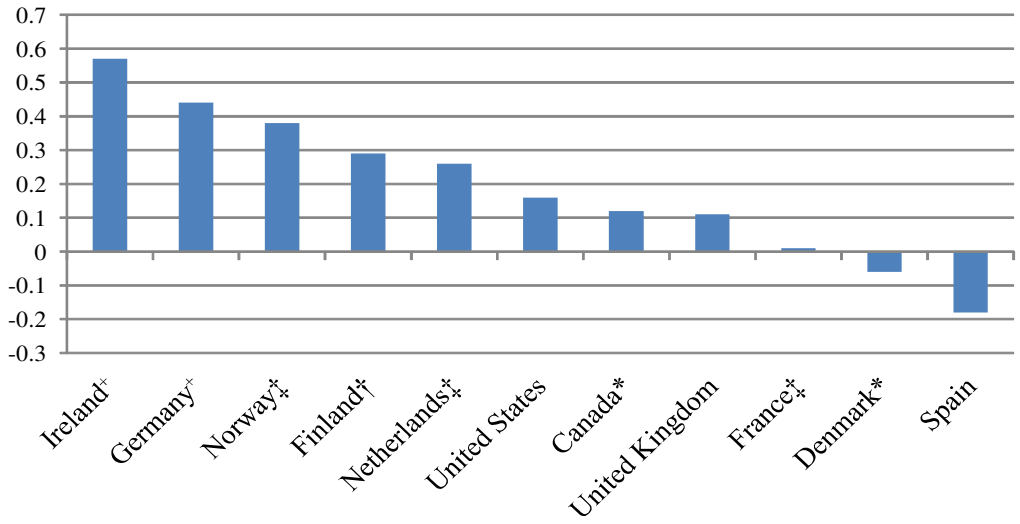
Germany and the United States had the opposite experience than Norway did with labour's terms of trade. The two countries respectively saw the CPI grow 0.59 percentage points and 0.57 percentage points faster than the GDP deflator. In the United States, the relatively high rate of growth sustained by the CPI was driven by rising food, energy, and housing costs. In Germany, energy and housing prices were the primary sources of high CPI growth relative to the GDP deflator. In both Germany and the United States, investment goods prices grew much slower than the CPI. In the United States, prices for information technology goods, which represent a significant share of investment, have since the 1980s fallen drastically (e.g. the cost of a computer with 1 gigabyte of RAM) which reduced GDP deflator growth.

Table 2 illustrates the relative importance of labour's terms of trade to each country's overall productivity-wage gap. The relative importance of labour's terms of trade in Norway is in part driven by it being the component largest of any of the 11 countries (Chart 5), but the relative size is even greater due to Norway's relatively small overall gap. Similarly, labour's terms of trade make a larger absolute contribution to the gap in the United Kingdom than in the United States or Germany because of the United Kingdom's relatively small overall productivity-wage gap.

Labour's share of income

Labour's share of income measures the fraction of aggregate income in the economy (i.e. GDP) which is paid to workers as compensation for labour. Up until quite recently, labour's share of income was considered constant by most economists, so much so that it became one of the main stylized facts presented in introductory macroeconomics courses. Labour's falling share of income over the past decades in OECD countries has been well documented (OECD,

Chart 7: Labour's Share of Income, Percentage Point Contribution to the Gap, 1986-2013 (per year)



Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010.
Source: Table 2

2012; International Labour Organization, 2015).

Chart 7 presents the percentage point contribution to the wage-productivity gap made by changes to labour's share of income over time. Notably, in three of OECD's countries, Spain, Denmark, and France, labour's share of income either held steady or improved. Labour's share of income fell the most in Ireland, in large part as a result of capital's share increasing as foreign firms moved their headquarters there due to favourable tax treatment.

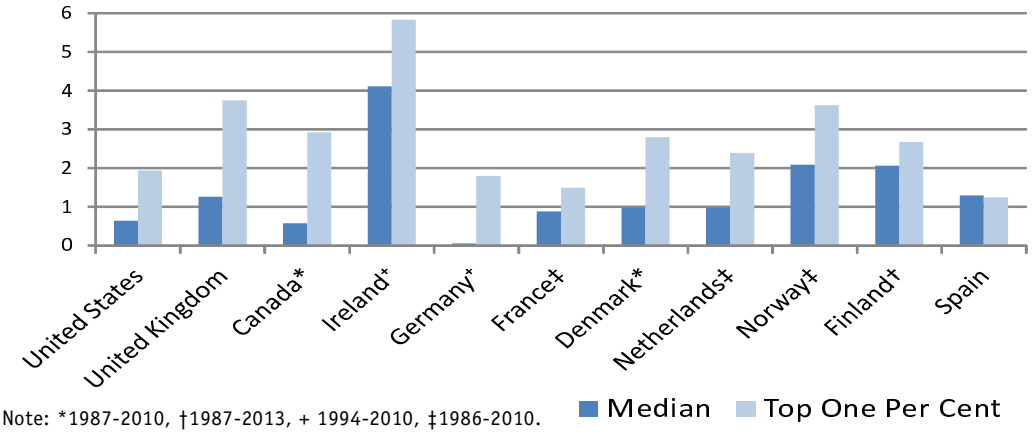
So far as the importance of labour's share of income to the overall productivity-wage gap, Table 2 presents the per cent contribution it made. In five of the 11 OECD countries studied (Finland, Ireland, the Netherlands, Norway, and Spain), labour's share of income made a contribution well in excess of 50 per cent.

Ultimately, a decline in labour's share of income over the period as a whole indicates that labour's bargaining power has been falling relative to that of capital. In terms of our decomposition, a decline in labour's share of income over time leads to an increase in the overall gap.

The causes of labour's deteriorating bargaining power are hotly debated. One of the most trumpeted causes is globalization. Proponents argue that capital is far more mobile than labour in an increasingly globalized world, which makes the threat of outsourcing and offshoring far more credible. Due to the threat of offshoring from countries with less strict labour regulations and lower labour costs, workers are increasingly forced to accept lower wages.

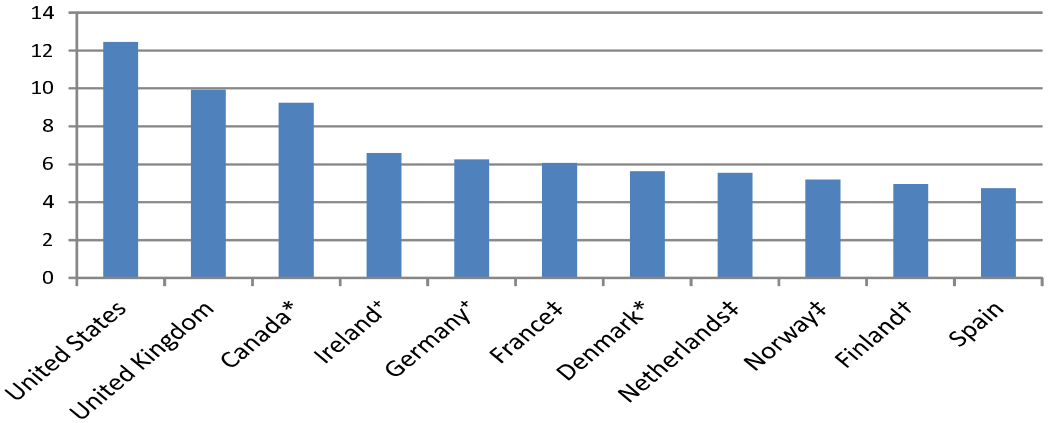
Some argue that labour's deteriorating bargaining power is less a matter of globalization and more a matter of technological change which is biased against labour. For example, the OECD (2012) argues that the spread of information and communication technologies have led to major innovation and productivity gains over recent decades, but have also had the effect of replacing workers altogether. The result is an increase in capital's bargaining power, and a decrease in labour's — particularly for workers in highly repetitive jobs which naturally lend

Chart 8: Hourly Real Wage Growth for Median and the Top One Per Cent, Selected OECD Countries, 1986-2013 (average annual per cent change)



Note: *1987-2010, †1987-2013, + 1994-2010, ‡1986-2010.
Source: Household Survey Microdata from Luxembourg Income Survey

Chart 9: Ratio of the Average Wage of the Top One Percent to the Median Wage, Selected OECD Countries, 2013



Note: *last year available is 2010.
Source: Household Survey Microdata from Luxembourg Income Survey

themselves to automation. Structural and institutional reforms may also have contributed to the reduction of labour's bargaining power.

Alternative Measures of Wage Inequality

The measure of wage inequality used in the analysis so far has been to compare the national average median to hourly real wages. While this measure captures whether or not the distribution is becoming more positively skewed overall, it does not capture developments throughout the distribution. For example, it may be the case that the median is growing at a similar rate as the mean, but the tails of the distribution are being stretched apart as those on the left tail experience little growth and those on the right tail experience extreme growth or vice versa (i.e. the distribution's skew may remain largely unchanged but the height of the distribution may be changing). There are several alternative measures of wage inequality, such as the wage Gini coefficient, the ratio of the 90th percentile of wages to the 10th per-

Table 4: Top One Percent's Share of Total Labour Income, per cent, Selected OECD Countries, 1986 and 2013

	1986	2013	Percentage-point Change
United States	6.3	9.1	2.8
United Kingdom	4.5	7.6	3.1
Canada*	4.8	7.5	2.7
Germany*	4.5	5.5	1.0
Denmark*	3.6	5.4	1.8
France*	4.6	5.3	0.7
Ireland*	4.7	5.3	0.6
Netherlands*	3.8	5.0	1.2
Norway*	3.4	4.7	1.3
Finland*	3.8	4.4	0.6
Spain	4.4	4.1	-0.3

Note: *last year available is 2010.
Source: CSLS calculations based on microdata from Luxembourg Income Survey

centile, or the ratio of the 90th percentile to the 50th, as well as growth for the top one per cent of wage-earners. Unlike SNA data, household surveys allow us to investigate how the wage distribution is evolving by focusing on the wage growth experienced by certain percentiles or subsamples. Mechanically, this decomposition is the same as the decomposition we have been employing throughout this article, with one change: we supplement the median with a percentile such as the top 1 per cent of the statistic of interest.

Chart 8, which is based on microdata, compares the real hourly wage growth of the median worker in a given country with the average real hourly wage growth of workers in the top 1 per cent of wage-earners.

It shows the sobering fact that the wages of highly paid workers have greatly outpaced the wages of workers in the middle of the wage distribution. In all countries except Spain. It is also important to consider the levels of wages to gauge the degree of wage inequality in these countries. Chart 9 provides the ratio of the wage of the top one percent to median wage as a measure of the level of wage inequality in a given country. The United States has by far the highest level of wage inequality using this measure, with the top one percent earning on average more than 12 times median income. Canada and the United Kingdom also have higher levels of inequality than the other 8 countries.

The proportion of the wage income of the top one per cent in total labour income has grown (Table 4). The OECD (2012) has documented labour's falling share of income, and found that removing the top one percent from labour income doubled the rate of decline of labour's share of income in Canada and the United States. In fact, the removal of the top one percent from total labour income hastened the decline in labour's share of income in all of the OECD countries they studied except Spain.

Table 5: Decomposition of the Gap between Labour Productivity and Real Wages Growth at Six Points in the Wage Distribution, in Selected OECD Countries

United States, 1986-2013

	Per cent per year			Percentage Point Contribution			
	Labour Productivity	Hourly Real Wage	Productivity-Wage Gap	Inequality	Employer Social Contribution	Labour's Terms of Trade	Labour's Share of Income
25th percentile	1.63	0.15	1.47	0.52	0.24	0.57	0.16
Median	1.63	0.64	0.99	0.03	0.24	0.57	0.16
75th percentile	1.63	0.34	1.28	0.33	0.24	0.57	0.16
One Percent	1.63	1.94	-0.31	-1.27	0.24	0.57	0.16
the Rest	1.63	0.44	1.19	0.23	0.24	0.57	0.16
Below Median	1.63	0.56	1.06	0.11	0.24	0.57	0.16

Canada, 1987-2010

25th percentile	1.18	0.40	0.78	0.52	0.15	-0.02	0.12
Median	1.18	0.57	0.62	0.36	0.15	-0.02	0.12
75th percentile	1.18	0.68	0.50	0.24	0.15	-0.02	0.12
One Percent	1.18	2.92	-1.74	-1.99	0.15	-0.02	0.12
the Rest	1.18	0.80	0.38	0.13	0.15	-0.02	0.12
Below Median	1.18	0.40	0.78	0.53	0.15	-0.02	0.12

Denmark, 1987-2010

25th percentile	1.61	1.08	0.73	0.11	0.67	0.02	0.06
Median	1.61	0.97	0.64	0.01	0.67	0.02	0.06
75th percentile	1.61	1.05	0.56	-0.07	0.67	0.02	0.06
One Percent	1.61	2.80	-1.19	-1.82	0.67	0.02	0.06
the Rest	1.61	0.90	0.71	0.08	0.67	0.02	0.06
Below Median	1.61	0.42	1.20	0.57	0.67	0.02	0.06

Finland, 1987-2013

25th percentile	2.20	1.97	0.15	0.12	-0.22	-0.04	0.29
Median	2.20	2.06	0.14	0.11	-0.22	-0.04	0.29
75th percentile	2.20	2.04	0.07	0.05	-0.22	-0.04	0.29
One Percent	2.20	2.67	-0.55	-0.58	-0.22	-0.04	0.29
the Rest	2.20	2.06	0.05	0.03	-0.22	-0.04	0.29
Below Median	2.20	2.04	0.07	0.05	-0.22	-0.04	0.29

France, 1986-2010

25th percentile	1.71	0.64	1.07	0.18	0.71	0.18	0.01
Median	1.71	0.88	0.83	-0.06	0.71	0.18	0.01
75th percentile	1.71	1.22	0.48	-0.41	0.71	0.18	0.01
One Percent	1.71	1.49	0.22	-0.67	0.71	0.18	0.01
the Rest	1.71	0.78	0.93	0.04	0.71	0.18	0.01
Below Median	1.71	0.47	1.24	0.35	0.71	0.18	0.01

UK, 1986-2013

25th percentile	1.65	1.31	0.33	0.44	0.10	-0.32	0.11
Median	1.65	1.26	0.39	0.49	0.10	-0.32	0.11
75th percentile	1.65	1.50	0.14	0.25	0.10	-0.32	0.11
One Percent	1.65	3.75	-2.10	-2.00	0.10	-0.32	0.11
the Rest	1.65	1.62	0.02	0.13	0.10	-0.32	0.11
Below Median	1.65	1.30	0.35	0.45	0.10	-0.32	0.11

Ireland, 1994-2010

25th percentile	3.75	3.48	0.25	1.51	-2.03	0.20	0.57
Median	3.75	4.11	-0.36	0.88	-2.03	0.20	0.57
75th percentile	3.75	5.15	-1.43	-0.16	-2.03	0.20	0.57
One Percent	3.75	5.83	-2.10	-0.84	-2.03	0.20	0.57
the Rest	3.75	4.96	-1.24	0.03	-2.03	0.20	0.57
Below Median	3.75	3.75	-0.02	1.24	-2.03	0.20	0.57

Netherlands, 1986-2010

	Per cent per year			Percentage Point Contribution			
	Labour Productivity	Hourly Real Wage	Productivity-Wage Gap	Inequality	Employer Social Contribution	Labour's Terms of Trade	Labour's Share of Income
25th percentile	1.27	0.23	1.03	0.84	-0.13	0.06	0.26
Median	1.27	0.98	0.29	0.09	-0.13	0.06	0.26
75th percentile	1.27	1.24	0.03	-0.17	-0.13	0.06	0.26
One Percent	1.27	2.39	-1.13	-1.32	-0.13	0.06	0.26
the Rest	1.27	1.02	0.25	0.05	-0.13	0.06	0.26
Below Median	1.27	0.42	0.84	0.65	-0.13	0.06	0.26

Norway, 1986-2010

25th percentile	1.80	2.34	-0.56	-0.03	0.26	-1.16	0.38
Median	1.80	2.09	-0.28	0.22	0.26	-1.16	0.38
75th percentile	1.80	2.15	-0.37	0.16	0.26	-1.16	0.38
One Percent	1.80	3.62	-1.84	-1.31	0.26	-1.16	0.38
the Rest	1.80	2.25	-0.47	0.05	0.26	-1.16	0.38
Below Median	1.80	2.11	-0.33	0.20	0.26	-1.16	0.38

Spain, 1986-2013

25th percentile	1.05	1.39	-0.33	0.13	-0.27	-0.01	-0.18
Median	1.05	1.29	-0.24	0.23	-0.27	-0.01	-0.18
75th percentile	1.05	1.59	-0.53	-0.07	-0.27	-0.01	-0.18
One Percent	1.05	1.24	-0.19	0.28	-0.27	-0.01	-0.18
the Rest	1.05	1.53	-0.48	-0.01	-0.27	-0.01	-0.18
Below Median	1.05	1.28	-0.22	0.24	-0.27	-0.01	-0.18

Germany, 1994-2010

25th percentile	1.39	-1.43	2.82	1.86	-0.07	0.59	0.44
Median	1.39	0.05	1.34	0.38	-0.07	0.59	0.44
75th percentile	1.39	0.68	0.71	-0.25	-0.07	0.59	0.44
One Percent	1.39	1.80	-0.41	-1.37	-0.07	0.59	0.44
the Rest	1.39	0.36	1.03	0.07	-0.07	0.59	0.44
Below Median	1.39	-0.93	2.32	1.36	-0.07	0.59	0.44

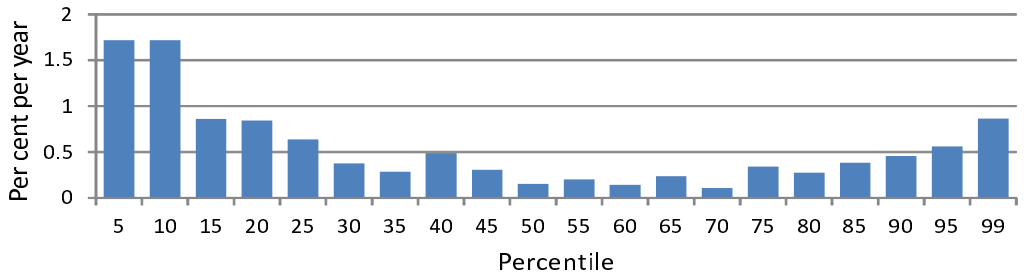
Source: CSLS Calculations nased on microdata from Luxembourg Income Survey

We can also consider the first and third quartiles (i.e. the 25th and 75th percentiles), as well as the prevailing wage of the top one percent, the rest, or those below median wage.[11] For the three latter subsets, we use the average hourly real wage of the subset in our decomposition. We use the average of the subset rather than the median of the subset because we want to capture the effect of high or modest-income earners pulling the average in one direction or another: we want to estimate how wages have changed for the group on the whole.

Table 5 displays the decomposition results using alternative wage measures in place of the median wage for all 11 countries in our dataset (The results using the median are also displayed for the sake of comparison.) The productivity-wage growth gap in the United States is largest when the median wage is used. This reflects the fact that real wage growth over the 1986-2013 period was lower at the median than at other points throughout the wage distribution. That being said, four of the five alternative real wage measures grew more slowly than labour productivity over the period. Only the wages of the top one per cent grew faster than productivity growth.

11 The latter three groups are subsets of the population. The top one per cent the subset of all those with income above the 99th percentile. The Rest is the complement of the top one per cent, and consists of all those who do not earn an income above the 99th percentile. The below median wage set is, as the name states, the subset of all of those with income below the 50th percentile.

Chart 10: Real Hourly Wage Growth by Percentile, United States, (average annual rate of change), 1986-2013



Source: CSLS calculations based on microdata from Luxembourg Income Survey

Chart 10 provides a closer look at the individual percentiles for the United States. Hourly real wage growth in the United States for the period studied was largely below 0.40 per cent per year roughly between the 35th and 70th percentiles. Otherwise, hourly real wage growth tended to be far closer to or above average hourly real wage growth for the whole wage distribution (0.67 per cent per year). By focusing on the median we inadvertently chose the group in the United States which appears to haveexperienced the least hourly real wage growth from 1986 to 2013.

These results convey a narrative all too familiar. In the United States, the middle income earners have experienced far less growth over the past decades than high or modest income earners.

The same picture obtained for most of the other 10 countries in Table 5. The hourly wage growth of the top one per cent exceed growth of productivity in all countries, even in the three countries where wage growth had exceeded productivity growth.

Conclusion

Labour productivity growth outstripped median hourly real wage growth for the past few decades in eight of the 11 OECD countries studied. For these countries, we decomposed the growing productivity-wage gap into four components: inequality, employement contributions to social insurance, labour's terms of trade, and labour's share of income. The size of the productivity-wage gap varied by country, as did the components driving its growth. Increasing inequality and labour's falling share of income increased the productivity-wage gap in most of the countries studied.

The productivity-wage gaps in the United States and Germany were significantly larger than any of the other countries studied. The former's gap was largely driven by and labour's increasingly unfavourable terms of trade, while the latter's gap was driven by these two factors and a decline in labour's share of income.

We also show that despite indications of growing wage inequality in 10 of the 11 OECD countries, our inequality measure fails to capture a number of aspects of the overall evolution of the wage distribution. For example, while the ratio of average to median wages in the United States has shown overall increases, there has been increased equality between middle and modest income earners.

Future research should seek to reduce the likihood that measurment error or definitional differences across countries are responsible for differences in trends. Wage data may be improved by using household surveys directly as opposed to accessing them through the Luxembourg Income Study. For example, using the

Labour Force Survey for Canada it is possible to create an annual wage series without needing to interpolate missing values from 1997 to 2016.

The lack of inclusive growth we observe in many OECD countries has significant societal implications. There may be less political support for productivity-enhancing policies in the future if the benefits of productivity growth are not shared equitably. The incentives for employees to work hard may diminish if they believe that they are not receiving their "fair share" of the firm's productivity gains. Finally, the current taxes and transfers system may not be well equipped to offset the growing trend of wage inequality among workers if it was designed assuming labour productivity growth will lead to real wage growth for all workers.

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The Decoupling of Median Wages from Productivity in OECD Countries

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Abstract

Over the past two decades, aggregate labour productivity growth in most OECD countries has decoupled from real median compensation growth, implying that increasing productivity is no longer sufficient to raise real wages for the typical worker. This article provides a quantitative description of decoupling in OECD countries over the past two decades, with the results suggesting that it is explained by declines in both labour shares and the ratio of median to average wages (a partial measure of wage inequality). Labour shares have declined in about two thirds of the OECD countries covered by the analysis. However, the contribution of labour shares to decoupling is smaller if sectors are excluded for which labour shares are driven by changes in commodity and asset prices (primary and housing sectors) or by imputation choices (non-market sectors). The ratio of median to average wages has declined in all but two of the OECD countries covered by the analysis and appears to reflect disproportionate wage growth at the very top of the wage distribution rather than stagnating median wages. The causes of these developments will be analysed in follow-up research.

In the long run, raising productivity is the only way to raise living standards, with real wages being the most direct mechanism through which the benefits of productivity growth are transferred to workers. Over the past two decades, however, aggregate labour productivity growth in most OECD countries has decoupled from real median compensation growth.[2] Increasing productivity no longer appears to be sufficient to raise real wages for the typical worker, suggesting that there is a role for public policies to support a broader sharing of the benefits of productivity gains in the economy.

This article analyses the extent of decoupling of wages from productivity growth in OECD countries over the past two decades. It analyses

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2 Real compensation growth is based on the value added deflator.

whether developments at the macro level mainly reflect changes in labour shares or changes in wage inequality. Existing studies have mainly focused on the United States (Bivens and Mishel, 2015) and Canada (Sharpe *et al.*, 2008), finding that in these countries there has been substantial decoupling of real median wages from labour productivity over the past three decades. The only recent cross-country study (Uguccioni and Sharpe, 2017) finds that there are large cross-country differences in decoupling of real median wages from productivity. The main contributions of this article are to (i) provide evidence on decoupling for the broadest possible range of OECD countries and (ii) to address a number of measurement issues that are likely to bias estimates of decoupling.

The analysis shows that for the covered OECD countries as a whole, total-economy decoupling over the period 1995-2014 is explained by declines in both total-economy labour shares and the ratio of median to average wages (a partial measure of wage inequality). These declines are fully accounted for by pre-2005 developments. Excluding sectors for which labour shares are driven by changes in commodity and asset prices or for which labour shares are driven by imputation choices (primary, housing and non-market sectors) lessens the contribution of labour shares to decoupling. For a number of countries, declines in total-economy labour shares reflect increases in housing rents, which are related to increases in house prices. For commodity-producing countries, declines in total-economy labour shares largely reflect increases in commodity rents. These are, in turn, related to price increases on global markets on which national policies have limited leverage.

While labour shares have declined significantly in about two thirds of the analysed OECD countries covered in this article, all but two countries have experienced significant declines in the ratio of median to average wages over the past two decades. The increase in wage inequality as measured by the decoupling of median from average wage growth appears to reflect disproportionate wage growth at the very top of the wage distribution. While wage growth at the 90th percentile (top 10 percentile) of the wage distribution has been similar to growth at the median, average wage growth for the top 1 per cent has exceeded growth at the median by a multiple.

This article is organised as follows. The first section describes the conceptual framework for decomposing macro-level decoupling into contributions from labour share and wage inequality developments, and provides descriptive evidence for the covered OECD countries. Section 2 investigates the role of the primary, housing, and non-market sectors as well as capital stock depreciation in total-economy labour share developments. Sector-level data on wage inequality for the sample of OECD countries covered by the analysis are not available so that no such analysis can be conducted for the wage inequality component. Section 3 nonetheless provides a more disaggregated perspective on wage inequality developments by analysing the role of disproportionate wage growth of top earners. Section 4 concludes.

Macro-level Decoupling: Overview

Framework

Conceptually, macro-level decoupling between real compensation growth of the median worker and labour productivity growth can be decomposed into the growth differential between average compensation and labour productivity and the growth differential between median and average compensation.

Using the notation Δ per cent X to denote the per cent growth rate of X, macro-level decoupling in this article is defined as follows:

$$Decoupling \equiv \Delta per\ \ cent\left(\frac{Y/P^{Y}}{L}\right) - \Delta per\ \ cent\left(\frac{W^{\text{med}}}{P^{Y}}\right) \quad (1)$$

where Y denotes nominal value added, P^{Y} denotes the value added price, L denotes hours worked and W^{med} denotes the nominal median wage. The first term on the right-hand-side is labour productivity growth and the second term is real median wage growth in terms of the value added price. By adding and subtracting real average wage growth $\Delta per\ cent(W^{\text{avg}}/P^{Y})$ equation (1) can be re-written as follows:

$$Decoupling \equiv \left[\Delta per\ \ cent\left(\frac{Y/P^{Y}}{L}\right) - \Delta per\ \ cent\left(\frac{W^{\text{avg}}}{P^{Y}}\right)\right] + \left[\Delta per\ \ cent\left(\frac{W^{\text{avg}}}{P^{Y}}\right) - \Delta per\ \ cent\left(\frac{W^{\text{med}}}{P^{Y}}\right)\right] \quad (2)$$

where the first term in square brackets denotes the growth differential between labour productivity and the real average wage and the second term in square brackets denotes the growth differential between the real average and the real median wage.

The growth differential between labour productivity and the real average wage can be approximated as $-\Delta per\ cent((W^{\text{avg}} \bullet L)/Y)$, i.e. the per cent decline in the labour share. The growth differential between the real average and the real median wage can be re-written as $\Delta per\ cent(W^{\text{avg}}/W^{\text{med}})$, i.e. the per cent increase in the ratio of the average to the median wage. A high ratio of the average to the median wage typically reflects high compensation at the top of the wage distribution, so that it can be interpreted as a partial measure of wage inequality.

In this article, compensation and value added are deflated by the same value added price index[3] so that decoupling between real average compensation and labour productivity reflects declines in labour shares.[4] Deflating compensation by a consumption deflator and value added by the value added deflator would drive an additional wedge between median wage growth and productivity growth (Uguccioni and Sharpe, 2017). This wedge is largely driven by countries' external terms of trade since the consumption deflator includes imported goods whereas the value added deflator includes only domestic production.[5]

For the countries covered by the analysis as a whole, the growth differential between real wages based on a consumption deflator and the value added deflator has been limited and depends on whether the Final Consumption Expenditure (FCE) deflator from the national accounts or the Consumer Price Index (CPI) is used in the analysis (Appendix Chart A1).[6] However, for a number of commodity-importing countries, real wages based on a consumption deflator would have grown less than real wages

3 Note that the value added price index is different from the GDP price index. GDP includes taxes less subsidies on products whereas value added does not. Value added is thus a more relevant concept to study the relation between labour productivity and wages.

4 Feldstein (2008) argues that wages and value added should be deflated by the same output price index, as the basic economic relation is between nominal wages and the marginal revenue product of labour.

5 Despite the exclusion of this wedge, the analysis here does cover the effects on the labour share and wage inequality of changes in the terms of trade. Only the wedge between the consumption and value added deflator per se is excluded from the analysis.

6 Differences between the FCE deflator and the CPI mainly reflect the treatment of imputed rents of home owner-occupiers. While both actual and imputed rents are included in households' final consumption expenditure for all countries, imputed rents are not included in the basket of goods and services underlying the CPI for a number of countries. The FCE deflator is therefore more comparable across countries than the CPI. See Appendix Chart A1 at: http://www.csls.ca/ipm/32/Schwellnus_Kappeler_Pionnier%20Appendix.pdf

based on the value added price index irrespectively of the precise measure of the consumption deflator used in the analysis (Appendix Table A1).[7]

Data Sources and Definitions

The growth differential between labour productivity and real average compensation in this article is directly computed from national accounts data. Labour productivity is computed as the ratio of real gross value added at factor cost to the number of hours worked while average compensation is computed as the ratio of real compensation to the number of hours worked in the economy. Real gross value added at factor cost is obtained by deflating nominal gross value added at factor cost by the corresponding value added deflator. Total compensation is computed as the sum of the compensation of employees and the compensation of the self-employed, which is imputed by assuming that hourly compensation of the self-employed and of dependent employees is the same at the level of individual industries (see Appendix). The compensation of employees encompasses remuneration in cash and in kind and includes employees' and employers' social contributions. Real compensation is obtained by deflating nominal compensation by the same value added price index used to deflate nominal value added at factor cost. Value added at factor cost, compensation of employees, employment and deflators are sourced from the OECD Annual National Accounts database.

The growth differential between average and median compensation is approximated by the growth differential between gross average and median wages, with gross wages being defined as compensation excluding employers' social contributions. The approximation is imprecise if developments in employers' social contributions differ for the median and average workers. However, more precise data are unavailable since national accounts do not report distributional statistics.[8] Median and average wages are sourced from the OECD Earnings Database that compiles data on gross wages of full-time workers from a variety of sources, including household, labour force and enterprise surveys. Gross wages encompass remuneration in cash and in kind, including regular payments, irregular supplements and employee social contributions. They exclude stock options, severance payments, cash government transfers, transport subsidies and employers' social contributions. Definitions are not fully consistent across countries, with data referring to weekly or monthly wages for most countries but to hourly or annual wages for some others.[9]

The labour share is defined as the ratio of total nominal labour compensation to value added at factor cost. Given that nominal value added is expressed at factor cost, i.e. net of taxes less subsidies on production, value added can be fully decomposed into total labour compensation, including an imputed labour compensation to self-employed workers, and total gross operating surplus (GOS), including the part of the mixed income of self-employed workers considered as GOS. Aggregate wage inequality is approximated by the ratio of median to average wages while top income inequality is approximated by the ratio of median wages of full-time employees to the average wage of the top 1 per

7 See Appendix Table A1 at: http://www.csls.ca/ipm/32/Schwellnus_Kappeler_Pionnier%20Appendix.pdf

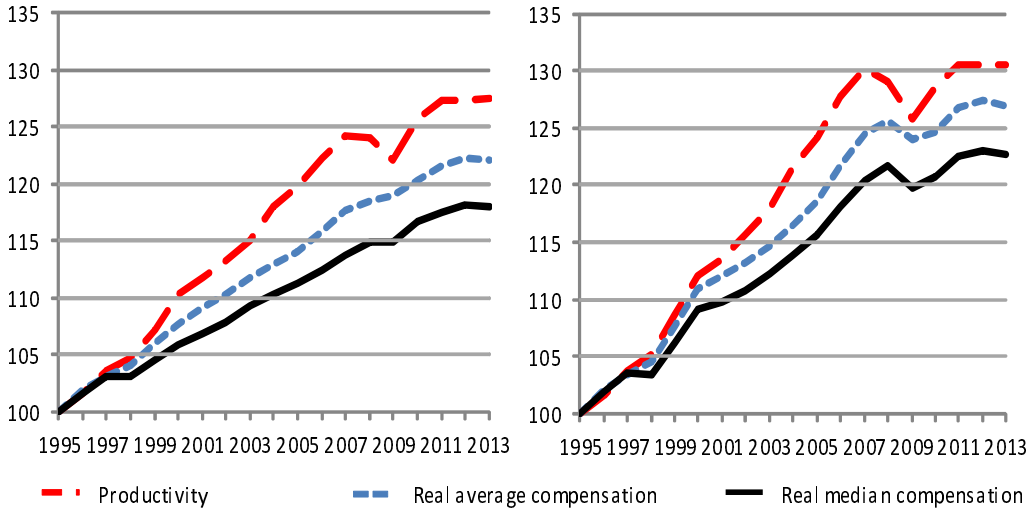
8 In the OECD countries covered by the analysis, employers' social contributions account for around 20 per cent of total compensation.

9 Ideally, median and average wages would be based on the distribution of hourly wages of both part-time and full-time workers. However, focusing on full-time workers has the advantage that the wage distribution is not affected by changes in the share of part-time workers when only the distribution of weekly or monthly wages is available.

Chart 1: Macro-level Decoupling in OECD Countries,1995-2013, (1995 = 100)

Panel A: Total Economy

Panel B: Total Economy Excluding Primary Housing, and Non-Market Sectors



Note: Unweighted average of 24 OECD countries. 1995-2013 for Austria, Belgium, Germany, Finland, Hungary, Japan, Korea, United Kingdom; 1995-2012 for Australia, Spain, France, Italy, Poland, Sweden; 1996-2013 for Czech Republic, Denmark; 1997-2012 for Canada, New Zealand; 1997-2013 for Norway, United States; 1998-2013 for Ireland; 1995-2010 for Netherlands; 2001-2011 for Israel; 2002-2013 for Slovak Republic. In Panel A, all series are deflated by the total economy value added price index. In Panel B, all series are deflated by the value added price index excluding the primary, housing and non-market sectors. The sectors excluded in panel B are the following (ISIC rev. 4 classification): (1) Agriculture, Forestry and Fishing (A), (2) Mining and quarrying (B), (3) Real estate activities (L), (4) Public administration and defence, compulsory social security (O), (5) Education (P), (6) Human health and social work activities (Q), (7) Activities of households as employers (T), and (8) Activities of extraterritorial organizations and bodies (U).

1. "Wage inequality" refers to total economy due to data limitations.

Source: OECD National Accounts Database, OECD Earnings Database.

cent of income earners from the World Wealth and Income Database (Alvaredo *et al.*, 2016).

Results

For the OECD countries covered in this article as a whole, there has been significant decoupling of real median wages from productivity over the past two decades as real median wages have grown at a lower average rate than labour productivity (Chart 1). Based on the total economy measure, median compensation would have been around 8 per cent higher than observed in 2013 if it had perfectly tracked labour productivity since 1995. Based on the measure excluding the primary, housing and the non-market sectors, decoupling implies a 5 per cent loss in compensation for the median worker over the period 1995-2013.

The decoupling of real median wages from labour productivity for the covered OECD countries as a whole reflects both declines in labour shares and increases in wage inequality. In line with previous studies on decoupling (Bivens and Mishel, 2015; Uguccioni and Sharpe, 2017), this article uses as a starting point compensation and value added in the total economy (Chart 1, Panel A). This measure of decoupling suggests similar contributions of declines in labour shares and increases in wage inequality to decoupling. However, the total economy includes sectors for which labour shares are largely determined by fluctuations in commodity and asset prices, such as the primary and

housing sectors, or for which labour shares are driven by imputation choices, such as the non-market sector. Labour share fluctuations in these sectors may have different distributional implications from those in the production sector. Once the primary, housing and the non-market sectors are excluded from the analysis, the contribution of the labour share to decoupling becomes smaller than the contribution of wage inequality (Chart 1, Panel B).

While real median wages have decoupled from labour productivity in the majority of countries (15 of 24) covered by the analysis, there have been large cross-country differences, both in the extent of decoupling and the relative contributions of labour shares and wage inequality (Table 1). Among large OECD countries, there was significant decoupling in Germany, Japan and the United States. In these countries the relative contributions of labour

Table 1: Cross-country Differences in Macro-level Decoupling in OECD Countries, 1995-2013

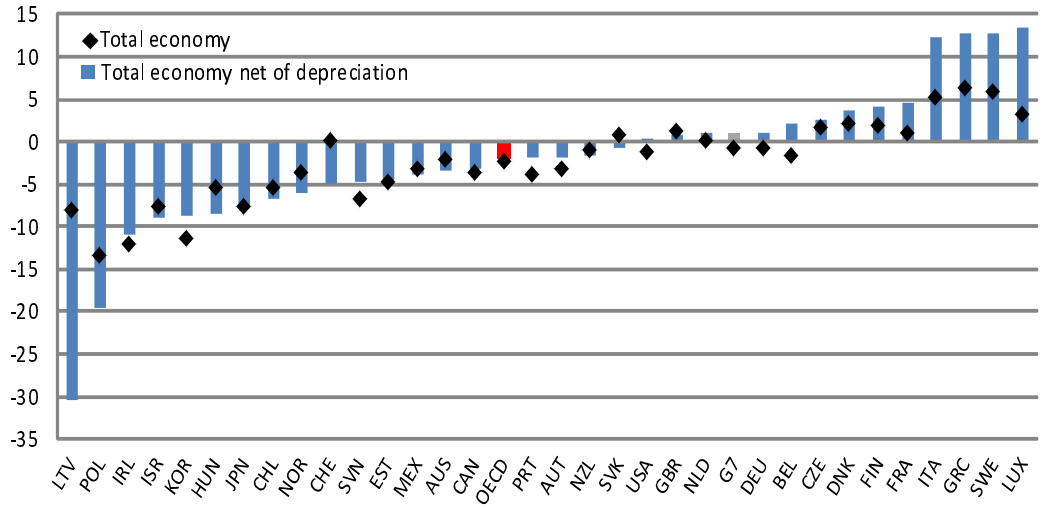
Annualised growth rates; excluding primary, housing and non-market sectors

	(1) Productivity	(2) Real average compensation	(3) Real median compensation	(4) Decoupling (3) - (1)
Australia	1.61	1.25	0.94	-0.67
Austria	1.05	0.88	0.76	-0.29
Belgium	1.50	1.13	1.03	-0.47
Canada	0.84	0.44	0.23	-0.62
Czech Republic	2.91	3.34	2.99	0.08
Denmark	1.25	1.59	1.43	0.18
Finland	1.36	1.90	1.79	0.43
France	1.05	1.32	1.26	0.20
Germany	0.61	0.45	0.34	-0.27
Hungary	1.70	1.25	0.41	-1.29
Ireland	2.67	1.68	1.54	-1.14
Israel	1.08	0.23	0.32	-0.77
Italy	-0.67	-0.03	-0.04	0.63
Japan	0.50	0.03	-0.04	-0.53
Korea	4.07	2.74	2.34	-1.73
Netherlands	1.85	1.37	1.14	-0.71
New Zealand	0.58	1.18	0.83	0.25
Norway	1.68	1.53	1.40	-0.28
Poland	3.64	2.31	1.84	-1.80
Slovak Republic	3.94	3.86	3.61	-0.33
Spain	-0.26	-0.07	0.18	0.44
Sweden	2.15	2.37	2.22	0.07
United Kingdom	1.03	1.63	1.40	0.36
United States	1.44	0.94	0.19	-1.25
OECD	1.57	1.39	1.17	-0.40
G7	0.69	0.68	0.48	-0.21

Note: See note to Chart 1 for country and year coverage. OECD and G-7 averages unweighted.
Source: OECD National Accounts Database, OECD Earnings Database.

Chart 2: Changes in Gross and Net Labour Shares in OECD Countries, 1995-2014

Percentage Points



Note: Three-year averages starting and ending in indicated years. OECD and G7 refer to unweighted averages for the relevant countries included in the figure. 1995-2013 for Australia, Canada, France, Korea, Latvia, Mexico, Portugal; 1996-2014 for Chile; 1997-2014 for United Kingdom; 1996-2012 for New Zealand.

Source: OECD National Accounts Database.

shares and wage inequality differed significantly. For instance, in the United States around 40 per cent of overall decoupling (0.5 percentage points of 1.25 percentage points) is explained by declines in labour shares while this factor explains virtually all decoupling in Japan. In a number of other OECD countries, real median wages have grown at similar or even higher rates than labour productivity. These countries include a number of large countries, such as France, Italy and the United Kingdom, where labour shares have increased and wage inequality has remained broadly constant or increased only modestly over the period.

Dissecting Labour Share Developments

Several recent studies have emphasised that distributional and policy implications of labour share changes depend on the inclusion of capital depreciation and housing rents in value added (Rognlie, 2015; Bridgman, 2014). This section provides an in-depth analysis of labour share developments, including for OECD countries for which overall decoupling cannot be computed because data on the wage distribution are unavailable.[10]

Gross or net labour shares?

Even though most analyses of labour shares are based on gross value added, only value added

10 The labour share analysis is based on National Accounts data only. Therefore, the country sample and time coverage changes compared to the overall decoupling analysis, which also makes use of Labour Force Surveys. Notably, the labour share analysis includes additionally the year 2014 and the following countries: Estonia, Greece, Latvia, Lithuania, Luxembourg, Portugal and Slovenia. The labour share analysis also changes the time coverage for a number of countries. For instance, the labour share analysis for Norway covers 1995-2014, instead of 1997-2013; the labour share analysis for Slovak Republic covers 1995-2014, instead of 2002-2013. For further details see Footnotes to Chart 1 and Table 2.

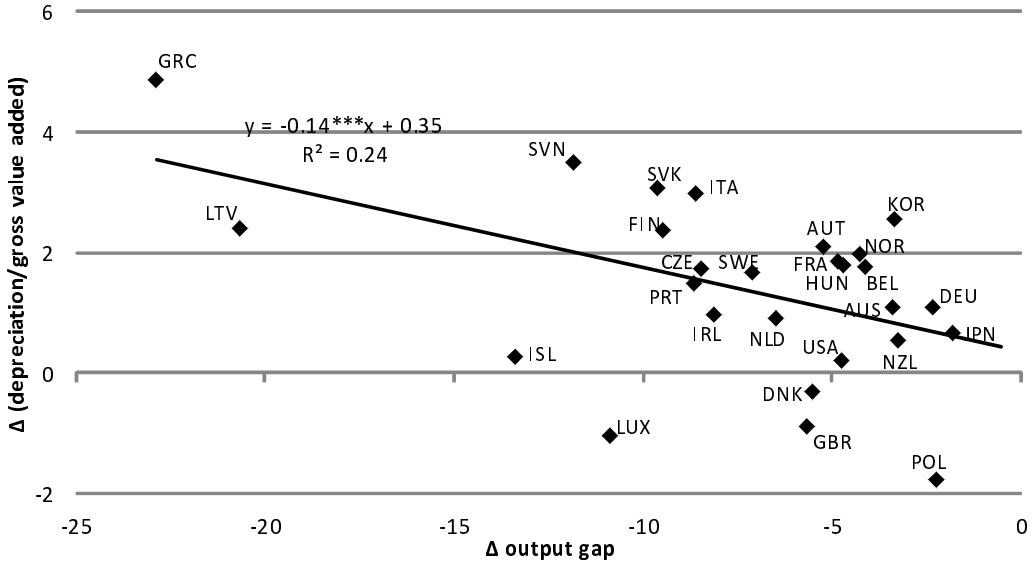
net of capital consumption is available for compensation of workers and capital owners once productive capital has been restored to its pre-production level.[11] From an income distribution perspective, it may therefore be more appropriate to base labour shares on net rather than gross value added (Bridgman, 2014; Rognlie, 2015; Cho *et al*., 2017).

For the analysed OECD countries and the G7 countries as a whole, developments in gross and net labour shares over the period 1995-2014 have been similar (Chart 2). This is consistent with Rognlie (2015, Figures 1 and 2) who shows that average net and gross labour shares of G7 countries diverged before 1975 but evolved similarly thereafter. However, for some countries there have been large differences between net and gross labour share developments.

There is little empirical evidence in the national accounts that differences between the evolution of gross and net labour shares are related to longer-term technological developments. The increase of around 2 percentage points in the average value added share of capital depreciation for the analysed OECD countries over the past two decades is commonly attributed to the substitution of rapidly depreciating ICT capital for more slowly depreciating traditional equipment (Appendix). However, the increase in the share of ICT capital in the total capital stock in volume terms (Appendix Chart A3) has been offset by the decline in relative prices so that the substitution of ICT equipment for other types of equipment cannot explain the increase in the value added share of depreciation, which is measured at current prices (Appendix Chart A4). In fact, the share of ICT capital in the total capital stock at current prices has remained broadly constant or has even

Chart 3: Relationship between the Change in Depreciation Share and Change in the Output Gap in OECD Countries, 2007-2014

Percentage point changes



Note: The ratio of depreciation to gross value added is expressed in current prices. 2007-2013 for Korea, Portugal, Sweden and United Kingdom; 2007-2012 for New Zealand.

Source: OECD National Accounts Database, OECD Economic Outlook Database.

11 Analyses based on gross labour shares include Karabarbounis and Neiman (2014); Pionnier and Guidetti, (2015); and OECD (2012).

declined for OECD countries (Appendix Chart A5).[12]

There is more support in the data for the hypothesis that the share of depreciation in gross value added is highly counter-cyclical, which implies that net labour share developments are largely driven by the business cycle rather than structural developments. The relationship between changes in the share of depreciation in value added and changes in output gaps appears to be negative (Chart 3). Greece, for instance, experienced the largest widening of the output gap over 2007 and 2014 and is the country in the sample for which the share of depreciation in value added increased most. The increase in the value added share of depreciation appears to mainly reflect cyclical developments rather than a long-term structural change driven by the long-term decrease in ICT prices.

In sum, the business cycle affects gross value added much more than capital consumption, thus implying that the value added share of depreciation is highly counter-cyclical. This makes it difficult to separate structural changes — which are the main focus of this article — from cyclical changes in the net labour share. Consequently, the remainder of the article focuses on gross labour shares.

Total-economy labour shares or labour shares excluding the primary, housing and non-market sectors?[13]

The decline in the total-economy labour share observed in many OECD countries may partly be driven by developments in specific industries for which there are significant conceptual and measurement issues. For instance, total-economy labour shares are partly driven by developments in housing rents. Although the typical worker may actually benefit more from increases in housing rents than from other forms of capital income, the overwhelming part of housing rents ends up in gross operating surplus (i.e. capital income) in the national accounts. Given that the labour share in the housing sector is well below the labour share of the total economy, an increase in the share of housing to total value added puts downward pressure on the total-economy labour share (Box 1).

A further issue with total-economy labour shares is that labour share developments are partly driven by commodity price developments and by imputation choices in the non-market sector (Table 1). For countries with large primary sectors (agriculture, forestry, fishing, mining and quarrying as well as extraction of oil and gas), developments in total-economy labour shares are largely driven by developments in commodity prices; when commodity prices increase, aggregate profits rise without commensurate increases in aggregate wages.[14] In Norway, for instance, where the oil and gas sec-

12 See Appendix at: http://www.csls.ca/ipm/32/Schwellnus_Kappeler_Pionnier%20Appendix.pdf

13 This article uses industry accounts and imputes labour compensation of the self-employed at the industry level rather than following the approach of Rognlie (2015) and Karabarbounis-Neiman (2014) of using the non-financial corporations' institutional account without correction for the self-employed. As in Rognlie (2015) and Karabarbounis-Neiman (2014). Pionnier and Guidetti (2015) have shown that in the national accounts of some countries self-employed workers are allocated to the non-financial corporations' institutional sector, thereby affecting levels and trends of non-financial corporations' labour shares.

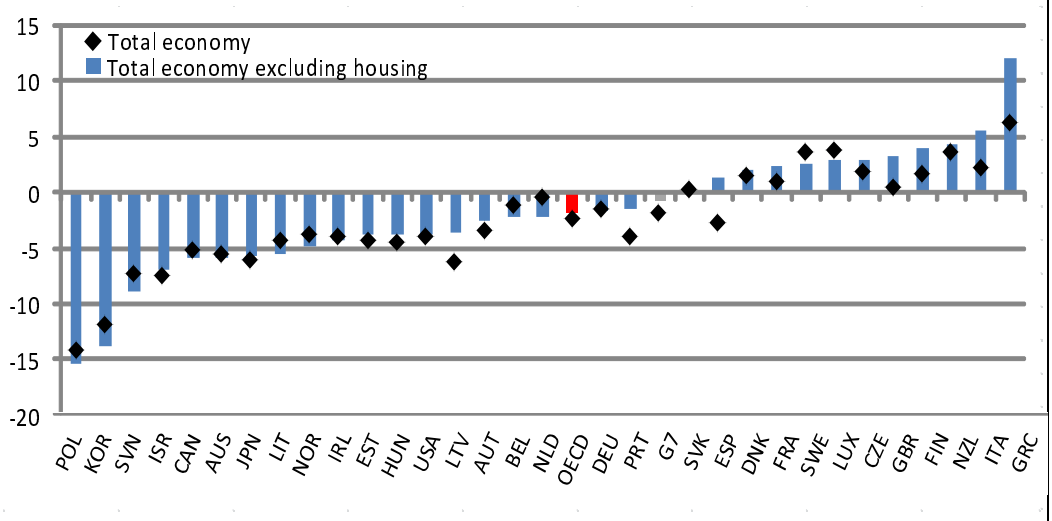
14 The decline in the aggregate labour share partly reflects a change in industry composition: as commodity prices increase, the share of the mining sector - for which the labour share is low - in total value added increases.

Box 1: Have Increased Housing Rents Contributed to Declines in Labour Shares?

For a number of countries, increases in housing rents contributed to declines in total-economy labour shares (Box Chart 1). Between 1995 and 2014, the share of the housing sector in total value added increased by more than 4 percentage points in Greece, Italy, Latvia, Portugal and Spain, and by more the 2 percentage points in the Czech Republic, Finland, Israel and United Kingdom (Appendix Chart A6). Housing value added consists of rents paid by tenants to landlords and imputed rents of homeowners which are both included in the national accounts. Since the share of this value added distributed as labour compensation is low or non-existent (employment in the housing sector mainly corresponds to real estate agents and employees of corporations engaged in renting activities), the overwhelming part of housing value added ends up in gross operating surplus (i.e. capital income) in the national accounts. Given that rents and house prices are highly correlated, a house price boom typically raises the total-economy capital share.

Box Chart 1: Change in Labour Shares of the Total Economy and Total Economy Excluding Housing in OECD Countries, 1995-2014

Percentage points



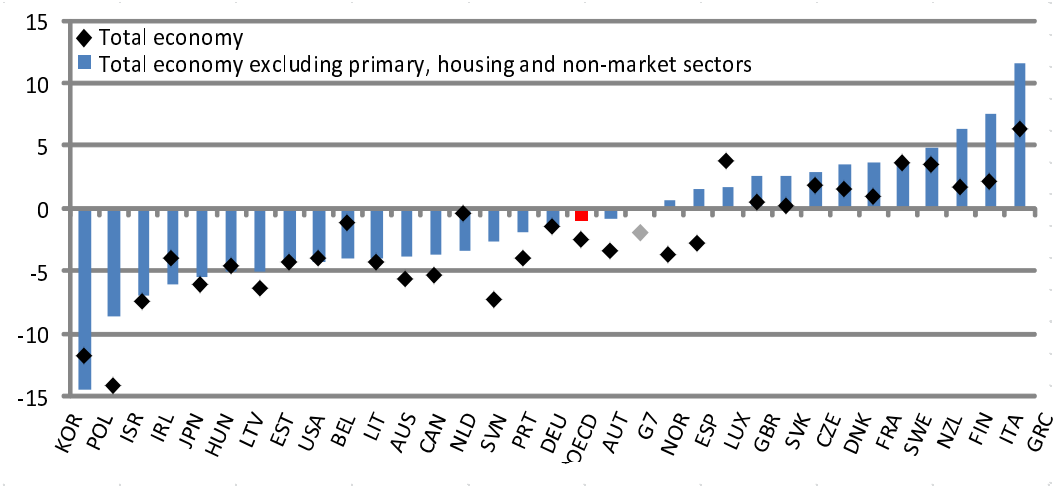
Note: Three-year averages starting and ending in indicated years. OECD and G7 refer to unweighted averages for the relevant countries included in the figure. 1995-2013 for Australia, France, Korea and Portugal; 1995-2012 for New Zealand; 1997-2012 for Canada; 1997-2014 for United Kingdom; 1998-2014 for Ireland and United States.
Source: OECD National Accounts Database.

The distributional consequences of increases in housing rents may be different from increases in capital income in the production sector of the economy. Housing wealth is more equally distributed in the population than productive capital so that increases in housing rents can be seen as an indirect channel through which income is transmitted to the typical worker (Murtin and Mira d'Ercole, 2015; Sierminska and Medgyesi, 2013).

Increases in housing rents and their distribution across workers raise a set of public policy issues unrelated to product and labour markets that are the main focus of this article. Increases in housing rents could, for instance, be addressed by public policies directly targeting the housing market, in particular by loosening overly restrictive land-use regulations. This would have the double benefit of raising workers' access to homeownership and limiting rent increases for tenants.

Chart 4: Changes in the Total Economy Labour Share with and without the Primary, Housing and Non-market Sectors in OECD Counties, 1995-2014

Percentage points



Note: Three-year averages starting and ending in indicated years. OECD and G7 refer to un-weighted averages for the relevant countries included in the Figure. 1995-2013 for Australia, France, Korea and Portugal; 1995-2012 for New Zealand; 1997-2012 for Canada; 1997-2014 for United Kingdom; 1998-2014 for Ireland and United States.

Source: OECD National Accounts Database.

tor is large, the non-housing labour share declined by around 5 percentage points over the period 1995-2014, but it increased by around 1 percentage point when agriculture, mining and non-market sectors are excluded as oil prices increased over the period covered by the analysis (Table 1).[15] Moreover, national accounting conventions for the non-market sector may bias developments in labour shares. Value added in the non-market sector is equal to the sum of wage compensation and capital consumption, which artificially implies limited variation over time.[16]

Declines in labour shares have typically been smaller (and increases larger) when housing, the primary sector (agriculture and mining) and the non-market sector are excluded from the analysis (Chart 4). The primary, housing and non-market sectors represent about one third of total value added on average across OECD countries.

Moreover, changes in the labour share of both the total economy and in this narrower aggregate have not been uniformly negative. For about two thirds of the analysed OECD countries, labour shares declined between 1995 and 2014 while they increased for the remaining third. This finding is consistent with Cho *et al.* (2017) who also conclude that there has been a small decline in the average gross labour share of 23 OECD countries over the last 20 years, but with substantial heterogeneity across countries. In their sample, gross labour shares declined in 14 countries, whereas they increased in the remaining 9 countries.

15 Since profits of the Norwegian mining sector partly flow into a sovereign wealth fund benefiting future generations of workers, the decline in the total-economy labour share overstates the extent to which value added is appropriated by capital.

16 The finance sector is included in the analysis. Excluding the finance sector would only have a marginal effect on labour share developments for most countries, the exception being Luxembourg for which the labour share would increase by an additional 2 percentage points if the finance sector were excluded.

Table 2: Changes in Labour Shares in OECD Countries, 1995-2014
Percentage points

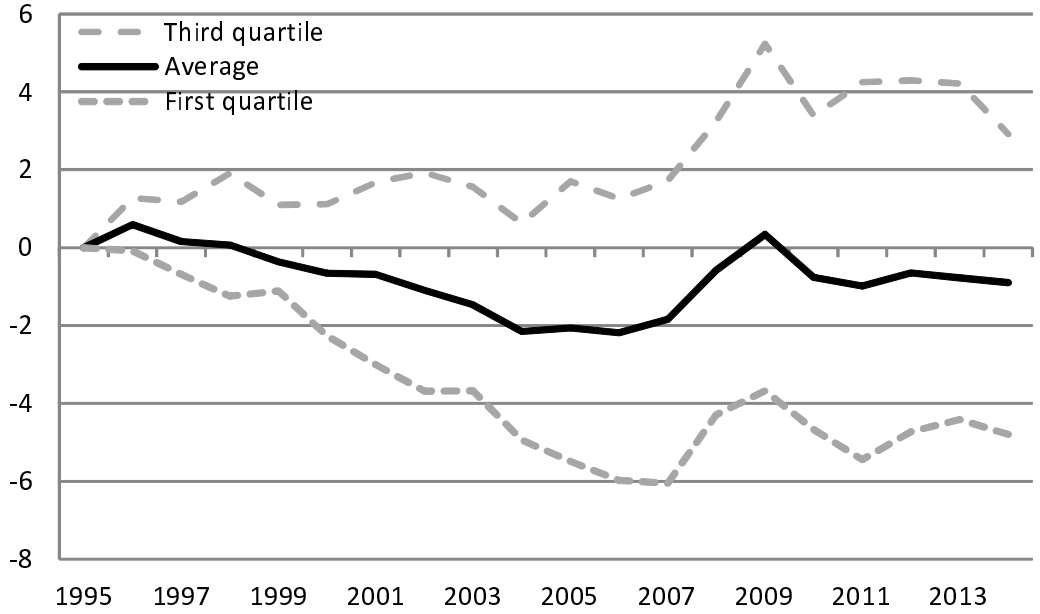
	(1) = Total economy	(2) = (1) excl. housing	(3) = (2) excl. primary sector	(4) = (3) excl. public sector
Australia	-5.7	-5.9	-2.5	-3.9
Austria	-3.5	-2.6	-0.7	-0.9
Belgium	-1.3	-2.2	-2.3	-4.0
Canada	-5.3	-5.9	-3.4	-3.7
Czech Republic	1.8	3.0	3.2	2.8
Denmark	1.5	2.1	3.4	3.5
Estonia	-4.3	-3.8	-2.0	-4.4
Finland	1.6	3.9	4.9	6.4
France	0.9	2.3	2.7	3.6
Germany	-1.6	-1.7	-1.3	-1.5
Greece	6.2	12.0	10.5	11.6
Hungary	-4.6	-3.8	-3.6	-5.1
Ireland	-4.0	-4.2	-4.0	-6.1
Israel	-7.5	-6.9	-6.8	-7.0
Italy	2.1	5.5	5.9	7.6
Japan	-6.1	-5.6	-5.2	-5.5
Korea	-11.9	-13.8	-12.7	-14.5
Latvia	-6.4	-3.7	-1.4	-5.0
Lithuania	-4.4	-5.5	-4.0	-4.0
Luxembourg	3.7	2.9	2.5	1.7
Netherlands	-0.5	-2.1	-2.0	-3.4
New Zealand	3.5	4.4	5.1	4.8
Norway	-3.8	-4.7	1.4	0.7
Poland	-14.2	-15.4	-8.0	-8.6
Portugal	-4.1	-1.5	-2.0	-1.9
Slovak Republic	0.2	0.3	1.9	2.6
Slovenia	-7.4	-8.9	-2.0	-2.7
Spain	-2.8	1.2	0.9	1.5
Sweden	3.6	2.5	2.7	3.6
United Kingdom	0.4	3.3	3.0	2.6
United States	-4.0	-3.7	-2.5	-4.3
OECD	-2.5	-1.9	-0.6	-1.1
G7	-1.9	-0.8	-0.1	-0.2

Note: Three-year averages starting and ending in indicated years. OECD and G7 refer to unweighted averages for the relevant countries included in the Table. 1995-2013 for Australia, France, Korea and Portugal; 1995-2012 for New Zealand; 1997-2012 for Canada; 1996-2014 for Chile; 1997-2014 for United Kingdom; 1998-2014 for Ireland and United States.
Source: OECD National Accounts Database.

For a number of countries, the change in the labour share is significantly more positive when the housing sector is excluded from the analysis (Table 2, Column 2). For most of these countries, including Greece, Italy, Spain and the United Kingdom, this reflects house price booms in the run-up to the global crisis of 2008-09 that were followed by a slow downward adjustment of rents in the subsequent bust so that the share of rents in value added increased over the period 1995-2014. For countries with large primary sectors, such as Australia, Canada and Norway, labour share developments are significantly more positive when the primary sector

Chart 5: Cumulated Change in Labour Share excl. Primary, Housing and Non-market Sectors in 31 OECD Countries, 1995-2014

Unweighted average, in percentage points



Note: 1995-2014 for Austria, Belgium, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Greece, Hungary, Israel, Italy, Japan, Lithuania, Latvia, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia and Sweden; 1995-2012 for New Zealand;1995-2013 for Australia and Korea; 1997-2012 for Canada; 1998-2014 for Ireland and United States.

Source: OECD National Accounts Database.

is excluded from the analysis, which reflects the trend increase in commodity prices over the period 1995-2014 (Table 2, Column 3). On the whole, for the OECD countries covered by the analysis the commodity price effect appears to be larger than the house price effect. Excluding the non-market sector typically amplifies changes in labour shares stemming from the remaining sectors because the labour share in the non-market sector is broadly stable (Table 2, Column 4).[17]

Pre- or post-crisis developments?

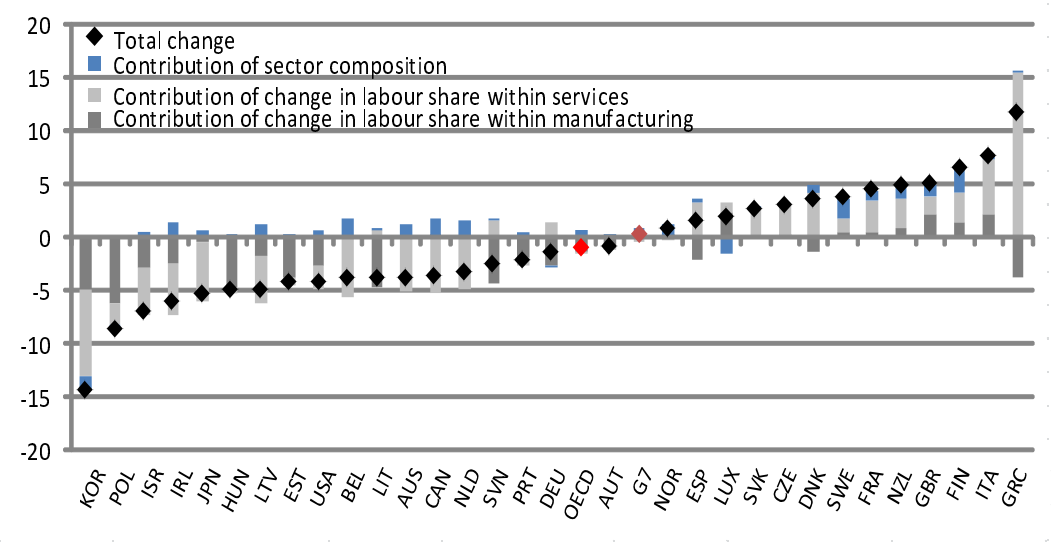
Most of the decline in the business labour share excluding the housing and primary sectors took place before the global crisis of 2008-09 (Chart 5). However, labour share developments have been very heterogeneous across countries, with no pre-crisis decline for the country at the third quartile of the distribution of cumulated labour share changes and a large decline for the country at the bottom quartile. Given that this narrowly defined labour share is not affected by house and commodity price developments, the timing of the decline and rebound suggests that the structural factors that drove down the labour share before 2005 weakened thereafter.

The timing of the decline and the rebound of the labour share is consistent with evidence suggesting that the pace of expansion of global value chains associated with China's integration

17 The stability of the labour share in the non-market sector reflects to a large extent the national account convention that value added in the government sector is equal to labour compensation plus consumption of fixed capital, so that the labour share is highly stable and around 1.

Chart 6: Contribution of Manufacturing and Services to Labour Share Developments in OECD Countries, 1995-2014

Excluding primary, housing and non-market sectors, percentage points



Note: Three-year averages starting and ending in indicated years. OECD and G7 refer to unweighted averages for the relevant countries included in the Figure. 1995-2013 for Australia, Korea; 1995-2012 for New Zealand; 1997-2012 for Canada; 1998-2014 for Ireland and United States.
Source: OECD National Accounts Database.

into the world trading system — which may have contributed to labour share declines (IMF, 2017) — slowed in the wake of the global crisis of 2008-09 (Ferrantino and Taglioni, 2014). Alternative explanations could be the slowing pace of IT-related technological change or the reduced scope of regulatory reforms, especially in network industries, which appear to be two major drivers of labour share declines (Karabarbounis and Neiman, 2014; Azmat *et al.*, 2012). The post-2005 rebound in the labour share may partly also reflect business cycle conditions, with limited downward adjustment of wages relative to profits during and in the wake of the global economic crisis.

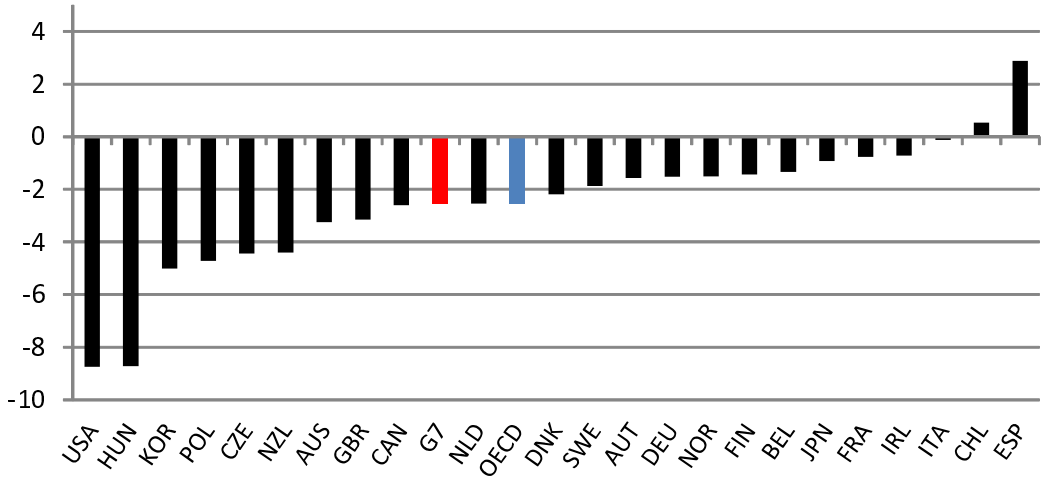
Manufacturing or services?

In most of the countries examined here, changes in labour shares when primary, housing and non-market sectors are excluded reflect similar rather than diverging developments in manufacturing and services and a limited role of changes in industry composition (Chart 6).[18] If labour share developments were entirely driven by declines in labour shares within manufacturing — which is more exposed to increased trade integration than services — or by a shift in industry composition from manufacturing to services, this would suggest globalization as the most plausible explanation of aggregate labour share developments. However, the similarity of developments in services and manufacturing does not imply that technological change is the ultimate source of aggregate labour share developments as globalization may induce technological change or displace manufacturing workers that are then re-employed in services at lower wages.

18 This is consistent with previous studies suggesting that labour share developments are overwhelmingly driven by developments within industries (OECD, 2012; De Serres *et al.*, 2001).

Chart 7: Change in Ratio of Median to Average Wages in OECD countries, 1995-2013

Percentage points



Note: Three-year averages starting and ending in indicated years. OECD and G7 refer to unweighted averages for the relevant countries. 1996-2013 for Chile, Czech Republic, Denmark; 1995-2012 for Australia, Spain, France, Italy, Poland, Sweden; 1997-2013 for Norway, New Zealand; 1998-2013 for Canada; 1995-2010 for Netherlands.

Source: OECD Earnings Database.

Dissecting Wage Inequality Developments

Increases in wage inequality have contributed to aggregate decoupling by reducing the ratio of median to average wages in a wide range of OECD countries. The average decline in the ratio of median to average wages based on the OECD Earnings Database was around 2 percentage points over the period 1995-2014, but for a number of countries, including the Czech Republic, Hungary, Korea, New Zealand, Poland and the United States, declines in the ratio were significantly more pronounced (Chart 7). Of the analysed OECD countries only Chile, Italy and Spain bucked the trend of increasing wage inequality.

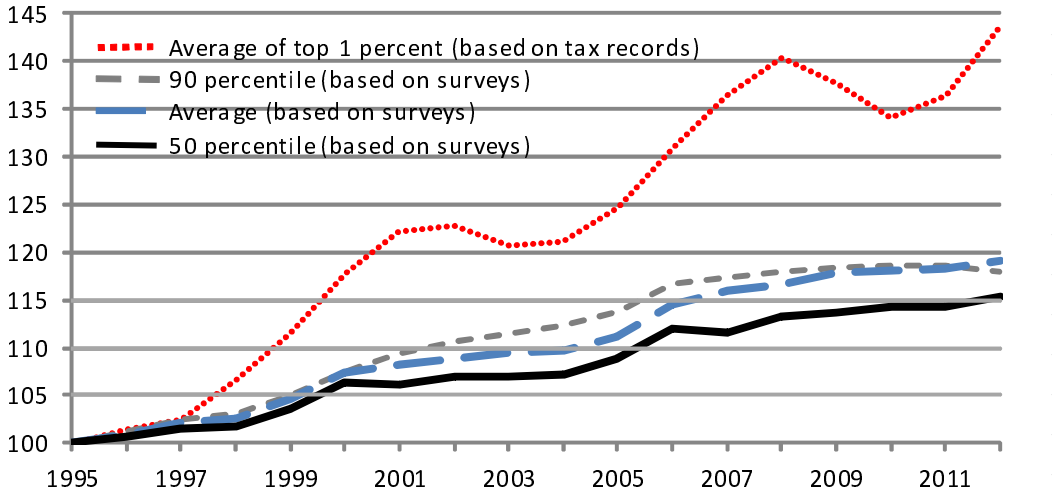
The decline in the ratio of median to average wages appears to be overwhelmingly driven by high wage growth of top earners. Information on wages of workers at the top of the wage distribution from surveys is unreliable — which reflects top-coding, sampling issues and under-reporting — so that it is preferable to base wage growth of top earners on tax records.[19] Alvaredo *et al*. (2016) provide average wage income of the top 1 per cent of income earners, which likely overlaps with the top 1 per cent of wage earners. According to these data, which are available only for a limited number of countries, the most striking development over the past two decades has been the divergence of wages of the top 1 per cent of income earners from both the 90th percentile and the median of wage earners (Chart 8).[20] Well-known explanations for increased wage inequality such as skill-biased technological change and globalization cannot plausibly account for the disproportionate wage growth at the very top of the wage distribution. Skill-biased technological change and globalization may both raise the relative demand for high-skilled workers, but this should be reflected in broadly rising relative wages of high-skilled

19 Atkinson *et al*. (2011), Burkhauser *et al*. (2012), Deaton (2005) and Ruiz and Woloszko (2016) discuss issues with the coverage of top earners in surveys.

20 To the extent that surveys only incompletely capture wage growth at the top of the wage distribution and therefore underestimate average wage growth, the actual decoupling of median from average wages may be larger than suggested by surveys.

Chart 8: Wages Trends in OECD Countries by Group, 1995-2012

Index, 1995=100



Note: Indices based on unweighted average for seven OECD countries: Australia (1995-2010), Spain (1995-2012), France (1995-2006), Italy (1995-2009), Japan (1995-2010), Korea (1997-2012), and United States (1995-2012), for which data on wages of the top 1 per cent of income earners are available. All series are deflated by country-specific value added price indices.

Source: OECD Earnings Database; World Wealth and Income Database.

workers rather than narrowly rising relative wages of top-earners. Brynjolfsson and McAfee (2014) argue that digitalisation leads to "winner-take-most" dynamics, with innovators reaping outsize rewards as digital innovations are replicable at very low cost and have a global scale. Recent studies provide evidence consistent with "winner-take-most" dynamics, in the sense that productivity of firms at the technology frontier has diverged from the remaining firms and that market shares of frontier firms have increased (Andrews *et al*., 2016). This type of technological change may allow firms at the technology frontier to raise the wages of their key employees to "superstar" levels.

Conclusion

This article is limited to a quantitative description of decoupling of real median wages from labour productivity in OECD countries as well as its proximate causes, i.e. changes in labour shares and wage inequality. The cross-country heterogeneity in these movements and the fact that wage inequality is mainly driven by high wage growth of top earners suggest that longer-term global trends such as technological change and globalization alone cannot fully account for decoupling of wages from productivity. Country-specific factors, including public policy settings, may play a significant role in shaping the effects of global trends on labour shares and wage inequality.

Further research needs to investigate the structural causes of the decoupling of wages from productivity and the relation with economic policies. Country- and sector-level data could be used to analyse the extent to which movements in labour shares and wage inequality are related to measures of technological change, trade integration and public policies. Of particular interest is the issue whether digitalization, declining real investment prices and trade integration with labour-abundant countries reduce labour shares and raise wage inequality and whether public policies can play a mitigating role. Micro-level data could be used to analyse

the transmission of productivity gains to wages at the firm level, in particular whether macro-level decoupling reflects changes in the composition of firms or changes within firms and the role of public policies in these developments.

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The Relationship Between Global Value Chains and Productivity

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OECD[1]

ABSTRACT

We review the evidence linking Global Value Chains (GVCs) and productivity. GVCs are a key feature of the world economy, with production increasingly fragmented across borders. However research has uncovered that GVCs are not primarily global in nature, but focused around regional clusters of production, and services and multinationals (MNEs) play a key role in these networks. A broad literature using both industry and firm-level data has uncovered that participating in GVCs can stimulate productivity growth through a myriad of channels. These include the potential for firm specialisation in core tasks, access to imported inputs, knowledge spillovers from foreign firms and pro-competitive effects of foreign competition. However, there are many potential obstacles to seizing the opportunities for growth. The changing organisation of production across firms and countries emphasises the importance of some well-established policy levers (such as trade policy) as well as some of those previously under-explored (such as domestic service market competition). Embeddedness within GVCs may also expose firms to new sources of risk and affect resilience of economies, as a shock to one part of the supply chain can propagate throughout production networks.

Global Value Chains (GVCs) are a key feature of the world economy. Production is increasingly fragmented across country borders, with various parts of the production process, from design to distribution, segmented across different countries (Baldwin, 2012). Firms are part of complex production networks that embody diverse goods and services inputs from other domestic and foreign firms.[2] Trade flows of any firm and country embody the value-added of a myriad of different countries and suppliers further up the value chain. This article provides a brief overview of what we currently know about the links between GVCs and productivity.

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2 Richard Baldwin calls this "the second great unbundling," i.e. the end of the need to perform most production stages next to each other: because of rapidly falling communication and coordination costs, production can be sliced and diced into separate fragments that can be spread around the globe.

GVCs reflect the segmentation of production across multiple countries.[3] Part of the literature often focuses on the outsourcing/offshoring aspect of GVCs, measured by gross trade in intermediate inputs (goods or services).[4] However, GVC participation is much wider than simply trading intermediate goods or offshoring. The availability of inter-country input-output tables has enabled different measures of GVC participation that reflect foreign value added that is both directly and indirectly embodied in trade.[5] Whilst the offshoring decision of inputs is clearly relevant, backward GVC participation also reflects indirect linkages along the whole supply chain network (such as suppliers of suppliers etc.), reflecting the ultimate sources of value-added. In addition, offshoring concerns only the sourcing of inputs, but forward GVC participation reflects the destination of value added, i.e. whether domestic value added is used in the exports of third countries (customers of customers).

The arrival of new trade in value-added metrics has uncovered that GVCs are becoming an increasingly important feature of the world economy, allowing measurement of all the sources of value-added ultimately embedded in exports. These metrics are an alternative way of expressing trade flows. Instead of being based on the source of gross trade observed at the border, these value-added metrics reflect the sources of value-added embodied in these gross flows.[6] They show that a substantial proportion of value-added comes from foreign firms and sectors — the so-called measure of "GVC participation" (which may be across different unaffiliated firms-between-firm trade — or between foreign affiliates of MNEs — within-firm trade). Production is increasingly clustered in regional supply chains, and services and multinationals (MNEs) play a key role in these networks.

The evidence presented in this article derives from complementary industry and firm-level sources. A small, but growing, body of work has begun to use these newer industry-level measures to examine links between GVC participation and productivity (e.g. Contantinecu *et al.*, 2017; Kummritz, 2016; Taglioni and Winkler, 2016). These build upon earlier studies using industry-level measures of offshoring from the perspective of the offshoring country (e.g. Egger and Egger, 2006; Amiti and Wei, 2009; Winkler, 2010). In contrast, the recent availability of detailed firm-level data has allowed a deep examination of the productivity mechanisms for some aspects of GVC participation, such as firm offshoring, gross trade in goods and foreign direct investment (FDI). However, studies examining broader aspects of GVCs, such as the role of services or intangible inputs and also indirect participation in GVCs at the firm level (for example as a domestic supplier of exporters) are only recently being uncovered (e.g. Dhyne and Rubinova, 2016).

This research has uncovered that participating in GVCs can stimulate productivity growth through many possible channels, as we outline

3 A range of related concepts have been introduced, including offshoring (Feenstra and Hanson, 1996), trade in intermediates (Antweiler and Trefler, 2002), fragmentation (Deardorff, 2001; Jones and Kierzkowski, 2001, Arndt and Kierzkowski, 2001), slicing the value chain (Krugman, 1995); trade in tasks (Grossman and Rossi Hansberg, 2008) and vertical specialization (Hummels, Ishii, and Yi, 2001).

4 For example, see materials offshoring measures of Feenstra and Hanson (1996, 1999) or services offshoring of Amiti and Wei (2009).

5 See for example, Johnson and Noguera, 2012, Koopman *et al.*, 2014, which build on the vertical specialization measures of Hummels *et al.*, 2001.

6 Accordingly, aggregating these different domestic and foreign sources of value-added results in gross trade itself.

in section 2. First, firms can specialise in their most productive, core activities and outsource their least productive tasks. Second, firms can gain from access to a larger variety of cheaper and/or higher quality and/or higher technology imported inputs. Third, interaction with frontier foreign (multinational) firms may facilitate knowledge spillovers through domestic supply chains. Fourth, access to larger markets and competition from foreign firms leads to the growth of more productive firms through leveraging scale economies while at the same time inducing the exit of the least productive firms.

Many of the policy lessons drawn from research on gross trade are clearly also relevant for GVCs. However, this may not be universally true, which we discuss in section 3. On the one hand, the changing organization of production across firms and countries emphasises the importance of some well-established policy levers in the context of GVCs (such as trade policy). On the other hand, some previously underexplored policy levers (such as domestic service market competition and debates about co-location of activities) may be brought to the forefront. The rise of complex supply chains therefore brings a new perspective to the policy debate.

This article is organised as follows. In the first section we highlight some key facts uncovered in recent analyses of GVCs, in particular, drawing on trade in value-added metrics. Secondly, we outline some of the salient issues for performance that have been uncovered so far. Thirdly, we illustrate some policy implications emphasised by GVCs. Finally, we discuss how embeddedness within GVCs may affect the resilience of economies to economic shocks, and conclude.

Background: Some Key Facts and Trends

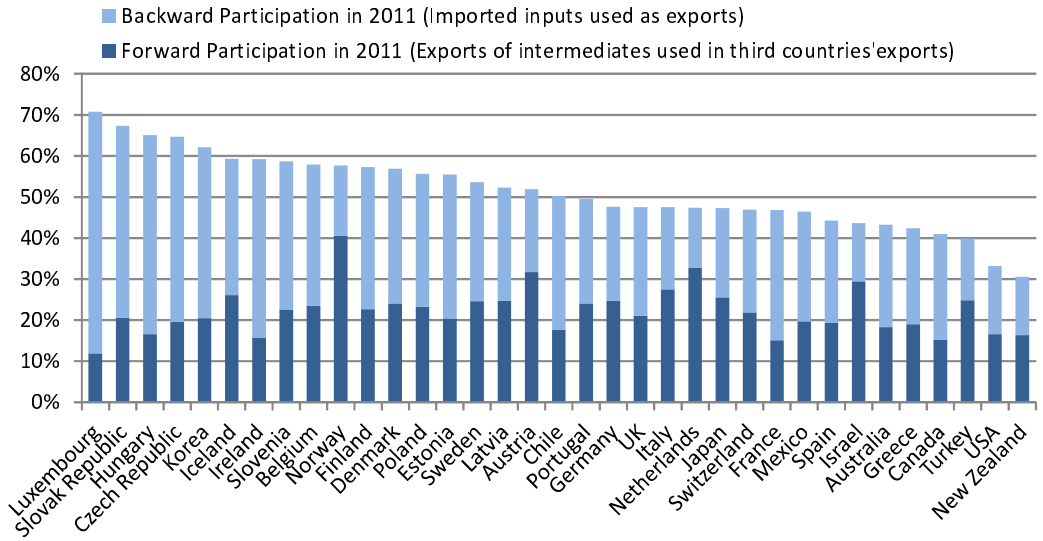
Economies can participate in GVCs by using imported inputs in their exports (the so-called backward linkages in GVC) or by supplying intermediates to third country exports (forward linkages). The overall participation in GVCs which is the total of backward and forward participation differs substantially across countries. Overall participation measure (measured as the sum of backward and forward linkages) reflects the importance of GVCs for an economy, with GVCs accounting for between one-third and two-thirds of gross exports (of goods and services) for OECD economies in 2011 (see summation of backward and forward linkages in Chart 1). At one extreme Luxembourg's overall participation is 71 per cent of their gross exports, whereas New Zealand's participation is 33 per cent of gross exports.

GVC participation depends on many factors. Typically, smaller, open economies that are close to large foreign markets are more integrated into GVCs (such as Luxembourg and other small European economies). Whereas larger economies (such as the US) and those that are more geographically remote (such as New Zealand) are less integrated into GVCs (OECD, 2013a)

In recent decades participation in GVCs has increased, presenting new opportunities for growth. The overall participation in GVCs has increased for every OECD member economy between 1995 and 2011 (Chart 2).[7] This presents a different picture from gross trade over the same period, with which GVC participation is only weakly correlated , and for some countries the two metrics show a very different pic-

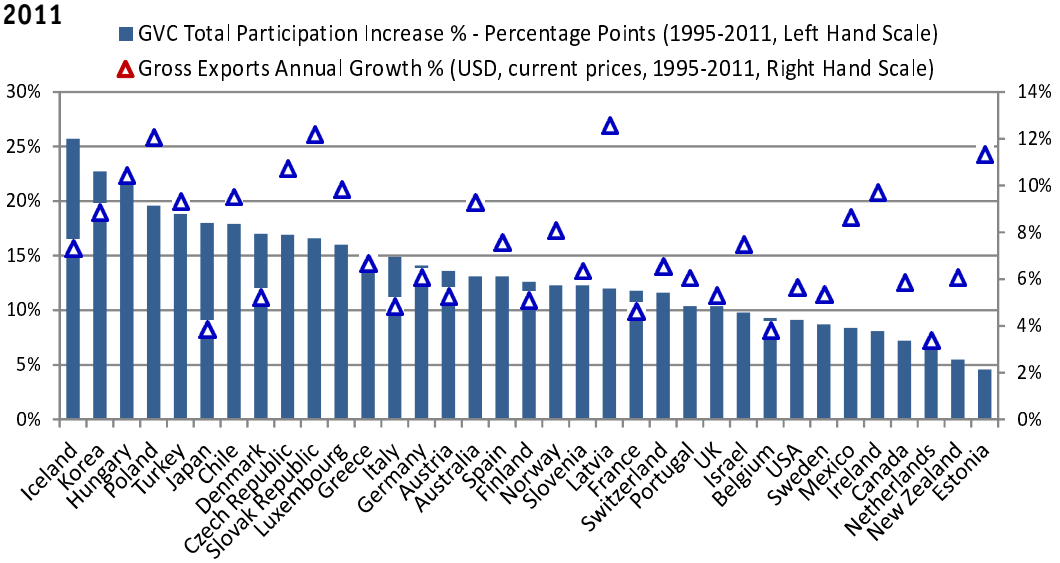
7 In most OECD countries the increase in GVC participation in the post-crisis period has been much slower than pre-crisis. According to the authors' calculations based on the OECD-WTO TiVA Database (2015 Edition), only Eastern Europe did not experience a slowdown after the crisis: their increase in GVC participation was faster in 2008-2011 than in 2005-2008.

Chart 1: Decomposing Overall GVC Participation into Backward and Forward Components in OECD Countries, 2011 (per cent of gross exports)



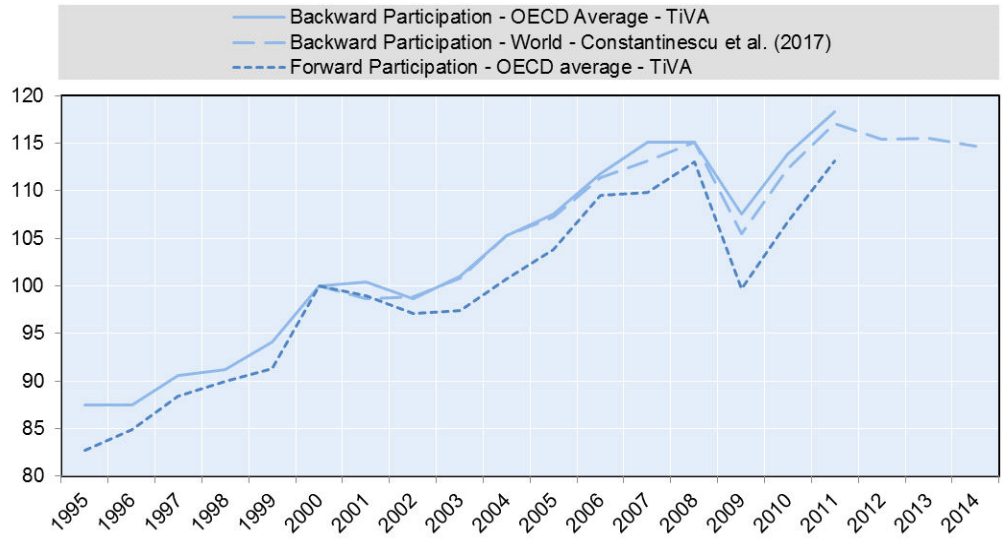
Source: Authors' calculations based on OECD-WTO TiVA Database, 2015 Edition

Chart 2: GVC Participation Increase & Gross Exports Growth in OECD Countries, 1995 - 2011



Source: Authors' calculations based on OECD TiVA Database, 2015 Edition. Total GVC participation is the sum of backwards and forwards participation. Gross exports reflect both intermediate and final exports of goods and services.

Chart 3: Aggregate Trends in Forward and Backward GVC Participation (per cent of gross exports)



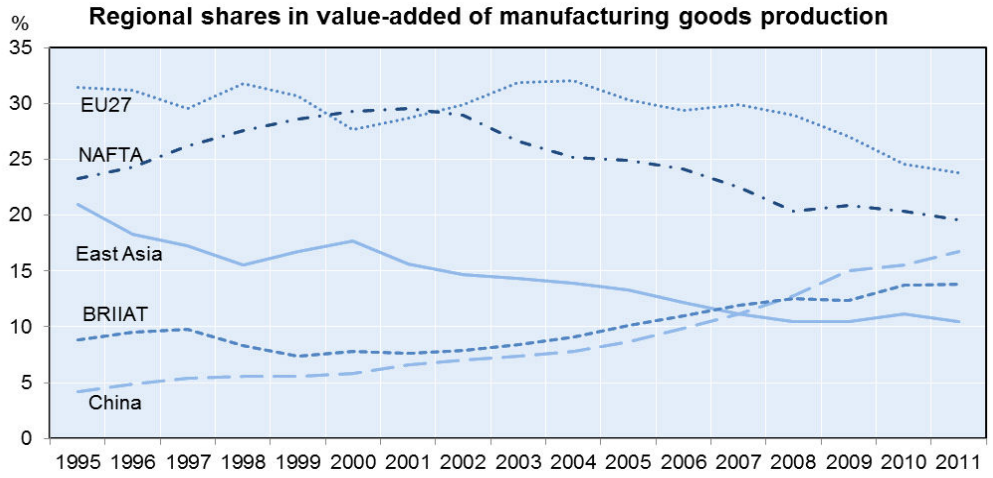
Source: Authors' calculations based on OECD-WTO TiVA Database, 2015 Edition for OECD countries and Constanintescu *et al.* (2017) using WIOD 2016 Edition for the world.
Notes: Averages are unweighted and the series have been normalised to the year 2000, such that 2000 = 100

ture.[8] Estonia's GVC participation grew the slowest within the OECD, however their gross trade grew the 3rd fastest (Chart 2). This may reflect Estonia upgrading into activities of higher (domestic) value-added, with the foreign content of ICT and electronics falling substantially as domestic value-added exports have risen (OECD and WTO, 2015a). Conversely, Korea's GVC participation grew the second fastest within the OECD over 1995-2011, however, its increase in gross trade was only the 11th fastest (Chart 2). This reflects Korea's role in the growth of Factory Asia, with China being the most important destination for Korea's intermediates (OECD and WTO, 2015b).

GVC participation has increased rapidly over the 1990s and the early and mid 2000s until the crisis, and following the crisis rebound quickly to pre-crisis levels. However, emerging evidence suggests that the proliferation of GVCs may have stalled since then (Chart 3). Several articles have noted that world trade, particularly in intermediate inputs, has stagnated since 2011 (Hoekman, 2015). Similarly, global participation in GVCs appears to have rebounded in the years since the crisis, 2010 and 2011, but not to have grown thereafter (e.g. using WIOD 2016 edition data see Constantinecu *et al*, 2017 or Timmer *et al.*, 2016). There are several competing explanations that are at the forefront of current research. This may in part reflect macroeconomic factors such as weak demand growth, changes in the composition of demand or continued economic and policy uncertainty. However, there may also be changes in the structure of global production networks, such as China's domestic upgrading and the reorganiza-

8 The pairwise correlation between growth in GVC participation and growth in gross exports over the period 1995-2011 is 0.29. Clearly the two metrics are related, for example, the foreign value-added component of direct exports will be reflected in both GVC participation and gross exports measures. Furthermore, some evidence suggests that joining a GVC as an indirect exporter (a domestic supplier of exporter) may facilitate learning about foreign markets that enable firms to subsequently export direct themselves (Bai *et al.*, 2017).

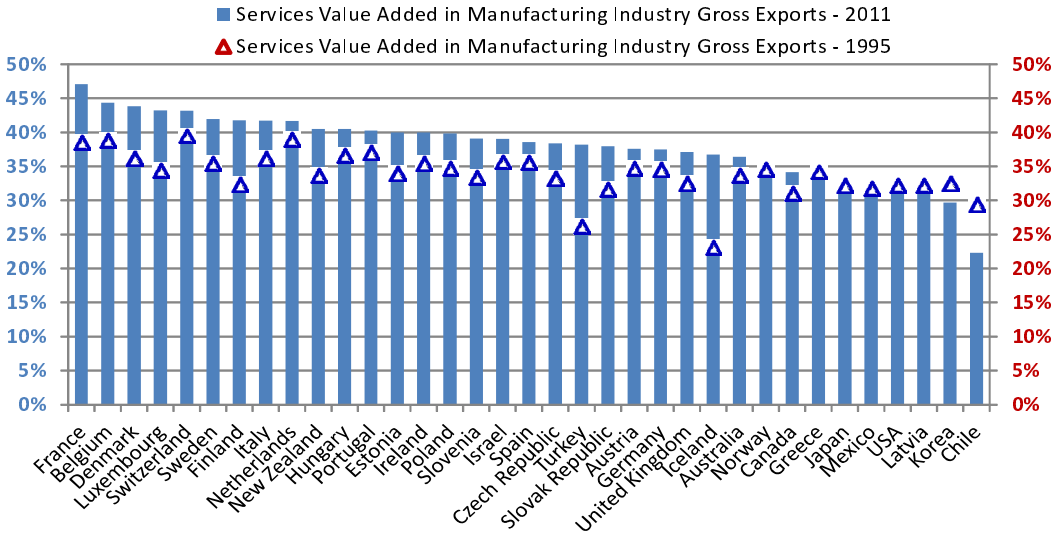
Chart 4: Regional Shares in World GVC Income for all Manufactures (per cent)



Source: Timmer *et al.* (2013)

Note: GVC income is defined as value-added in the production of final manufacturing goods. East Asia includes Japan, South Korea and Taiwan. BRIIAT includes Brazil, Russia, India, Indonesia, Australia, and Turkey. EU27 includes all European countries that have joined the European Union. NAFTA includes Canada, Mexico and the US.

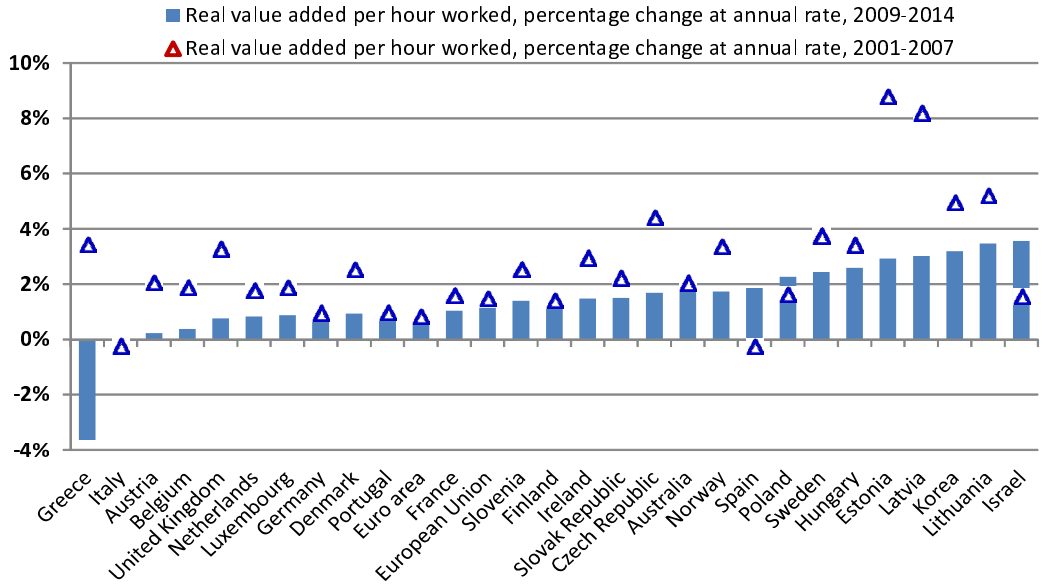
Chart 5: Services Value Added in Manufacturing Exports in OECD Countries, 1995 and 2011, (per cent of manufacturing gross exports)



Source: Authors' calculations based on OECD TiVA Database, 2015 Edition

tion of East. Asian value chains, or the shortening of value chains to mitigate supply chain risks and rising labour costs in emerging economies. Relatedly, any link between the current productivity slowdown and GVCs is currently unclear. In particular, the productivity slowdown appears to pre-date the crisis period (OECD, 2015a) when GVC proliferation was expanding rapidly. Investigating the different factors driving the trends in GVC participation and whether these are related to the productivity slowdown is beyond the scope of this article but is clearly an interesting direction for future research.

Chart 6: Labour Productivity Growth in Business Services (Excl. Real Estate) in EU Countries



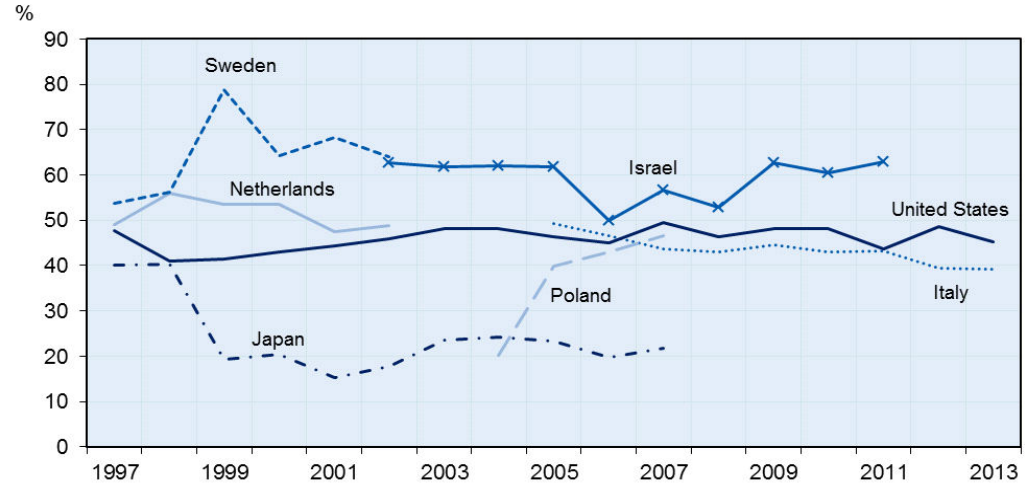
Source: OECD Compendium of Productivity Indicators 2016

GVCs are characterized by regional hubs, with the bulk of production activity clustered within regional supply chains (Baldwin, 2012). However, there are asymmetric growth opportunities within production networks. This is because the geography of GVCs is transforming, with a declining global share of manufacturing value-added from traditional production centres in Europe and North America and the growth of emerging economies such as China (Chart 4, and Wiebe and Yamano, forthcoming). The rising importance of China and its central role in "Factory Asia" is a well-documented feature of modern manufacturing. However, the emergence of China as a key hub has accompanied a reorganization of activities elsewhere, with some countries' industries experiencing declining importance of "peripheralization," in global value chains.

GVCs highlight the interdependencies across the production network, with the performance of input suppliers affecting productivity in output markets, which we elaborate in the next section. Peripheralization may therefore affect domestic productivity growth, both through these indirect network effects as well as through more direct channels, such as reduced productivity spillovers from GVC participants to other firms or constrained growth opportunities of the most productive domestic firms - those firms most likely to be directly engaged with GVCs. Finally, the concentration of activity in key hubs plays an important role in the transmission of shocks along GVCs and therefore affects countries' resilience, which is explored in the subsequent section.

Services are key to GVCs. Goods and services are increasingly being both joint inputs to and jointly produced by manufacturing firms. Services provide the link that helps coordinate cross-border production (such as transport, distribution, finance, communication and business services). The strong complementarity of services with global production networks, and the trend towards increasing service activities in OECD economies, "servicification," are highlighted in new measures of trade in value-added. The importance of services to GVCs is reflected

Chart 7: Share of Intra-firm Exports in Total Exports of Affiliates Under Foreign Control, 1997 -2013



Source: Authors' calculations based on OECD Activities of Multinational Enterprises Database, May 2016

in the high proportion of upstream services value-added that is ultimately embedded in exports. This "servicification" is not only due to the growing size of service sectors in economies, but services represent a substantial portion of value-added even for manufacturing industry exports. Services comprise 37 per cent of the value-added in manufacturing exports for the OECD as a whole in 2011, and above 40 per cent for several countries including the France and Italy and the EU as a whole (Chart 5).[9]

However, in recent years, overall productivity growth in services has been sluggish (Chart 6). Emerging evidence from OECD work shows that the productivity growth slowdown is accompanied by a marked divergence in productivity performance between global frontier firms and others. The slowdown in service sector growth has not been a result of a slowdown of frontier firms, as service sector firms at the global frontier have achieved strong productivity growth of 5 per cent per annum over the period 2001-2009. But rather it is driven by the sluggish performance of non-frontier services firms, which have shown flat growth of -0.1 per cent per annum over the same period, with the majority of the divergence appearing before the crisis (Andrews *et al.*, 2015).[10]

Multinationals (MNEs) are one of the main drivers of GVCs, which creates asymmetric growth opportunities for local firms depending upon how well they are integrated with MNEs. MNEs coordinate complex international production networks, where relationships with suppliers range from arm's-length contractual relationships to direct ownership of affiliates. Using firm-level trade data allows us to distinguish the role of MNEs from other firms within an industry. Cross-border trade between MNEs and their affiliates alone accounts for a substan-

9 The importance of services is not reflected in gross trade flows, where goods remain more likely to be traded directly across borders than services. This serves to highlight the importance of new trade in value-added measures.

10 Of the divergence in productivity growth between frontier and non-frontier firms by 2013, three-quarters of this was revealed before the crisis - by 2007 (Andrews *et al.*, 2015). The divergence is observed using unweighted data of firms within each 2 digit sector, which comprise nonfarm non-financial business sectors excluding mining. However, the divergence is stronger for services than manufacturing.

tial portion of world trade in goods, comprising nearly half of US exports (Chart 7). Although data on MNE contribution to GVCs more broadly are not directly available, emerging research combining input-output and firm-level data estimates that MNEs and their affiliates abroad may account for one third of global production and 50-60 per cent of global exports (De Backer *et al*., 2017).

Participating in GVCs provides an opportunity for knowledge spillovers from these multinationals to local firms for two reasons. First, MNE firms are typically the firms at the global productivity frontier (OECD, 2015a). Second, MNEs generate knowledge spillovers along the value chain through sharing knowledge with domestic suppliers and encouraging the adoption of new practices (see Alfaro, (2014) for a review of the academic literature). The mobility of workers from MNEs to other domestic firms can also be an important channel for knowledge transfers, which can lead to productivity gains for their new employers (Balsvik, 2011). However, such spillovers are unlikely to be realized universally, as only firms with sufficient absorptive capacity are likely to achieve the potentially available productivity gains; we discuss this further in the next section.

Key Implications for Productivity

Understanding the productivity effects of GVCs is the focus of a growing literature. A large body of research has used firm-level data on trade in goods and foreign ownership to uncover links between trade participation, offshoring, or multinational status and productivity. Far less is known about the link between productivity and broader aspects of GVCs shown to be important using industry GVC participation metrics, such as indirect participation in GVCs (as a supplier of exporters) or the role of services and intangibles. However, new findings are emerging using novel data on domestic supplier networks of trading firms and input linkages across industries and countries. In this section we draw on this emerging literature where possible, to highlight the pertinent performance implications of GVCs that have been uncovered so far.

Specialization, Offshoring and Productivity

Specialization in tasks is an important source of GVC productivity gains. The growth of GVCs has led to increasing specialization in specific activities within value chains, with firms often no longer part of complete domestic supply chains. Reductions in trade costs and innovations in ICT have increased the scope of tasks that can be offshored in recent years (OECD and World Bank, 2015). By specializing in those core tasks most efficiently provided by the firm, and offshoring less efficient parts of the production process abroad, firms can reap productivity gains (Grossman and Rossi-Hansberg, 2008). This specialization process is linked to the ability to import cheap, additional and/or higher quality varieties of offshored inputs (which we discuss in the following section), which could be an improvement on previous in-house inputs, or from efficiency gains from the restructuring of internal processes (which we discuss in the section on growth and upscaling).

Measuring offshoring is often problematic at the firm-level, given limited information on the precise tasks previously performed in-house or intermediate inputs sourced from other domestic firms. Accordingly, firm productivity studies often employ industry-level measures of offshoring or proxies for firm offshoring, such as firm imports of materials or services. Empirically these productivity gains have been shown to extend to both the offshoring of manufacturing production processes and service functions

(see for example, Amiti and Wei, 2009; Schwörer, 2013; Winkler, 2010).

Foreign Inputs

Trade in goods, services and intangible inputs is at the heart of global value chains. The bulk of trade is comprised not of final goods or services, but of trade in intermediate parts and components and intermediate services. Among OECD economies, trade in intermediate inputs accounted for 56 per cent of total goods trade and 73 per cent of services trade over the period 1995-2005 (Miroudot *et al.*, 2009). Firms can integrate into GVCs by supplying intermediate inputs for the exports of firms in other countries or as users of foreign inputs in their own exports. GVCs present a new means to access international markets: economies need no longer build complete supply chains at home; instead, they can leverage foreign inputs in their production.

The available variety and quality of foreign inputs (capital, labour and intermediates) can positively impact firm productivity. The availability of previously unobtainable varieties of imported inputs provides additional possibilities for production, allowing firms to save on costs or upgrade the quality of their inputs. Increases in the available variety and quality of imported intermediate goods and capital can therefore positively impact firm productivity. A large literature finds that productivity gains in firms that directly import these inputs (Amiti and Konings, 2007; Goldberg *et al.*, 2010; Topalova and Khandelwal, 2011; Bas and Strauss-Kahn, 2015; Halpern *et al.*, 2015).

In addition, foreign competition in the domestic input market may also lead to price reductions or quality improvements for domestic suppliers, benefiting users of domestic inputs too. These pro-competitive effects in domestic input markets can also lead to productivity gains for firms that source inputs locally (Amiti and Konings, 2007). Emerging evidence is also revealing how the liberalization of service markets, particularly the entry of new foreign service providers, can lead to substantial productivity gains in downstream manufacturing firms (Arnold *et al.*, 2011; Arnold *et al.*, 2016). However, firm-level research on how users of domestic inputs are affected is not as developed as research on firms that use foreign inputs directly.

However, imported inputs also reflect the embodiment of the skills, factors of production and technologies used to produce them. These skills, factors and technologies are embodied in all prior stages of the value chain, which highlights the importance of measurement using value-added (rather than gross) trade metrics. Whilst research on this area is at a relatively nascent stage, recent work at the OECD using industry data highlights that the jobs embodied in value-added exports are increasingly shifting towards higher levels of skill (OECD, forthcoming). Therefore imported inputs may allow access to a greater variety of human capital than is available domestically.[11] Industries that source intermediates that embody a higher R&D knowledge content tend to have higher total factor productivity in levels (Nishioka and Ripoll, 2012), suggesting embodied R&D can be a form of technology transfer to local firms.

MNEs are an important vehicle for provision of foreign knowledge and services inputs to affiliates within the firm group. In Chart 7 earlier, we saw that MNEs cross-border trade with their affiliates accounts for a substantial portion of world trade in goods. However, MNEs are also an important source of knowledge and services for their affiliates (OECD, World Bank and

11 Note however, that local skills remain pertinent for GVC participation, particularly for knowledge-intensive activities, with ongoing OECD work directed in this area (OECD, World Bank and WTO, 2014; Jamet and Squicciarini, 2016).

WTO, 2014). Moreover, the possession of strategic assets (such as investments in knowledge, R&D and skills) can be an important motivation for foreign direct investment (FDI), in order to protect the use of these assets (see Antras and Yeaple, 2014).[12] MNEs may transfer knowledge and services embodied in intermediate goods, as highlighted above, or choose to provide direct disembodied transfers to their affiliates, which we consider in the next section (Keller and Yeaple, 2013).

MNEs, Knowledge Spillovers and Upgrading

GVCs are a well-established vehicle for productivity spillovers to local firms. A substantial part of GVC integration is mediated through FDI, and such multinational enterprises are typically at the global frontier of productivity, innovation and technology. Exposure to the global frontier can provide an opportunity for local firms to increase productivity through learning about advanced technologies or superior organizational and managerial practices (Ciuriak, 2013, Saia *et al*., 2015; Guadalupe *et al*, 2012).

A large literature has investigated FDI spillovers and arrives at a broad consensus in favour of positive productivity spillovers to industries that supply multinationals through backward linkages (Javorcik, 2004), with little evidence through other linkages (Havránek and Iršova, 2011; Alfaro, 2014).[13] Lead firms tend to demand more or better quality inputs from suppliers and may directly share knowledge and technology and encourage the adoption of new practices to achieve this.

The literature generally uses aggregated industry-level measures of linkages and little is currently known about how spillovers are transmitted firm-to-firm along the value chain. Examining the diffusion of knowledge from the frontier throughout supply chains may be a fruitful application of new data on firm linkages in production networks and further research in this area would be valuable.

Knowledge acquisition is an important motive for FDI, which may increase the scope for knowledge diffusion. Firms may relocate some activities, including innovation activities, to obtain access to so-called strategic assets - skilled workers, technological expertise, or the presence of competitors and suppliers - and learn from their experience (OECD, 2008). Firms locate in leading edge countries close to the technology frontier, in order to benefit from the diffusion of advanced technologies (Griffith *et al*, 2004). In addition, MNE acquisition of foreign firms can lead to a relocation of innovative activities to where they are most efficiently undertaken and increase knowledge diffusion to affiliates within the group (Stiebale, 2016).

Knowledge spillovers from the frontier accrue asymmetrically, benefitting firms with sufficient absorptive capacity. A prerequisite for local firms to gain from spillovers is sufficient capacity to absorb frontier technologies. By investing in their own tacit knowledge, such as through engaging in R&D, firms can increase their ability to absorb new technologies (Griffith *et al*, 2004). This can pose a particular challenge for firms far from the frontier, with low absorptive capacity, as they are unlikely to benefit from exposure to frontier technologies (Saia *et al*., 2015). In addition, positive spillovers may be offset by MNEs crowding out some local firms, at least in the short-term following entry of MNEs (Aitken and Harrison, 1999; Kosová, 2010). The additional competition in output

12 This is because writing and enforcing contracts over the use of strategic assets with an arm's length supplier may not be possible.

13 Less consistent evidence is found in favour of horizontal spillovers, to firms within the same industry, or through forward linkages to firms downstream (Iršova and Havránek, 2013).

markets and increased demand for inputs may lead to lower growth rates and exit of local firms far from the frontier.

Investments in knowledge based capital is an important driver of GVC upgrading and growth. Empirical evidence confirms the links between innovation, value creation and economic growth (OECD, 2010a). The value created by a GVC is unevenly distributed and depends on the ability of participants to supply sophisticated and hard-to-imitate products and services (OECD, 2013a). To upgrade the efficiency of production processes or increase the value-added of their products requires investment in organisational capital, skills and ICT to complement the necessary product/process innovations (OECD, 2013b). Value-added creation is distributed unevenly along the value chain, with the highest value-added often relating to more upstream processes (such as R&D, design) or more downstream processes (such as marketing) rather than in the middle (such as assembly). Increasingly, the bulk of the value added of products or services stem from forms of knowledge-based capital such as brands, basic R&D, design and the complex integration of software with new organisational processes (OECD, 2013b). However, there are many aspects of upgrading that are currently unknown. In particular, we know little about the extent of interdependencies between activities, for instance, whether complex manufacturing capabilities are a pre-requisite to engage in high-value added activities like R&D, design and marketing.

Growth and Upscaling

To participate directly in GVCs requires scale. For the largest, most productive firms that are able to export, access to new customers in foreign markets can not only lead to increased learning and innovation (Crespi, Criscuolo and Haskel, 2008) but also incentivize complementary investments and the restructuring of internal processes to meet the additional demand. These may include investment in communication technology and product innovation (Lileeva and Trefler, 2010) or investments in process innovation (Bustos, 2011). In addition, expanded production can make more complex organizational structures efficient, improving decision making within firms. Evidence from Portuguese and US firms suggests that increased demand or trade liberalization leads to firms investing in additional layers of management within the firm, raising their productivity (Caliendo and Rossi-Hansberg, 2012; Caliendo *et al*., 2016).

However, small firms are often not able to build the necessary internal capabilities to meet the strict product and quality standards demanded, or overcome external barriers such as regulations and customs procedures. Building such capabilities can require substantial investment in process and product innovations, managerial and workforce skills development and adoption of modern technologies. Only firms with sufficient scale are able to incur the substantial sunk costs to develop these capabilities necessary for GVC integration. However, unlike trade in final goods, GVCs present opportunities for SMEs to become specialized in a subset of productive tasks, which may alleviate some of the barriers to SME participation. Scale requirements are likely to be a particular problem for firms operating in small, geographically isolated economies. Firm size tends to grow with market size, meaning that smaller markets are likely to have fewer firms with sufficient scale to participate directly in GVCs.[14]

14 For European countries, the size of the domestic market is correlated almost one-for-one with the number of exporting firms (Mayer and Ottaviano, 2008).

Upscaling may yield productivity gains. The cost of many productivity-enhancing investments, including those concerning GVC participation listed above, is largely fixed. Such investments are only viable for sufficiently large firms that can spread the fixed costs over high sales volumes. Firm upscaling may therefore contribute to productive investments. Firm-level research shows correlations consistent with this narrative; larger manufacturing firms are on average more productive, across many dimensions, than smaller firms and are more likely to invest in skills, ICT and R&D (OECD, 2010b, 2013a; Gonzàlez *et al*., 2012).

However, new trade in value-added metrics highlight the importance of indirect contributions to the value chain, not apparent in trade in final goods metrics. Indirect participation can provide a way to overcome many of the barriers to scale. Through intermediaries and international buyers, domestic producers can avoid design and marketing costs, search costs and reduce foreign market information barriers, and benefit from the transfer of knowledge from foreign firms (Artopoulos *et al*., 2013). Many firms are indirectly connected to GVCs, for instance, as domestic suppliers of exporters, and therefore gross trade flows will understate the importance of SMEs to global supply chains. Unfortunately data on the SME contribution to GVCs are often not available and, therefore, relatively strong assumptions are required to decompose industry-level TiVA data into the contribution of SMEs and large firms.[15] Exploratory and ongoing work at the OECD, using such an approach, highlights a sizeable contribution of SMEs to value-added trade flows which far exceeds their contribution to gross trade (OECD and World Bank, 2015).

Scale issues remain pertinent for indirect contributions to the value chain. Exporting firms are likely to pass down relevant product and quality standards, demanded by their foreign customers, to domestic suppliers. Accordingly, domestic suppliers have to overcome additional sunk costs to supply exporting firms, which only sufficiently large suppliers can do. Emerging evidence on domestic micro-linkages between firms is consistent with this narrative; Belgian suppliers of exporters are indeed larger and more productive than suppliers of non-exporters (Dhyne and Rubinova, 2016).

What Does this Mean for Policy?

GVCs can provide new avenues for growth, as highlighted in previous sections. However, there are many potential barriers to deeper GVC integration and to firms' ability to seize the opportunities for growth. Many of these obstacles will be familiar to those versed in the comprehensive literature on trade in final goods and FDI. However, some of these barriers are particularly relevant for GVCs, such as trade policy, when goods cross borders multiple times. In this section, we focus on these most prominent obstacles and their policy implications.

Trade Policy

Global value chains amplify the productivity effects of removing trade barriers relative to trade in final goods. The complex web of inter-

15 Piacentini and Fortanier (2015) outline a preliminary disaggregation of industry-level OECD TiVA data using firm-level data from the OECD Structural and Demographic Business Statistics Database and OECD/Eurostat Trade by Enterprise Characteristics Database. The purchases of domestic inputs by SMEs and large firms are estimated from the residual between output, value-added and imports. Purchases of foreign inputs are segmented based on the share of goods imports purchased by SMEs and large firms. SME and large firm supply of inputs is assumed to be in proportion to their respective share of industry gross output. The authors highlight that their results depend heavily on these assumptions chosen to estimate the unobserved transactions between firms of different sizes.

national production networks means intermediate goods often cross borders multiple times, each time accumulating additional tariffs and other trade costs. In addition, tariffs are levied on the gross value of the good (including imported inputs and previously incurred trade costs), rather than on the value added domestically at the last production stage. Since exports often embody a substantial proportion of foreign value-added this means a low nominal tariff can translate into a high tariff on value-added trade (Miroudot *et al*., 2013a).

Global value chains increase the interdependence of trade policy, highlighting the importance of regional and multilateral trade agreements. Industries and countries are tied together through the network of forward and backward linkages. Downstream industries are affected by the whole system of trade costs incurred by their suppliers and conversely the whole network of suppliers is impacted by final goods trade costs. Accordingly, trade in value-added is affected not only by bilateral trade costs, but is also tied to third country barriers, through which intermediate inputs travel before reaching their destination (Noguera, 2012).

Border Bottlenecks

Trade facilitation is important to achieve the gains from deeper GVC integration. The efficiency of customs and port procedures shape the global value chain, more so than trade in final goods. Customs administrative procedures and clearing processes raise the cost of accessing export markets and importing intermediates, with the costs accumulating when inputs are traded many times as in GVCs. This raises costs both in monetary terms and in time delays, the latter requiring firms to hold larger inventories and working capital. For particularly time-sensitive products or those with uncertain demand, the effect of delays can be substantial, with each day in transit costing up to 2 per cent of the value of the good (Hummels and Schaur, 2013). Recent OECD analysis finds that a small improvement in trade facilitation performance can increase value-added imports by between 1.5 and 3.5 per cent (Moïsé and Sorescu, 2015).[16]

Coordination of Standards

The diversity of standards has become one of the major barriers to integrating into GVCs. Technical barriers to trade cover 30 per cent of international trade and more than 60 per cent of agricultural products are affected by sanitary and phytosanitary measures in particular (Nicita and Gourdon, 2013). Whilst product quality and safety standards are needed to protect final consumers and the environment, these are far from harmonized across countries and there is little mutual recognition of alternative standards (OECD, 2013a). In addition, these standards are not always applied with the same consistency, with import refusals varying over the business cycle (Grundke and Moser, 2016). This in turn might hinder the development and the introduction of innovative products which would ultimately lead to productivity growth.

However, not all standards are imposed by national regulatory authorities. Multinationals and upstream buyers themselves may impose their own private quality standards on downstream suppliers (World Economic Forum, 2015). These may vary across buyers as well as markets and if these standards are more stringent and heterogeneous than those imposed by national authorities, this may reduce the effectiveness of national standard coordination and present an additional barrier to GVC integration.

16 Specifically, an increase of 0.1 on a scale of 0 to 2 for an index of trade facilitation.

The cost of diverse standards can be amplified within GVCs, much more so than final goods trade, as the compliance needs to be coordinated at each stage of production and for each market ultimately supplied. Compliance can require firms to make costly investments in duplicate production processes, specific packaging and labelling, or to undertake multiple certification processes for the same product.[17] These compliance costs are particularly acute for SMEs and are a major obstacle to their GVC participation (OECD and World Bank, 2015; OECD, 2013c).

Policies to Promote Competitive Domestic Markets

Fully leveraging GVCs requires efficient domestic markets and removal of internal barriers to competition. New data on trade in value-added have highlighted that service inputs are much more important to GVCs than was recognized under prior analyses of trade in final goods (Chart 5). Services are a key element in manufacturing competitiveness and are required for the coordination of complex international supply chains. Production at each stage requires a suite of complementary services, including transport and logistics, finance, communication, and other business and professional services. In addition, R&D and design services are involved in upstream stages and distribution networks, advertising and marketing services downstream. Global production networks are therefore shaped by the quality and cost of these complementary services.

Addressing the barriers to competition in local service markets and trade in services is particularly salient, given the significance of services to GVCs in particular. OECD members have few explicit barriers to services trade but there are several differences in regulation. OECD work on Service Trade Restrictiveness Indicators reveals restrictions on foreign ownership, restrictions on the movement of people (e.g. quotas, stay duration limits), barriers to competition and regulatory transparency even amongst advanced economies. Indeed, evidence suggests services trade costs have remained persistently high over recent decades, despite substantial liberalization in goods trade (Miroudot *et al*., 2013b). Pro-competitive domestic regulations and the liberalization of trade in services are important to ensure the efficient functioning of the supply chain, which may be particularly important for geographically isolated countries (Hallaert *et al*., 2011) and would also improve the productivity of the domestic downstream markets which also use these services (Bourlès *et al*., 2013).

Lifting barriers to competition in goods markets can also promote integration within GVCs, and increase innovation and productivity. Lifting product market regulations can spur productivity growth through increased competition, increasing GVC participation. Productivity growth can be achieved through several channels. First, increased competition and entry of new firms strengthens the efficiency incentives of incumbents and provides incumbents incentives to innovate to maintain their market position. In addition, by providing easier and cheaper access to inputs, reductions in red tape can also lead to gains in downstream industries utilising these intermediates (Abe, 2013).

Policies to Bolster SME Participation

Addressing the barriers to small and mediuem-sized enterprises (SMEs) upscaling is key to encouraging GVC participation. The possibility of indirect participation in GVCs

17 Undertaking multiple certification processes as well as repeat testing of goods already tested in other countries may also increase the administration costs to public authorities.

(through domestic supply of exporters) and task specialization, give many SMEs new opportunities, particularly relative to those in final goods trade alone (as mentioned earlier). However, GVC participation still requires additional capital, for example, through required investment in product and process innovation and working capital to finance exports, and access to finance is a particular challenge for the upscaling of SMEs. GVCs therefore highlight policies that address credit market imperfections and support development of complementary sources of exended financing, such as venture capital markets (OECD and World Bank, 2015).

The issue of SME upscaling is also intimately connected with the reallocation of resources. Policies that impede labour market flexibility and limit immigration might restrict the ability of SMEs to hire additional, skilled workers to scale-up production. Bankruptcy legislation and judicial efficiency can encourage experimentation with innovation and new technologies, if failures are not penalized too severely, and speed the reallocation of resources from exiting firms to more productive uses (Andrews and Criscuolo, 2013).

Policies to Facilitate Innovation and Spillovers

Policies that develop absorptive capacity are key to ensuring productivity spillovers. Knowledge-based capital is a central part of GVCs, with upstream activities including R&D, design and innovation often comprising the highest share of value-added in the production chain (Baldwin, 2013). However, sufficient absorptive capacity on the part of local firms and workers is a prerequisite to benefiting from the trickle-down of spillovers. Building absorptive capacity includes developing local innovation and enhancing human capital. Given the well-known market failures affecting investment in innovation, several countries promote innovation through incentives to collaborate between firms and universities, R&D fiscal incentives and state funding of basic research. Recent OECD work (Andrews *et al.*, 2015) suggests that university-industry collaboration might play an important role in helping laggard firms benefit from knowledge spillovers from frontier firms, especially if they are SMEs.

Investment in innovation is an important driver of GVCs and is central to moving into higher value-added activities. Success in GVCs requires investment in knowledge based assets that extend far beyond R&D, for example, in capabilities for efficiently reorganizing production, in producing and commercializing more sophisticated and complex products and for successfully moving into higher-value downstream or upstream activities. Thus, innovation policies for succeeding in GVCs need to take a much broader view than just R&D. Policies that encourage stronger links between firms and research, educational and training institutions can facilitate the knowledge transfers required for upgrading in GVCs. However, GVC participation often implies a relocation of innovation to where it is most efficiently undertaken, as noted earlier, and this restructuring can lead to overall increases in innovation and greater diffusion within firms (Stiebale, 2016). This complements within-country research finding that location-specific incentives for innovation (such as state-level R&D tax credits) may simply reallocate innovation from one location to another, rather than increasing aggregate innovation (Wilson, 2009). Location-specific incentives for innovation may therefore mute one of the potential channels for gains from GVCs.

Policies to Realize New Technology Potential

Reaping the benefits of new technologies requires policies that support complementary investments in knowledge based capital. The

rise of GVCs has been made possible by falling transport costs and advances in communication technology over the recent decades (OECD, 2013a). Many new disruptive technologies are on the horizon with the potential to transform production, for instance, through nanotechnology, 3D printing, advances in robotics or enhanced data analytics using machine-to-machine communication (OECD, 2015b).

However, adoption of new technologies, which is the focus of subsidies or tax credit policies, cannot by itself lead to substantial productivity gains, unless it is complemented by changes in the organization of work (Brynjolfsson and Hitt, 2000). What matters more than adoption, is how the technology is used within organizations. Accordingly, a large body of evidence on recent technological advances, such as ICT, highlights that the performance effects of new technologies depend on complementary firm-level investments, such as in organization structures, management capability and skills development (Draca *et al.*, 2006; Biagi, 2013).

Shocks, Resilience and Growth

Embeddedness within a GVC affects the resilience of economies to macroeconomic shocks.[18] International trade is a key mechanism for the cross-country transmission of shocks and GVCs can intensify this propagation relative to trade in final goods alone. The international fragmentation of production means industries in different countries are connected through a complex web of intermediate input linkages. Accordingly, a shock to one part of the supply chain can propagate throughout the production network. This was as highlighted by the 2016 Kunamoto earthquake when Japanese supplier disruption led to the temporary shutdown of US auto plants and by the 2011 Tohoku earthquakes (Boehm, Flaaen, and Pandalai-Nayar, 2015) and Thailand's great floods in the same year (Fujita, 2013).

Through these interconnections, firms are potentially exposed to a myriad of risks, including geopolitical risks (such as political violence), infrastructure risks (such as the 2010 Icelandic volcano eruption and disrupted air travel), and financial risks (such as the recent economic crisis) (OECD, 2013a). In the aggregate, growing evidence supports the role of GVCs as a conduit for shocks, with strong correlations between countries' GVC links and business cycle co-movement (Burstein *et al.*, 2008; Bergin *et al.*, 2009; Ng, 2010).

Mitigating supply chain risks implies a productivity trade-off. The small margin of error that firms typically build into value chains in order to reduce costs considerably increases risks (OECD, 2013a). Firms can mitigate their vulnerability to (supply) shocks through holding additional input inventories (Kahn, 1987; Alessandria, Kaboski and Midrigan, 2011) or diversifying their range of input suppliers (OECD, 2013a). However, holding additional inventories is costly to the firm as it ties up working capital. Supplier diversification may increase input costs through purchasing in smaller quantities (per supplier), sourcing from more expensive suppliers and the costs of transacting with more firms or countries. Therefore, in an effort to mitigate supply shocks, firms may incur higher production costs and reduce their productivity even during normal times.

Resilience is also determined by position within a GVC. Evidence for the United States suggests that industry growth is more strongly determined by industries that are directly linked (as customers or suppliers) and less correlated with indirect links (e.g. with the suppliers of their suppliers) (Carvalho, 2014 and OECD,

18 See OECD, 2013a: Chapter 8 for an extensive discussion of resilience.

2013a). In addition, position within a GVC determines resilience to different types of shocks. Downstream industries are relatively more vulnerable to supply shocks higher up the value chain.

GVC position (and hence resilience) is determined by productive investments. Firms can reduce their vulnerability to supply shocks by moving up the value chain and specializing in upstream activities such as design, R&D and innovation. Firms can also move up the value chain by improving efficiency or increasing the value-added of their products; either by upgrading their existing product mix, adding new products or moving into new value chains (OECD, 2013a). These often require substantial productive investments. However, moving up the value chain does not immunize firms to GVC shocks. Rather, their position determines the type of shocks a firm is more exposed to. Upstream industries further from the final consumers are more exposed to demand shocks (Acemoglu *et al*., 2015).

Increasing task specialization may also impact the resilience to shocks. The unbundling of the supply chains has permitted specialization in activities for which there is a comparative advantage. Firms can join a production network, specialising in a small part of the value chain, and at an aggregate level, developed economies are increasingly specialising in specific upstream or downstream activities (such as R&D, marketing, design). Indeed, the specialization in productive tasks is one of the oft-cited mechanisms through which productivity gains of GVCs are realised (e.g. OECD, World Bank and WTO, 2014). However, specialization can reduce resilience to shocks, particularly in the production of complex goods, where many countries and suppliers perform highly specialized tasks. Risks increase with the customization of the task and the greater number of countries linked through production networks (Taglioni and Winkler, 2016).

Conversely, the micro-structure of GVC supply chain networks can also generate macroeconomic shocks. Linkages between firms and industries are not evenly distributed; instead, a minority of multinational firms are the drivers of GVCs and production networks are disproportionately dependent on a minority of input suppliers. This is true within domestic production networks, such as the United States (Carvalho, 2014), and emerging evidence finds similar results for global supply chains (Cerina *et al*., 2015). These key hubs can propagate disruptions to many other sectors, amplifying microeconomic fluctuations in one part of the economy into a macroeconomic shock. Evidence for the US suggests that fluctuations in these key sectors are highly correlated with aggregate manufacturing growth since the 1960s (Acemoglu *et al*., 2012; Carvalho, 2014). MNEs may also play an important role in propagation of shocks, with emerging evidence suggesting intra-firm trade exhibited greater volatility than arm's length trade during the recent economic crisis (Altomonte *et al*., 2012).

Evidence on resilience to shocks is only starting to emerge. However, structural policies that facilitate the flexible operation of markets appear to be important (Canova *et al*., 2012; Caldera Sanchez *et al*., 2015). This complements a wide breadth of recent research concerning preventing shocks, and monetary and macro-prudential policy prescriptions. Flexible labour and product market policies increase the scope for firms to adjust in response to shocks across many dimensions, with policies found to be more important for firms in volatile sectors (e.g. Calvino *et al*., 2016). First, increased competition in goods and factor markets may increase the flexibility of wages and prices, enabling firms to absorb such shocks. Second, flexible labour and product market policies may accelerate the exit of the least productive firms and the reallocation of factors more generally to

more productive activities across firms. Third, such policies may ease the reorganization of activities and reallocation of factors within firms to mitigate the effect of shocks. For example, evidence from trade shocks suggest firms respond by transitioning from traditional manufacturing activities into provision of services (Breinlich *et al*., 2014), product upgrading (Amiti and Khandelwal, 2013) or through investment in innovation.[19] However, there may be an important distinction in short and medium term effects of such policies. For example, stringent labour market policies may cushion the initial impact of shocks but stifle the reallocation and recovery process, extending the impact of the shock (Caldera Sanchez *et al*., 2015).

Conclusion

Recent decades have witnessed the widespread growth of GVCs across many developed and emerging economies. The unbundling of production across complex networks, involving the inputs of goods, services and intangibles from many firms and many countries, has presented new channels for growth. The recent availability of detailed firm-level data, combined with new trade in value-added metrics have uncovered many of these mechanisms. However, the rise of complex GVCs presents some additional policy complexities, such as the importance of domestic competitiveness in services and facilitating firms to join domestic supply chains of exporters.

GVCs are not primarily global in nature, but focused around regional clusters of production. The geography of GVCs has changed significantly in the last decades with some countries and industries having become key hubs in regional production (such as China's emergence onto the world stage). Eastern European countries have become increasingly connected to European value chains, whilst other regions have remained relatively peripheral (e.g. South America or New Zealand). Therefore the productivity effects of GVCs are likely to be heterogeneous across countries, as well as firms and workers. Further research is warranted to examine how the changes in the geography and structure of GVCs (such as becoming a key hub or peripheral) affect productivity.

However, emerging evidence suggests that the fragmentation of production may have stagnated since 2011, raising the question of the extent to which further productivity gains from GVCs can be realized going forward. On the horizon there are many structural and technological factors that are likely to influence GVCs, leading to further reorganization of production networks. These include rising demand and labour costs in emerging economies, an uncertain policy environment and the arrival of new digital and production technologies such as 3D printing, advances in robotics or enhanced data analytics using machine-to-machine communication. Some of these advances may lead to a reorganization of some activities closer to sources of demand (e.g. 3D printing, rising emerging economy labour costs), whilst others may lead to increasing complexity of production networks (e.g. advances in communication technologies, services liberalization). Further research is needed to uncover whether these factors will reverse the recent stagnation of production fragmentation and their effects on productivity.

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It's a Small, Small World... A Guided Tour of the Belgian Production Network

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ABSTRACT

This article presents stylized facts about the participation of Belgian firms in global and local value chains, using transaction data at the firm level to depict the Belgian production network and its integration in the world economy. These data allow the identification of the various channels through which a Belgian firm has access to the world market, either to source its inputs or to sell its output. We also discuss how the level of efficiency of individual firms is related to their position in the local and global value chains.

Production fragmentation is a pervasive phenomenon in the world economy. Firms buy inputs from other firms and sell their output for intermediate use, giving rise to a sequencing of production stages.[2] This fragmentation has been mostly viewed as an international process, with some countries specialized in early stages of production (design of the product), some in medium stages (early production stages) and others in final stages (final assembly, marketing, distribution), but this process may also occur locally. Newly available international input/output tables have enabled an analysis of international supply linkages and the extent to which value added is sequentially created along the global value chains (Timmer *et al*., 2014; Koopman *et al*., 2014). Sectoral linkages within countries and how they affect technological diffusion have also been studied, mostly using input/output tables (Acemoglu *et al*., 2012).

However, little work has been done on domestic production networks at the firm level due to lack of data availability.[3] The goal of this article is to provide a description of the integration into the globalized economy of firms that are not directly involved in international trade. To do so, we provide a detailed description of the organization of a domestic production network and

1 The authors are economists in the Economics and Research Department at the National Bank of Belgium. This article has benefited from comments made by participants at various CompNet network workshops and conferences, especially J. Amador, R. Baldwin, E. Bartelsman, F. di Mauro and M. Timmer, and at the First OECD Global Forum on Productivity held in July 2016 in Lisbon. The authors would also like to thank two anonymous referees and A. Sharpe for fruitful comments. The views expressed are those of the authors and do not necessarily reflect the views of the National Bank of Belgium. The statistical evidence presented does not violate the confidentiality restrictions associated with the underlying data. No information allowing the identification of a single firm has been released. Remaining errors are ours only. Emails: emmanuel.dhyne@nbb.be; cedric.duprez@nbb.be

2 See, for example, Antras and Chor (2013) and Fally and Hillberry (2014) for theoretical frameworks highlighting the role of the sequentiality of production.

how it integrates itself into global value chains (GVC).

At the firm level, the integration into GVC has largely been addressed by analyzing the decision to export or to import. The widely used new trade models with heterogeneous firms (Melitz and Redding, 2014) show a positive relation between the level of technological efficiency of a firm and its export status (Bernard and Jensen, 1999; Ottaviano and Mayer, 2007).[4] In related literature, there are firm-level studies that stress the link between imported intermediate inputs and productivity (Antras *et al*., 2016; Bernard *et al*., 2009; Amiti and Konings, 2007).

Recent research, however, has questioned the exclusive focus on exporting (or importing) firms. Some empirical papers have shown that many firms are exporting indirectly through trade intermediaries or other manufacturing firms.[5] More generally, one finds evidence that many firms are indirectly connected to the rest of the world. Some firms supply parts and components that are then integrated into exports. Others buy inputs whose parts or components are imported.

Exporting and importing firms therefore act as connectors of the domestic production network to the rest of the world. Dhyne and Duprez (2015) documented that phenomenon using a sample of around 350,000 Belgian firms.[6] In their sample, the number of exporting firms is relatively small (less than 5 per cent of firms), of which almost half export less than 10 per cent of their turnover. However, almost 80 per cent of their sample supplied inputs to the rest of the world, either directly or indirectly through third companies. Overall, around 20 per cent of their sample, on average, ultimately exported at least 10 per cent of their output, and almost 10 per cent exported at least 25 per cent of their output. The situation is even more striking when it comes to imports. Almost all Belgian firms use foreign inputs, obtaining supplies directly or indirectly from importers, particularly in the case of energy and commodities.

This article provides additional evidence on indirect international trade by showing how close firms are to world markets, either as a source of inputs or a destination for output. The data used make it possible to identify potential commercial channels through which a domestic firm can source foreign inputs or serve foreign demand. Using a similar dataset, Dhyne and Rubinova (2016) found evidence of a performance premium that rises with the proximity to foreign demand. We extend this result by showing that the same applies to the import side. In the spirit of Antras *et al*. (2016), we also find a stronger impact of the distance to foreign inputs on firm performance than that normally associated with the distance to foreign demand.

Describing and understanding the organization of domestic production networks at a very disaggregated level is crucial to understanding

3 Atalay *et al*. (2011) use transaction data to characterize the organization of the production network in the United States, but their sample only covers large firms and their main customers. Bernard *et al*. (2016b) use the collection of the main supplier/customer relations for Japanese firms, but do not observe the size of the transactions. To our knowledge, the Belgian business-to-business (B2B) transaction data is the first micro dataset available that provides an exhaustive description of the inter-firm linkages, including the magnitude of those transactions.

4 The impact of export activities on TFP growth has also been addressed to test the learning-by-exporting assumption, but empirical evidence is not as clear.

5 For instance, Bernard *et al*. (2010) have shown that wholesalers and retailers play a major role in US exports. Similarly, Bernard *et al*. (2016a) have found that a significant share of the value of products sold abroad by Belgian manufacturing exporters is not directly produced by those firms.

6 While also considering Belgian data, their analysis is restricted to the sample of firms registered in the Central Balance Sheet Office of the National Bank of Belgium, which only covers around 50 per cent of the VAT affiliates considered in this article.

the evolution of total factor productivity in advanced economies (Oberfield, 2013). Over the last decades, the development of information and communication technologies and the reduction in transport costs have completely overhauled the organization of production and corporate boundaries. Efficient or cost-saving production may require fragmentation of the production process among multiple producers. Firms have more and more intensively outsourced or offshored tasks they were doing in-house and concentrated on the business activities where they are most efficient. For example, it has been commonly observed in many countries that firms have increasingly outsourced support activities like catering, cleaning and security services to specific service providers (Goldschmidt and Schmieder, 2017).

These changes have led to the organization of production in very complex networks reshaping the way technological or trade shocks propagate within an economy. Analyzing the spread of shocks through the network may provide very useful insight for understanding the global TFP slowdown observed in the last decade and why the technology gap between frontier firms and laggards has been widening. While these important questions are clearly beyond the scope of our article, we intend to contribute to this literature by providing a first description of the production network and illustrate how the integration of individual firms into the Belgian production network and the global economy affects productivity.

This article is structured as follows. The first main section presents the new database. A second section provides an initial set of network-related statistics that describe the Belgian production network and its development over the 2002-2014 period. The third section is dedicated to the analysis of the proximity of Belgian firms to foreign markets, while section the fourth section investigates the link between our measures of proximity and the firm's economic performance. The fifth and final section presents some tentative conclusions.

The Belgian Production Network

In order to document firms' involvement in the international fragmentation of production as well as the organization of the production network, we use two datasets which are available for the 2002-2014 period. The first dataset managed by the National Bank of Belgium provides firm-level information on exports and imports by product and by country.[7]

The second dataset comes from the annual declarations of deliveries by business customers to the Belgian tax administration. It records for every VAT-registered business the annual value of its deliveries to any other VAT affiliate, as long as this amount is greater than or equal to 250 euros per year. This annual value of sales from firm *i* to firm *j* is called a transaction. This transaction is not split between the potentially multiple goods and services traded between firms *i* and *j*. It only represents the total value of goods and services traded between those two firms. However, we may observe bilateral trade between those two firms. In this case, we observe both the transaction between *i* (as a seller) and *j* (as a buyer) and its reverse transaction between *j* (as a seller) and *i* (as a buyer). This

7 The term firm refers to any legal entity registered by the tax administration under a VAT number. It is therefore a legal concept of a firm that is used. This concept covers all kinds of organisations from the Belgian affiliates of multinationals to the local corner store or the self-employed. A given firm may have more than one plant operating under the same VAT number. Transactions between those plants are not observed in our data. Alternatively, some organizations may decide to use more than one VAT number to handle specific activities (for example, on VAT number will deal with production, another with domestic business relations and a third one with exports). Trade between the different VAT affiliates is observed.

dataset therefore provides all the linkages between all Belgian firms. These data, described in Dhyne, Magerman and Rubinova (2015), enable us to fully characterize the local production network.

Merging these two datasets therefore gives a full picture of any domestic or international linkages that involve at least one Belgian firm. We will discuss in the next two sections some facts about the organization of the domestic production network and its interrelation with world markets, but first it is useful to discuss the specificities of such a dataset.

The firm-to-firm transaction data can be viewed as a kind of input-output matrix where each row and each column is a firm. In that respect, it is therefore a very suitable tool for analyzing the organization of production chains at the national level, in the same way that world input/output tables (Timmer *et al*., 2014) provide a description of the contribution of a given industry in a given country to global value chains. Still, this dataset departs from traditional I/O tables in a number of ways.

First, we have no information of what is traded between two firms. We are therefore not able to distinguish between intermediate inputs and investment inputs. In our data, buying an investment good is considered as an intermediate purchase. Conversely, investment expenditure is part of final demand in an input-output framework.

Second, the manner in which wholesale and retail trade intermediaries are recorded is fundamentally different from that of standard I/O tables. In standard I/O tables, the contribution of the wholesalers and retailers to the economy and their intermediate deliveries to other sectors is measured in terms of the value added generated by wholesalers and retailers. In our transaction data, we observe gross transactions to or from trade intermediaries. The contribution of wholesalers and retailers in the network is therefore much larger than in standard I/O tables. These firms, as shown in section 2, play a crucial role in the domestic production network. They are in fact most of the time the ultimate step between the producer and the final consumer. They are also a key player in connecting firms.

Third, there is no intra-firm trade in our dataset, which means that the diagonal of our firm-to-firm I/O matrix is 0. On the contrary, in standard I/O tables, the main action is in the diagonal. This affects measures of production fragmentation, as the Antras *et al*. (2012) upstreamness indicator.

Stylized Facts on Domestic Trade

Before looking at how Belgian firms are involved in GVCs, we first describe the Belgian production network. As we do not restrict our analysis by any firm characteristics such as size or productivity level, we obtain the largest coverage of the Belgian economy available for our analysis. This means we use the set of all legal entities that are registered with a VAT number both for tax declarations and in international trade data. Each year, we observe between 676,000 and 861,000 VAT declarants, which is twice the number of firms that have to report their annual financial statement to the National Bank of Belgium Central Balance Sheet Office. The difference is due to the self-employed or fiscal representatives of foreign firms that do not have to file a financial statement.

Characteristic 1: Belgian Firms Typically Have a Small Number of Domestic Customers and Domestic Suppliers

On average, we observe around 20 domestic business customers for each firm (Table 1).[8]

8 By customers, we only refer to business customers. Firms may also serve final demand and may have many households in their client portfolio, but these transactions are not observed in our dataset.

Table 1: Firm Production Network Characteristics in Belgium

	2002	2007	2010	2014
# of firms	676,016	737,326	770,902	860,735
excluding wholesalers and retailers	*486,508*	*549,747*	*585,079*	*680,651*
# of domestic transactions	13,312,924	15,008,281	16,201,273	17,304,408
excluding wholesalers and retailers	*4,416,893*	*5,382,637*	*5,878,684*	*6,975,793*
Avg. # of domestic business customers	19.7	20.4	21.0	20.1
excluding wholesalers and retailers	9.1	9.8	10.0	10.2
Network's density	2.9E-5	2.8E-5	2.7E-5	2.3E-5
# of exporters	29,056	24,463	22,550	21,464
# of importers	32,711	35,164	42,361	46,151

Note: The decline in exporters is counter-intuitive with the idea that countries are moving towards a more globalized economy. The decline is partly due to changes in the reporting thresholds of intra-EU trade activities by Belgian firms. In 2006, firms that exported less than 1,000,000 euros per year to other EU countries on an annual basis were exempted from reporting, while the reporting threshold before 2006 was 250,000 euros.

This indicates that the density of the production network, which is equal to the ratio between the observed transactions and the potential number of transactions is very small (around 2.3E-5 in 2014).[9] If we exclude from our sample firms that are operating as wholesaler or retailer (NACE Rev 2 45 to 47), the average number of domestic business customers falls to 10. This illustrates how important the distribution sector is in connecting firms not only to final demand but also to other firms themselves, especially on the domestic market.

The distribution of the number of customers and suppliers is highly skewed. One quarter of the firms in our sample had no Belgian business customers in 2014.[10] One quarter have at most three domestic suppliers. The median firm has only two Belgian customers but nine domestic suppliers. By contrast, 1 per cent of the firms have at least 300 domestic customers and 1 per cent have at least 175 domestic suppliers.

Characteristic 2: Belgian Firms Typically Trade Locally on the Domestic Market

Geography matters on the domestic market. Even in a small country like Belgium, the organization of the production network is mostly local. One quarter of the domestic business transactions involve domestic partners located within a six kilometer range. The median domestic transaction involves two firms separated by less than 20 kilometers. Only 1 per cent of the domestic transactions are between firms 155 kilometres or more apart. This is well documented in Dhyne and Duprez (2016), who have also pointed to significant cultural trade barriers within Belgium.

9 The potential number of transactions in a production network is given by the product of the number of firms and the number of firms minus 1.

10 The firms that have no Belgian business customers are firms that are either only serving foreign markets or domestic final demand. By construction, the average number of domestic suppliers is equal to the average number of domestic customers.

Table 2: Relationship Between Number of Customers/Suppliers and Employment and Labour Productivity in Belgium

Correlations between:	2002	2007	2010	2014
Employment and # customers	0.400***	0.405***	0.401***	0.398***
Employment and # suppliers	0.633***	0.626**	0.604***	0.615***
Labour productivity[2] and # customers	0.032**	0.057***	0.056***	0.066***
Labour productivity and # suppliers	0.038***	0.070***	0.069***	0.074***

Notes: All variables are in logs. Labour productivity is measured as value added per employee.

Characteristic 3: Larger Firms and More Productive Firms Tend to Manage a Larger Number of Domestic Customers or Domestic Suppliers

When firm-level characteristics are available, simple correlations between size or labour productivity (in level) and the number of customers and suppliers show that the ability to manage a large portfolio of customers and suppliers increases with firm size and firm efficiency, as shown in Table 2.[11]

Characteristic 4: The Network's Organisation Changes Significantly Every Year

Between 2002 and 2014, the structure of the Belgian network changed dramatically. Not only do we observe a large increase in the number of sampled firms and in the number of transactions, but we also observe a high transaction replacement rate. Every year, on average 43 per cent of the transactions between firms from the previous year are not repeated and 44 per cent are newly created. In 2014, only 13 per cent of the transactions observed in 2002 were still open.[12]

How Close are Belgian Firms to World Markets?

Because we have a full description of both international and domestic transactions, we are able to identify the various channels used by a Belgian firm to access a foreign supply of inputs or to serve foreign demand for goods and services. Importers and exporters are able to directly access some foreign markets (according to the countries they are importing from/exporting to and the products and services they trade with these countries), but they may be able to reach more foreign markets by trading with other Belgian importers or exporters.

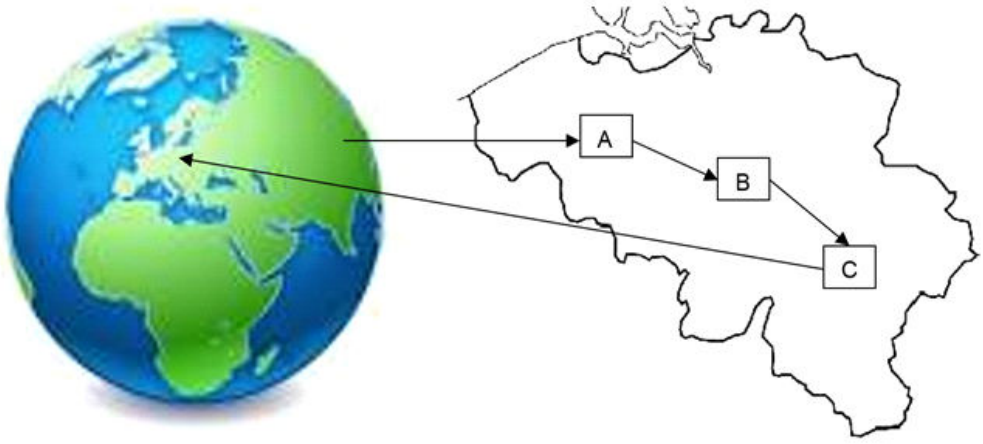
More generally, a domestic firm that may not directly import or export may source foreign inputs or sell its products abroad indirectly by trading respectively with a Belgian importer or a Belgian exporter.

Indirect access to foreign markets is reflected in the phenomenon of the so-called carry-along trade described in Bernard *et al*. (2016a). In Dhyne and Rubinova (2016), the Belgian production network was used to identify how far a firm was from foreign demand. Here, we extend this approach to the import side and we characterize firms by the number of transactions they need to import foreign inputs or by the number

11 Note that in Table 2 the correlation between labour productivity and the number of customers/suppliers increases over time. This may reflect the fact that the gap between productive and unproductive firms has widened over time.

12 In 2007, 28 per cent of the 2002 transactions were still observed, in 2010 20 per cent. Note that the high churn rate is partly due to new or exiting firms.

Figure 1: Closeness of Belgian Firms to Foreign Supply/Demand



of transactions needed for their products to be exported. For instance, if firm A is an importer which sells to firm B (which is not importing), firm B is considered to be a 1st rank M-customer as it is just two transactions away from imported inputs. If firm C (which is not importing) is not a customer of firm A but of firm B, firm C is three transactions from the imported inputs and is called a 2nd rank M-customer. If firm C is an exporter, while firms A and B only serve the domestic market, B is considered to be two transactions from the foreign demand or a 1st rank X-supplier, while A is three transactions away from the foreign demand or a 2nd rank X-supplier.

We define the distance between a given firm and foreign demand as the smallest number of transactions that are needed for that firm's products to cross the border. Similarly, we define the distance between a given firm and foreign inputs by the smallest number of transactions that are needed for that firm to consume foreign inputs. These two measures characterize the Belgian economy's degree of participation in GVCs and its exposure to foreign demand or supply.

Characteristic 5: A Large Fraction of Belgian Firms are at Most Three Transactions From Foreign Markets

Results obtained applying this approach to all domestic transactions and international transactions observed in 2014 are presented in Table 3 (Panel A).

Our first measure of the integration of Belgian firms into GVCs is based on the (smallest) number of transactions involved in the X and M trajectories, disregarding the size of those transactions. As the reporting threshold of a domestic transaction is very low (250 euros in a given year), any firm that is able to sell at least 250 euros in goods and services to an exporter is, according to the analysis conducted in Panel A, a 1st rank X-supplier even if this transaction is not important for both the buyer and the seller. Similarly, a firm that buys at least 250 euros in goods and services from an importer is a 1st rank M-customer.

To restrict our analysis to relevant or economically meaningful transactions, we follow Dhyne and Rubinova (2016) and only consider transactions that represent a minimum fraction of the supplier's total sales or of the customer's total input consumption. We consider that a transaction between two firms is relevant if it represents at least 1 per cent of either the total sales of the supplier or the total input consumption of the customer. Concerning international trade rela-

Table 3: Distribution of Number of Transactions for Belgium Businesses Needed to Sell or Buy from the Rest of the World, 2014 (in %)

Panel A – All transactions

# of transactions to buy from RoW \ # of transactions to sell to RoW	1	2	3	4	≥5	∞(1)	Total
1	1.7	2.3	0.7	0.1	0.0	0.7	5.4
2	0.8	25.8	24.2	3.3	0.3	22.1	76.4
3	0.0	1.3	3.6	0.8	0.1	10.0	15.8
4	0.0	0.0	0.0	0.0	0.0	0.1	0.1
≥ 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
∞(1)	0.0	0.4	1.2	0.4	0.0	0.2	2.3
Total	2.5	29.8	29.7	4.5	0.4	33.1	100.0

Panel B – Relevant transactions

# of transactions to buy from RoW \ # of transactions to sell to RoW	1	2	3	4	≥5	∞(1)	Total
1	1.3	1.3	0.6	0.1	0.0	0.5	3.9
2	0.8	20.1	25.0	5.4	0.6	19.5	71.3
3	0.1	2.2	5.2	1.7	0.2	12.2	21.6
4	0.0	0.0	0.1	0.1	0.0	0.7	1.0
≥ 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
∞(1)	0.0	0.3	1.1	0.5	0.1	0.2	2.3
Total	2.1	23.9	32.1	7.8	0.9	33.1	100.0

Panel C – Essential transactions

# of transactions to buy from RoW \ # of transactions to sell to RoW	1	2	3	4	≥5	∞(1)	Total
1	0.9	0.5	0.6	0.3	0.1	0.4	2.8
2	0.4	5.7	10.1	9.5	4.3	13.9	43.8
3	0.3	4.4	8.4	7.8	3.6	12.2	36.7
4	0.1	0.9	1.9	2.0	1.1	7.2	13.2
≥ 5	0.0	0.1	0.1	0.1	0.1	0.7	1.1
∞(1)	0.0	0.2	0.5	0.8	0.5	0.3	2.4
Total	1.7	11.8	21.6	20.6	9.7	34.6	100.0

Note: (1)An infinite number of (relevant/essential) transactions means that there are no (relevant/essential) X-trajectory or (relevant/essential) M-trajectory that connect the firms to the foreign markets.

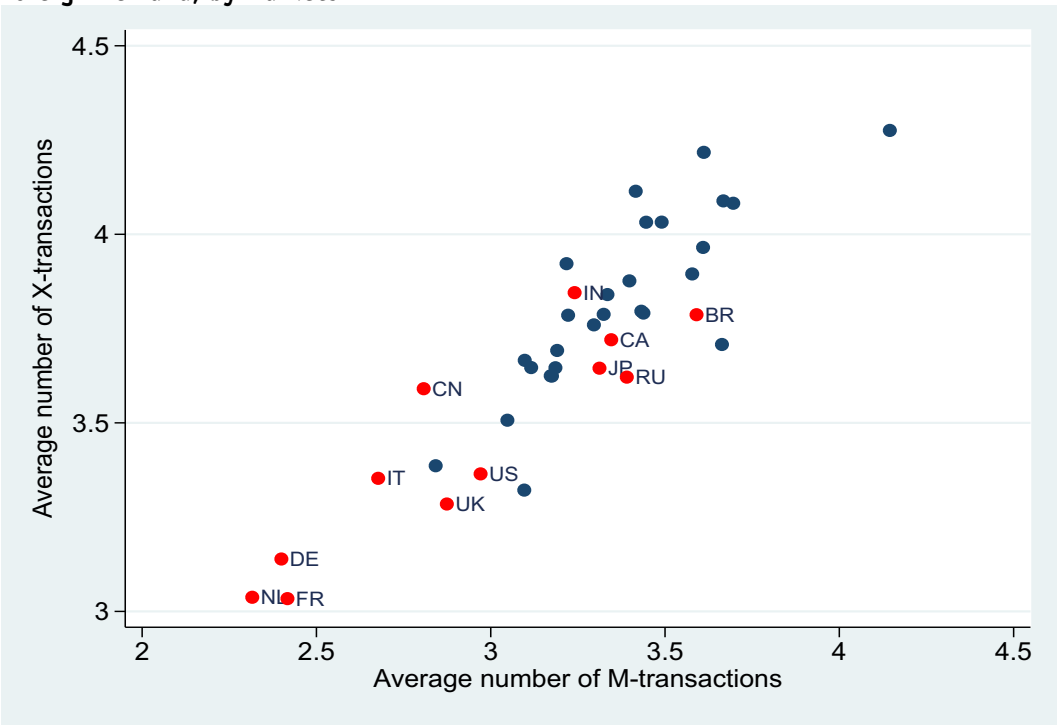
tions and according to this definition of a relevant transaction, a firm is an exporter (resp. importer) if at least 1 per cent of its total sales (resp. total expenses) are made abroad.

As can be seen from Panel B of Table 3, this new definition of the X and M trajectories has a relatively limited impact on our results. Considering only relevant transactions in 2014, 58 per cent of Belgian firms were still at most three transactions from foreign demand. Similarly, still 97 per cent of Belgian firms were at most three relevant transactions from foreign supply. Globally, 57 per cent of Belgian firms were at most three relevant transactions from both foreign demand and foreign supply, compared to 60 per cent when considering any transaction. This confirms the strong integration of a majority of Belgian firms into the GVCs.

Restricting even further the number of transactions to essential transactions accounting for at least 10 per cent of total sales or total input consumption of a firm naturally increases the (smallest) number of transactions needed to reach the foreign market but does not affect the share of firms connected to either world supply or world demand, as shown in Panel C.

At a macro level, the results presented in Table 3 can be summarized by the distance to the foreign market averaged across firms as proxied by the number of transactions required to engage

Chart 1: Average Number of Transactions Needed to Source Foreign Inuts and Serve Foreign Demand, by Markets



in international trade. In 2014, considering only those firms connected to export markets, the average number of transactions needed ranged between 2.6 (any transactions) and 3.4 (only essential transactions). On the import side and considering only the firms connected to import markets, the average number of transactions is smaller, ranging respectively between 2.1 and 2.6.

Characteristic 6: Belgian Firms Need More Transactions to Source From / Serve More Geographically Remote or Smaller Markets

It is well documented that the gravity variables affect the probability of a firm exporting to or importing from a given country. As a result, the number of firms directly exporting or importing varies considerably across countries of origin or of destination. Indeed, as more remote/smaller markets are more costly to serve or to source from, fewer firms will be able to establish a direct link with those markets. As expected, this is naturally reflected in the average number of transactions required to reach those countries. The probability that a non-exporting firm will trade with either an exporter to or an importer from these markets declines with the remoteness or the smallness of the markets. Chart 1 shows that Belgian firms need on average more transactions to reach more distant markets or less important markets, for both the export and import side.

Characteristic 7: The Global Connectedness of Belgian Firms to Foreign Markets Does Not Vary by Country

Strikingly, if we apply our measure of GVC participation by country of origin or destination, we find that the share of firms that are not connected to a given export or import market do not vary strongly across countries. Considering the 40 main partner countries and relevant transactions only, we find that on average 33 per cent of Belgian firms cannot sell to a particular foreign market and that 2.3 per cent of Belgian

firms cannot source inputs from a particular foreign market. For both imports and exports, we do not observe any significant difference of that share across countries as it varies between 33.3 per cent and 33.4 per cent for the export side and between 2.10 per cent and 2.12 per cent for the import side. This means that Belgian firms that are able to connect with an exporter or with an importer can reach any of the 40 main markets. Given Characteristic 6, markets only differ according to the number of transactions needed to reach them.

As the share of firms not X-connected to any particular foreign market is almost constant and equal to the share of firms not X-connected at all, this finding suggests that the Belgian production network can be viewed as the sum of two components: the first one, covering 66 per cent of the firms, is to some extent exposed to both world demand and supply fluctuations, the second is only exposed to import shocks.

Productivity and Closeness to World Markets

Finally, we have undertaken an econometric analysis of the relationship between total factor productivity (TFP) in level and the distance to foreign markets. This exercise is limited to the 195,412 firms for which we observe their financial statement and for which the information required to estimate TFP using the Wooldridge-Levinhson-Petrin estimator (employment, material inputs, value added, capital stock) is available.[13] Estimated TFP is available for the 2002-2014 period.

As mentioned above, the empirical literature provides considerable evidence of a positive correlation between firm-level productivity and the international trade status of firms (for Belgian firms, see Muûls and Pisu, 2009). Dhyne and Rubinova (2016) also document a clear produc-

13 See Wooldridge (2009) for more details on this estimator.

Table 4: Total Factor Productivity and GVC Participation in Belgium

Explanatory variables	(1)	(2)
Employment (in log)	0.132***	0.112***
	(0.009)	(0.009)
International trade status		
Only exporting	0.343***	0.261***
	(0.034)	(0.030)
Only importing	0.512***	0.442***
	(0.068)	(0.067)
Two-way trader	0.872***	0.660***
	(0.078)	(0.078)
X-suppliers		
1st rank	0.230***	0.223***
	(0.028)	(0.028)
2nd rank	0.142***	0.139***
	(0.033)	(0.033)
3rd rank	0.109**	0.111**
	(0.049)	(0.050)
M-customers		
1st rank	0.311***	0.291***
	(0.067)	(0.066)
2nd rank	0.295***	0.289***
	(0.066)	(0.065)
3rd rank	0.175**	0.179**
	(0.075)*	(0.075)*
Number of …		
destination markets	-	0.042***
		(0.005)
destination markets squared	-	-0.002***
		(0.000)
sourcing markets	-	0.025***
		(0.009)
sourcing markets squared	-	-0.002**
		(0.000)
domestic customers	-	6.1E-05***
		(2.1E-05)
domestic customers squared	-	-5.9E-10***
		(1.8E-10)
domestic supplier	-	0.002**
		(0.000)*
domestic supplier squared	-	-3.8E-07***
		(1.0E-07)
Financial participations		
Member of a Belgian group	0.194***	0.184***
	(0.018)	(0.017)
Belgian multinational	0.132	-0.012
	(0.031)	(0.028)
Belgian affiliate of a foreign multinational	0.553***	0.471***
	(0.037)	(0.044)
Time dummies	YES	YES
Sector dummies	YES	YES
R^2	0.302	0.311
N	1,181,027	1,181,027

Note: Explained variable: TFP (in logs), estimated using the Wooldridge LP estimator.

Standard errors are clustered at the sector level (NACE Rev 2 classification at two digits). ***, ** and * coefficients are respectively significant at the 1 per cent, 5 per cent and 10 per cent level. The sample covers the 2002-2014 period.

tivity ranking according to the distance to export markets. Here we extend this type of analysis by also controlling for distance to import markets and other firm characteristics (firm size, number of customers, number of suppliers, number of destination markets, number of sourcing markets, etc.). Distance to foreign markets is computed considering the number of relevant transactions. The numbers of customers/suppliers/destination markets/sourcing markets are also evaluated considering only the relevant transactions.

While we cannot interpret the results presented in Table 4 as causal relations because of endogeneity issues between TFP (in level) and some of our explanatory variables, we still observe significant correlations between efficiency and our control variables.

As commonly observed, within NACE 2-digit sectors, the most productive firms tend to be the largest ones. They also tend to be more deeply integrated into the global economy. Two-way traders are the most efficient firms in the Belgian economy, followed by firms that only import and then firms that only export.

Firms that are active on international markets are followed in the productivity ranking by 1st rank M-customer and 1st rank X-supplier. We observe a clear productivity ranking based on the two distances to foreign markets. M-customers that are closer to foreign inputs are more efficient, reflecting their potentially greater ability to source better inputs (Dhyne and Duprez, 2017). Similarly X-suppliers that are closer to foreign demand are more efficient. As the productivity premium is higher for importers than for exporters, we find the distance to imports has a greater influence than the distance to exports.

The less efficient firms are those which are more than four transactions away from the foreign markets. These firms suffer a productivity handicap of 67 per cent in comparison to the most efficient ones.

Total factor productivity also seems to be related to the number of transactions a firm is able to engage in. Among the exporting firms, serving more markets increases efficiency. Similarly, sourcing inputs from more markets is related to higher efficiency. The marginal effect of the number of destination or sourcing markets declines but remains positive in the observation range in our sample.

A positive (non-linear) relation is also observed between efficiency and the number of domestic customers and domestic suppliers but the impact of these local transactions on efficiency is much more limited than the impact of international transactions.

Finally, as expected, firms that are members of a Belgian or a foreign group tend to also be more productive. Foreign affiliates of multinationals have the largest productivity premium.

Concluding Remarks

The purpose of this article has been to provide some facts about the degree of integration of the Belgian economy into global value chains and to describe the organization of the domestic production network.

Using a unique dataset that makes it possible to observe domestic or international transactions involving at least one Belgian firm, we find that most Belgian firms have a limited number of domestic suppliers or domestic business customers; most of their domestic transactions are local; and larger and more efficient firms are able to manage larger customer or supplier portfolios.

In terms of GVC participation, we find that, even if the share of directly exporting or importing firms is small in the Belgian production network (between 2 and 5 per cent of Belgian VAT affiliates), Belgian firms require on average between 2.6 and 3.4 transactions to serve foreign

demand and between 2.1 and 2.6 transactions to source foreign inputs. Only one-third of Belgian firms are totally disconnected from demand from the rest of the world. This share does not vary by destination countries, but firms that can export indirectly need more transactions to reach more remote and less important foreign markets. We also find a clear productivity ranking of Belgian firms according to their closeness to foreign markets.

These results have a number of important policy implications. First, they illustrate the potential damage associated with rising protectionism. Our findings suggest that restraining imports would not only hamper direct importers but almost the entire production network as well.

Second, the results could also affect the way policy-makers should address the competitiveness issue. Because exporters or importers are essential for the integration of an economy into global value chains, the economic debate on the competitiveness of a country has mostly focused on changes in its exporters' competitive position.[14] However, focusing only on the competitiveness of the exporting/importing firms does not seem to be sufficient in itself to assess the competitiveness of an economy.

Third, it is also important to look at the firms that are indirectly connected to international markets. These firms tend to lag behind in terms of technological efficiency. As described in Andrews *et al*. (2016), their technological gap has tended to widen during the recent period, jeopardizing their ability to survive and flourish in the global value chains. Evidence based on the CompNet Database (Compnet, 2014) also suggests that, when Belgian firms are compared to their German or French counterparts, it was the less efficient Belgian firms that suffered a sharp deterioration in their competitiveness over the 1998-2011 period, being unable to offset the increase in labour costs with productivity gains (National Bank of Belgium, 2013). This may push more firms out of the internationally integrated value chains and have a negative long-run impact on the growth potential of the Belgian economy, as trade and especially international trade can serve as a vector of technological spillover.

This article also points out the potential for new information from the analysis of production networks. This type of data allows a better understanding of the exposure of an economy to external shocks and how shocks propagate throughout the economy. It also challenges the way we measure productivity, raising the issue of production boundaries and how they affect our measures of performance.

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Firm-level Productivity Differences: Insights from the OECD's MultiProd Project

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ABSTRACT

Productivity plays a central role in shaping the welfare of societies and the competitiveness of countries. Productivity differences, for instance, explain a large share of the differences in income per capita across countries. This article investigates the role of productivity heterogeneity across 18 countries over the period 2001-2012. In particular, it analyses the evidence that emerges from the distributed micro-data approach carried out in the OECD MultiProd project. The main outcome of the project is a unique dataset of harmonized cross-country moments that are representative for the population of firms and comparable across countries even at a detailed industry level. We look at the 90-10 percentile ratio of labour productivity and multifactor productivity and show that: i) productivity dispersion is high in both manufacturing and non-financial market services; ii) it has increased over time, especially in services; iii) a substantial part of this dispersion comes from differences among firms within the same sector of activity in each country; iv) this within-sector dispersion remains the most important component of the overall dispersion for the entire period.

One of the main objectives of economic research is to understand why some nations are more developed than others. A simple measure of economic development, output per capita, illustrates the large disparity found across countries. These disparities largely reflect different levels of productivity across countries. Hall and Jones (1999), for example, find that in the United States output per worker, a measure of labour productivity (LP, henceforth), is 35 times greater than in Niger. LP differences can be partially explained by differences in physical and human capital (Caselli, 1999). However, the main reason for the disparity between these two

1 This article has benefited from helpful feedback from Dirk Pilat, Nick Johnstone, Giuseppe Nicoletti, and CIIE delegates at the OECD. We would also like to thank the editor Andrew Sharpe and two anonymous referees for useful comments and suggestions. All errors remain our own. Emails: giuseppe.berlingieri@oecd.org, patrick.blanchenay@utoronto.ca, sara.calligaris@oecd.org, and chiara.criscuolo@oecd.org

countries comes from differences in aggregate multifactor productivity (MFP, henceforth), which reflects the overall efficiency with which inputs are combined in the production process. More generally, Prescott (1998) suggests that differences in aggregate MFP are the main driver of international income differences found both across countries and over time. This point is further illustrated by Klenow and Rodiguez-Clare (1997), who conduct a cross-country analysis of 98 nations and suggest that 90 per cent of the country divergence in growth of output per worker correspond to disparity in MFP growth.[2]

In turn, aggregate productivity growth depends closely on MFP at the firm level. If firms increase the efficiency with which they turn inputs into outputs, they can contribute to overall efficiency gains. However, empirical evidence finds substantial heterogeneity in MFP across firms, even within narrowly defined industries. In the US manufacturing sector, the MFP ratio between an industry's 90th and 10th percentile plants is on average 1.92, implying that plants in the 90th percentile roughly make twice the amount with the same inputs as those plants in the 10th percentile (Syverson, 2004). Such dispersion is not only found in developed countries but also in developing ones. For instance, Hsieh and Klenow (2009) find that the ratio of MFP between 90th and 10th percentiles in the manufacturing industries of China and India is on average more than 5:1.

In light of the large dispersion of firms' MFP, analysing industry average productivity does not offer the complete picture: countries might display the same average but very different underlying distributions. This fact has important policy implications. For instance, low average productivity can be explained by either too few firms at the top (lack of innovation), or too many firms at the bottom (weak market selection), two different situations that would entail very different policies.[3] To better design policy strategies, it is therefore essential to understand how firm-level productivity patterns translate into aggregate productivity.

Economists typically attribute differences in MFP across firms to either slow technology adoption or inefficient technology usage.[4] In addition, a growing body of literature attributes high aggregate MFP not only to the efficiency of technology use and speed of adoption but also to the efficient allocation of resources across firms. Resource reallocation can raise aggregate productivity when there is a flow of inputs from low- to high-productivity firms. Conversely, when factors are allocated in an inefficient manner, aggregate productivity is adversely affected.

These important issues have been investigated by two intrinsically interrelated branches of the literature. The reallocation literature typically focuses on the drivers of resource reallocation, such as creative destruction, and upscaling and downscaling of firms, together with the factors that may influence them, such as technological change, regulation and recessions. The misallocation literature typically identifies a specific distortion or a bundle of distortions (policies and/or institutions) and examines the extent to which they adversely impact aggregate productivity. The results obtained in the misallocation literature show that distortions in the economy can have a quantitatively important effect on aggregate productivity.[5]

2 See Hsieh and Klenow (2010) and Hopenhayn (2014) for a more recent review of the literature.

3 On this topic see, for example, Malerba and Orsenigo (1995 and 1996), Breschi *et al*. (2000) and Van Dijk (2000).

4 See Parente and Prescott (1994), Comin and Hobijin (2006), Schmitz (2005) and Bloom *et al*. (2013).

5 See Restuccia and Rogerson (2013) for a review on the misallocation literature, and Foster *et al*. (2001, 2002, 2014) for examples of works in the reallocation literature.

The OECD contributes to this debate by providing new policy relevant evidence through the multifactor productivity (MultiProd) project. This project provides a comprehensive picture of productivity patterns across a large set of countries over the last two decades.[6] In particular, the project collects micro-aggregated data and moments of the productivity distribution that allow for a cross-country analysis of a wide variety of topics, including productivity heterogeneity, allocative efficiency, misallocation, aggregate productivity growth, and the link between productivity and wages. A similar approach has been used in the past in academic circles (see, for example, Bartelsman, Scarpetta, and Schivardi, 2005; Bartelsman, Haltiwanger, and Scarpetta, 2009), as well as within the OECD (OECD, 2003), the World Bank and, more recently, the European Central Bank.

One of the main contributions of the MultiProd project is to build cross-country harmonized micro-aggregated data of paramount importance for understanding differences in productivity performance across countries. The project relies on a distributed microdata methodology, and the micro-aggregated results (at the cell level) are collected, checked and analysed at the OECD.[7]

An important aspect of the methodology is to make sure the data are comparable across countries. Therefore, productivity is measured in exactly the same way across countries, conditional on the available data. To further ensure harmonization and representativeness, in particular for countries where MultiProd relies on production surveys, an appropriate set of weights is built using information from business registers, which typically cover the whole population of firms. We use these weights to reweight production surveys.

Many studies based on micro-level datasets adopt a resampling procedure in order to achieve a representative dataset (to name a few, for example, Schwellnus and Arnold, 2008, and Arnold *et al.*, 2008). However, MultiProd is to our knowledge the first project based on a distributed microdata approach to have implemented a highly disaggregated, variable-specific, reweighting strategy for both representativeness and aggregation. This reweighting strategy allows us to compute moments representative for the population of businesses and suitable for cross-country comparison even at the two-digit industry or at a more disaggregated level.

The output of the algorithm is a collection of statistics at different levels of aggregation over the 1994-2012 period, depending on data availability. It allows for various decompositions of aggregate productivity level, growth and dispersion to understand the role of particular industries or groups of firms in explaining aggregate outcomes (e.g. small vs large; multinational corporations; old vs young; low vs high productivity; etc.). For instance, changes in the overall productivity dispersion are decomposed to quantify how much of an increase in dispersion is due to an increase in within-industry dispersion and how much comes from a reallocation of resources to industries characterized by a higher dispersion. Moreover, the role of the largest firms can be investigated in great detail and compared to that of the most productive firms ("frontier firms"). Finally, MultiProd attempts

6 The time period is to some extent country specific depending on data availability and is limited to more recent years for some countries. For more details on MultiProd, see Berlingieri *et al.,* (2017).

7 The OECD pioneered this methodology at the beginning of the 2000s (OECD, 2003). It currently follows the distributed microdata approach in three ongoing projects: MultiProd (Multifactor Productivity), DynEmp (Dynamics of Employment) and MicroBeRD (Microdata-based Analysis of Business Expenditure on R&D). See further details in Section 2.

to shed light on the nature of wage inequality across countries, as well as on the effects of various policies (e.g. employee protection legislation, minimum wage, coordination in wage setting) on the dispersion of wages and productivity.

This article focuses on one specific pillar of the MultiProd project: productivity heterogeneity. It describes the main methodological tools used to carry out the analysis on productivity heterogeneity, and the specific contributions of the MultiProd project. After a description of the distributed microdata approach and of the MultiProd dataset, we present some evidence on productivity heterogeneity looking at the 90-10 percentile ratio of LP and MFP. We show a twofold result: i) dispersion is high in both manufacturing and non-financial market services; ii) it has increased over time, especially in services. Furthermore, we decompose the aggregate dispersion of productivity into within-industry and between-industry components: the within-industry dispersion accounts for most of the total dispersion in both manufacturing and non-financial market services. With a share of more than 80 per cent in almost all years, the within sector variance of productivity is the most important component for the entire period. However, the pattern over time displays a constant or increasing trend until 2008, when it is reversed into a slight decline during the Great Recession.

The rest of the article is organized as follow: Section 2 provides an overview of the data and methodology used. Section 3 discusses the MultiProd dataset. Section 4 looks at the evolution of productivity dispersion across sectors and over time, as well as at the decomposition of the productivity dispersion across sectors. Section 4 concludes.

Data and Methodology

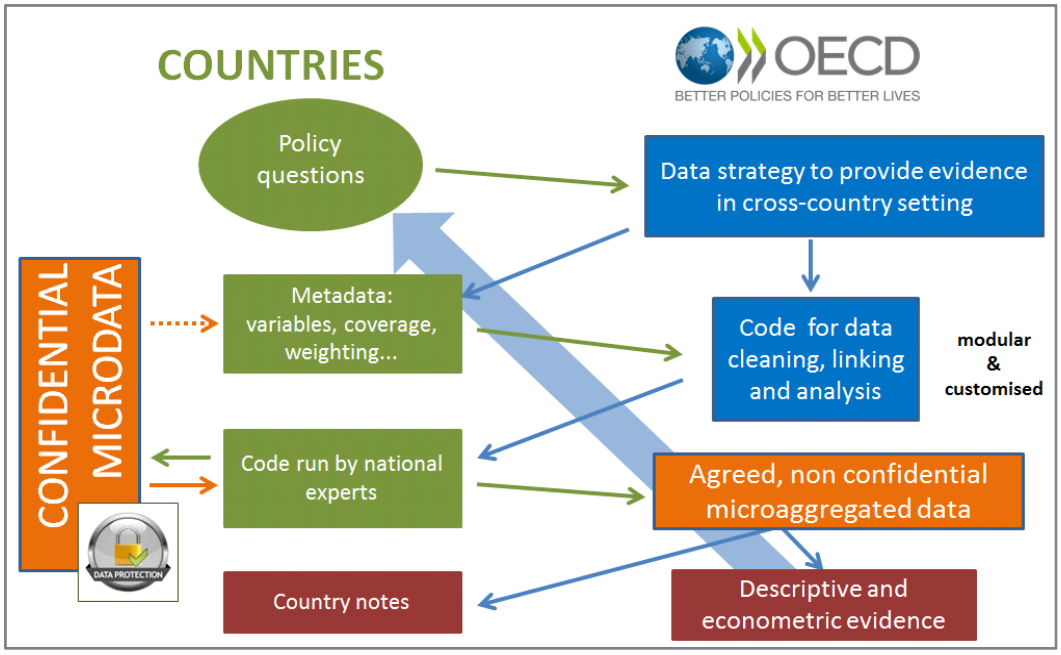
The distributed microdata approach

In recent years, the policy and research communities' interest in harmonized cross-country microdata has increased significantly. This has been partly driven by improvements in computing power but, fundamentally, it reflects the recognition that microdata are instrumental for understanding the growing complexity in the way economies work and the heterogeneity in economic outcomes.

While considerable progress has been made in providing researchers with secure access to official micro-data on firms at the level of a country, significant obstacles remain in terms of transnational access. The challenges of transnational access are many, starting from locating and documenting information on available sources and their content (i.e. coverage, variables, classifications, etc.) and on accreditation procedures (i.e. eligibility, rules, costs and timing). There are language barriers, as translated versions of information on data and accreditation procedures seldom exist or are incomplete. In addition, completing country-specific application forms for accreditation procedures is often demanding and different procedures exist for data held by different agencies even within the same country. Finally, data access systems differ across countries, implying that while remote access or execution could be possible in some countries, in others it is only possible to access on site, requiring researchers to travel to the location in question. These are just some of the challenges related to accessing data, before researchers can even begin confronting differences in the content and structure of micro-data themselves, and the time and human capital investment required to become acquainted with the "nitty gritty" of each database.

As a result, multi-country studies requiring the exploitation of micro-data are very difficult

Figure 1: Distributed Micro-data Analysis



to conduct, and often rely on the formation and co-ordination of networks of national researchers, with each team having access to their respective national micro-data. The comparability of the country level results needs therefore to be insured via the use of a common protocol for data collection and aggregation and a common model specification for the econometric analysis.

The OECD pioneered this methodology, called distributed microdata analysis, at the beginning of the 2000s (OECD, 2003). It currently follows this approach in three ongoing projects: MultiProd, DynEmp, and MicroBeRD.[8] The distributed micro-data analysis involves running a common code in a decentralized manner by representatives in national statistical agencies or experts in public institutions, who have access to the national micro-level data. At this stage, micro-aggregated data are generated by the centrally designed, but locally executed, program codes, which are then sent for comparative cross-country analysis to the OECD. Figure 1 summarizes how the distributed micro-data approach works.

The advantages of this novel data collection methodology are manifold: it puts a lower burden on national statistical agencies and limits running costs for such endeavours. Importantly, it also overcomes the confidentiality constraints of directly using national micro-level statistical databases while at the same time achieving a high degree of harmonization and comparability across countries, sectors and over time.

In spite of these advantages, this procedure is still not widely applied today when collecting statistical information. This may have to do with the amount of time needed to set up and manage the network as well as to develop a well-functioning, "error-free" program code which is able

8 MultiProd, DynEmp, and MicroBeRD are projects carried out by the Directorate for Science, Technology and Innovation (STI) at the OECD. The DynEmp project provides harmonized microaggregated data to analyse employment dynamics (www.oecd.org/sti/dynemp) and MicroBERD provides information on R&D activity in firms from official business R&D surveys (www.oecd.org/sti/rdtax).

to both accommodate potential differences across national micro-level databases and minimize the burden on the researchers who have access to the data and run the code.

The MultiProd project is based on a distributed data collection exercise aimed at creating a harmonized cross-country micro-aggregated database on productivity patterns from confidential micro-level sources. In particular, the goal of the project is to investigate the extent to which different policy frameworks can shape firm productivity, and the way resources are allocated to more productive firms (i.e. allocative efficiency). Such analysis will be a key input for policy makers as firm-level productivity and efficient reallocation are the key engines of future growth.

The MultiProd Dataset

Variables and country coverage

The MultiProd program relies on two main data sources in each country. First, administrative data or production surveys (PS), which contain all the variables needed for the analysis of productivity but may be limited to a sample of firms. Second, a business register (BR), which contains a more limited set of variables but covers the entire population of firms. The program works also in the absence of a business register and this is indeed not needed when administrative data on the full population of firms are available. However, when data come from a PS, the representativeness of the results are substantially improved and, thus, their comparability across countries.

Census and administrative data, indeed, normally cover the whole population of businesses with at least one employee. Still, these datasets do not always exist and PS data need to be used.

Table 1: Temporal Coverage of the MultiProd Database, by Country

COUNTRY	YEAR																	
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AUS									■	■	■	■	■	■	■	■	■	■	■
AUT															■	■	■	■	■
BEL										■	■	■	■	■	■	■	■	■	
CAN							■	■	■	■	■	■	■	■	■	■	■	■	■
CHL												■	■	■	■	■	■	■	■
DNK							■	■	■	■	■	■	■	■	■	■	■	■	■
FIN		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
FRA		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
HUN					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
IDN									■	■	■	■	■	■	■	■	■	■	■
ITA								■	■	■	■	■	■	■	■	■	■	■	■
JPN	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
LUX										■	■	■	■	■	■	■	■	■	■
NLD							■	■	■	■	■	■	■	■	■	■	■	■	■
NOR		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
NZL							■	■	■	■	■	■	■	■	■	■	■	■	
PRT											■	■	■	■	■	■	■	■	■
SWE									■	■	■	■	■	■	■	■	■	■	■

Source: MultiProd dataset, March 2017.

One of the big challenges of working with firm-level production surveys is that the selected sample of firms might yield a partial and biased picture of the economy. Whenever available, BRs, which typically contain the whole population of firms, are therefore used in MultiProd to compute a population structure by year-sector-size classes. This structure is then used to re-weight data contained in the PS in order to construct data that are as representative as possible of the whole population of firms and comparable across countries.

The MultiProd program computes a series of productivity measures that go from the least to the most data-demanding methodologies. To mention a few, gross output based LP; value added based LP; a Wooldridge (2009)-residual MFP based on value added as in Ackerberg *et al.* (2006); a Solow-residual based MFP using external, country-industry specific labour and intermediate shares; a Solow-residual based MFP using external, industry specific labour and intermediate shares (the cross-country-year median); a Superlative index based MFP using labour and intermediate shares calculated as the average between the labour/intermediate share of the firm (averaged over time) and the geometric mean of firm labour/intermediate shares in the industry.

For the MFP calculations a measure of capital stock is needed. In the baseline case, the program defines the capital stock variable through the perpetual inventory method (PIM) in order to increase the comparability of results across countries; the initial value is set to the capital stock reported by the firm in the initial year, whenever this is available. For countries that have capital stock information but not invest-

Table 2: Representativeness of the MultiProd Database for Manufacturing and Non-Financial Market Services, 2011

	Share of firms (%)		Share of employment (%)	
	BR	Eurostat	BR	Eurostat
Austria		69		92
Belgium		70		97
Denmark		102		117
Finland*	98	100	98	100
France		101		108
Hungary		94		99
Italy	11	11	54	54
Netherlands	6	4	56	44
Norway		71		89
Portugal**		92		97
Sweden		94		90

Source: MultiProd dataset (March 2017) and Eurostat, Business demography statistics

Note: Share of business registers and Eurostat data present in MultiProd. Manufacturing and non-financial market services only. The data come from different sources and the methodology used to treat the data (i.e., cleaning and calculation of sectors of activity) might differ; hence the comparison must be taken with caution. Shares higher than 100 per cent are likely to be due to these different methodologies adopted to treat data in the two sources. Due to data limitations, we can only compare the MultiProd dataset to the total number of firms with at least one employee from Eurostat.

*: Finland is 100 per cent of firms with at least 1 FTE.

**: data for Portugal include the population of active companies, but exclude individual enterprises (i.e. sole proprietors and self-employed).

ment data, the capital stock becomes the main measure of capital. Finally, labour is measured by the number of employees or persons engaged (depending on data availability).

At the time of writing, 18 countries have been successfully included in the MultiProd database (namely, Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Hungary, Italy, Indonesia, Japan, Luxembourg, Netherlands, Norway, New Zealand, Portugal and Sweden). The data for each of the countries included so far are collected annually and at firm-level.

For most countries the time period covered by MultiProd spans between the early 2000s and 2012. Table 1 details for each country the exact period covered. MultiProd collects data for all sectors of the entire economy, whenever available. However, for the purposes of this analysis we have restricted our sample to the manufacturing and non-financial market services sector.

To provide an idea of the coverage for the European countries contained in the MultiProd dataset, Table 2 reports for 2011 the share of firms and employment with respect to both the Business Register (when available) and to Eurostat data (annual business demography by size class database). The table is constructed for the manufacturing and non-financial market service sectors. The data from Eurostat refer to the total number of firms or the total number of firms with at least one employee, in accordance with the micro-data used in MultiProd.

Comparing across different data sources is never easy, but data from Eurostat give a good benchmark to compare our data. The coverage is rather high in most of the countries (and results are very similar for each year of the sample). In particular, we have datasets covering roughly the population of firms for all countries reported in the table, except for Italy and the Netherlands. However, for these two countries the full BR is available, and thus the samples are reweighted. For instance, Italy has a skewed distribution with a large mass of very small firms which cannot be captured by production surveys. The survey used by MultiProd contains only 11 per cent of the total population of firms (both with respect to the BR and to the data published by Eurostat) but it accounts for 54 per cent of total employment. At the same time we have access to the entire population of firms from the Business Register, which we use to reweight our sample moments.

In the Netherlands the situation is similar, with the only existing survey of firms representing a very small share of firms, but the BR allows us to re-weight those firms ex-post in order to make the reported statistics representative of the total economy. In other words, in all countries except Italy and the Netherlands each firm has a weight equal (or close) to one, whereas the Italian and the Dutch datasets have been reweighted using the BR, which cover the population of firms.[9]

The weighting procedure entails the following two main steps:

1) Preparation of the population structure from the Business Registry (BR): the number of firms by year, industry, size class is obtained from the BR, using the most detailed industry level available and seven size classes (with thresholds at 5, 10, 20, 50, 100 and 250 employees).

2) Calculation of actual weights: the weights are computed, for each variable, as the number of firms in the population of the corresponding industry and size class divided by the number of firms in the survey, after having cleaned the data through an outlier filter.

9 The weights are variable-specific, hence missing information or outliers might cause weight to be different from one even in the presence of data containing the entire population of businesses.

Output

MultiProd output is a collection of files that contain statistics for different variables computed yearly at a detailed sectoral level.[10] The program is flexible to allow for multiple levels of aggregation at which the output is produced and, for each of those levels, the types of aggregated data to be included.

The statistics are never collected at the level of the individual firm. Instead the programme splits firms along various dimensions, into cells, and for each cell collects aggregate annual data. In addition, these statistics are collected in terms of both levels and growth rates. The dimensions used for the split are the following, which can be specified at different levels of aggregation:

- Sector: 1-digit (STAN A7) aggregation level and 2-digit (STAN A38) aggregation level;
- Firm-level productivity distribution: splitting firms into productivity quantiles (with productivity defined in various ways, such as LP, MFP à la Wooldridge 2009, MFP à la Solow);
- Gross output distribution: splitting firms into quantiles based on gross output;
- Size class: splitting firms into groups based on employment levels;
- Age of the firm: splitting firms into groups based on age;
- Ownership: independent firm vs. affiliate of a business group, and nationality of the group;
- Demographics: entrants, exitors, incumbents, etc.

The output is provided also combining the previous dimensions together (e.g. the interaction of age and size classes).[11]

Several statistics are collected:

- Basic moments: mean, median, standard deviation, and number of non-missing values, for a series of variables.
- Several measures of aggregate productivity: decomposition of both aggregate LP and/or MFP, together with allocative efficiency measures (Olley-Pakes 1996 covariance terms).
- Measures of allocative efficiency based on Hsieh and Klenow (2009), and Petrin and Sivadasan (2013) to analyse the role of allocation and selection.
- Distribution characteristics for productivity levels, productivity growth rates, output and wages. These include both non-parametric measures such as percentiles and parameters of the distributions (e.g., pareto).
- Descriptive statistics of firm characteristics (including growth rate and wage dispersion) by quantiles of the productivity distribution in levels and growth, and by quantiles of the sales distribution.
- Characteristics (productivity, age, persistence, size, ownership, investments etc.) of firms at the productivity frontier.
- Employment dynamics by quantiles of the productivity distribution.
- Estimated parameters from distributed regressions at the firm level, with the aim of establishing a set of stylised facts for each country regarding the relationship between productivity, firm characteristics (size, age, previous performance, ownership, etc.) and structural characteristics (concentration, misallocation, sectoral policies, etc.).
- Tabulations of firms with negative value added and graphs of the sectors' productivity distributions.

The output produced by the program covers a wide range of topics: productivity heterogene-

10 For further details see Berlingieri *et al.*(2017).

11 However note that, although possible, the code never combines more than three dimensions at the same time; the reason is that the number of firms in each cell would become small enough to incur confidentiality problems, especially at high levels of industry disaggregation.

ity; allocative efficiency; granularity; and wage dispersion and its link to productivity.

In order to examine the effects of policies and macro shocks on productivity heterogeneity we collect information about the distribution of productivity (using different measures for it, as described before). In particular, we aggregate productivity and its variance to the sector level, and we decompose productivity dispersion into within- versus between-sector and within- versus between- quantile dispersion. Given the relevance of this topic, this article is focused exclusively on this block of results.

The access to firm-level data across multiple countries also allows us to conduct an extensive examination of allocative efficiency over time and across countries, applying a number of different methods. The methods used are: the Olley and Pakes (1996) static productivity decomposition, as well as a dynamic version of it (Melitz and Polanec, 2015); measurement of job reallocation; measurement of productivity dispersion in the top and bottom size quantile of firms in each sector and comparison to the productivity dispersion in the whole sector; measurement of misallocation according to the Hsieh and Klenow (2009) procedure with some refinements; a description of the distribution of firm-level distortions in each input and their overall impact on aggregate productivity; analysis of the gap between the value of the marginal product of an input and its marginal cost as in Petrin and Sivadasan (2013); and run of distributed firm-level regressions of these measures of misallocation on firm characteristics such as size, age, and ownership.

In addition, the role of the largest firms can be investigated in great detail and compared to that of the most productive firms ("frontier firms"). This analysis sheds light on the so-called "granular" hypothesis, which posits that aggregate fluctuations are the results of microeconomic shocks and not economy-wide shocks, as usually assumed.[12] Such idiosyncratic shocks, even if they are uncorrelated, may not cancel on average if sectors are dominated by a small number of large firms. This fact can have important implications for policies aimed at increasing economic resilience, and highlights the importance of studying firm-level data to better understand aggregate outcomes. The MultiProd project can offer new insights on this hypothesis by analysing how much of a country's economic activity is driven by a small number of important firms, and how much of the observed productivity variation is indeed the result of microeconomic variations. The program collects a number of indicators, such as: the market share and the share of employment accounted for by the top decile of firms in terms of gross output and productivity; the sectoral level Hirsch-Herfindahl Index (HHI); the decomposition of aggregate productivity in both level and growth between the contribution of the largest firms and that of the other firms.

Finally, data collected in the MultiProd project are instrumental to understand the evolution of the between-firm component of wage dispersion, which has been found to account for a large share of the wage inequality of individuals (see, for example, Dunne *et al*., 2004, Card *et al*., 2013, Card *et al*., 2014, Song *et al*., 2015). In particular the program decomposes the wage dispersion in the within and between contribution both for industry and productivity quantiles; calculates the share of each industry and productivity quantile in the overall within component of wage dispersion; identifies the impact

12 With "granularity" we refer to the extent to which economic activity in general, and aggregate productivity in particular, is driven by a small number of large firms. When large firms represent a disproportionate share of the economy, indeed, aggregate fluctuations may be governed by idiosyncratic shocks to these large firms. This hypothesis - called the "granular hypothesis" and proposed in Gabaix (2011) - suggests that aggregate fluctuations can be traced back to micro shocks hitting a small number of large firms.

of various policies (e.g. minimum wage) on dispersion through distributed regressions.

The next section will focus on productivity heterogeneity, and provide evidence on the dispersion of productivity and its evolution over time obtained with the MultiProd dataset.

Productivity Heterogeneity

A startling fact of firm-level productivity analysis is the large and persistent differences in both LP and MFP between firms, even within narrowly defined sectors.

The MultiProd project offers a detailed understanding of productivity dispersion by investigating the relationship between micro-economic dispersion and economy-wide dispersion, in order to provide a better illustration of productivity variation within countries. In particular, to document productivity heterogeneity, MultiProd collects information about the distribution of productivity, aggregates productivity and its variance at the 2-digit sector and at the macro-sectoral level, and decomposes productivity dispersion into within — versus between — sector components.

Productivity Dispersion and its Evolution over Time

In order to capture heterogeneity in the data, MultiProd calculates several measures of dispersion for productivity within macro-sectors and 2-digit industries: the standard deviation; the 90-10, 90-50, and 50-10 ratios; as well as the interquartile range (i.e., the difference between the 75th and the 25th percentile).

In particular, the 90-10 productivity ratio is defined as the ratio of the 90th percentile to the 10th percentile of the productivity distribution. It is used widely in the productivity literature to assess the spread of the productivity distribution. The measure is quite intuitive since a 90-10 ratio of X can be interpreted as firms at the top of the productivity distribution, proxied by firms at the 90th percentile, producing X times as much as firms at the bottom of the distribution, proxied by firms at the 10th percentile, given the same amount of inputs.

As an example, in Table 3 we illustrate the 90-10 ratio for both (log) LP and (log) MFP in 2011. The table illustrates some important features. First, there is a rather significant produc-

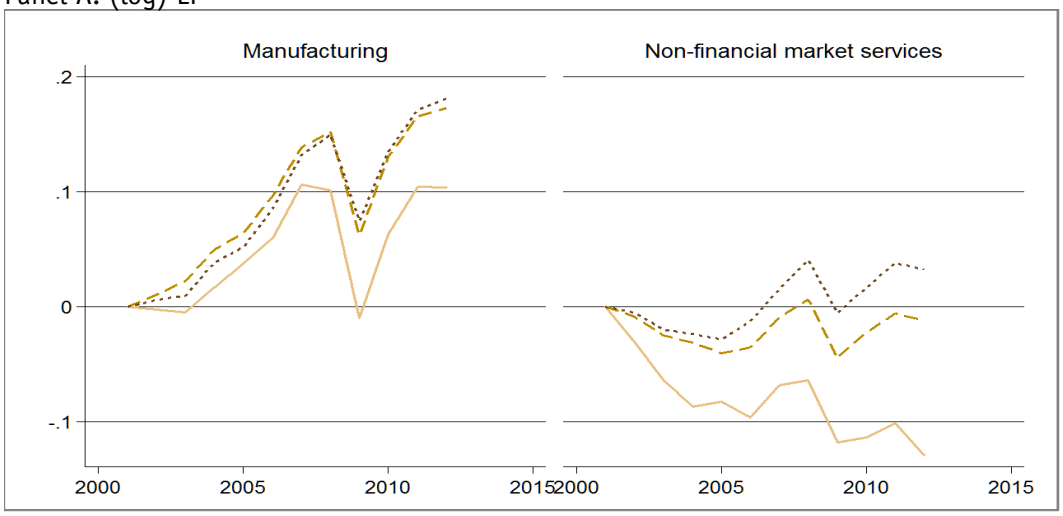
Table 3: Productivity 90-10 Ratio in 2011, by Country

	Log(LP_VA) 90-10 ratio		Log(MFP) 90-10 ratio	
	Manufacturing	Services	Manufacturing	Services
Australia	1.87	2.05	1.90	2.12
Austria	1.96	2.42		
Belgium	1.60	1.74	1.80	1.78
Chile	3.00	3.53	3.07	3.87
Denmark	1.46	1.96	1.32	1.80
Finland	1.17	1.38	1.19	1.34
France	1.35	1.81	1.40	1.78
Hungary	2.79	3.29	2.54	2.86
Indonesia	3.11	-	3.41	-
Italy	1.66	2.01	1.60	1.88
Japan	1.26	1.38	1.17	1.38
Netherlands	2.00	2.98	2.27	2.27
New Zealand	1.84	2.09	1.92	2.08
Norway	1.73	2.17	1.87	2.08
Portugal	1.88	2.65	1.88	2.75
Sweden	1.45	1.86	1.59	2.45
Unweighted Average	1.88	2.22	1.93	2.17

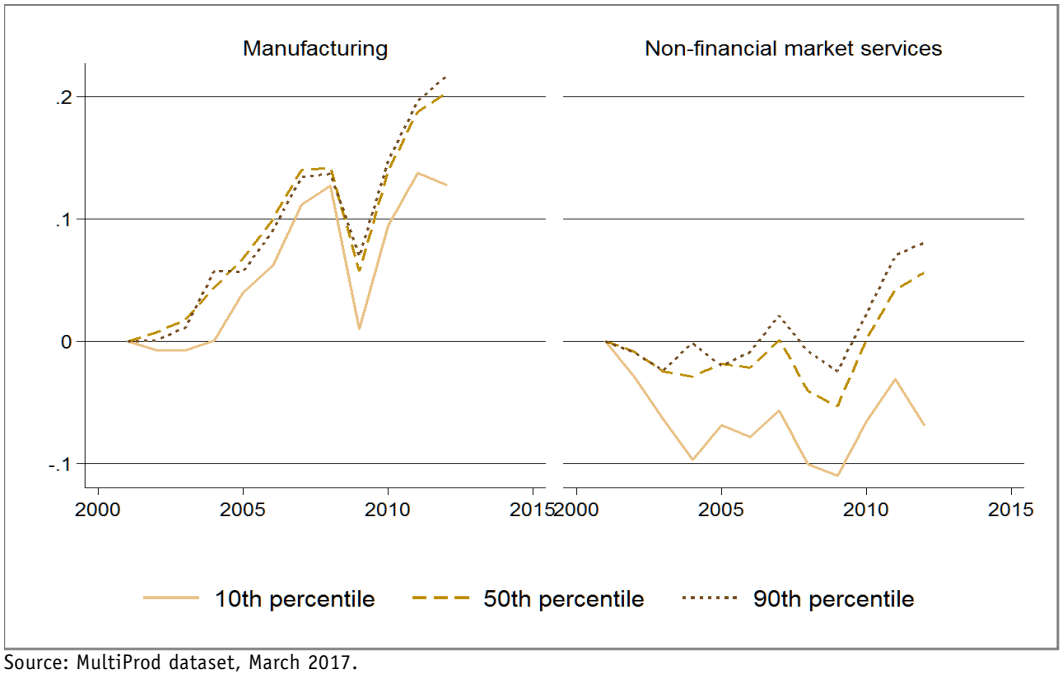
Source: MultiProd dataset, March 2017.

Chart 1: Top, Median and Bottom Decile Over Time

Panel A: (log) LP



Panel B: (log) MFP



Source: MultiProd dataset, March 2017.

Note: Lop-LP and Log-MFP (Wooldridge) in the 10th, 50th and 90th percentile of the productivity distribution, for manufacturing (left panel) and services (right panel) since 2000. The countries included are AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, PRT, SWE. IDN is available only for manufacturing; therefore, for comparability across sectors, it has been excluded from the graph. The graphs can be interpreted as the cumulated growth rates of MFP within each country and sector over the period. For instance, in 2012 in manufacturing in the 90th quantile of productivity is roughly 24% higher than in 2001. The estimates reported in the graph are those of year dummies in a cross-country regression of log-productivity in the 90th, 50th and 10th percentile of the distribution.

tivity dispersion in both manufacturing and services between the top performing and the bottom performing firms, and both in terms of LP and MFP. Second, dispersion is on average higher in services than in manufacturing, whether in terms of LP or MFP. Third, the ratio is particularly high in Chile, Indonesia and Hungary. Finally, in 2011, on average across

countries, firms in the top decile of the distribution can produce more than six times as much value added per worker as firms in the bottom decile of the same country's manufacturing sector, and nine times in services. Essentially the same proportion is kept when looking at the 90-10 ratio in terms of MFP: with the same amount of measured inputs, firms at the top of the distribution produce almost seven times the output of firms at the bottom in the manufacturing sector, and almost nine times in the services sector. The large dispersion reflects the heterogeneity of the sample, with developing countries such as Indonesia displaying a very high dispersion.[13]

Chart 1 shows the productivity (LP and MFP, respectively) of the 10th, the 50th and 90th percentile of the (log) productivity distribution, normalizing the year 2001 to 0. In each figure, the left panel represents productivity dispersion in manufacturing and the right panel represents productivity dispersion in (non-financial) market services. The data show that there has been an increase in dispersion of productivity over time, especially in the services sector. The negative effect that the Great Recession had on the productivity trends is also evident from the figures, especially at the bottom of the distribution.

Productivity Dispersion Decomposition

To better understand the origin of the productivity dispersion, it is possible to decompose the total econmy productivity variance V_t at a point in time into two components: a within-industry component V_{Ft} and a cross-industry component V_{Xt}. The within-industry component V_{Ft} captures how much a firm's individual productivity differs from the sector (labour-weighted) average. The cross-industry component V_{Xt} captures instead how much sectors vary from each other.

$$V_t = V_{Ft} + V_{Xt} \tag{1}$$

The within-industry variance V_{Ft} is the average over all sectors j of the square deviation of firms' productivity P_{it} to their sector (weighted) average LP $\bar{P}_{jt}$:

$$\begin{aligned} V_{Ft} &= \frac{1}{L_t}\sum_j \sum_{i\varepsilon j} L_{it}\left(P_{it} - \bar{P}_{jt}\right)^2 \\ &= \sum_j \frac{L_{jt}}{L_t}\sum_{i\varepsilon j}\frac{L_{it}}{L_{jt}}\left(P_{it} - \bar{P}_{jt}\right)^2 \\ &= \sum_j \frac{L_{jt}}{L_t}\delta_{jt}^{\,2} \end{aligned} \tag{2}$$

and the cross-industry component V_{Xt} is the average of the squared deviation of sector j's average productivity $\bar{P}_{jt}$ to the economy-wide productivity $\bar{P}_t$:

$$V_{Xt} \equiv \sum_j \frac{L_{jt}}{L_t}\left(\bar{P}_{jt} - \bar{P}_t\right)^2 \tag{3}$$

where L_{jt}/L_t is the employment share of sector j at time t, and $\delta_{jt}^{\,2} \equiv \sum_{i\varepsilon j}\frac{L_{it}}{L_{jt}}\left(P_{it} - \bar{P}_{jt}\right)^2$ is the labour-weighted industry variance of firm-level LP.[14]

The MultiProd project contributes to the literature by offering a detailed decomposition of overall productivity dispersion based on cross-country microeconomic data. This decomposition can help understand how much of the country-level dispersion in productivity comes from

13 The table display the average dispersion within 2-digit sectors. While performing the same exercise within 4-digit sectors would partially reduce the dispersion (not available due to confidentiality), the comparison across countries at the 2-digit is nevertheless informative. Moreover, the microdata used for MultiProd contain, or are representative for, the whole population of firms with at least one employee, which naturally imply a higher level of dispersion than other more selected samples.

Table 4: Share of Within-Sector LP Variance in Total Productivity Dispersion, 2011

	LP Dispersion	
	Manufacturing	Services
Australia	98	99
Austria	86	90
Belgium	76	88
Chile	90	97
Denmark	84	63
Finland	65	76
France	63	85
Hungary	79	99
Indonesia	79	-
Italy	82	65
Japan	75	89
Netherlands	80	71
Norway	83	73
Portugal	62	76
Sweden	53	74
Unweighted Average	77	82

Source: MultiProd dataset, March 2017.

microeconomic dispersion within narrowly defined sectors, and how much comes from more aggregate shocks that affect whole sectors. This is achieved by looking at the ratio V_{Ft}/V_t which reflects the importance of microeconomic shocks to aggregate dispersion. The decomposition suggested here is a cross-sectional decomposition of productivity dispersion in a given period t.

Table 4 presents the ratio V_{Ft}/V_t for LP in 2011. The two columns report the share of total LP dispersion accounted for by within-sector dispersion, for manufacturing and services respectively. The results show that on average within-sector dispersion accounts for more than 77 per cent (82 per cent) of the overall LP dispersion observed across firms in manufacturing (services): a large share of dispersion comes from heterogeneity in LP between firms within the same two-digit sector. In other words, a substantial part of productivity heterogeneity does not come from the type of activity that firms engage in, per se, but rather from more intrinsic differences among firms within the same sector of activity in the same country.[15]

In addition to the above decomposition, the overall within-industry component can then be further decomposed into the contribution from each industry, to precisely pin down which industry drives productivity dispersion, i.e. which are the industries where dispersion is stronger. Similarly to Carvalho and Gabaix

14 Note that this is the variance decomposition of LP. It can be generalized to MFP but the choice of the appropriate weights becomes less straightforward. In the literature it is common to use output weights (gross output or value added, depending on how MFP is estimated) but the resulting weighted average does not correspond to the precise measure of aggregate productivity. Moreover, the standard Domar weights used to decompose (gross output) MFP productivity growth do not yield an exact decomposition. Van Biesebroeck (2008) shows that to do so one would need more complex input weights.

15 Table 4 displays the average dispersion within 2-digit sectors. As already stated in footnote 11 for the previous exercise, performing this decomposition within 4-digit sectors would partially reduce the share of within-sector productivity variance (not available to us due to confidentiality). The comparison across countries at the 2-digit level is nevertheless informative. Moreover, the microdata used for MultiProd contain, or are representative for, the whole population of firms with at least one employee, which naturally imply a higher level of dispersion than other more selected samples.

Table 5: Contribution of the Top Three Sectors in the Share of Within-Sector LP Variance in Total Productivity Dispersion, 2011

	Manufacturing	Var. Share	Services	Var. Share
Australia	Food products, beverages and tobacco [CA]	35	Transportation and storage [H]	26
	Machinery and equipment n.e.c. [CK]	28	Legal and accounting activities, etc [MA]	25
	Basic pharmaceutical products and pharmaceutical preparations [CF]	13	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	21
Austria	Machinery and equipment n.e.c. [CK]	17	REAL ESTATE ACTIVITIES [L]	34
	Basic metals and fabricated metal products, except machinery and equipment [CH]	15	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	25
	Wood and paper products, and printing [CC]	12	Administrative and support service activities [N]	1
Belgium	Chemicals and chemical products [CE]	42	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	35
	Food products, beverages and tobacco [CA]	30	Legal and accounting activities, etc [MA]	22
	Wood and paper products, and printing [CC]	7	Transportation and storage [H]	22
Chile	Wood and paper products, and printing [CC]	54	REAL ESTATE ACTIVITIES [L]	39
	Food products, beverages and tobacco [CA]	22	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	36
	Coke and refined petroleum products [CD]	11	Transportation and storage [H]	10
Denmark	Machinery and equipment n.e.c. [CK]	28	Transportation and storage [H]	25
	Furniture; other manufacturing; repair and installation of machinery and equipment [CM]	24	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	22
	Food products, beverages and tobacco [CA]	15	REAL ESTATE ACTIVITIES [L]	13
Finland	Computer, electronic and optical products [CI]	28	REAL ESTATE ACTIVITIES [L]	64
	Wood and paper products, and printing [CC]	17	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	18
	Basic pharmaceutical products and pharmaceutical preparations [CF]	12	Telecommunications [JB]	5
France	Basic pharmaceutical products and pharmaceutical preparations [CF]	17	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	22
	Computer, electronic and optical products [CI]	17	Legal and accounting activities, etc [MA]	22
	Food products, beverages and tobacco [CA]	12	Transportation and storage [H]	11
Hungary	Transport equipment [CL]	32	Administrative and support service activities [N]	36
	Computer, electronic and optical products [CI]	25	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	23
	Machinery and equipment n.e.c. [CK]	23	REAL ESTATE ACTIVITIES [L]	15
Indonesia	Transport equipment [CL]	34		
	Chemicals and chemical products [CE]	18		
	Food products, beverages and tobacco [CA]	17		
Italy	Machinery and equipment n.e.c. [CK]	15	Telecommunications [JB]	23
	Transport equipment [CL]	13	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	22
	Basic metals and fabricated metal products, except machinery and equipment [CH]	12	Transportation and storage [H]	14
Japan	Coke and refined petroleum products [CD]	25	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	37
	Chemicals and chemical products [CE]	17	Legal and accounting activities, etc [MA]	34
	Machinery and equipment n.e.c. [CK]	11	Administrative and support service activities [N]	11
Netherlands	Chemicals and chemical products [CE]	34	Administrative and support service activities [N]	35
	Food products, beverages and tobacco [CA]	10	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	28
	Coke and refined petroleum products [CD]	10	Telecommunications [JB]	12

Norway	Machinery and equipment n.e.c. [CK]	28	Telecommunications [JB]	31
	Electrical equipment [CJ]	14	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	22
	Transport equipment [CL]	11	Transportation and storage [H]	16
Portugal	Coke and refined petroleum products [CD]	28	REAL ESTATE ACTIVITIES [L]	21
	Food products, beverages and tobacco [CA]	20	Telecommunications [JB]	21
	Wood and paper products, and printing [CC]	17	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	18
Sweden	Computer, electronic and optical products [CI]	35	REAL ESTATE ACTIVITIES [L]	39
	Wood and paper products, and printing [CC]	14	Telecommunications [JB]	16
	Transport equipment [CL]	12	Wholesale and retail trade, repair of motor vehicles and motorcycles [G]	15

Source: MultiProd dataset, March 2017.

(2013), who investigate the importance of granularity - or microeconomic shocks - in driving macroeconomic fluctuations, one can decompose the within-industry component of the productivity variance into the weighted productivity variances of industries, as shown in the last term of Equation (2).[16]

We report in Table 5 the top three contributors to LP variance in 2011 for each country, and for manufacturing and services respectively. Some sectors, such as "food products, beverage and tobacco", "machinery and equipment", "wholesale and retail trade, repair of motor vehicles and motorcycles," and "transport and storage" regularly appear amongst the sectors characterized by the highest productivity dispersion. This suggests that there might be sectoral features of the within-sector distribution of firms that might affect the distribution of productivity.

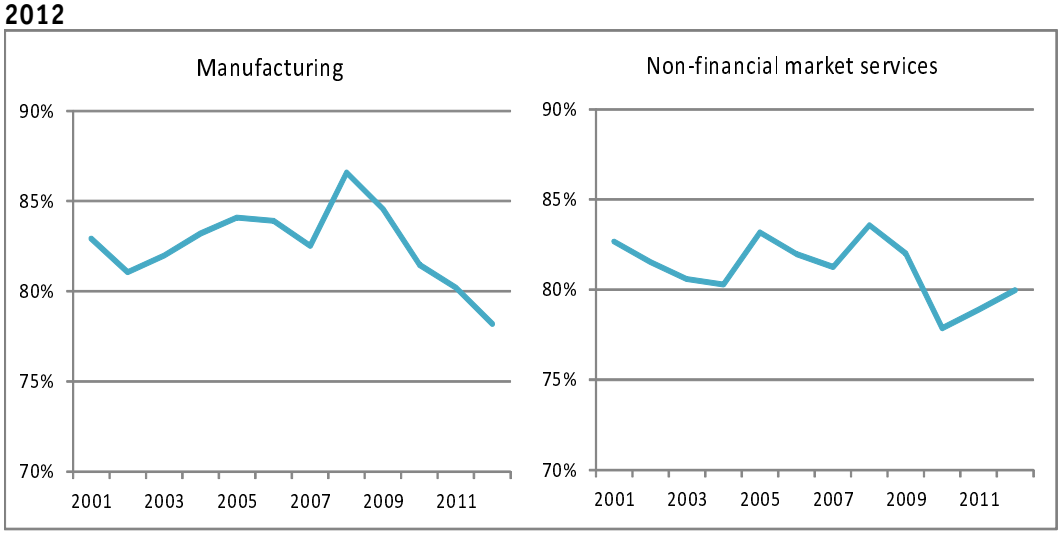
We now describe how the share of within-sector variance of LP evolves over time, particularly in light of the Great Recession. The results displayed in Chart 2 suggest that within sector variance of LP remained the most important component of overall variance, well above 75 per cent, but its importance declined in both manufacturing and services after 2008. In other words, this suggests that in the aftermath of the crisis a larger share of the productivity dispersion came from productivity differences across rather than within sectors. This might suggest that the aggregate shock of the Great Recession might have affected more systematically certain sectors, such as durables, relative to how systematically it affected firms at the top and the bottom of the productivity distribution within sectors. Nonetheless, this impact still left a large part of productivity heterogeneity that cannot be explained by sectoral differences, suggesting that cross-sectoral analyses are likely to underestimate the amount of productivity divergence in the economy.

Conclusions and Avenues for Future Research

This article provides an overview of the main contributions of the MultiProd project in light of the current literature. It focuses, in particular, on the role of productivity heterogeneity and the evidence that emerges from the distributed micro-data analysis carried out in the project, which resulted in a unique dataset of harmonized cross-country moments that are representative for the population of firms and

16 This is an exact decomposition of the within-industry component of variance, which differs from what they define as fundamental volatility for the weights (not squared in the present case) and the variance (computed on the cross section of firms and not constant over time).

Chart 2: Share of Within-Sector log-LP Dispersion in Total Productivity Dispersion, 2000-2012



Note: Share of within-sector dispersion in overall macro-sector Log-LP dispersion. Average across countries and sectors, weighted by employment. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, PRT, SWE.

comparable across countries even at a detailed two-digit industry level.

We have shown that productivity dispersion is high in both manufacturing and non-financial market services: in 2011, for instance, firms in the top decile of the distribution produced more than six times as much value added per worker as firms in the bottom decile of the same country's manufacturing sector, and nine times in services. Moreover, dispersion has increased over time, especially in services. A substantial part of this productivity heterogeneity seems to come from differences among firms within the same sector of activity in the same country, rather than from the type of activity that firms engage in, per se. On average, the within-sector dispersion accounts for more than 77 per cent (82 per cent) of the overall LP dispersion observed across firm in manufacturing (services). Finally, the analysis of the within sector variance of LP over time suggests that it remained the most important component of the overall variance, well above 80 per cent, for almost the entire period. From 2008 onward its importance slightly declined both in manufacturing and services, suggesting that the Great Recession might have systematically affected certain sectors, more than systematically affecting firms at the top and the bottom of the productivity distribution within sectors. In any case, within-sector variance remains by far the main component of the overall LP variance even after 2008.

This article has focused on productivity heterogeneity, but, thanks to the richness of the output of the MultiProd project, other analyses can be carried out in order to:

- Better depict the Schumpeterian process of creative destruction across countries;
- Gauge whether resources are efficiently allocated through the analysis of the firm-level productivity distribution, with further refinements by size, age, and ownership categories;
- Identify the largest firms and understand how they differ in terms of their weight in the economy, their productivity performance, and their contribution to aggregate productivity growth;
- Identify firms at the 'frontier' - the best performers - and understand how they differ

across countries, what drives their performance, and how much they contribute to aggregate productivity growth;

- Investigate the cross-country differences in firm-level productivity performance and allocative efficiency before, during and after the financial crisis;
- Investigate the relationship between productivity and wage dispersion, and gauge to what extent heterogeneity in productivity has contributed to wage inequality; and
- Examine the effectiveness of various policy frameworks aimed at shaping firm productivity and enhancing resource allocation to more productive firms.

These are just some of the possible interesting avenues that we plan to address in subsequent work. Last but not least we aim at linking differences in these important features of productivity dynamics and distributions to structural changes, such as digitalization and globalization, and country framework conditions and policies.

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Productivity and Reallocation: Evidence from the Universe of Italian Firms

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ABSTRACT

This article investigates the contribution of allocative efficiency to aggregate labour productivity growth in Italy between 2005 and 2013. Exploiting a unique dataset that covers the universe of firms, we find that allocative efficiency increased during the period of observation. We show that the dynamics of aggregate labour productivity benefited from the reallocation of resources among continuing firms and from the net effect of business demography. Among industries, we find that reallocation has been stronger in industries that are more exposed to import competition from developing countries. Moreover, we document that the observed adjustments have not evenly affected all firms across the productivity distribution: selection has become tougher for firms belonging to the lower tail, forcing the exit of the least productive firms and favoring the reallocation of the workforce to the best performing ones.

Thanks to the increasing availability of firm-level data, a growing theoretical and empirical literature has documented large and persistent productivity differences across countries and firms within narrowly defined sectors (Bartelsman *et al*., 2005). This research agenda has considerably improved our understanding of aggregate productivity dynamics by highlighting two distinct mechanisms of adjustment. On the one hand, aggregate productivity is the result of technological and managerial decisions made by entrepreneurs (Aghion *et al*., 2009; Bloom and Van Reenen, 2010); on the other hand, it reflects the ability of an economy to allocate resources towards its most productive units (Hsieh and Klenow, 2009).

Several studies have documented that the share of aggregate productivity explained by the latter, i.e. allocative efficiency, is substantial in an accounting sense. In the United States it accounts for 50 per cent of aggregate labour productivity;[2] in Europe its importance is smaller and ranges between 15 and 38 per cent (Bartelsman *et al*., 2009). Moreover, it explains a substantial part of productivity differentials among countries (Andrews and Cingano, 2014). Intuitively, the larger the share of employment that goes to more productive firms, the higher the aggregate productivity.

1 The authors are advisors in the Structural Economic Analysis Directorate at the Bank of Italy. They are grateful to Matteo Bugamelli, Francesca Lotti, Paolo Sestito and Corrado Abbate for helpful comments, as well as Maria Gabriela Ladu for excellent research assistance. This article also benefited from the comments of two anonymous referees and the editor. The views expressed herein are those of the authors and do not involve the responsibility of the Bank of Italy. Emails: andrea.linarello@bancaditalia.it; andrea.petrella@bancaditalia.it.

2 Allocative efficiency is defined as zero when resources are randomly allocated across firms. In this situation aggregate labour productivity would be 50 per cent lower than the actual level.

One interesting conclusion of this line of research is that misallocation of resources across firms due to frictions in factor and output markets may lower aggregate productivity.

Despite the increasing interest from both academic researchers and policy makers on misallocation, the most instructive measure of firm-level heterogeneity to detect possible distortions in the allocation of resources still is debated. Following the pioneering contribution of Hsieh and Klenow (2009), several studies used the dispersion in revenue productivity to proxy for misallocation. Although Hsieh and Klenow (2009) acknowledge that dispersion of marginal revenue products alone cannot be interpreted as misallocation because the results might be influenced by measurement error and model misspecification, the importance of these two factors in explaining productivity gaps is still an open question. Recently, however, Bartelsman *et al.* (2013) argued, both theoretically and empirically, that within-industry covariance between size and productivity, also known as OP covariance (Olley and Pakes, 1996), is a robust measure to assess misallocation.

In this article we will focus on labour productivity dynamics in Italy, which has been disappointing with respect to its main Euro area partners; in particular, our aim is to investigate the contribution of allocative efficiency to its aggregate dynamic. We take advantage of a unique dataset covering the universe of Italian firms operating in the private business non-agriculture and non-financial sector over the period 2005–2013. Data on the universe of firms, while largely available for other countries (among others, United States, France and Belgium), is new for Italy and it is the outcome of a collaboration between the Bank of Italy (BoI) and the Italian National Statistical Agency (ISTAT). The dataset combines information from several statistical, administrative and fiscal sources. It contains information on firm location, legal form, date of incorporation, industry classification, number of persons employed, turnover and value added.

In order to assess the importance of allocative efficiency in Italy, we follow Olley and Pakes (OP) (1996) and decompose aggregate labour productivity into the unweighted firm-level average productivity and the OP covariance term between labour productivity and size. We find that the contribution of the OP covariance to aggregate labour productivity increased by almost 7 percentage points between 2005 and 2013. We then apply the dynamic decomposition proposed by Melitz and Polanec (2015) to aggregate labour productivity growth. This allows us to distinguish between two mechanisms affecting allocative efficiency: first, the reallocation of resources among existing firms; second, the selection, i.e. entry and exit, of firms in the market.

Our results show that, among incumbents, between 2005 and 2013 the reallocation component contributed positively to aggregate productivity growth. Its contribution was larger (in absolute value), with the exception of some years during the crisis, than the decline observed throughout the entire period in average productivity. The net contribution of firm demography is always positive in our data: the exit of the least productive firms more than compensates the entry of newborn firms, whose productivity level is on average lower than that of incumbent firms.

We then look at the correlation between our measures of reallocation and selection and some industry structural characteristics. Not surprisingly, when we focus on the effect of the business cycle, we find that average productivity and reallocation among existing firms increased more in the industries experiencing a boom. This is consistent with the evidence that firms invest in productivity-enhancing technology

and machinery when they experience an increase in market size (Syverson, 2011). We also document that the contribution of entry and exit to aggregate productivity growth is countercyclical, i.e. it is lower in industries that experience a boom. This result is consistent with the cleansing hypothesis, i.e. that recessions are periods of tougher selection for business initiatives (Caballero and Hammour, 1994; Foster *et al.*, 2014). Moreover, we show that the reallocation effect is stronger in sectors that were more exposed to competition from developing countries; a fiercer competitive environment — especially in low value-added sectors — might have favored an improvement of allocative efficiency through the exit of the least productive firms and the reallocation of resources towards the most productive ones. A similar mechanism has been highlighted for United States manufacturing firms by Bernard *et al*. (2006), as a consequence of the exposure to low-wage country imports.

We conclude our analysis by providing some suggestive evidence of the underlying forces behind the observed increase in allocative efficiency. We explore the role of firm entry, exit and employment growth along the productivity distribution. Between 2005 and 2013, we find that the entry rate declined and the exit rate increased for firms in the low tail of the productivity distribution. Moreover, average employment growth declined for all percentiles of the productivity distribution: in particular employment growth became negative for the least productive firms, while it remained positive for the most productive ones. These results suggest that the Italian economy undertook some structural adjustments, eventually reinforced during the crisis, that led to the exit of low productivity firms and that favored the reallocation of workforce towards the best performing ones.

Taken as a whole, our results suggest that behind the poor productivity performance of the Italian economy, which is driven by the decline in average productivity within firms, the reallocation of inputs and business demography show positive dynamics. There are, however, some drawbacks in the measure of productivity and allocative efficiency that we use that deserve some discussion. First, our measure of productivity (value added per worker) might not be informative about the underling dynamics of technical efficiency, as it may reflect changes in prices and markups. Second, the correlation between changes in the OP covariance and dispersion-based measures of misallocation (in the spirit of Hsieh and Klenow (2009)) can be either positive or negative from a theoretical point of view, suggesting that some caution is needed when interpreting the evidence arising from either of these two measures. Finally, although the OP covariance has attractive features, it can be negatively correlated with model-based measures, where the dynamics of aggregate productivity are typically captured by changes in output that are not explained by changes in inputs expenditure (in the spirit of Solow (1957).[3]

Recently, several studies have explored the misallocation hypothesis as one of the possible causes behind the productivity slowdown experienced by many advanced economies (Cette *et al.*, 2016). Gopinath *et al*. (2015) show that the decline in real interest rates, observed in Southern Europe, was associated with capital inflows increasingly misallocated towards firms with high net worth, though not necessarily being the most productive. García-Santana *et al*. (2016) document, for the case of Spain, that the increase in misallocation has been more severe

3 See Petrin and Levinsohn (2012) for a detailed discussion.

in those industries in which the influence of the public sector is larger (e.g. through licensing or regulations).

Several contributions have also analyzed the role of allocative efficiency in Italy. Gamberoni *et al.* (2016) — using data on incorporated firms with more than 20 employees — show an increase in allocative efficiency after the global financial crisis in Italy, as well as in other European countries. Calligaris *et al.* (2016), using data on incorporated firms, document for the Italian manufacturing sector an increase in allocative efficiency starting in 2008.

The evidence provided in this article is broadly in line with the analysis conducted so far on the Italian case, highlighting a significant role of allocative efficiency in shaping productivity dynamics. However, while existing studies struggle to find a positive reallocation of labour before 2008, our results show that the contribution of the OP covariance to aggregate productivity growth before the crisis was positive, although limited. Part of this discrepancy can be attributed, as discussed above, to the different methodology used to measure misallocation. Another important difference is due to data sources used: as a matter of fact, while the existing evidence on allocative efficiency in Italy is limited to the subsample of incorporated firms, one of our main contributions to the current debate is that of using data for a much broader set of firms. Moreover, we propose a simple, though effective, method to exploit the detailed sectoral disaggregation of our dataset, in order to net out our results from sectoral composition effects and cyclical conditions at the sector level.

Data

Our firm-level dataset covers all active firms for 2005 to 2013, i.e. firms whose production processes were active for at least 6 months in a given business year. The construction of the dataset is the result of collaboration between the Bank of Italy (BoI) and the Italian National Statistical Agency (ISTAT). The dataset combines information from the business registry (Archivio Statistico delle Imprese Attive - ASIA) with other statistical, administrative and fiscal sources. It contains information on firm location, legal status, incorporation date, industry classification (NACE rev. 2), number of persons employed, turnover, and value added.[4]

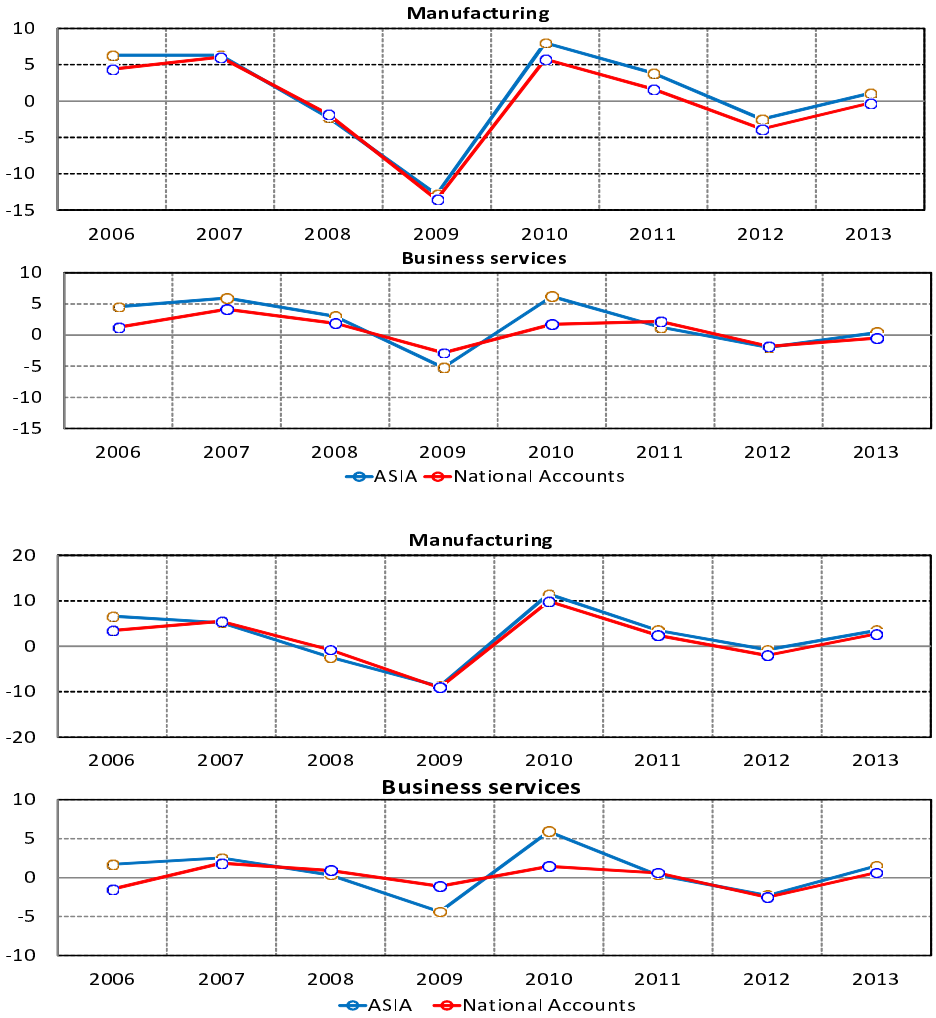
The construction heavily relies on work done at ISTAT over the past few years for the construction of the FRAME-SBS dataset, an integrated firm-level census dataset that covers all active firms. While the census FRAME-SBS represents the source of information in our dataset starting from 2012, the joint effort of BoI and ISTAT contributed to filling the gaps backwards and building a longer time series of data, suitable for studying the evolution of the Italian economy starting from the mid- 2000s.

Our aim is to exploit the microeconomic heterogeneity behind aggregate trends in labour productivity. With this aim at hand, we exclude from our dataset several sectors. First, we exclude agriculture, mining and quarries (NACE divisions 1-9), and regulated sectors such as gas, energy and waste (NACE divisions 35-39) for which labour productivity dynamics could reflect changes in prices that are independent from the firms' underlying productivity. Second, we exclude the financial sector (NACE divisions 64-66) for which data are not available. Third, we exclude the non-business service sector (NACE divisions 84-88 and 90-99), because their overlapping with the public sector might influence the productivity dynamics. Finally we exclude some sectors for which aggregate labour productivity computed using firm-level data significantly diverges from estimates inferred from National Account data.[5]

4 See Abbate *et al.* (2017) for a detailed description of the dataset

Chart: 1 Comparison between ASIA Database and Italian National Accounts Estimate of Value Added and Value Added Per Worker, 2006 - 2013

A) VA growth rate



Source: Own elaborations on Istat data

At the aggregate level, our firm-level dataset closely tracks National Accounts data. Panel (a) of Chart 1 compares the growth rates of value added between the two data sources, for manufacturing and business services separately; panel (b) shows the comparison for the growth rates of labour productivity. In the manufacturing sector, the goodness of fit for both value added and labour productivity dynamic is excellent. Some differences emerge in the business services sector, largely due to the fact that National Account data include estimates of the underground economy and illegal workforce, that weigh more in business services than in manufacturing. According to the latest official figures, the illegal economy accounts for 7 per cent

5 We exclude from the analysis NACE divisions 19 (Manufacture of coke and refined petroleum products), 41-43 (construction), 53 (Postal and courier activities), 61 (Telecommunication) and 68 (Real estate activities). See Table B.1 in the appendix for a complete list of sectors used in the analysis. The full appendix can be found in the full online version at: http://www.csls.ca/ipm/32/Linarello_Petrella%20Appendix.pdf

Table 1: Descriptive Statistics for the ASIA Dataset, 2005-2013

Levels and Growth Rates

	# of firms	# of employees	Value added (Millions of Euros)	Value added per employee (Euros)	Employees per firm
			Manufacturing		
2005	443,623	4,092,856	196.08	47.91	9.23
2006	437,926	4,088,521	209.10	51.14	9.34
2007	432,761	4,132,101	215.39	52.13	9.55
2008	426,798	4,138,323	208.78	50.45	9.70
2009	412,571	3,961,776	173.79	43.87	9.60
2010	402,670	3,842,702	193.35	50.32	9.54
2011	404,919	3,847,575	201.37	52.34	9.50
2012	414,524	3,858,736	197.73	51.24	9.31
2013	407,047	3,769,859	196.60	52.15	9.26
2005--06	-1.28	-0.11	6.64	6.75	1.19
2006--07	-1.18	1.07	3.01	1.92	2.27
2007--08	-1.38	0.15	-3.07	-3.22	1.55
2008--09	-3.33	-4.27	-16.76	-13.05	-0.96
2009--10	-2.40	-3.01	11.25	14.70	-0.62
2010--11	0.56	0.13	4.15	4.02	-0.43
2011--12	2.37	0.29	-1.81	-2.09	-2.03
2012--13	-1.80	-2.30	-0.57	1.77	-0.51
2005--13	-8.24	-7.89	0.27	8.86	0.38
			Services		
2005	2,467,007	7,702,550	287.35	37.31	3.12
2006	2,486,227	7,943,321	301.96	38.02	3.19
2007	2,529,322	8,219,761	313.32	38.12	3.25
2008	2,543,113	8,443,327	311.82	36.93	3.32
2009	2,515,252	8,357,716	284.29	34.02	3.32
2010	2,518,288	8,405,556	303.17	36.07	3.34
2011	2,513,429	8,490,370	302.14	35.59	3.38
2012	2,543,379	8,626,073	291.13	33.75	3.39
2013	2,517,042	8,526,864	288.29	33.81	3.39
2005--06	0.78	3.13	5.09	1.90	2.33
2006--07	1.73	3.48	3.76	0.27	1.72
2007--08	0.55	2.72	-0.48	-3.11	2.16
2008--09	-1.10	-1.01	-8.83	-7.89	0.08
2009--10	0.12	0.57	6.64	6.03	0.45
2010--11	-0.19	1.01	-0.34	-1.34	1.20
2011--12	1.19	1.60	-3.64	-5.16	0.40
2012--13	-1.04	-1.15	-0.98	0.18	-0.12
2005--13	2.03	10.70	0.33	-9.37	8.50
			Total		
2005	2,910,630	11,795,406	483,424	40.98	4.05
2006	2,924,153	12,031,842	511,059	42.48	4.11
2007	2,962,083	12,351,862	528,703	42.80	4.17
2008	2,969,911	12,581,650	520,590	41.38	4.24
2009	2,927,823	12,319,492	458,079	37.18	4.21
2010	2,920,958	12,248,258	496,513	40.54	4.19
2011	2,918,348	12,337,945	503,505	40.81	4.23
2012	2,957,903	12,484,809	488,857	39.16	4.22
2013	2,924,089	12,296,723	484,891	39.43	4.21
2005--06	0.46	2.00	5.72	3.64	1.53
2006--07	1.30	2.66	3.45	0.77	1.35
2007--08	0.26	1.86	-1.53	-3.33	1.59
2008--09	-1.42	-2.08	-12.01	-10.14	-0.68
2009--10	-0.23	-0.58	8.39	9.02	-0.34
2010--11	-0.09	0.73	1.41	0.67	0.82
2011--12	1.36	1.19	-2.91	-4.05	-0.16
2012--13	-1.14	-1.51	-0.81	0.71	-0.37
2005--13	0.46	4.25	0.30	-3.79	3.77

Note Figures for 2005-2013 are cumulative per cent changes.
Source: Own elaborations on Istat data.

of people employed and 6 per cent of value added in manufacturing, against 16 per cent and more than 20 per cent in business services.

Tables 1 and 2 report descriptive statistics from our firm-level dataset. The number of firms in the manufacturing sector declined almost every year; in 2013 there were about 36,000 fewer firms than in 2005. In business services, the number of firms does not exhibit a clear pattern, and in 2013 there were more firms than at the beginning of the period. Between 2005 and 2013, average firm size — measured by the number of persons employed — increased in both sectors: in 2013 the average firm employed 9.3 people in the manufacturing sector and 3.4 in the business service sector.

In our final dataset, aggregate labour productivity — measured as real value added per employee — increased between 2005 and 2007, and declined during the global financial crisis (2007–09) and the sovereign debt crisis (2011–13); overall, it was 3.8 per cent lower in 2013 than in 2005. The aggregate dynamics reflect different patterns between manufacturing and services: in the former, aggregate labour productivity increased 8.9 per cent between 2005 and 2013, while in the latter it declined by 9.4 per cent. Before the crisis, the increase of labour productivity in the manufacturing sector was due to a rise of value added greater than the one of employment after 2008; instead, the adjustment of the labour force has been stronger. In business services, the negative growth of aggregate labour productivity reflects both a constant increase in the number of people employed, and a decline in value added since 2007.

Productivity Decompositions

Aggregate labour productivity (Φ) in year t corresponds to the weighted average of the individual firm's productivity (ρ_i), with the weights (ω_i) being the firms' share of total employees. More formally:

$$\Phi_t = \sum_{i=1}^{\eta} \rho_{it}\omega_{it} \qquad (1)$$

Aggregate productivity can be further decomposed as the sum of the unweighted average firm productivity ($\bar{\rho}$) and the covariance between firm productivity and the share of employees:

$$\begin{aligned}\Phi_t &= \bar{\rho}_t + Cov(\rho_{it}, \omega_{it}) \\ &= \bar{\rho}_t + \sum^{\eta} (\rho_{it} - \bar{\rho}_t)(\omega_{it} - \bar{\omega}_t)\end{aligned} \qquad (2)$$

The covariance term is often referred to as static "Olley and Pakes (OP) covariance". In Olley and Pakes (1996), this decomposition — applied to the US telecommunications industry — allowed the authors to distinguish between the efficiency gains deriving from a reallocation of resources towards the most productive firms (measured by the increase in the OP covariance), and those arising from the productivity growth of individual firms (captured by the changes in the average productivity term). The former component has been found to explain the largest share of the observed productivity gain.

Recent developments in the economic literature devote increasing attention to allocative efficiency, since it reflects institutional and regulatory features that distort the functioning of the markets. As an example, Olley and Pakes (1996) document that, in the 1980s, the aggregate productivity of the US telecommunications industry grew considerably after an episode of market liberalization, and that this increase was largely due to an improvement of allocative efficiency. In another study, Bartelsman *et al.* (2013) quantify the contribution of

allocative efficiency, by showing that US aggregate labour productivity is roughly 50 per cent higher with respect to a hypothetical scenario where workers are randomly allocated across firms.

In addition to studying the contribution of allocative efficiency to aggregate productivity, it is possible to analyze the dynamics of aggregate productivity through a decomposition that assesses — for any pair of years — the relative contribution of three groups of firms: the ones that survive (also called incumbents), entrants and exiting firms. The demographic processes play a role in determining the productivity dynamics, since entrants and exiting firms are different (also with respect to the incumbents) in terms of productivity. For incumbents, it is possible to further distinguish the contribution of two more components: (i) the variation in the efficiency of individual firms (so-called within margin); and (ii) the reallocation of resources to firms characterized by different productivity levels (so-called between margin).

In order to rewrite equation (2) in dynamic terms, firms are divided in three groups g, as mentioned above:[6] **entrants (E)** that were not active at time t-1 and enter the market at time t; **exiting (X)** firms that were active at time t-1 and exit from the market at time t; and **incumbents (S)** that are active on the market in both periods. With these definitions in hand, equation (2) can be rewritten as:

$$\Phi_t = \sum_{i=1}^{\eta} \rho_{it}\omega_{it} = \sum_{g \varepsilon G} \Phi_{gt}\omega_{gt} \qquad (3)$$

where the weights w_{gt} correspond to the share of employees in group g, F_{gt} represents the aggregate productivity of group g, and G = {E, X, S}.

A dynamic version of equation (2) can be derived based on the methodology — known as dynamic OP decomposition — recently proposed by Melitz and Polanec (2015). Considering two consecutive time periods, it is possible to express the aggregate productivity of the first period (Φ_1) as the weighted average of the productivity of the firms that will survive and that of the firms that will exit the market; analogously, the aggregate productivity of the second period (Φ_2) can be expressed as the weighted average of the productivity of the firms that have survived and that of the firms that have entered the market:

$$\Phi_1 = \Phi_{S1}\omega_{S1} + \Phi_{X1}\omega_{X1} \qquad (4)$$

$$\Phi_2 = \Phi_{S2}\omega_{S2} + \Phi_{E2}\omega_{E2} \qquad (5)$$

The difference between $\Ö_2$ and $\Ö_1$ returns the variation in aggregate productivity:

$$\begin{aligned}\Phi_2 - \Phi_1 = {} & (\Phi_{S2} - \Phi_{S1}) \\ & + \omega_{E2}(\Phi_{E2} - \Phi_{S2}) \\ & + \omega_{X1}(\Phi_{S1} - \Phi_{X1})\end{aligned} \qquad (6)$$

where the first term (Φ_{S2} - Φ_{S1}) represents the productivity variation for the firms that are active on the market in both periods (the incumbents); the second (Φ_{E2} - Φ_{S2}) is the contribution of entrants, which is positive (negative) if their productivity is higher (lower) than that of the incumbent firms; the third (Φ_{S1} - Φ_{X1}) is the contribution of firms that exit the market, which is positive (negative) if their productivity is lower (higher) than that of the incumbents. The term (Φ_{S2} - Φ_{S1}) can be further decomposed into the variation of the

6 In all the analyses presented below, firm demography has been purged of false entrants and false exits, in the spirit of Geurts and Van Biesebroeck (2014). To identify false entry and exits, we use an administrative register of events that collects information on corporate operations. As a consequence, we are able to exclude from our data operations such as mergers and spinoffs.

incumbents' average productivity ($\Delta\ \bar{\rho}_S$) and the one of the covariance between incumbents' productivity and the share of employees (ΔCov_S), capturing the intensity of the reallocation process. To sum up, the variation of aggregate productivity can be expressed as the sum of the following four components (the first being average productivity, followed by reallocation, entry and exit respectively):

$$\begin{aligned}\Phi_2 - \Phi_1 &= \Delta\bar{\rho}_S + \Delta Cov_S \\ &+ \omega_{E2}(\Phi_{E2} - \Phi_{S2}) \\ &+ \omega_{X1}(\Phi_{S1} - \Phi_{X1})\end{aligned} \qquad (7)$$

where the sum of average productivity and reallocation add up to the contribution of the incumbents, and the sum of entry and exit add up to the contribution of net firm demography.[7]

Results

Baseline Results

We first have applied the static decomposition in equation (2) to Italian aggregate labour productivity for the total economy, and for manufacturing and services separately. In the 2005-13 period, the weight of allocative efficiency ($(Cov(\rho_{it},\omega_{it}))/\Phi_t$) has risen by nearly 7 percentage points from 35.3 per cent to 42.2 per cent at the end of the period, growing more strongly and steadily in manufacturing than in services. In Appendix Table B1 we report the static OP contribution for each 2-digit sector between 2005 and 2013.

The increasing importance of the static OP covariance for aggregate productivity is suggestive of the fact that reallocation may have played a major role in shaping the dynamics of Italian labour productivity in the period of observation. The decomposition outlined in equation (7) allows us to shift our focus to the growth rate of aggregate productivity — a more relevant variable both for policy and welfare considerations — and to have a more complete picture of the reallocation process, including firm demography as well.

Table 2 shows the results obtained applying the above-mentioned decomposition to our firm-level data. The first column contains the contribution of incumbent firms' average productivity to the dynamics of aggregate productivity; this contribution reflects both variations in technical efficiency at the firm level and fluctuations in the demand faced by firms, that may influence — especially in the short run — the pricing strategies of firms.[8] The second column shows the contribution of the reallocation among the surviving firms; in other words, it tells how much of the observed productivity dynamics depends on reallocation of employment shares to the most efficient firms. The contribution of entry (third column) is typically negative, as it reflects the lower productivity of these firms with respect to the incumbents;

7 For sake of simplicity, we have described here the baseline Melitz and Polanec (2015) decomposition, which defines aggregate productivity as a weighted average of individual firms' log productivities. Despite returning a straightforward decomposition, this approach has two drawbacks: (i) the growth of aggregate productivity measured in logs does not correspond to that of aggregate productivity measured in levels, which is the one that should be preferred when evaluating welfare implications (Petrin and Levinsohn, 2012); (ii) in the baseline decomposition, the covariance term would not be invariant to changes in average productivity (i.e. a uniform increase in productivity for all firms would also map into the covariance term, rather than on the within-firm productivity term only). Melitz and Polanec (2015: 374) explain how these issues can be addressed, by performing the decomposition on data in levels and by defining a scale-independent covariance term. All the results presented in this article are obtained using this decomposition in levels.

8 It has to be stressed that we are not able to perfectly control for price variations, since the deflators at our disposal are disaggregated at the 2-digits level. Hence, price variations may still show up in our data, as long as they depart from the average price dynamics within each 2-digit sector.

Table 2: The Decomposition of Aggregate Productivity's Dynamics

	Surviving firms		Firm demography			
	Average productivity	Reallocation	Entry	Exit	Net	Aggregate productivity
			Manufacturing			
2005--06	3.43	3.04	-0.87	1.15	0.28	6.75
2006--07	-0.07	1.73	-0.98	1.24	0.26	1.92
2007--08	-4.31	0.91	-0.96	1.14	0.18	-3.22
2008--09	-17.66	3.72	-0.73	1.62	0.89	-13.05
2009--10	7.30	6.89	-1.10	1.61	0.52	14.70
2010--11	-1.63	5.67	-1.19	1.17	-0.02	4.02
2011--12	-4.93	2.69	-1.03	1.18	0.15	-2.09
2012--13	-4.56	5.89	-1.07	1.51	0.45	1.77
2005--13	-14.73	21.75	-6.71	8.55	1.84	8.86
			Services			
2005--06	-2.04	3.44	-2.09	2.59	0.50	1.90
2006--07	-0.92	1.16	-2.41	2.45	0.04	0.27
2007--08	-2.93	-0.48	-2.16	2.45	0.29	-3.11
2008--09	-9.55	0.49	-1.76	2.93	1.17	-7.89
2009--10	-0.02	5.79	-2.38	2.65	0.27	6.03
2010--11	-5.49	3.95	-2.80	3.01	0.21	-1.34
2011--12	-5.66	0.20	-2.46	2.77	0.31	-5.16
2012--13	-4.91	4.55	-2.76	3.29	0.53	0.18
2005--13	-11.76	4.86	-10.93	8.46	-2.47	-9.37
			Total			
2005--06	-1.20	4.50	-1.79	2.13	0.34	3.64
2006--07	-0.79	1.52	-2.06	2.10	0.05	0.77
2007--08	-3.14	-0.39	-1.87	2.06	0.20	-3.33
2008--09	-10.66	-0.57	-1.49	2.58	1.09	-10.14
2009--10	0.99	7.80	-2.14	2.37	0.23	9.02
2010--11	-4.95	5.57	-2.48	2.52	0.04	0.67
2011--12	-5.54	1.32	-2.18	2.35	0.17	-4.05
2012--13	-4.85	5.10	-2.39	2.85	0.46	0.71
2005--13	-12.46	10.41	-10.99	9.25	-1.74	-3.79

Notes: Net demography is defined as the sum of entry and exit.

The decomposition on the 2005-13 period is not obtained by cumulating the contributions across years, but is instead obtained by applying the Melitz-Polanec decomposition on the initial and final year only. This means that the groups of incumbents, entrants and exiters are not directly comparable to the ones taken into account in the year-by-year exercises. This may lead to some counter-intuitive results: as an example, the annual net contribution from firm demography is positive in all years, but the contribution over the entire period is negative.

such a productivity divide may derive on one side from the smaller size of entrants, on the other from the fact that newborn firms tend to compress their markups, setting up more aggressive price strategies upon entry, in order to rapidly acquire market shares (Foster *et al.*, 2016) thus reducing measured labour productivity. The positive contribution of exit, instead, reflects the selection mechanisms that force the exit from the market of the least productive firms.

In the period under analysis (2005–13), aggregate productivity in manufacturing has risen by 8.9 per cent, despite the fall experienced in correspondence to the two episodes of economic crisis. The generalized decline of average productivity has been counterbalanced by a positive contribution of reallocation in every year of our sample. Despite being positive in the vast majority of the cases, in services the reallocation has not been strong enough to counterbalance the steady decline experienced in terms of average productivity; this had a detrimental impact on the overall dynamics of aggregate productivity, which fell by 9.4 per cent over the 2005–13 period. Both in manu-

Table 3: Firm Demography

	2006	2007	2008	2009	2010	2011	2012	2013
				Manufacturing				
Entry rate	5.55	5.35	5.36	4.39	4.42	4.83	4.47	4.58
Entrant share of VA	1.78	1.75	2.07	1.62	1.62	1.93	1.88	1.91
Entrant relative size (1,2)	30.50	34.07	36.61	35.97	37.31	37.33	40.24	41.02
Entrant relative productivity (2)	82.77	80.31	84.40	81.75	82.65	80.90	73.13	74.71
Exit rate	5.60	5.72	5.98	7.13	5.84	5.65	6.68	6.84
Exiting share of VA	1.23	1.08	1.23	1.61	1.16	0.93	1.09	1.34
Exiting relative size (1,3)	19.43	16.63	19.11	20.19	18.63	15.04	13.76	16.65
Exiting relative productivity (3)	81.79	64.01	63.65	64.14	60.14	57.31	53.95	50.22
				Services				
Entry rate	9.67	11.02	9.29	7.96	8.02	8.92	7.82	7.95
Entrant share of VA	3.81	4.41	4.17	3.56	3.80	4.13	3.57	3.55
Entrant relative size (1,2)	40.87	40.19	45.19	45.59	48.34	41.74	46.71	42.90
Entrant relative productivity (2)	74.86	75.05	78.14	75.62	74.45	70.92	62.88	69.72
Exit rate	6.31	6.27	7.69	8.09	7.26	8.47	9.09	10.15
Exiting share of VA	2.28	1.98	2.39	2.83	2.27	2.40	2.52	2.80
Exiting relative size (1,3)	33.92	30.74	43.61	32.78	32.61	29.20	24.82	23.44
Exiting relative productivity (3)	71.79	67.56	72.03	62.17	74.76	52.51	53.60	46.15
				Total				
Entry rate	7.70	8.31	7.41	6.25	6.30	6.96	6.22	6.34
Entrant share of VA	2.84	3.14	3.17	2.63	2.75	3.08	2.76	2.77
Entrant relative size (1,2)	35.98	37.35	41.20	41.09	43.17	39.71	43.70	42.03
Entrant relative productivity (2)	78.52	77.44	80.95	78.44	78.16	75.49	67.63	72.04
Exit rate	5.97	6.01	6.87	7.63	6.58	7.12	7.94	8.57
Exiting share of VA	1.78	1.55	1.83	2.24	1.74	1.69	1.84	2.10
Exiting relative size (1,3)	26.69	23.66	32.04	26.81	25.97	22.54	19.60	20.25
Exiting relative productivity (3)	76.59	65.85	68.19	63.07	68.11	54.67	53.76	48.05

Notes: Average values across the 315 5-digit industries belonging to manufacturing.

(1)In terms of value added.

(2) With respect to surviving firms

(3) With respect to active firms at t.

facturing and services, our results show two clear and to some extent diverging patterns. On the one hand, the reallocation of resources from least to most productive firms contributed positively to aggregate productivity growth; on the other hand, the fall in average productivity hampered productivity growth. As discussed in the introduction, the decline in average productivity measured as real value added per worker might be interpreted with caution because it might not reflect changes in technical efficiency; nonetheless, its decline is neither surprising nor new for the case of Italy. Several studies have documented the structural weaknesses of the Italian economy (e.g. size distribution of firms, high share of family-owned firms and low propensity to innovate, among others) that are limiting productivity growth (Brandolini and Bugamelli (2009)).

Aggregate productivity has also been influenced by firm demography. As expected, the entry component is always negative (since entrants are, on average, less productive than incumbents), and the exit one is always positive (since exiting firms are less productive than incumbents, as well). Overall, the net contribution of firm entry and exit has sustained the dynamics of aggregate productivity in almost

all years, despite being relatively small in magnitude; the contribution of firm demography has been substantially higher in the years of deepest financial crisis (2008–09), as a result of an increase in the exit component induced by a more pronounced selectivity on the market.

Ultimately, the contribution of firm demography depends on two factors: on one side, the rates of entry/exit from the market; on the other, the relative productivity of entering and exiting firms with respect to the incumbents. The dynamics of these two factors is reported in Table 3. Services are characterized by substantially higher entry and exit rates relative to manufacturing. Moreover, while in manufacturing the exit rate is always higher than the entry rate,[9] in services it is usually the opposite,[10] if we exclude the sudden tightening up of the selection process in the most acute phase of the sovereign debt crisis (2012 and 2013).

Entry rates in both manufacturing and services have shrunk over time, while the pattern followed by exit rates is less clear-cut; it is apparent, though, that exit rates suddenly increased in the years of crisis, suggesting that recessions influence firm demography mainly by pushing firms out of the market, rather than by preventing the entrance of new firms. Looking at relative size and productivity of these firms with respect to incumbents, new entrants in manufacturing tend to be smaller but more productive with respect to those in services. Relative productivity has been declining for both entering and exiting firms throughout the whole period of observation, more intensely in manufacturing, where — as shown in Table 2 — the process of reallocation has sustained the aggregate productivity of incumbents.

Netting from Sectoral Composition

The results of the aggregate labour productivity decomposition presented in Table 2 may crucially depend on composition effects: the relative weight of the four components could be different across more narrowly-defined sectors, as it is likely to be influenced by structural sectoral characteristics — such as the degree of competitiveness or the exposure to international trade, for example. In order to check whether our results are significantly affected by these composition effects, we have replicated the dynamic OP decomposition on each narrowly-defined sector (according to the 5-digit Ateco 2007 classification), pooled together all the sectors, and estimated for each component the following OLS model:

$$\Delta y_{st} = \delta_s + \delta_t + \varepsilon_{st} \qquad (8)$$

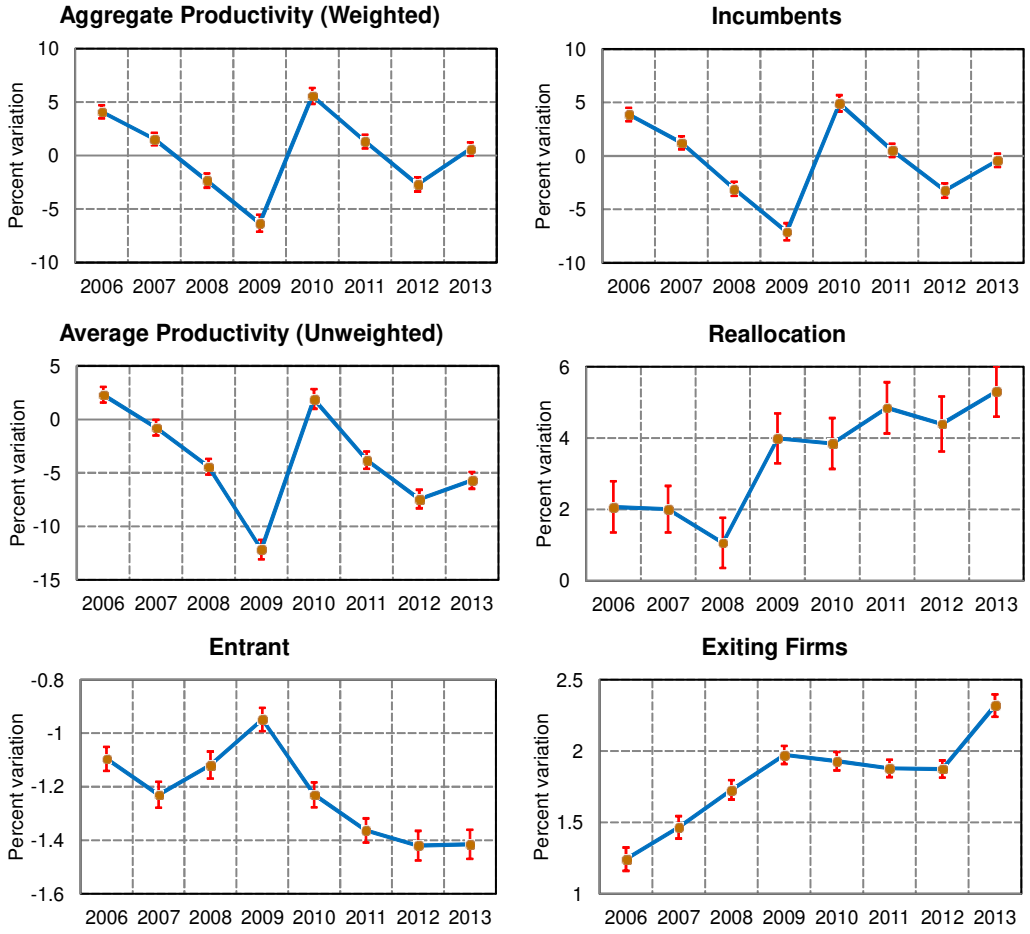
where Δy is one of the four components of aggregate labour productivity growth between year t and t - 1 (as defined in equation (7)), s indexes 5-digit sectors, t indexes years, δ_s are sector fixed effects, δ_t are fixed effects for year t, and ε_{st} is an error term. The idea behind this specification is to control for invariant sectoral characteristics by means of the sectoral fixed effects δ_s. The year fixed effects δ_t estimated under this framework can thus be interpreted as the contribution of each component to the dynamics of aggregate productivity, net of the composition effects discussed above.[11]

For each component, Chart 2 plots the estimated year fixed effects for the total economy. The results presented in Table 2 are broadly confirmed; moreover, the evolution over time of the various components emerges now more clearly, highlighting in particular the steadily-increasingly positive role of reallocation in

9 This is coherent with other data sources — such as the Infocamere database — that provide information on firm demography in manufacturing.

10 This pattern has been also documented in Lotti (2007).

Chart 2: The Decomposition of Productivity Dynamics, Net of Sectoral Fixed Effects, 2006-2013



Notes: Dependent variables were winsorized at the 5th and 95th percentile across the whole sample.
Aggregate productivity growth expressed in per cent, is the sum of productivity growth in incumbents,entrants and exiting firms. Productivity growth in incumbents is the sum of unweighted average productivity growth and reallocation, expressed in percentage points.

counterbalancing the fluctuations in average-firm productivity.

Net of sectoral composition, aggregate labour productivity — which was moderately increasing until 2007 — experienced a conspicuous swing in the years of the financial crisis and then settled on a pattern of sluggish growth, interrupted by a new trough at the onset of the sovereign debt crisis. This pattern is largely dominated by the contribution of incumbent firms, which summarizes the often diverging contribution of the average productivity and of the reallocation terms: on one side, the firms' average productivity sluggishly growing at the beginning of our sample — suffered sharp declines in correspondence to the

11 When applied to narrowly-defined sectors, the dynamic OP decomposition may return extremely high values (in absolute terms) on some of its components; this is typically the case when dealing with sectors characterized by a few small firms. When we estimate model 8, it is therefore particularly important to clean for these outliers, that may severely affect our estimates, despite having little relevance in aggregate terms. To do that, we winsorize our dependent variables — i.e. the contribution to aggregate productivity growth of each component in equation 7 — at the 5th and 95th percentile across the whole sample.

Table 4: Elasticity of the Aggregate Productivity Components to the Sectoral Business Cycle

	Average productivity	Reallocation	Entry	Exit	Aggregate productivity
Manufacturing	0.1345***	0.0644**	-0.0039***	-0.0006	0.1683***
	[0.036]	[0.026]	[0.001]	[0.001]	[0.050]
Services	0.0742***	0.0423***	-0.0018	-0.0033***	0.0956***
	[0.026]	[0.015]	[0.002]	[0.001]	[0.025]
Total economy	0.1087***	0.0522***	-0.0024**	-0.0027***	0.1295***
	[0.022]	[0.014]	[0.001]	[0.001]	[0.026]

Note: The reported coefficients are the elasticities of each component to the sectoral business cycle, are captured by an aggregate sales index computed for each sector at the 5 digit level of disaggregation. Standard errors clustered at the sectoral level (5 digit). All the regressions have been weighted by the number of employees in each sector.

two crisis episodes, and negatively weighed on aggregate productivity in all post-crisis years, except 2010; on the other side, the contribution of reallocation — initially less sizable — experienced a considerable jump at the onset of the financial crisis, maintaining its contribution at the same high levels in the following years. Adding to the positive effect of the reallocation process, the contribution of firm demography strengthened over the period of observation, thanks to the relevant increase of the exit component, driven by a more selective market environment after the two crisis episodes. These broad tendencies are largely confirmed when the exercise is repeated for manufacturing and services separately.[12] The most notable difference relates to the contribution of reallocation, which — despite being similar in size at the beginning of the sample — experienced a stronger increase for the firms in services than for those in manufacturing; nonetheless, the former were penalized by worse dynamics of the average productivity term.

Cyclical Fluctuations

The results presented in the previous sections do not disentangle the effect that different cyclical conditions at the sectoral level may have on the four components in the aggregate productivity decomposition. In order to explore the role of the business cycle, we enrich equation 8 with an additional term, exploiting the information on real sales at the industry level. More specifically, we estimate the following regression by OLS:

$$\Delta y_{st} = \delta_s + \delta_t + \beta \Delta I_{st} + \varepsilon_{st} \quad (9)$$

where ΔI_{st} is the growth rate of a real sales index for each 5-digit sector s between years t-1 and t. In this case, our coefficient of interest is β, representing the elasticity of each component of labour productivity to the business cycle at the industry level.

Table 4 collects the estimated β coefficients for each component, and for manufacturing and services separately. The first two columns confirm that both average productivity and reallocation among existing firms are procyclical: a one-standard-deviation increase in the growth of real sales is associated with an increase of average productivity and reallocation by 1.1 and 0.5 percentage points, respectively. The elasticity on average productivity is stronger in manufacturing, while the one on the reallocation component is not statistically different between the two sectors. As regards the exten-

12 These results are shown in Charts C.1 and C.2 in the appendix at: http://www.csls.ca/ipm/32/Linarello_Petrella%20Appendix.pdf

Table 5: The Aggregate Productivity Components in the Long Run vs. Sectoral Characteristics

	Average productivity	Reallocation	Entry	Exit	Aggregate productivity
			Panel (a):		
log Herfindahl	-0.8766	1.6105**	0.3955*	-0.6597***	1.4351**
	[0.884]	[0.732]	[0.214]	[0.197]	[0.706]
N	580	580	577	576	580
R2	0.007	0.032	0.016	0.052	0.026
			Panel (b):		
ImpPen developing	-8.9043	25.7745*	-5.1873	22.7467***	18.7375
	[15.348]	[13.732]	[5.632]	[4.613]	[16.677]
N	184	189	191	190	190
R2	0.003	0.037	0.020	0.224	0.016

Note: Robust standard errors. All the regressions have been weighted by the number of employees in each sector. The regressions in panel (a) have been performed on data disaggregated at the 5-digit level. Those in panel (b), instead, refer to manufacturing sector only, and have been performed at the 4-digit level, since data on import penetration were not available at a more disaggregated level.

sive margins (i.e. entry and exit), columns 3 and 4 show that both elasticities are negative and smaller in size with respect to the intensive margins. A negative elasticity of entry means that — during booms — the negative contribution of entry to aggregate productivity growth is stronger. It is interesting to notice that the aggregate effect is driven by the estimates in the manufacturing industries, for which the coefficient is statistically significant. This elasticity is in line with the evidence relative to the years of the global financial crisis (2008 and 2009), but are at odds with the results for the aggregate productivity decomposition during the sovereign debt crisis (2012–13). However, while the first crisis triggered a credit crunch that reduced the availability of finance to less productive new initiatives; the second crisis was characterized by a fall in aggregate demand and an increase in uncertainty that reduced the average productivity of new projects. A negative elasticity of exit has a different interpretation because it implies that during recessions the positive contribution of exit to aggregate productivity growth is stronger. The correlation is coherent with a large body of literature, that claims that during recessions selection processes are tougher.[13]

Industry Characteristics

Finally, we explore to what extent the four components of equation (7) are influenced by structural characteristics at the industry level. In order to do so, we perform an OLS estimation on the following regression:

$$\Delta y_s^{LR} = \beta x_{s,\,t0} + \varepsilon_s \qquad (10)$$

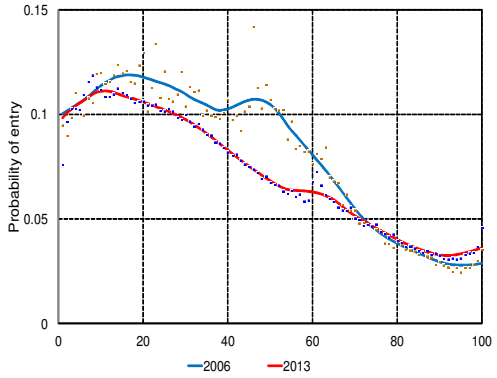
where Δy_s^{LR} is the long-run sectoral contribution (between 2005 and 2013) of each of the four components defined in equation (7), $x_{s,t0}$ is the structural sectoral characteristic of interest in sector s, measured at the begining of the period, and ε_s is an error term.

Market structure In the panel (a) of table 5, we look at the effect of the degree of concentration within each industry, measured by means of the Herfindahl index on sales (mea-

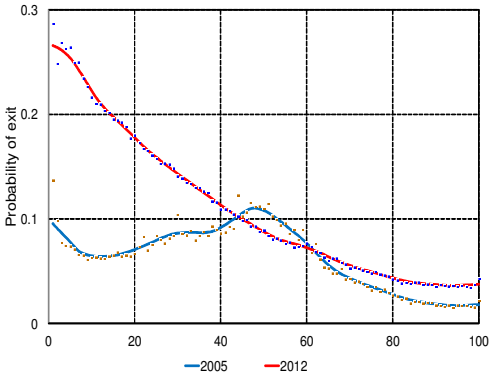
13 In this sense, our results are coherent with the theoretical and empirical literature that investigated the cleansing effect of recessions (Caballero and Hammour, 1994; Foster *et al.*, 2014).

Chart 3: Entry and Exit Probability, by Percentile of the Productivity Distribution

a) Entry



b) Exit



sured in logs): $x_{s,t0} = \ln(H_{s,2005})$. The last column indicates that more concentrated industries experience higher aggregate productivity growth. By looking at the different components, it is apparent that the overall effect is likely to be driven by reallocation. In concentrated industries the positive effect of reallocation is stronger: a 1 per cent increase in the concentration index leads to a 0.2 per cent increase of the reallocation component. This might reflect the "winner takes all" dynamics, i.e. the fact that technological leaders increase their advantage with respect to laggard firms. Significant effects also emerge in terms of firm demographics: our results show that in more concentrated sectors the negative contribution of entry and the positive contribution of exit are attenuated in size. In the case of exit, this result is mostly driven by the fact that exit rates tend to be lower in more concentrated sectors. As regards entry, instead, the attenuation is mainly due to the fact that in concentrated sectors the entrants are more similar to incumbents in terms of relative productivity, probably as a consequence of higher barriers to entry.

Import penetration In the last two decades, Italy has been exposed to a substantial increase in competition from abroad (especially from developing countries), as a consequence of the gradual reduction in trade costs and of the process of globalization; this induced a deep restructuring of the Italian productive system, that is likely to have influenced the dynamics of aggregate productivity. We therefore focus on the manufacturing sector and look at the correlation between import penetration from developing countries and the different components of the aggregate productivity decomposition. Import penetration is measured as the share of imports from developing countries in domestic consumption; it has been computed for each 4-digit industry, and refers to year 2005. The results are displayed in panel (b) of Table 5. Despite being non-significant for aggregate productivity as a whole, import penetration from developing countries has an impact on some of its components. In particular, import penetration has a strong and positive effect on reallocation and exit; this might be consistent with the fact that a greater exposure to competition from developing countries favors the exit of least productive firms and the reallocation of resources towards most productive incumbents. The effect is sizable: a one-standard-deviation increase in the import penetration index is associated with an increase of the reallocation and exit components by 3 and 2.6 per cent, respectively.

Chart 4: Employment Growth, by Percentile of the Productivity Distribution

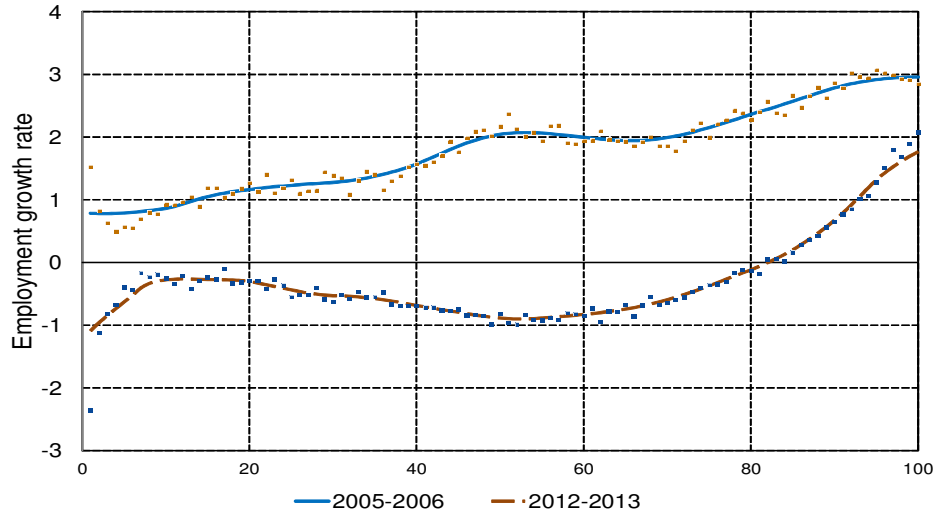
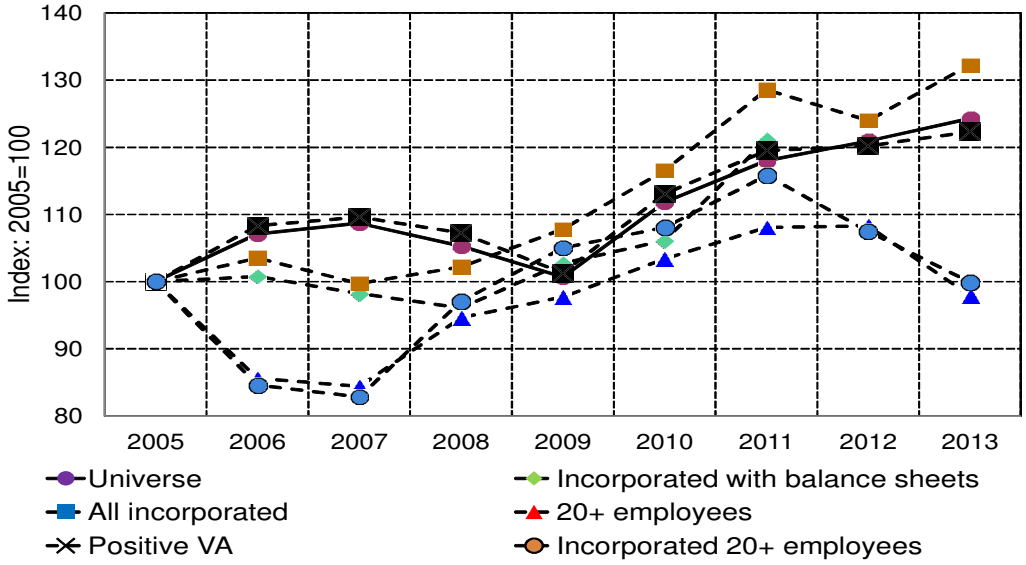


Chart 5: The Evolution of OP Covariance Across Samples



Effects Along the Productivity Distribution

In this section we provide some suggestive evidence at the firm and industry level on the underlying mechanisms of the documented increase in allocative efficiency in Italy between 2005 and 2013.

We start by exploiting our firm level data. First, we divide firms into within-industry percentiles of the labour productivity distribution; second, for each percentile we compute the entry rate, the exit rate and the average employment growth of surviving firms. The left panel of Chart 3 shows the entry rates in 2006 and in 2013. As already documented in Table 3, entry rates have fallen in Italy. As the chart shows, however, the decline has not been homogeneous along the productivity distribution. Entry rates fall up to the 70th percentile of the productivity distribution, while they remain almost unchanged for top percentiles. The right panel shows the exit rates in 2005

and 2012. Exit rates increased for almost all percentiles of the productivity distribution; nonetheless, they more than doubled for the lowest percentiles, while the increase has been very small among the most productive firms.

Chart 4 reports the average employment growth of surviving firms in 2005–06 and in 2012–13. In 2005–06 employment growth was higher for the more productive firms, ranging from almost 1 per cent among firms in the lowest percentiles to about 3 per cent for firms in the top percentiles of the productivity distribution. This corroborates the evidence presented in the previous sections, showing that the contribution of reallocation to aggregate productivity growth in Italy was positive even before the crisis. In 2012–13 employment growth declined for all firms; it became negative for firms up the the 80th percentile of the productivity distribution, and it remained positive for the most productive firms. Overall, this pattern positively contributed to the strengthening of the allocative efficiency of the Italian economy.

The Importance of Observing the Universe of Firms: A Comparison With Other Popularly Used Data

Among the features of this work, the completeness and the quality of the data used are two of the most relevant aspects; this is especially true for the Italian case, since this article is the first one — to our knowledge — that exploits data on the universe of Italian firms to analyze productivity dynamics. In order to stress the importance of having access to data on the universe of firms, we have fictitiously reduced our sample, and then compared our results with those obtained from different sample cuts that are commonly used in the literature.

Chart 5 summarizes the discrepancies across different sample cuts, by showing the evolution of the covariance term deriving from the static OP decomposition across different sample cuts. To produce the graph, we perform the static OP decomposition on progressively smaller samples to obtain the weight of the OP covariance term on the aggregate productivity of each subsample. The series of these weights are then converted to index numbers to better analyze their evolution.

The results highlight stark differences across sample cuts. As a matter of fact, most of the sample cuts fail to single out the increased weight of the OP covariance term in the years 2005–07 and its reduction at the onset of the global financial crisis (2008–09), which are only captured by the full sample (either including or excluding firms with negative value added). The subsequent recovery is captured by the samples that only include incorporated firms, but not by the samples with 20 or more employees, which display divergent dynamics.

Conclusion

In this article we exploit a unique dataset covering the universe of Italian firms operating in the non-agricultural and non-financial sector over the period 2005–2013, in order to document the contribution of allocative efficiency to the dynamics of aggregate labour productivity. Following the Olley and Pakes methodology, we have decomposed aggregate labour productivity as the sum of firm average productivity and a term capturing the strength of allocative efficiency. We find that allocative efficiency increased by almost 7 percentage points between 2005 and 2013.

We then analyzed the the dynamics of aggregate labour productivity, distinguishing between the contribution of different factors: on one side, the contribution of incumbent firms, depending on both the average firm productivity and the reallocation of resources across firms; on the other, the contribution of firm demographics (entry and exit of firms in

the market), mainly driven by selection mechanisms. The reallocation component — net of sectoral composition effects — positively contributed to the dynamics of aggregate productivity in all years, even before the burst of the global financial crisis (years 2005–07 in our sample). Over the whole period 2005–13, it steadily increased its relevance. The net contribution of firm demography is always positive in our sample: the positive contribution linked to the exit of least productive firms more than compensated the negative contribution arising from the entry of small low-productivity newborn firms.

The contribution of the different components to the dynamics of aggregate productivity varies according to the business cycle. Average productivity and reallocation are both procyclical, consistent with the evidence that firms tend to invest more when they experience a positive demand shock. The contribution of entry and exit is, instead, countercyclical, pointing at a more stringent selection process during recessions. Reallocation is also stronger in sectors that were more exposed to competition from developing countries; this might have favored an improvement of allocative efficiency through the exit of the least productive firms and the subsequent reallocation of resources towards the most productive incumbents.

Over the period of observation, the different response of entry rates, exit rates and employment growth along the productivity distribution also provides some suggestive evidence on the mechanisms behind the observed increase in allocative efficiency. In the same time span, exit rates increased and entry rates dropped for firms in the low tail of the productivity distribution, suggesting that the prolonged phase of recession gave rise to a more selective environment. Moreover, average firm employment growth declined across the whole distribution, becoming negative for the firms in the lower tail. Overall, these results suggest that the structural adjustment of the Italian productive system — already in action before the global financial crisis — reinforced during the prolonged period of recession; such adjustment predominantly occurred through the exit of the least productive firms and the reallocation of workforce to the best performing ones.

To our knowledge, this article is the first one that analyzes productivity dynamics using detailed data on the universe of Italian firms. The advantage of using complete and high-quality data is non-negligible: we show that different sample cuts, often used in the literature, fail to capture the changes in the incidence of allocative efficiency over aggregate productivity.

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Appendix:[14]

Dealing with Missing Values

The validity of our empirical exercise crucially rests on the quality of the data used. One of the main concerns is therefore related to the non-negligible share of firms —especially in the years between 2005 and 2010— for which we are not able to measure value added. As documented in Abbate *et al*. (2017), the missing information has been filled by imputing the median value added per worker within cells defined by industry classification, size class, location and legal form.

We present an additional exercise that aims at checking the robustness of our estimates against the exclusion of the imputed information on value added. It would be desirable for us that the results of this exercise closely followed those presented in Table 2; that would allow us to claim that the imputation performed did not significantly distort our estimates. Appendix Table 2 displays the results obtained excluding from the analysis the records with imputed value added: they are completely in line with those presented above both in terms of average productivity and reallocation; some slight difference emerges in the net contribution of firm demography, which is sometimes negative, especially in services. The results obtained for period 2012–13 exactly replicate those presented in Table 2, since in those years data did not present missing values.

Overall, this robustness exercise suggests that the imputation method used to fill in the missing information did not significantly distort the results of our decomposition.

Alternative Productivity Measure

We have performed the decomposition exercise using as an alternative measure of productivity, namely sales per worker. Since the information on sales is always present in our database, we would be comforted if the relative importance of the four components was similar to the one resulting from the previous exercise on value added per worker. Of course, the two measures differ in many respects. Though different, however, value added per worker and sales per worker broadly share similar dynamics, as shown in Appendix Chart 3: in manufacturing, the dynamics of sales per worker tracks quite closely the one of value added per worker; in services, the two dynamics are still similar, despite showing bigger discrepancies, especially in the last part of the sample. Moreover, it is interesting to look at sales per worker, since it can represent a valid alternative for measuring labour productivity (as in Bartelsman *et al*. (2013)).

Appendix Table 3 shows the decomposition applied to sales per worker. The results confirm that the reallocation has sustained aggregate dynamics in both manufacturing and services, though experiencing larger swings than in the previous exercise and turning negative in a few cases; the contribution of average sales per worker is largely negative throughout all the sample, just like the average productivity component in Table 2. Entry and exit still offer a negative and positive contribution, respectively, but their net effect —even if small— is not positive in all periods; it is confirmed, however, that the largest contributions from firm demography were registered in the years of the financial crisis (2008–09).

14 Full appendix available at: http://www.csls.ca/ipm/32/Linarello_Petrella%20Appendix.pdf

Portugal: A Paradox in Productivity

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ABSTRACT

Portugal has a lower level of productivity than advanced economies but, paradoxically, the recent improvement in several of its determinants did not lead to convergence in productivity levels. The objective of this paper is to better understand the larger slowdown in productivity growth in Portugal than the one occurring in those countries by considering its main determinants. It presents a set of different reasons for the divergence with developed economies since the mid-1990s that are associated with an increasing misallocation of capital, labour and skills both at a sectoral and firm level. Moreover, it outlines some policy proposals to enhance aggregate productivity growth in the Portuguese economy within a framework of growing integration in global markets.

Portugal is experiencing a slowdown of productivity growth, similar to the one occurring in advanced economies. Given that aggregate productivity growth is the main source of per capita income growth, this slowdown is associated with a slower improvement of living standards.

A number of hypotheses do explain the productivity slowdown: a decline in the birth rate of innovative firms able to deal with greater regulatory complexity (OECD, 2015a); insufficient investment in infrastructure, equipment, R&D and information and communication technology (ICT); weak aggregate demand (Sakellaris and Wilson, 2004; Jorgenson *et al*, 2008; Adler *et al*., 2017); a slower pace of technology diffusion (Andrews *et al*., 2015); non-competitive product markets and capital misallocation (Isaksson, 2007; Dias *et al*., 2015); rigid labour markets and rapid ageing of the population leading to skills and labour mismatches and insufficient knowledge-based and human capital accumulation (Bloom *et al*., 2012; Adler *et al*., 2017; Aiyar *et al*., 2016).

In a neoclassical world, Portugal, poorer than most developed economies, is expected to converge both in the level of productivity and in the average wealth of the population. That was the goal when Portugal became a European Community member.

The objective of this article is to understand why this expected convergence has not happened. The article consists of four sections. The first section compares the recent evolution of productivity in Portugal and the most developed countries, the EU core and G7, confirming that the Portuguese economy is falling behind in productivity levels.[2] The second section examines the state of productivity determinants or

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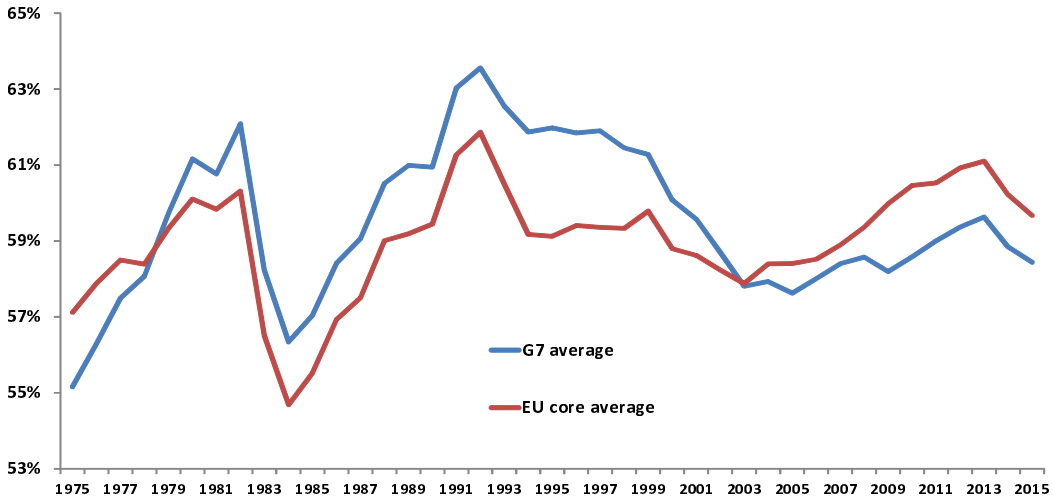
2 EU core includes the following 15 countries that were members in 2003: Italy, Belgium, The Netherlands, Luxembourg, France, Germany, UK, Denmark, Ireland, Portugal, Spain, Finland, Sweden, Austria and Greece. Exceptions are explicitly stated in the charts. For example, Luxembourg is only included for LP but not in MFP. Austria and Greece are not included in both.

Chart 1: GDP Per Hour Worked - Portugal as a Proportion of the G7 and EU Core, 1975 - 2015

Employment-weighted averages, USD, constant prices, OECD PPP



Note: EU core is defined as the 15 EU member states in 2003 except Austria and Greece

drivers in Portugal to shed light on possible explanations for the slowdown. The article then discusses policies to enhance Portuguese productivity performance within a framework of integration in global markets. The final section concludes with a brief review of the main findings.

Productivity Developments in Portugal

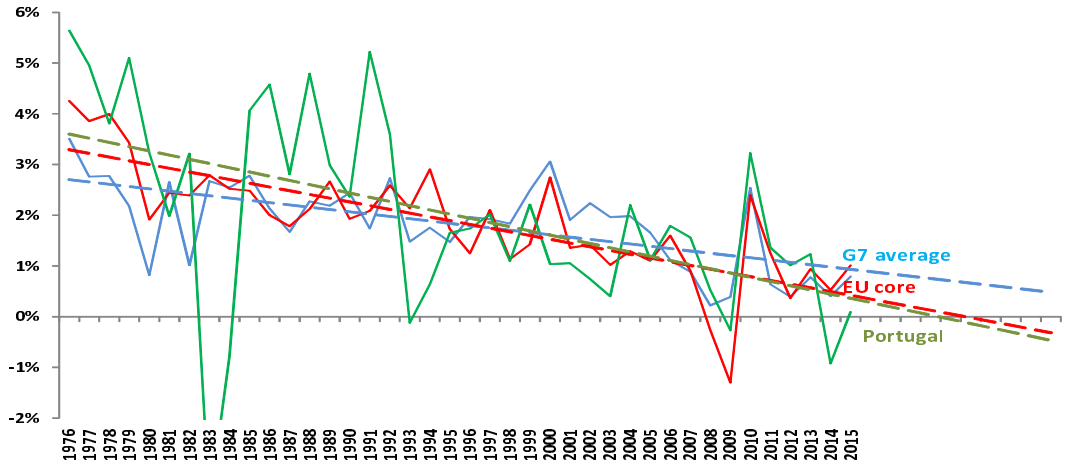
Aggregate productivity (AP) reflects the efficiency of production. In an aggregate production function, productivity growth can be measured through the change in labour productivity, or the partial productivity of any other input, or in multifactor productivity.

Labour productivity (LP) measures units of output produced per unit of labour input. LP growth reflects the gains from the use of the labour input and from multifactor productivity and capital, through its service per unit of labour. This same logic can be applied to capital or any other input. Assuming decreasing marginal returns, Portugal is expected to converge in LP with developed countries, better endowed with capital and labour. Multifactor productivity (MFP) measures the residual in economic growth. MFP growth reflects the increase in output that is not explained by a change in the quantity of inputs. It can be interpreted as the change in the stock of knowledge applied in production. If everything else is equal, countries with a lower stock of knowledge will tend to imitate those with a higher stock and thereby converge.

Both LP and MFP growth in Portugal converged with developed economies from a very low base after the transition to democracy in 1974 until the 1990s. Improvements in the level of education and in the allocation of skills, a higher rate of investment in tangible capital and important reforms after EC entry help explain it. Since then productivity growth slowed and Portugal started to fall behind due to insufficient investment in ICT and R&D, labour market rigidity and the allocation of labour and capital to non-tradable industries,[3] partly dominated by state-owned firms and less open to

Chart 2: Growth Rate of Labour Productivity in Portugal, G7 and EU Core, Actual and Trend Values, 1976 - 2015

Employment weighted averages, USD, constant prices, 2010 PPPs, OECD



Note: EU core is defined as the 15 EU member states in 2003 except Austria and Greece

competition. The evolution after the global financial crisis of 2008 is not yet clear given that MFP stagnated and the recovery in LP may be associated with a significant loss of employment up to 2013. Data since 2014, when employment started to grow again, show a negative change in the level of LP that is canceling the previous growth.

Labour Productivity

Charts 1 and 2 compare productivity in Portugal with the employment-weighted average for G-7 countries, a proxy for globally developed markets, and the average for EU core countries. They show that LP grew faster in Portugal than in advanced countries up to 1992, except in the period 1982-1984 when the second oil shock and a balance of payments crisis led to a significant slowdown in real GDP growth but currency devaluation did prevent an enormous fall in employment.

Between 1985, the year before Portugal joined the European Community (EC), and 1992, there was a catching-up. LP growth was 3.8 per cent

Table 1: GDP Per Hour Worked - Compounded Annual Growth Rates in Portugal, the G7 and the EU Core, 1970-2015

	1970-1980	1980-1990	1985-1992	1992-2000	2000-2007	2007-2015
Portugal	3.2	2.2	3.8	1.5	1.3	0.9
G7	2.9	2.2	2.2	2.3	1.7	0.9
EU core	3.8	2.3	2.2	2.2	1.2	0.7

Source: OECD. USD constant prices, 2010 PPPs. G7 and EU core: employment weighted averages.
G7: Canada, France, Germany, Italy, Japan, UK and USA
EU core: 15 members in 2003 less Austria and Greece

3 Tradable industries are industries where exports are more than 15 per cent of sales. They include agriculture, mining, manufacturing, transports, tourism, consulting and other technical activities. The remaining industries, including the state sector, are non-tradable.

per year on average, significantly above that of the G7 countries and the EU core (2.2 per cent) (Table 1). This higher growth is associated with the implementation of important liberalization reforms after EC entry, improvements in human capital and a higher rate of investment that led to a higher capital-labour ratio (Freitas, 2012).

LP growth up to 1992 was also a result of better labour allocation. Employment did move from agriculture and agro-food, textiles and other traditional industries to service sectors such as trade, utilities, construction, real estate, business services, finance or tourism, where there were higher productivity levels (Laíns, 2008).

After 1992, however, LP growth started to progressively slow down (Chart 1), registering an annual growth rate of 1.2 per cent for the 1993-2014 period. As a consequence, LP in Portugal diverged up to 2003 with the EU core and up to 2007 with G7. Worse, Portugal was expected to grow faster in terms of LP but the underlying trend is of a tiny divergence with the EU core (dashed lines in chart 2), with whom Portugal is economically more integrated, and a stronger divergence with G7 (seen in the higher decreasing slope of Portugal).

Labour was allocated to smaller firms and non-market entities in trade and services sectors, which represented 72 per cent of total employment. Non-structural factors such as deficient capital allocation to protected industries and to state-owned firms, distorted competition and rigid labour markets also explain the slowing down of LP (McKinsey, 2004).

Further trade liberalization with the creation of the World Trade Organization in 1995, reinforced by China´s accession in 2001, the end of the multi-fiber agreement and the EU enlargement to Central European countries in 2004, opened the European market for developing economies. It had two consequences for traditional exporting industries (textiles, footwear, pulp, etc.) in Portugal: a reduction in employment due to business closures, because low relative wages were no longer a comparative advantage, and further improvements in LP in the remaining firms in these industries (Laíns, 2008).[4]

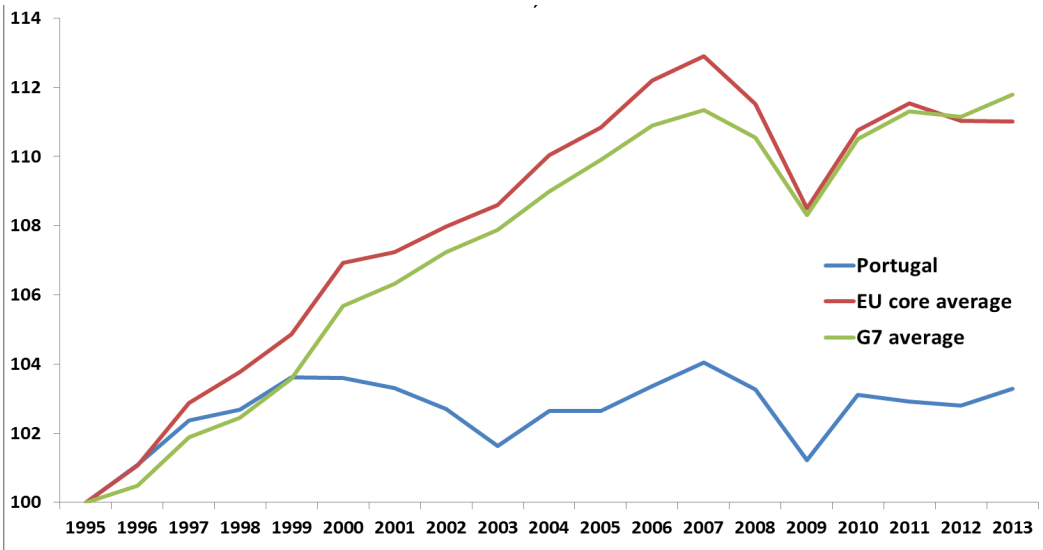
But LP gains in manufacturing were not sufficient. Overall LP divergence is evident since 1992, initially in trade and market services, and in the 2000s even LP growth in manufacturing became lower than in the EU core (Sondermann, 2012). Compared to most developed economies, manufacturing was always a relatively small sector in Portugal in gross value added terms (GVA) because there was a direct transition of resources from agriculture to low LP growth activities such as construction, trade and market and non-market services.

A consequence of the low LP growth in Portugal, together with a higher increase in Portuguese real wages, the increasing consumption levels financed externally at Euro-related low interest rates and with permanent deficits in the current account (Blanchard, 2007) was an unsustainable level of debt owed by households, firms and the Portuguese state. This situation ended in a near-bankruptcy in 2011.

The relative level of LP in Portugal recovered after 2007. Despite the important reforms recently introduced in the labour market and the catching-up in the level of education (section 3), it is difficult to know if this trend is sustainable. The stock of capital per person employed has decreased since 2013 and recent employment growth is likely bringing back to the labour market low skilled and less productive workers who became unemployed after 2000. If this is the case, and the latest available information up to 2016 seems to confirm it, this will negatively

4 Bloom *et al.* (2015) explain the same effects in 12 European countries with Chinese import competition after its accession to the WTO.

Chart 3: Multifactor Productivity Growth - Portugal, EU Core and G7, 1995 - 2013
1995 = 100, OECD



EU core: 15 members in 2003 less Austria, Luxembourg and Greece

Table 2: Multifactor Productivity - Compounded Annual Growth Rates in Portugal, the G7 and the EU Core, 1995-2013
Yearly compounded growth rates

	1995-2000	2000-2010	2010-2013
Portugal	0.7	0.0	0.0
EU core*	1.3	0.4	0.1
G7	1.1	0.4	0.3

Source: OECD.stat
EU Core: (the above EU countries and Belgium, Denmark, Finland, Ireland, Spain, The Netherlands and Sweden). Unavailable data for Greece, Austria and Luxembourg.

affect LP growth in the near future and reinforce its decreasing trend.

Multifactor Productivity

Multifactor productivity (MFP) growth was also higher in Portugal than in most other developed economies between the 1970s and the beginning of the 1990s. According to Eckaus (2008), the average annual growth rate of MFP in Portugal was 0.4 percentage points higher than in the EU core between 1975 and 1985 and 2.1 points higher between 1985 and 1990. After 1990, the rate of growth fell off but it was still above the EU core average by 0.2 points in 1990-1995. Throughout this period MFP in Portugal also grew faster than in the United States and Japan.

Eckaus explains this situation through catch-up from a very low base, improvements in human capital due to a doubling of the average years of education for the working age population, and foreign investment (both private and EU funds) in non-traditional sectors such as the auto industry and ICT sector. Liberalization reforms after the entry to the EC in 1986 most probably helped.

However, MFP growth slowed at the end of the 1990s,[5] falling below that of the G7 and EU

core countries (Chart 3 and Table 2). Multifactor productivity grew by 0.2 per cent per year between 1995 and 2013, with no growth between 1999 and 2013. Portugal was not converging in MFP with most advanced countries.

Balta and Mohl (2014), using a different methodology, find that the TFP-based technological gap between advanced and "laggard" economies (Portugal, Spain and Italy) within the Euro area persisted or widened (depending on the industries) in the decade preceding the global financial crisis. In some non-tradable industries (utilities, construction and some services) that grew substantially in Portugal during this period, there was even negative MFP growth partly due to insufficient investment in R&D and ICT, or, during the crisis, due to capital misallocation (Gopinath *et al*., 2017).

The insufficient investment in intangibles is consistent with the consumption-based model of economic growth in Portugal after 1995. An external inflow of money associated with low interest rates from Euro membership, together with wage growth in non-tradable sectors, led to growing consumption levels. This situation in turn led to a deterioration in the current account and a substantial increase in external debt. Resources were misallocated to non-tradable and protected industries where MFP declined and total investment was not boosted by the surge in domestic demand (Reis, 2013). The share of GVA in wholesale and retail trade, state services and construction was, in 2000, more than 10 percentage points greater in Portugal than in the Euro core countries.

Distributional Features

In OECD countries, the productivity growth slowdown is associated with a widening dispersion of productivity gains in each sector and with higher wage dispersion (Berlingieri *et al*, 2017; Andrews *et al*., 2015). Neo-Schumpeterian growth theory states that firms at the frontier are able to innovate and adopt new technologies and knowledge, thus maintaining a higher rate of productivity growth. The remaining firms, however, may face a slowdown in productivity growth when there are frictions in technology and innovation diffusion through learning or catching-up.

This is observed in many markets where the effects of digital technologies and globalization led to winner-take-most dynamics and is more pronounced in industries where recent product market reforms were less pro-competition, suggesting that policy decisions are limiting the diffusion process (Andrews *et al*, 2016).

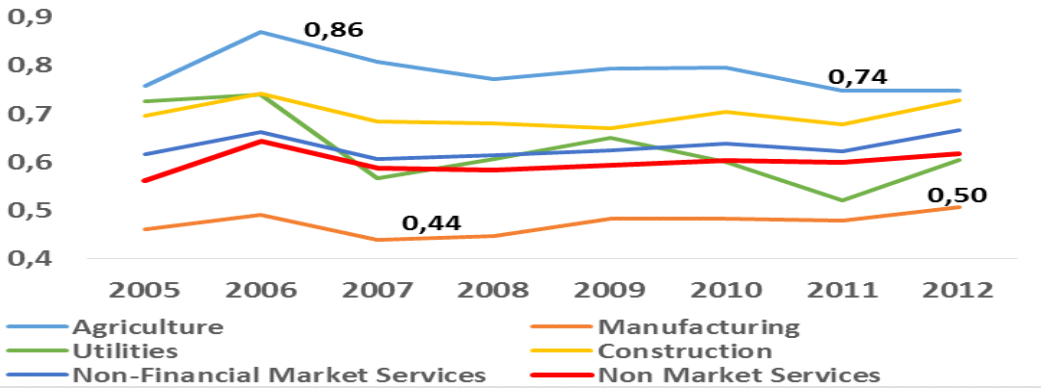
A question, then, is whether this is happening in Portugal. Chart 4, based on the OECD´s Multiprod output shows the sectoral evolution of the standard deviation of LP and MFP growth rates between 2004 and 2012. In most industries a stabilization or a reduction in the dispersion can be observed. The dispersion of LP growth rates in the manufacturing sector has increased, but that was not the case for MFP. The standard deviation at a 3-digit industry level also shows stability in the degree of dispersion.[6] An explanation would be that, in global terms, none of the Portuguese firms are at the global frontier and the data only compare firms at the national frontier with the laggards, where productivity convergence seems to be easier (Bartelsman *et al*., 2008). However, at least some Portuguese

5 From this point on these are OECD numbers, while those presented in Eckaus (2008) are estimates for the EC.

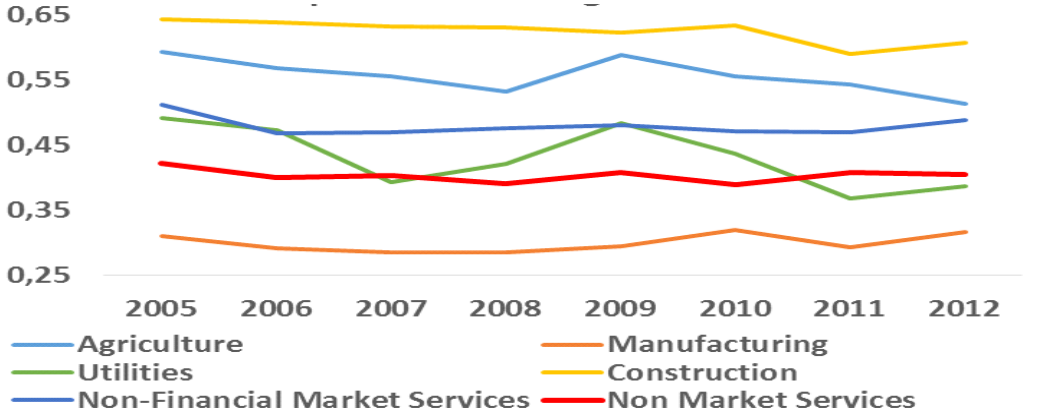
6 With certain exceptions the industries where an increase in the standard deviation includes: pharmaceutical products, chemicals, wood and paper, rubber and plastics, electrical equipment, furniture, accommodation and food services, legal and accounting services, and advertising and market research. Industries with a decrease include: computers, electronic and optical products, publishing, audiovisual and broadcasting activities, IT, electricity and gas, real estate, and telecommunications.

Chart 4: Dispersion of Growth Rates in Portugal, 2005-2012

Panel A: Labour Productivity



Panel B: Multifactor Productivity



Source: based on OECD's Multiprod output. MFP computed as a Solow residual.

Note: Market Services: Wholesale and retail trade, transportation and storage, accommodation and food services, Publishing, audiovisual and broadcasting, telecommunications and IT; Real estate, Legal, accounting, head offices and management consultancy activities, technical, testing and analysis, advertising, market research, veterinary and administrative service activities, repair of computers and household goods.

firms are integrated into global value chains and are either leading their specific field (e.g. Amorim for cork appliances in aerospace industry, CGC genetics or Via Verde for road tolls) or are multinationals where higher productivity levels justify the operation in Portugal.

Moreover, Santos *et al.* (2017) present evidence of spillovers from recently introduced structural reforms in the Portuguese business environment and product markets that impact MFP at a firm level. These spillovers are both related to diffusion from the frontier through learning and innovation by laggards and catching-up by other firms via the adoption of existing technologies or imitation of production processes.

The stability in dispersion, then, may be due to the low number of Portuguese SMEs connected to GVCs. These are benefiting from the diffusion and catching-up mechanisms but most of the Portuguese firms are not. This is consistent with the low competitive pressure in some product markets highlighted in section 3.

A consequence from a widening dispersion of productivity gains at the OECD level was higher wage dispersion due to skill biased technology enhancements, resulting in a job polarization

Table 3: Dispersion Measures of Wages (per worker)

Sectors	90/10 (2006)	90/10 (2014)	90/50 (2006)	90/50 (2014)	50/10 (2006)	50/10 (2014)	Gini Coefficient 2006	2014
Agriculture	4,41	4,46	1,91	1,83	2,31	2,43	0,32	0,31
Mining	3,62	3,79	1,86	1,80	1,95	2,10	0,29	0,30
Manufacturing	3,17	3,12	1,88	1,82	1,69	1,71	0,29	0,27
Utilities	5,82	5,12	2,40	2,35	2,43	2,18	0,42	0,40
Construction	3,88	4,09	1,95	1,91	1,99	2,14	0,33	0,31
Market Services	4,64	4,66	2,23	2,17	2,08	2,14	0,36	0,35
Total	4,24	4,41	2,12	2,06	2,00	2,14	0,34	0,33

Source: IES, firm level data.

where middle income workers become unemployed.

Firm level data shows that the distribution of average wages in firms became less unequal between 2006 and 2014. Table 3 presents different measures of dispersion that confirm lower wage dispersion. The ratio between the 90th and 10th percentiles slightly increased in some sectors (agriculture, market services, construction) but decreased in others (manufacturing, utilities). The increase was fully explained by the evolution in the ratio between middle and low-wage workers (50th and 10th percentiles), given that there was a decrease in the dispersion between wages in the 90th and 50th percentiles. Moreover, Gini coefficients decreased in all sectors except in mining.

Therefore, it seems that distributional effects of the slowdown in productivity growth in Portugal do not match those observed in other OECD countries. Lower productivity growth in Portugal is neither associated with a dispersion of productivity gains between firms in the same sector nor with higher wage dispersion between high and low skilled workers due to skill biased technology enhancements. Consequently, public policies to improve productivity in Portugal may not need to be constrained by equality concerns, as sometimes it is argued (OECD, 2016).

The difference between the Portuguese case and the OECD thesis may arise from the economic crisis, which resulted in a huge increase in unemployment in Portugal, but wage moderation policies were highly progressive (OECD, 2017a). The increase in income inequality was due to higher unemployment (peaked at 17.5 per cent in the first quarter of 2013), not greater wage inequality, given that average earnings for the total economy became more equal. The S90/S10 ratio decreased from 7.1 to 6.4 between 2006 and 2013 (Arnold and Rodrigues, 2015).

Indeed, it was low-wage earners, young and less-skilled workers who were more affected by the increase in the unemployment rate since 2000 and by the worsening of economic conditions that followed the 2008 financial crisis and the near-bankruptcy of 2011.

Productivity Determinants

A way to understand the deceleration of productivity in Portugal is to consider the determinants of LP and MFP growth. Syverson (2011) reviews the productivity literature and presents evidence of very significant effects on aggregate productivity from physical capital investment in information technology, R&D, and human capital accumulation. Moreover, the business environment can affect firm incentives to apply the above factors to raise their own productivity level through a better resource allocation from higher product market competition and knowledge and technology spillovers. Gonçalves and Martins (2016) broadly confirm these determinants for Portuguese manufacturing firms.

Some of the productivity determinants have recently registered a positive evolution —

investment in R&D, ICT capital growth, formal education, birth rate of new firms or increasing integration on global markets. Thus, other reasons must explain why Portugal is not converging in terms of productivity.

Investment in Equipment and Infrastructure

Portugal benefited from a huge inflow of foreign capital after EC entry in 1986. This included both private and official EU funds, and purely financial and FDI flows and it resulted in an increase in the net stock of capital per person employed. According to OECD data, the inflow resulted in capital intensity growth of 4.6 per cent per year between 1995 and 2013, significantly above the EU core (2.7 per cent) and G7 (2.4 per cent) averages.[7]

However, this growth in capital intensity was accompanied by a decrease in both LP and MFP growth rates, as noted earlier in the article. Capital services from this inflow appear not to have been of a sufficiently "high quality" nature to have had a significant positive impact on productivity (e.g. Sakellaris and Wilson, 2004). Capital productivity fell 46 per cent in Portugal between 1995 and 2013.[8]

The unproductive use of capital in the Portuguese economy is also confirmed by the decreased, almost to nil, of the capital per worker contribution to trend labour productivity growth (adjusted for cyclical effects) in Portugal between 2000 and 2015 (Ollivaud *et al.*, 2016).

The weak effect of this capital inflow on productivity is unexpected given the low relative level of capital per worker in Portugal, half of the EU15 core. But capital misallocation and excessive consumption of imported goods and services explain this situation.

A between-sector misallocation of capital since the 1990s can be seen in the growth of non-tradable sectors and in investment in infrastructure and housing. Reis (2013) hypothesizes that the financial integration after 1995 was not reflected in 'financial deepening' in the tradable sector but through the expansion of less productive private and state firms in the non-tradable sector.

Indeed, a significant part of capital was channeled to state and/or 'protected' industries such as wholesale and retail trade, real estate or construction, which registered higher profits but lower LP (OECD productivity indicators).

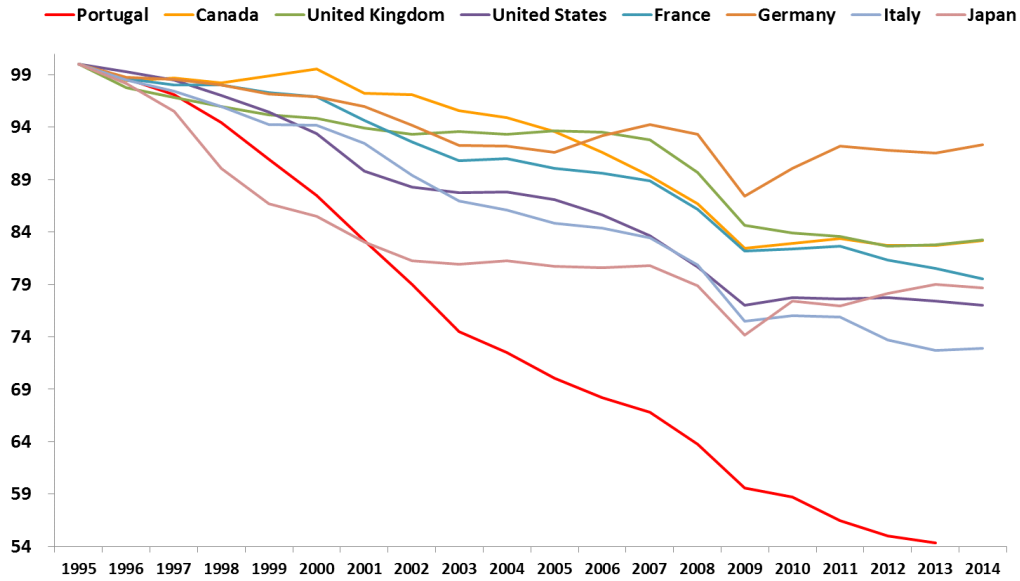
Moreover, there was considerable investment in infrastructure and housing during the 1990s, when the stock of capital in structures was 257 per cent of GDP while the stock of transportation and other equipment was only 78 per cent of GDP. This difference, although partially reflecting the longer life-time of structures, shows that investment in Portugal was too concentrated. Even when capital inflows started to slow down after 2000, structures still represented 60 per cent of total new investment, well above other EU countries and despite the dubious economic (but not political) rationale for such investment. The construction sector represented 11.5 per cent of total employment in 2000, well above that of the EU core countries (6.2 per cent). For example, part of a third highway between Lisbon and Porto (urban areas with 2.8 and 3.6 million people, respectively) was built, when the second highway had a very low level of traffic. Many road investments were made under badly negotiated public-private

7 Capital intensity is the ratio of capital services (the flow of productive services that capital delivers in production) per hour worked.

8 Capital productivity is measured as the ratio between the volume of GDP and the volume of capital input, defined as the flow of capital services. Capital services are estimated by the OECD using the rate of change of the productive capital stock, which considers the reduction in the productive capacity of fixed capital assets. A common computation method for all countries ensures comparability.

Chart 5: Capital Productivity in Portugal and Developed Economies, 1995-2014

1995 = 100, OECD



partnerships where the risk was entirely borne by the Portuguese state. Investment in housing led to a situation in which there were 5 million residential units for a population of 10 million. But because the rental market has not been working since the 1970s, the physical condition of many houses is deteriorated. Most of the residential investment was in new houses in city outskirts and not in refurbishing the old houses in city centers.

These poorly thought out policy decisions contributed to a rapid increase in the level of Portuguese debt but had limited influence on productivity growth. The construction boom was financed by the banking sector, resulting in a credit misallocation that still exists today. Despite being the hardest hit industry in the last fifteen years and its very low profitability, construction still remains the sector accounting for the largest share of bank loans (17 per cent of the total), with the highest non-performing rate, 28 per cent (IMF, 2015).

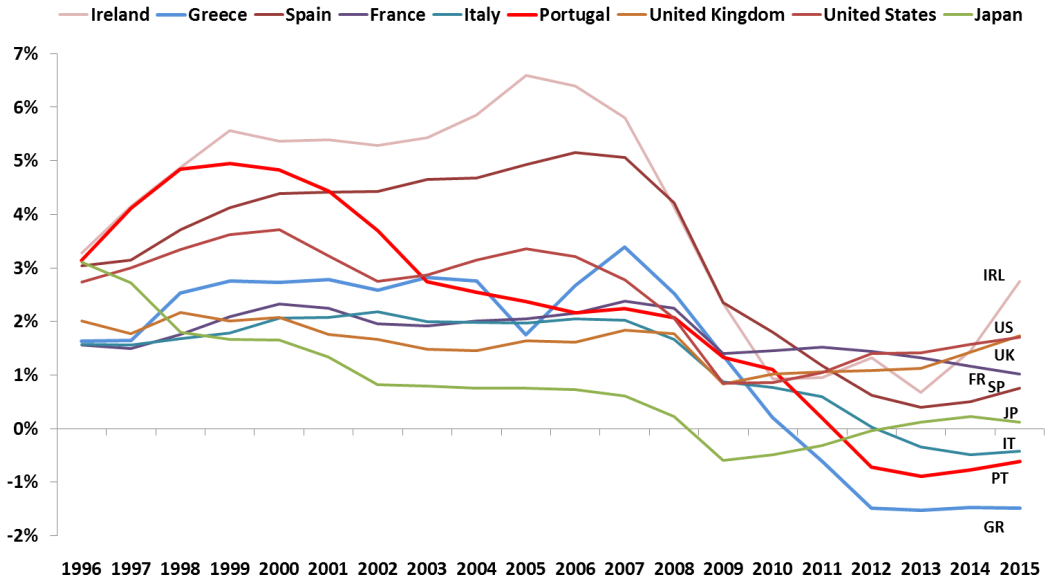
Finally, excessive consumption is seen by the external financial inflows that were channeled through the banking system to fund imports of goods and services such as cars or tourism. These flows were reflected in an average deficit of 8.4 per cent of GDP in the Portuguese current account during the decade of 2000.

An increasing mis-allocation of capital via an over-focus on non-tradable sectors (OECD, 2017b), bad investment decisions in infrastructure and housing when capital was abundant, together with a low level of capital per worker and a recent financing constraint to the whole economy has resulted in investment growth below the level needed to replace the capital stock. This is a very important bottleneck to productivity growth.

R&D, ICT and Innovation

Gross domestic expenditure on R&D in Portugal was 1.3 per cent of GDP in 2014, up from 0.7 per cent in 2000. The number of researchers per thousand employed is now higher than in the OECD or the EU28. Moreover, and according to the OECD, Information and Communication Technology (ICT) capital services per hour worked grew an average of 11.3 per cent

Chart 6: Net Capital Stock Growth Rate in Selected OECD Countries, 1996-2015



Source: AMECO. Note: Growth rates of net capital stock (constant prices): 2014-2015: provisional data

between 1995 and 2013, above that of the United Kingdom, the United States and Japan.

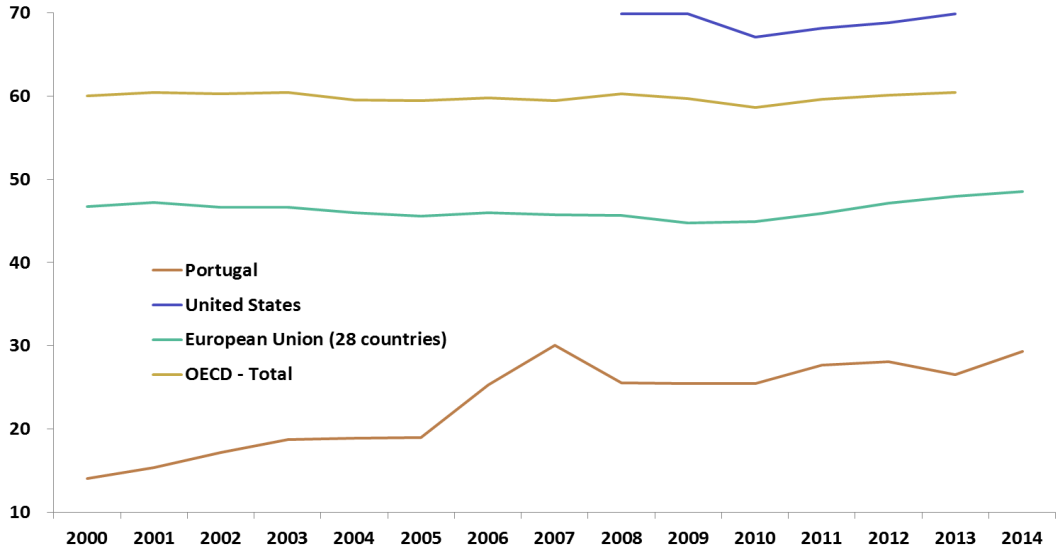
Furthermore, Portugal is seen as a moderate innovator and is ranked 18th in the European Innovation Scoreboard 2016 (EIS), presenting an innovation performance only slightly below the EU average. In the mostly perception-based Global Competitiveness Report 2015, Portugal ranks (out of 140 countries) well in some indicators: technological readiness 26th (32nd in 2008); innovation 28th (35th in 2008); availability of scientists and engineers 21st (48th in 2008); availability of new technologies 18th (28th in 2008); and quality of scientific research institutions 21st (33rd in 2008);

These improvements in innovation performance are the outcome of public policies that aimed to increase the stock of knowledge produced in the Portuguese scientific community. However, they did not lead to higher LP or MFP growth because these policies targeted mainly non-market research. R&D is still too concentrated in the state sector, mainly in universities, and is mostly of a fundamental and not of an applied nature (Heitor *et al.*, 2014).

The rankings mostly reflect the level of R&D expenditure but do not consider the efficiency or the market usage of these investments. Business oriented policies were based on tax credits and subsidies to investment in R&D and innovation. But these were insufficiently evaluated, were partly targeted at non-tradable industries and achieved limited success. Other policy efforts, such as the placement of PhDs in firms, failed.

Investments in information technology and R&D benefit productivity growth through the improvement of production processes and better products and services (Jorgenson *et al.*, 2008; Balasubramanian and Sivadasan, 2011). Furthermore, such investments may generate productivity spillovers through the diffusion of innovation knowledge (Gersbach and Schmutzler, 2003) and technology transfer (Bloom *et al.*, 2007) from firms in the global or national productivity frontier. The question is to what degree did this happened in Portugal?

Chart 7: Business Enterprise Researchers Per Thousand Employed (% of total), 2000-2014



Source: OECD

The low number of researchers in business, the low total expenditure in R&D or the low number of patent applications by Portuguese firms indicates that these positive effects on productivity growth were limited.

The number of researchers per 1,000 employees who work in businesses in Portugal in 2014 are still half of the OECD and U.S. average and 60 per cent of the EU28 average (Chart 7). In a similar way, expenditure on R&D in Portugal is almost half of the OECD average (2.4 per cent of GDP in 2014). Business expenditure on R&D in total R&D sending is growing (from 28 per cent in 2000 to 50 per cent in 2014) but partially due to lower state spending. It still is below that of most developed economies (the OECD average is almost 70 per cent).

Patent applications per 1,000 researchers in Portugal are also very low, at one tenth of the OECD average. The number of Portuguese patent applications filed under the Patent Cooperation Treaty per 1,000 researchers (FTE) was 4 in 2014 (2 in 2000), well below the OECD average of 38 (21 in 2000).

R&D and innovation resources were excessively allocated to non-market sectors, significantly limiting the potential positive effects on productivity growth. Significant incentives were destined to increase the stock of knowledge but were not sufficient in encouraging more efficient and innovating producers to replace less efficient ones, exposing a lack of coordination between science and innovation policies in this area.

The small number of medium and large firms with financial strength for long term investment and the relatively large percentage of firms in services, where R&D and technology are less important, help explaining why a growing share of incentives were channeled through the state sector and not via businesses. Portugal needs to improve the market orientation of R&D and to evaluate public policies in order to benefit productivity growth.

Human Capital Accumulation

Portugal is rapidly converging with the EU15 average in formal education. The gap on the

workforce with tertiary education was reduced by 5 percentage points in the last 15 years (to 8.2 percentage points). In secondary education, 12 years of formal education is legally required in Portugal. The recent results of PISA and TIMSS tests show that this convergence is not only a question of formal educational attainment but also of educational performance.

However, this convergence in education attainment toward the EU average coincided with the slowing down of productivity growth. Human capital accumulation arising from increased education and training is expected to accelerate LP and MFP growth (Fox and Smeets, 2011). In the case of Portugal, it was not sufficient. Three reasons may explain why: wasted resources, poorly-aligned incentives and insufficient policy evaluation.

Primary and secondary education in Portugal is still too centralized and schools have little autonomy. Financing is too dependent on the state and is not associated with school performance. Real expenditure grew by 33 per cent since 2008, the largest increase among OECD countries except Turkey (OECD, 2016). Because the number of students fell by 6 per cent, the growth in expenditure per student was even higher. Overall, Portugal has spent 6.1 per cent of GDP in education in 2013 (4.6 per cent in 2008), above the OECD average of 5.2 per cent.

An increase would be justifiable if the goal was to improve adult education, where the gap in education is wider and long-term unemployment is concentrated. But this seems not to be the case because only 0.3 per cent of persons 25 and over were enrolled in upper secondary education in 2014.

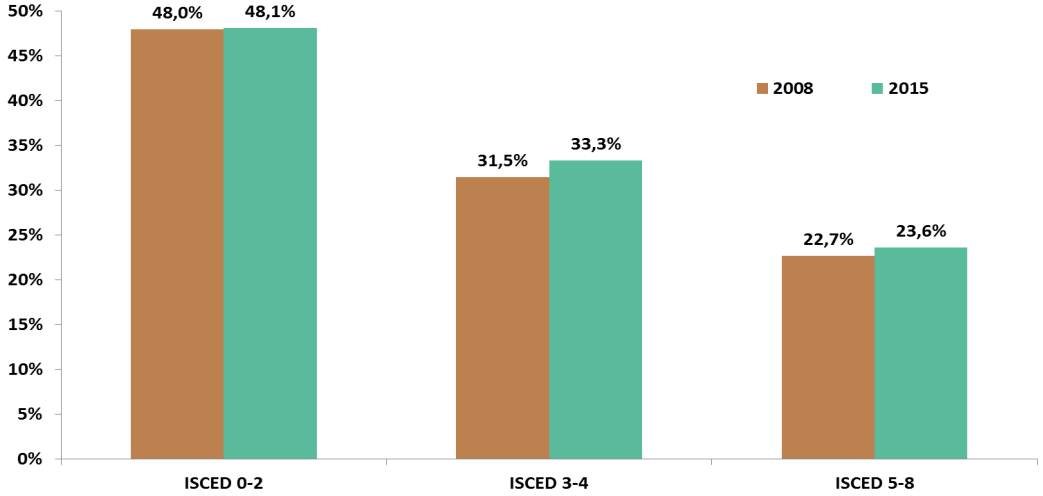
Training and vocational programs oriented toward the needs of employers improve skills of employees and help the unemployed re-enter the labour market. But the effectiveness of these policies varies considerably and has room for improvement. The number of graduates in vocational programs is growing rapidly although it is still below the OECD average. In 2014, 41 per cent of 25-34 years-old with upper secondary education had graduated from a vocational program, below the OECD average of 59 per cent (OECD, 2015b). The employment rate for this group was around 80 per cent, indicating a high level of effectiveness.

Training policies benefited from a recent attempt to increase on-the-job training and to integrate employers and other stakeholders in their design. But although Portugal received financial support from the EU in the last 30 years for these policies, their use was seldom duly evaluated, often resulting in a waste of resources with no sustainable effects for the beneficiaries.

Poorly-aligned incentives do not help. Education funds are allocated to the Ministry of Education while vocational and training funds are divided between the Ministries of Education and Labour. In practical terms, several government branches compete for these centrally managed funds, presenting a long and often confusing range of policy measures and programs. Moreover, both unions and employers saw frequently EU funds as a way to finance their activities and governments usually felt obliged to spend them to avoid the perception of not taking advantage of their availability, independently of the expected return.

A second point is that employment-friendly labour market institutions facilitate a better matching between supply and demand. Despite recent improvements — the reduction in the regulatory differences between permanent and temporary contracts and in severance payments, and a review of the definition of fair dismissal (OECD, 2017a) — Portugal still remains the OECD country with the strictest employment protection legislation for individual dismissals (OECD, 2017b).

Chart 8: Employment in Tradable Industries as a Share of Total Employment in Each Skill Level



Source: Portugal Statistics Labour Force Survey. ISCED 0-2 corresponds to lower level of education and ISCED 5-8 to higher.
Note: Tradable industries presented in footnote 2 above.

Furthermore, the Portuguese labour market has two important segmentations. The first segmentation is between permanent and temporary employees, where the first group consists of two thirds of the labour force that are highly protected from individual dismissals, while the remaining are either under short-term and unstable contracts or are free-lancers, in the private sector, and often with weaker incentives for training to improve their skills. The second segmentation crosses the first and is between permanent public employees, with a better-paid (the wage differential may reach 14 per cent or more after adjusting for qualifications, according to Mercer (2013), job-for-life guarantee, from the remaining workers with temporary contracts (in the state and private sectors) and with permanent ones in the private sector (better protected but with no job-for-life guarantee and vulnerable to collective dismissals).

These two segmentations progressively benefited the non-tradable sector, more sheltered from competition and with lower productivity, attracting workers from manufacturing and better-paid skilled workers. Tradable industries are still too dependent on low-skilled workers while high-skilled ones are mostly on non-tradable industries (Chart 8). The growth of these sectors led to a misallocation of labour and skills thus hampering LP and MFP growth.

The recent improvement in formal education may also strengthen Portuguese firms with better-skilled managers. However, it does not necessarily affect all firms. Bloom *et al*. (2012, 2014) show that manufacturing firms in Portugal have one of the lowest scores in management practices, associated with weaker market competition, more regulated labour markets and lower worker skills and conclude that management explains a very significant share (up to half of it) of MFP differences across countries. Moreover, managers in state-owned companies or business owners still tend to centralize decisions more frequently, thereby preventing changes from workers' learning-by-doing that benefit labour productivity growth (Benkard, 2000).

Finally, the ageing of the Portuguese population is another reason for a slowdown in productivity growth. A quarter of the workforce is expected to be more than 55 years old very soon

and this age group may be less able and willing to effectively use new technologies, dampening innovation. Aiyar *et al*. (2016) find Portugal as one of the worse affected countries by labour force aging in terms of future MFP growth. This result should be seen cautiously because it is assumed that human capital at that age will not improve. However, the percentage of Portuguese youth (20-24 years old) with a degree is now similar to the EU15 average and, even if it will take some time, the younger Portuguese workers will be more productive when growing older.

The remarkable progress in formal education in the last 15 years has been associated with wasted resources, non-aligned incentives and increasing labour and skills misallocation to low-productivity sectors due to double labour market segmentation. These must be improved so that productivity growth can accelerate, even with an ageing population.

Business Dynamism

Policy incentives for new firms to be created, grow and thrive were in place for many years: venture capital, business angels, seed financing and an entrepreneurial ecosystem. These incentives were complemented by a friendly business environment where new laws were implemented in a way intended not to be harmful for economic activity. Important legal simplifications and cost reductions for the establishment of new firms were implemented in the last 10 years thus reducing barriers to entry.

Portugal was one of the countries with the greatest improvement in OECD's Product Market Reforms indicator between 2008 and 2013. It now ranks 9th among the EU countries and 12th out of 33 OECD countries. In a similar way, Portugal has the 25th most favourable business environment among 189 economies in the World Bank's Ease of Doing Business Index (World Bank, 2017)

Moreover, the country has a high birth rate of firms (number of new firms as a percentage of existing firms). In 2013, it was 14.3 per cent, the fourth highest among 26 European countries. As in other countries, there is a on-going trend where young entrepreneurs create internet-based firms.

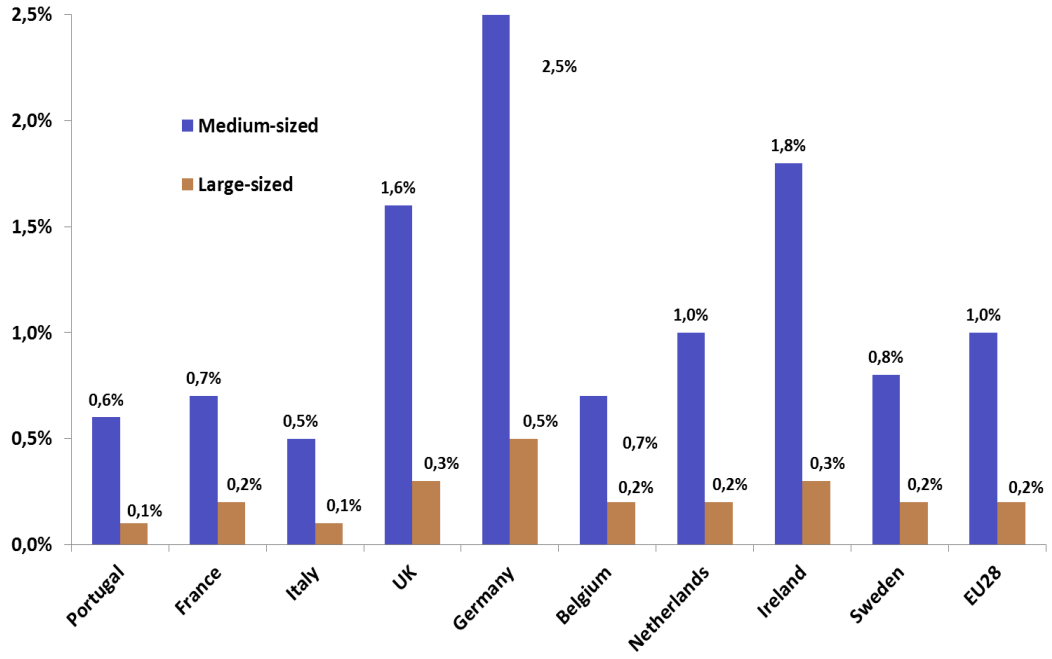
The examples of business dynamism highlighted above may indicate that the Schumpeterean process of creative destruction is in place in Portugal. However, its effects are not being felt in terms of productivity growth because two main problems are affecting business dynamism.

The first is that new Portuguese firms have also a high mortality rate. Despite the high birth rate, the number of firms have decreased 4% between 2008 and 2012, recovering afterwards. This is not a problem if the new firms, with a higher productivity level, are replacing old and stagnant ones. However, most of these start-ups are not able to grow. Between 2009 and 2013 only 6 per cent of the Portuguese firms were less than 2 years old (OECD, 2017b). This requires an evaluation of policy incentives.

Moreover, half of the small firms are more than 10 years old (OECD, 2017b) but some continue to exist despite being in a near insolvent situation. In the period 2010-2014, 41 per cent of Portuguese firms had interest payments that exceeded the cash-flow they could generate in at least one fiscal year. Around 20 per cent of firms paid more in interest than the generated cash-flow in every one of those 5 years. Their survival, even considering tax evasion, indicates that barriers to exit are more present than the high mortality rate might imply and confirm a within-industry resource misallocation (Dias *et al*., 2015).

Braguinsky *et al*. (2013) also show that Portuguese firms, in contrast to firms in other developed countries, are even shrinking and that several labour laws discriminate against medium and large firms, a disincentive to grow. This

Chart 9: Share of Enterprises by Size in 2015



Source: European Commission

explains why there are too few firms with more than 50 employees in Portugal, half (as a percentage of the total) of the EU28 average, one third of the UK and Ireland or one fifth of Germany (Chart 9). The existence of large firms is important because it may facilitates the integration of SMEs into global value chains.

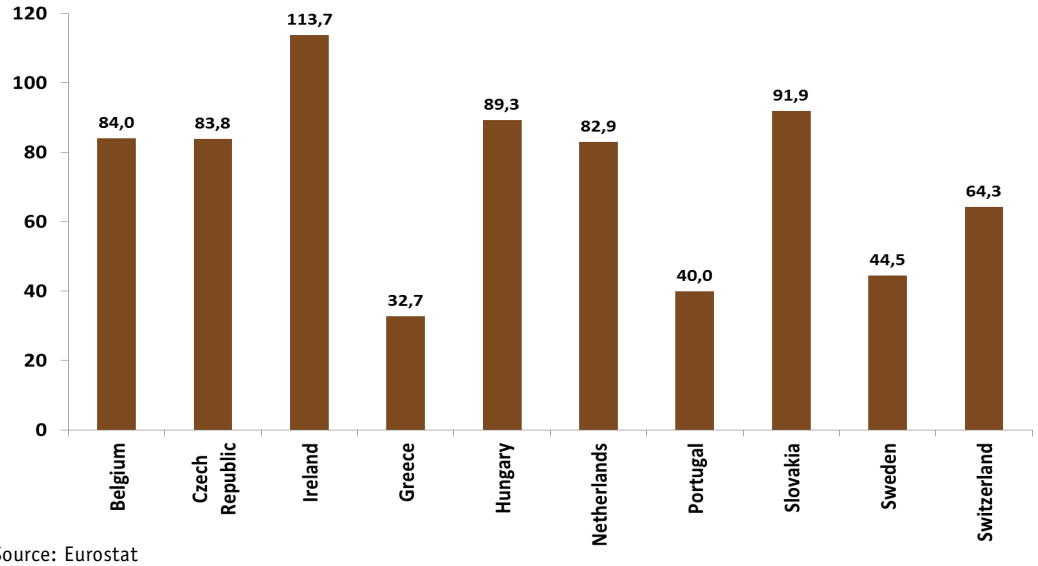
EU data confirms that large and medium-sized Portuguese firms also account for a lower share of employment (37 per cent) than in France (52 per cent), United Kingdom, (63 per cent) and Germany (58 per cent), indicating both an inefficient labour allocation and an insufficient reallocation of labour. Therefore, creative destruction is not occurring and a misallocation of resources exists because they are not moving from firms with lower productivity into new and innovative ones, with a higher level of productivity (Lentz and Mortensen, 2008; OECD, 2015a).

The second is that obstacles still negatively affect the growth of firms. Despite the simplification efforts of the last decade, firms still complain about excessive regulations, a justice system characterized by long delays, an arduous environmental licensing regime and an unstable legal environment, where tax conditions are permanently changing and new levies being introduced (Portugal Statistics, 2015).

Furthermore, excessively low levels of equity capital, incomprehensible and unstable financial policies where alternative financing has a limited impact on firms, and a stricter environment that reduces the access to financing, especially for new firms, are also barriers to business dynamism.

The level of debt of Portuguese firms reached almost 180 per cent of GDP in 2012. After considerable deleveraging, it still was 150 per cent of GDP by mid-2016. This represents one of the highest business debt levels in the EU, 20 percentage points above the Euro area average. Most Portuguese firms face liquidity problems and financing difficulties and, according to

Chart 10: Exports as a Proportion in Middle-Size European Countries, in % of GDP, 2014



Source: Eurostat

Banco de Portugal, almost 30 per cent have non-performing loans.

Finally, the difficulty for new firms to survive increases the market power of incumbents thus reducing product market competition. A consequence is that firms, when facing less competition, have a reduced incentive to bear the temporary but "disruptive" costs of introducing productivity-enhancing technology or change production practices (Foster *et al.*, 2001, 2006; Bloom *et al.*, 2015). This is more relevant for non-tradable industries, protected from external competition. Furthermore, it may limit the efficiency of knowledge and technology diffusion mechanisms, thus explaining why there was stability in the dispersion of productivity growth rates since 2005.

Higher productivity growth requires a business environment where more firms survive and scale-up their activity so that product market competition is increased, resource misallocation is minimized and incentives for firms to invest in enhancing-productivity technology and production practices are acted upon.

Openness and Internationalization

The international trade literature shows that more open countries experience faster productivity growth (e.g. Edwards, 1998, for empirical evidence).

Portugal is a small and not particularly open economy, at least compared with countries of similar size and level of development. Export flows confirm this picture. Between 1995 and 2008, when resources were mostly allocated to non-tradable sectors, exports as a percentage of GDP increased 0.77 percentage points annually, from 22 per cent to 32 per cent of GDP.

Since 2009 exports as a share of GDP have risen almost three times faster, an annual average of 2 percentage points, attaining 41 per cent in 2015. This is because Portuguese firms faced a domestic recession and had no alternative than to focus on external markets. But the export share of GDP still is well below those of other middle sized European countries such as Belgium, Czech Republic, Hungary, Slovakia and Ireland (Chart 10).

After 2010 a growing number of Portuguese firms benefited from a reduction in unit labour costs, gaining market share, looking for new

markets and increasing the internationalization of their activities. The number of exporting firms grew 6 per cent per year from 2010 to 2014, when 1 in 5 Portuguese companies exported goods or services.

Although the economics literature usually finds that more productive firms are the ones that start exporting, some research shows firms experiencing productivity growth after entering foreign markets (De Loecker, 2007). Moreover, an increase in competition abroad can also raise the incentive of firms to engage in innovative activities and induce them to make difficult productivity-enhancing investments, such as quality upgrading in plants, leveraging the benefits of productivity gains across larger markets and leading to aggregate productivity growth via the "within" firm component (Syverson, 2011).

Export developments show that the Portuguese economy is improving its external competitiveness but from a low base. Portuguese firms are slowly adapting to a context where developing countries have almost free access to the EU market. Given that Portuguese exporters are more productive than non-exporters, pay better wages, invest more on human capital and generate larger spillover effects (Correia and Gouveia, 2016), a higher growth in exports would help to reallocate resources to these sectors and minimize the inefficient allocation to non-tradable industries.

The idea of a relatively closed economy is confirmed by the low level of FDI stocks in Portugal, 51 per cent of GDP, below most of the EU middle-size economies and of EU28 average (80 per cent). Part of it may be associated with its peripheral location in the EU single market and the comparative disadvantage related to production costs, skilled labour and productivity relative to Eastern European countries. The EU entry by these countries in 2004 negatively affected the Portuguese economy by deviating FDI flows from countries such as Germany or Italy to the new EU members. These investments are usually export-oriented and thus allocate resources toward tradable sectors. Moreover, FDI driven spillovers may account for a substantial portion of productivity growth, especially in high-tech sectors (Keller and Yeaple, 2009).

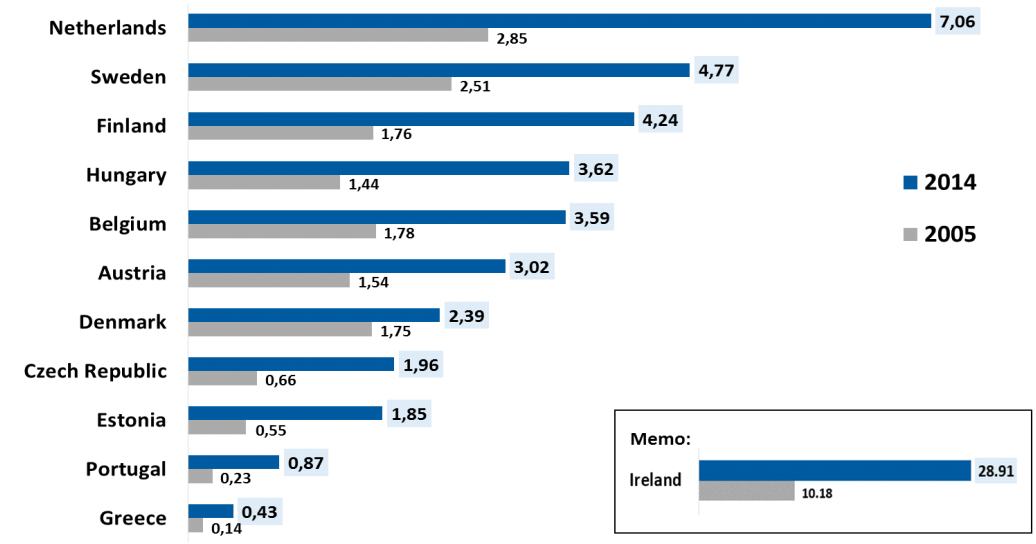
A low degree of openness is also seen in Portuguese receipts from the sale and use of patents, non-patented knowledge, drawings and models, brands and technical consulting services. A four fold increase in technological receipts as a proportion of GDP took place between 2005 to 2014. But receipts are much lower than in other countries (Chart 11). Given that tradable sectors such as ICT, electronics, machinery or pharmaceuticals are the largest investors in R&D, higher and growing receipts may be associated with a better allocation of capital and labour.

The level of participation in global value chains also confirms that Portugal is not as open as it is usually referred to as a small-open economy (Chart 12).[9] The progressive fragmentation of international trade is making Portuguese firms more integrated in global value chains and improving the value added of their production, but at a slow pace when compared with Eastern European countries. Portugal is below countries of similar size such as Sweden, Ireland, Hungary or the Czech Republic, and more so in forward linkages, thus delaying potential benefits for productivity growth (Criscuolo *et al*., 2016).

Although the Portuguese economy is becoming more open, the level of openness is still insufficient when compared with similarly developed economies. More openness, and more competitive firms operating in global markets, is a way to improve resource allocation and reverse the sluggish productivity pace in Portugal.

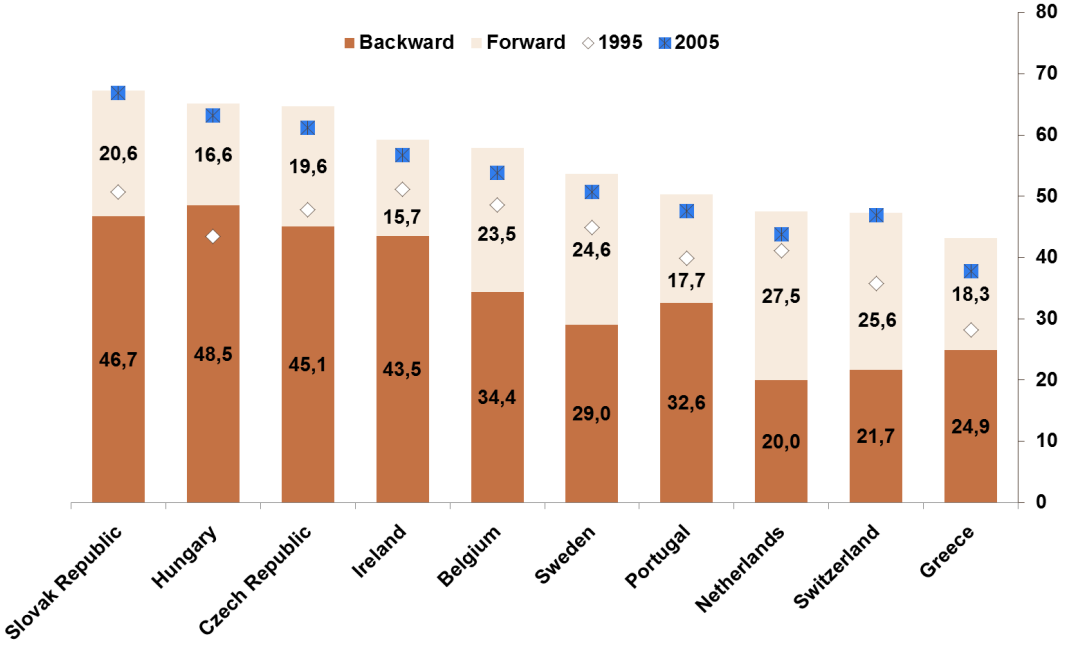
9 The GVC participation index adds up backward linkages, the import content of exports, and forward linkages, the domestic content incorporated in the exports of other countries.

Chart 11: Technological Receipts as a Proportion of GDP in EU Countries, 2005 and 2014



Source: OECD

Chart 12: GVC Participation Index, as a Proportion of Gross Exports, 2011



Source: OECD - Trade in Value Added (TIVA), October 2015

Policies to Improve Productivity Growth

The above assessment of the Portuguese situation indicates that there are different reasons for the slowdown in productivity growth and a lack of convergence with developed economies since the mid-1990s. Five types of resource misallocation can be identified:

- Between-sector misallocation of capital in non-tradable sectors and via the insufficient market orientation of R&D investments;

- Between-sector misallocation of labour and skills in non-tradable, including state, industries where workers are better paid but the level of productivity is lower;
- Within-sector misallocation of capital and labour related to the survival of excessively indebted and economically non-viable zombie firms;
- Between-firms resource misallocation arising from the insufficient number of firms able to grow and become large; and
- Within-firms resource misallocation from low competitive pressure to innovate in non-tradable sectors

Given that the potential return of policy reforms is significant (e.g. Bouis and Duval, 2011), improved public policies are needed to change incentives, reduce market inefficiencies, and enhance aggregate productivity growth (Albrizio and Nicoletti, 2016).

Markets

Greater product market competition is necessary in oligopolistic sectors such as wholesale trade, wholesale banking, professional services, energy and other network industries, by removing institutional barriers to entry and to growth. Tax and other targeted policies to attract FDI, in areas such as health or tourism, could improve capital utilization, raise the capital per worker ratio and facilitate the up-scaling of firms and productivity acceleration.

This enhanced competition would reduce mark-ups and rent-seeking, and increase physical and human capital stocks in tradable industries, including foreign and private investment in equipment and ICT, thus diminishing between-firms and within-firms misallocation.

An evaluation of policies to implement a transparent and simple set of public incentives that promote a change of resources from sheltered to tradable sectors is needed. In this way, the insolvency of non-viable and excessively indebted zombie firms is achieved by cancelling credit lines, subsidies and other public policies that sustain their survival while helping to reduce credit misallocation in the banking sector (McGowan *et al.*, 2017). Such action would accelerate the replacement of zombie firms by freeing the portfolio of lenders in order to reorient financing to growing firms with higher productivity levels, thus reducing within-industry and between-sector inefficiencies.

Formal education, specific training and learning-by-doing should improve human capital in accordance with the expected needs of employers. Secondary and tertiary education curricula can include on-the-job training, access to tertiary education can be complemented with detailed information about future job prospects and graduate courses should be less compartmentalized so that students can have flexible choices when deciding their future careers.

This is important due to the expected positive effects on LP through better between-sector skills allocation and because formal education is associated with a higher employment rate and with a wage premium. Tertiary education in Portugal produced, in 2012, a wage premium of 68 per cent over upper secondary education, above the OECD average of 55 per cent.

Coordinated policies in the areas of education and employment are also required so that incentives are aligned and oriented to improve the skills of workers and to prompt managers in family and state owned firms to correct practices that negatively affect productivity growth (Bloom *et al.*, 2014).

Human capital accumulation should be complemented with a less segmented labour market that reduced upon the currently highly restricted allocation of skills and workers between tradable and non-tradable activities and the state and private sectors. This is achieved by establishing the same laws throughout the economy so that asymmetric employment guarantees

are dismantled, learning-by-doing potential is enjoyed, performance-based bonuses and promotions are available and labour market matching is improved. The attraction of specialized migrant workers may compensate for a lack of skills and help minimize the effects of an aging and declining population.

A flexible labour market would prevent hysteresis effects caused by unemployment from hampering structural change thus facilitating the transfer of resources from low to high productivity activities while reducing labour slack and long-term unemployment. This can be reinforced by decreasing economic rents in certain non-tradable sectors in order to balance relative wages with tradable sectors and by wage setting institutions to ensure wages reflect differences in labour productivity.

Third, the last decade has shown that the simplification and deregulation of administrative procedures are not sufficient if the number of new laws and regulations is not reduced. These laws are currently promulgated by too many jurisdictions at the local, national, EU and international level, including regulatory agencies at different layers. The principle that all situations ought to be anticipated by the legislator should be replaced with regulatory predictability based on common sense and general principles so that organizational slack is limited.

The business environment can be improved in an array of ways: less corruption, stronger public entities, better defined property rights, lower requirements to investment and for enforcing a contract, and a lower tax burden and compliance costs (Julio *et al.*, 2013; Arnold and Barbosa, 2015). Furthermore, market distortions such as legal requirements that create negative incentives to becoming larger should be eliminated and an excessive and confusing number of taxes, subsidies and policy programs to be made simpler and manageable by small firms so that between-firms allocation is bettered.

Firms

Portuguese firms are too small and too indebted. Favourable conditions are needed for firms to scale-up and to enter international markets. Public policies can help by targeting new and innovative firms and by removing barriers for zombie firms to exit.

One way is to improve the effectiveness of the different financing policies by simplifying the institutional setting and to close the gap between their medium and long term needs and the willingness of lenders to provide it. The difficulty of firms to grow and the small number of large firms indicate that alternative sources of financing are not truly effective. Policy incentives should be changed so that firms may reach a sustainable debt-to-equity ratio: elimination of the tax debt bias and promotion of profit reinvestments by entrepreneurs. Moreover, the tax system should reward those that are more prone to take risks and initiative.

Dynamic firms operating in liberalized markets are keener on taking advantage of policies that support R&D spending and technology developments. This is a way for firms to increase the number of researchers, patent applications and investment in other intangible capital, thus benefiting from diffusion mechanisms, prompting applied R&D and improving within-firm resource allocation.

Too many firms are exclusively focused on the domestic market. For productivity to accelerate, the relatively small size of the Portuguese economy requires access to larger markets to achieve scale economies.

SMEs may also take advantage of global value chains by adjusting their activity to external demand. This can be done by developing incentives to supply larger exporting companies with differentiated products and services. It is a way to survive and to achieve efficiency gains from higher integration in global markets.

As long as firms grow and develop their connections to international markets, technology diffusion can more easily cross borders, thus creating better conditions to benefit from knowledge spreading externalities and promoting the attraction of foreign investment in R&D and a widespread use of digital technologies to improve productivity in production processes (IMF, 2016).

Moreover, if these internationalization efforts were also directed to academic and scientific stakeholders and if labour market segmentation between the state and private sectors is mitigated, domestic knowledge and technology diffusion could be reinforced and skills become allocated to industries with higher level of productivity.

Some of the above policies are being implemented. But often there is a loss of continuity in public policies when a new government takes office. Moreover, policy evaluation is not undertaken on a regular basis, thus hurting the ability to continuously learn and improve public policy. Therefore, evaluation from a productivity perspective can lead to better policies.

The best option may be to establish an independent productivity council, similar to those in Australia and New Zealand (Banks, 2015). This advising body would have the aim to evaluate and to identify and underline the benefits of pro-productivity policies, thus being useful in counterbalancing interests opposed to reforms.

Conclusion

The growing integration of the Portuguese economy into global markets was expected to lead to a convergence in productivity to the most developed countries. Paradoxically, this has not happened. After 40 years of democracy and economic integration Portugal still has almost the same gap in labour productivity with developed countries.

Since the 1990s, inappropriate incentives increased resource misallocation at industry and firm levels, exacerbating market inefficiencies. Insufficient policy evaluation explains why it is taking so long to correct them.

The recent improvement in some productivity determinants has not been sufficient. Economic policy was too focused on creating jobs independently of their sustainability while ignoring reforms to improve resource allocation and productivity growth.

The policy proposals in this article may help to enhance resource allocation, to improve competitiveness and to achieve a higher economic return. More is needed from the public sector, namely stable and effective policies that are continuously evaluated.

More is also needed from the private sector. Portuguese firms are still too small, too indebted and structurally too dependent on domestic demand. But firms are the key for the Portuguese economy to become better integrated into global value chains so that the global productivity frontier is more frequently reached.

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The Role of Urban Agglomerations for Economic and Productivity Growth

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ABSTRACT

This article discusses how urban agglomerations – cities – affect economic productivity. It uses an internationally harmonized definition of cities that aims to capture the true extent of an urban agglomeration and is not limited by administrative city boundaries. It shows that labour productivity increases with city size. Among OECD metropolitan areas, agglomerations with more than 500,000 inhabitants, a 1 per cent population increase is associated with a 0.12 per cent increase in average labour productivity. Partly, this is explained by "sorting" as more productive workers tend to live in bigger cities. But bigger cities provide additional "agglomeration economies" to those working in them. Comparable workers are 0.02-0.05 per cent more productive in cities with a 1 per cent larger population. These differences compound to significant differentials, e.g. a similar worker in Madrid (6 million inhabitants) is, on average, nearly 15 per cent more productive than a worker in Toledo (120,000 inhabitants). Furthermore, the paper also shows that cities affect economic performance beyond their boundaries. Since 1995, per capita GDP growth in regions within 90 minutes driving of a large urban agglomeration has been approximately 0.4 percentage points higher than in those with no large urban agglomeration within 300 minutes of driving.

Cities and urban agglomerations are the most productive places in OECD countries. More than 75 per cent of the most productive regions in terms of output (gross domestic product) per worker are urban and more than half are regions with a metropolitan area of 1.5 million or more inhabitants (OECD, 2016a). One of the universal patterns found across countries and regions is that across cities of all sizes, city size is positively correlated with productivity levels. The more people that live in a city, the higher the average level of productivity of its inhabitants. A city of 20,000 inhabitants is likely to have more productive residents than a city of 10,000 inhabit-

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ants, just as a city of 2 million inhabitants is likely to have more productive residents than a city of 1 million inhabitants.

Several mechanisms are responsible for this phenomenon. One explanation lies in the fact that urban populations are equipped with skills and qualifications that make them on average more productive. For example, urban dwellers are on average more highly educated than inhabitants of rural areas. This gap arises on the one hand, because institutions of higher education tend to be located in urban areas, making access for local residents easier and more affordable and also increasing the educated workforce as people who come to study in a city are more likely to stay after they graduate. On the other hand, cities offer more and better job opportunities for highly educated people, thus attracting people with high levels of education and offering better matches between worker skills and the jobs they fill.[2] This might be particularly relevant for highly educated "power" couples as larger cities make it more likely for both partners to find suitable jobs (Costa and Kahn, 2000).

Beyond differences in skills and education, there is another important set of mechanisms that make workers in cities, and especially larger cities, more productive. This set is summarized under the term "agglomeration economies". Agglomeration economies increase the level of productivity in cities independent from individual characteristics of their inhabitants. Several channels through which agglomeration economies occur are frequently mentioned.[3]

One mechanism concerns knowledge and the innovations it spurs. Closer proximity and more face to face contact between workers can lead to a faster spread of new ideas within cities, thus causing firms to adopt new innovative production techniques more quickly. Another mechanism is related to scale and the capacity to share infrastructure or input facilities. Since most infrastructure investments include fixed costs that are to some degree independent from the number of users, larger cities with a higher number of users can use infrastructure more efficiently on average. The same applies to local inputs. A law firm specializing in exports and investment to a specific country requires a large enough local demand. Finally, the greater number of businesses and workers in cities makes it easier for businesses to find workers that closely match the required profiles and workers can work in jobs that better match their skills.

All these mechanisms increase the productivity of workers in cities beyond the level that they would have in less densely populated areas. These ideas are not new, but build on a long history of research, with early discussion of the concept of agglomeration benefits ranging back to the 19th century economist Alfred Marshall and gains from specialization being a key aspect of Adam Smith's work.

The influence of cities on productivity goes beyond their own borders. For example, Camagni, Capello and Caragliu (2015) find that productivity in second tier cities (with less than 1 million inhabitants in the larger urban zone) is positively affected by the presence of other cities. Partridge *et al*. (2009a) estimate positive effects on population growth in US counties that are close to higher tiered urban centres, but also find evidence that the largest urban areas adversely affect growth in mid-sized metropolitan areas in their vicinity. Looking at long run

2 Andersson, Burgess and Lane (2007) find that in denser counties in California and Florida high-skill workers are more likely to be matched with firms that have high average skill levels. Studies for Italy and Portugal find positive but weaker evidence for such "assortative" matching (Andini *et al*, 2013 and Figueiredo, Guimarães and Woodward, 2014).

3 See Duranton and Puga (2004) for a detailed discussion.

trends and using the loss in market access of cities close to the border between East and West Germany after the postwar division, Redding and Sturm (2008) find strong adverse effects on population growth, especially in the early years following the split.

Thus, it is likely that distances to cities can determine levels of productivity and economic growth. This effect can be positive, as larger cities provide specialized services and serve as hubs for trade and transport. For less-densely populated rural areas, cities can be an essential part of their economy as they markets for products, concentrate public and private services, e.g. patent offices or marketing agencies and provide greater variety in shopping and cultural amenities. Obviously, the closer a region is located to a city, the easier it is for its businesses to access these functions and the easier for residents and businesses in the region to "borrow" agglomeration economies from the city.[4] Conversely, theoretical discussions also highlight that concentration of activity in metropolitan centres might cast "agglomeration shadows" on smaller cities and surrounding areas as the core benefits from productivity and population growth at the expense of surrounding areas (Fujita, Krugman and Venables, 1999).

This article presents evidence from several OECD research projects on the determinants of productivity and growth in cities and regions. Primarily, it summarizes evidence collected in Ahrend *et al*. (2014) and Ahrend and Schumann (2014). Its contribution is threefold. First, in order to better understand how cities affect countries as a whole, it assesses how closeness to urban centres affects economic growth in all regions. Instead of using geographical distance, the article focuses on road-based travel distance and in particular travel time.[5] These variables are more important in determining the accessibility of a city from a region and are therefore more likely to influence the region's economic performance.

Second, it aims to understand the economic benefits of cities themselves and estimates the magnitude of these "agglomeration economies" for five OECD member countries on two continents. In other words, it estimates the difference in productivity of comparable workers in cities of different sizes.

As a third contribution, the article uses an internationally harmonized - functional - definition of urban areas (FUAs) as the unit of observation rather than an administrative city definition, as does most related literature.[6] This is important, because administrative boundaries of cities are often arbitrary and do not correspond to the economic and social realities that define a city. In contrast, the definition of FUAs

4 Camagni, Capello and Caragliu (2016), for example, find that for Europe, proximity to high-level urban functions in other cities is positively associated with productivity and its growth. The authors rely on house prices as a proxy for the productivity differential between cities arguing that it reflects the net benefits of a city, including the productivity benefits they provide. The concept of borrowed size is often attributed to Alonso (1973), who highlighted that smaller cities can sustain urban functions that would typically require larger cities (and markets) if they are located close enough to larger cities.

5 The focus on road-based travel compared to other modes, e.g. rail-based travel, is due to the fact that in Europe (the focus of this part of the study), 92.5 per cent of kilometres travelled by ground transport are travelled by road-based transport (Eurostat, 2017; data for 2014).

6 Many countries have their own function-based regional delineations. For example, Metropolitan Statistical Areas in the United States aim to combine areas with close economic ties. France and the United Kingdom have definitions of local labour markets based on commuting flows (Zone d'Emploi and Travel to Work Areas respectively) that cover the whole country. The advantage of the FUA definition developed by the European Union and the OECD is that it applies the same methodology for all countries (with threshold values adapted for North American and Asian OECD countries) and allows to divide countries into dense urban centres, the surrounding less densely populated commuting zone and low density areas that lie outside (functional) urban areas.

that is used by the OECD and throughout the article defines cities as urban cores and their surrounding commuting zones. As this definition is largely independent from administrative boundaries, it provides a better description of what a city is.

Across OECD countries productivity increases with city size. For metropolitan areas, i.e. functional urban areas with at least 500,000 inhabitants, every 10 per cent increase in population is associated with 1 per cent higher productivity in terms of gross domestic product (GDP) per worker. This means that the output per worker in Paris, the largest French metro area with 12 million inhabitants, is expected to be more than 18 per cent higher than in the second largest metro area Lyon with nearly 2 million inhabitants.[7]

In line with previous work and theoretical predictions, the results indicate that these positive effects are not limited to the cities and metro areas themselves. Per capita GDP in regions that contain urban agglomerations grew faster over the 1995-2010 period than in those without a major city. The benefit increases with city size, from 0.16 per centage points faster annual growth for regions with an urban agglomeration with 200,000 and 500,000 inhabitants to 0.5 per centage points for regions with large metro areas of 2 million or more inhabitants. These effects are sizeable given that many OECD countries grew by less than 2 per cent per year during the period, with growth in some countries below 1 per cent per year.

The estimates also show positive growth effects for regions that are close to large metro areas. The annual average per capita GDP growth rate in regions that had twice the travel time to the nearest metro area was about 0.2 per centage points lower than in closer regions.

Part of the success of (larger) cities comes from their ability to attract highly educated or more diverse workers.[8] Cities are therefore more productive because they attract more productive workers. But this "selection" of more productive workers into larger city is only part of the story. Another part comes through productivity benefits that are conferred by the cities themselves through agglomeration economies. The estimated impact cities have on the productivity of its residents and those in surrounding regions is substantial. Even after controlling for the non-random selection of the city in which they live, the effect of agglomeration on workers' productivity is estimated at 0.2 per cent to 0.5 per cent for a 10 per cent increase in the population in a city. This means that the same person working in Madrid with its more than 6 million inhabitants is nearly 15 per cent more productive, on average, than he or she would have been working in Toledo with its 120,000 inhabitants. It also means that roughly half of the productivity benefit of larger cities comes through agglomeration economies.

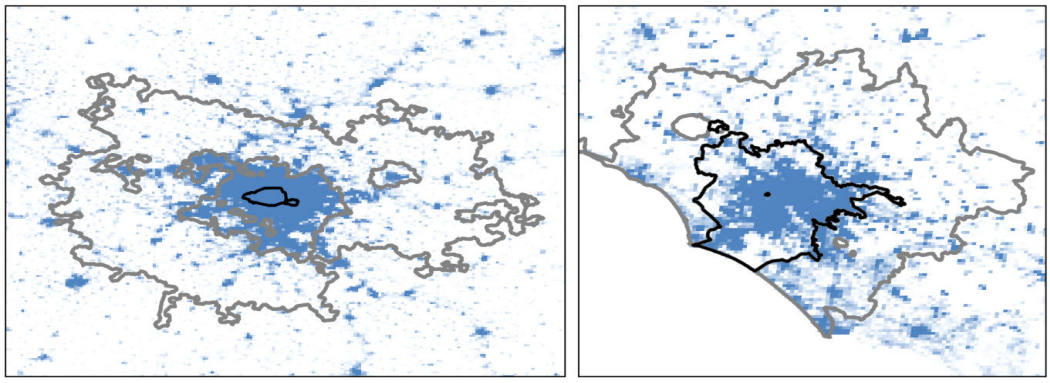
For cities that are close to other urban areas, there seems to be some room to "borrow" agglomeration economies, even net of selection. A 10 per cent larger number of urban dwellers living in a 300 kilometre radius around the city is associated with about 0.1-0.2 per cent higher productivity.

The remainder of the article is structured as follows. Section 2 provides an overview of the data and statistical definitions used, as well as descriptive evidence on productivity levels in cities, and shows that larger functional urban

7 The actual difference is even larger with Paris producing more than 30 per cent more GDP per worker than Lyon in 2014 (http://measuringurban.oecd.org/, accessed 9 November 2016).

8 Keeping with the French example, the per centage of university graduates in the working age population in Paris is larger than in Lyon. The diversity and amenities of cities were widely popularized in the early 2000s as an argument for the attractiveness and success of cities. See Florida (2002), for one of the most well-known studies on this topic.

Chart 1: Administrative Boundaries and EU-OECD Metropolitan Areas for Paris and Rome



Notes: Shades of blue denote population density (dark blue: 1,500 inhabitants/km² or more; light blue: 500-1,500 inhabitants/km²), black lines delineate the administrative city, grey lines the urban centre(s) and commuting zone.

Source: Adapted from OECD (2012).

areas are more productive on a per capita basis with positive spillovers to surrounding and connected regions. Section 3 uses micro-level data to distinguish the contribution of agglomeration economies from effects caused by differences in (observable) worker characteristics, e.g. education levels, due to sorting. Section 4 concludes.

Data and Definitions

The work summarized in this contribution combines different data sources and definitions of spatial units. For regions, the OECD defines subnational territorial units at two different levels; the higher Territorial Level 2 (TL2) and the lower Territorial Level 3 (TL3). In total there are 362 TL2 regions and 1792 TL3 regions in OECD countries. As there is very little data on the TL3 level available outside of Europe, all analysis using regional data focuses on approximately 600 European TL3 regions from 18 countries for which GDP growth rates and other data is available from 1995 to 2010.[9]

The study uses travel time and travel distance to urban centres in Europe as explanatory variables for economic growth. Travel time is measured as the number of minutes required to travel by car from the geometric center of a TL3 region to the centre of the closest functional urban area (FUA) above the respective population threshold. Travel distance indicates the distance in kilometres between those two points using the fastest road connection. Travel time assumes normal road conditions without congestion. The data are based on route planning information from Google Maps that has been collected using Google Maps' Application Programming Interface (API). When centroids of regions do not lie exactly on a road, the closest point on a road has been used as start or end point of a route, respectively.

The median travel distance to the centre of the closest FUA with at least 500,000 inhabitants is 105 kilometres. Due to a small number of very remote regions, the mean distance is larger at 127 kilometres. Median and mean travel times are 76 and 105 minutes, respectively. Across all observations, the average travel speed as predicted by Google Maps is 78 kilometres per hour. The correlation between travel time and travel distance is 0.86. This relatively high cor-

9 Excluded from the analysis are those regions that are not part of the mainland of a country, such as exclaves and oversea territories.

relation indicates a fairly homogenous quality of road infrastructure across Europe.

In the EU-OECD definition, functional urban areas are densely populated urban centres with a surrounding commuting zone.[10] Based on gridded population density data, high density population clusters with more than 50,000 inhabitants are identified (100,000 inhabitants in Japan, Korea and Mexico). All municipalities who have at least 50 per cent of their inhabitants living in the high density cluster are considered part of the urban centre of the functional urban area. If there are two high density clusters and at least 15 per cent of the working population of one high density cluster commutes into the other, they are considered part of the same functional urban area. Finally, the commuting zone is defined as those municipalities from which at least 15 per cent of the working population commute into the municipalities in the urban centre.

A minimum threshold for the population size of the functional urban areas is set at 50,000 persons. The definition is applied to 30 OECD countries (Iceland, Israel, Latvia, New Zealand and Turkey are not included). It identifies 1,197 urban areas of different sizes (small urban areas with population below 200,0000, medium-sized urban areas with a population between 200,000 and 500,000 people, and metropolitan areas with population higher than 500,000.

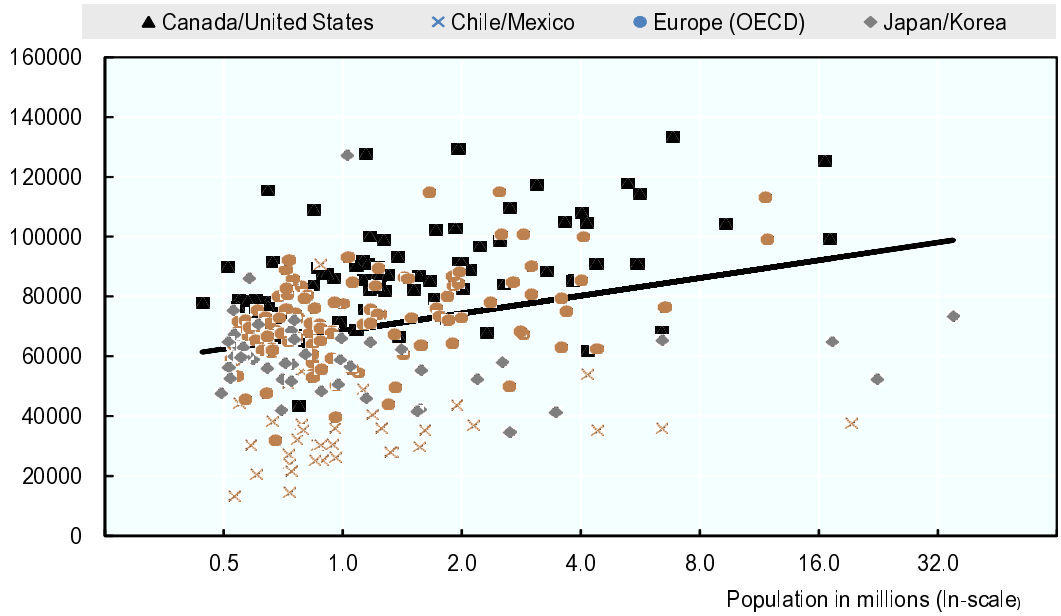
This definition overcomes previous limitations for international comparability of urban areas. Traditional definitions based on administrative boundaries are often not comparable across countries, because the shape and size of administrative areas varies from country to country. The boundaries of the city of Paris, for example, cover only a fraction of the urban centre of the metropolitan area, while, the urban centre of the metropolitan area of Rome coincides with the administrative city, but both exclude the substantial commuting zones surrounding the urban centres (Chart 1). The aim of the OECD approach to functional urban areas is to create a methodology that can be applied in all countries, thus increasing comparability across countries. The OECD definition may not correspond to national definitions. Therefore, the resulting functional urban areas may differ from the ones derived from national definitions.[11]

For Germany and Spain, social security data was used. Employment surveys for Mexico and the United Kingdom and the American Community Survey for the United States. For Germany, the data cover 2 per cent of all social security contribution paying employees and are based on the Employment Panel of the German Federal Employment Agency, with the data hosted at the Research Data Centre of the Institute for Employment Research. For Spain, a 4 per cent sample of workers, pensioners and unemployment benefit recipients, the Continuous Sample of Working Histories, was used. Mexico's employment survey (National Occupation and Employment Survey) covers 0.4 per cent of the population per quarter and the UK Annual Survey of Hours and Earnings is a 1 per cent sample of national insurance paying workers. For the United States, the public use file of the American Community Survey, a 1 per cent ample of the population, was used. For Germany, Mexico, Spain and the United Kingdom the data allowed a match to functional urban

10 Adapted from the Reader's guide in OECD (2016b) and OECD (2012).

11 For five OECD countries, Germany, Mexico, Spain, the United Kingdom and the United States, the definition of functional urban areas is matched with large scale microdata sets that include worker wages and (some) characteristics. As the match requires geographic information on residence at small spatial scales, e.g. municipalities, these data are typically confidential and not directly accessible. The selection therefore aimed to cover large OECD countries across several continents, which had suitable datasets that could be accessed directly or in collaboration with local partners.

Chart 2: City Size and Labour Productivity, 2010



Notes: Labour Productivity is measured as GDP (USD in constant PPP and constant prices, reference year is 2005) divided by the total employment in a Functional Urban Area. Data refer to 2010 or the closest available year.
Source: OECD Metropolitan Explorer.

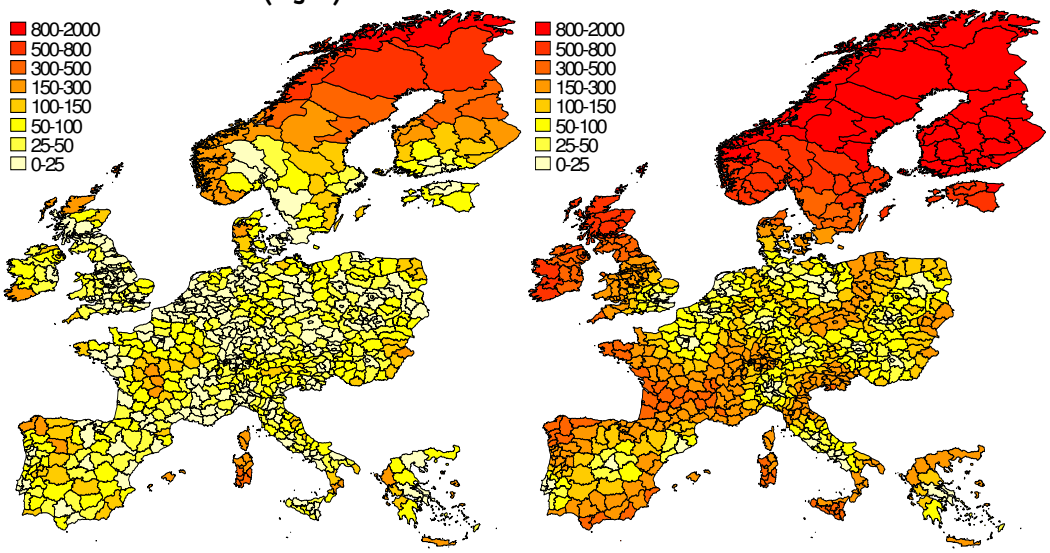
areas of all sizes, for the United States the analysis was restricted to metropolitan areas with more than 500,000 inhabitants.

Descriptive evidence

Per capita GDP increases with city size. On average across all functional urban areas with more than 500,000 inhabitants in the OECD, a 1 per cent increase in population is associated with an increase in per capita GDP of approximately 0.1 per cent. In some countries, such as France, the effect is significantly larger. There, a 1 per cent increase in population is associated with a 0.2 per cent increase in per capita GDP (Bettencourt and Lobo, 2016). Studies that focus on productivity tend to find smaller but still substantial effects, with estimates ranging between 3-8 per cent higher productivity for a doubling, i.e. 100% increase, in population (Rosenthal and Strange, 2004).

A similar pattern is noticeable if productivity levels are analysed rather than GDP. Chart 2 presents the average level of productivity measured in US dollars per worker on the vertical axis and plots these against the size of the city — as measured by its resident population. It becomes obvious that larger cities benefit from a productivity premium. In per centage terms, a 1 per cent increase in the population in a metro area is associated with, on average, 0.12 per cent higher labour productivity. But this does not necessarily imply that relocating people into larger cities will raise productivity. As outlined above, a significant part of this productivity premium can be attributed to the characteristics of the workforce in larger cities, i.e. these workers would be more productive wherever they chose to work. In section 3 the analysis aims to disentangle this "selection" effect from the agglomeration benefits that a larger city confers by virtue of its size.

Chart 3: Distance to Closest Functional Urban Area with 500,000 Inhabitants (left) and 2 Million Inhabitants (right)



Note: The chart shows the distance in kilometres to the closest functional urban area (FUA) with at least 500,000 inhabitants (left), and 2 million inhabitants (right). Darker colours indicate larger distances. With the exception of northern Europe, most regions are relatively close to FUAs with 500,000 inhabitants, but distances to large FUAs vary greatly.

Regional economic growth and distance to cities

This section describes the role of cities for the economic growth of surrounding regions, focusing on the relation between growth and distance to urban centres in Europe. It shows that there are important spillovers from cities to surrounding regions. Regions containing large cities have been growing faster than regions that do not contain large cities. Likewise, regions that do not contain large cities, but are located close to them have been growing faster than regions that are far away from large cities. Since 2000, travel time from a region to the closest large city has been negatively correlated with per capita GDP growth.

The empirical strategy is based on cross-section regressions of the average annual regional per capita GDP growth rate between 1995 and 2010 on an outcome variable of interest. Most specifications include initial log-per capita GDP in 1995 and a set of country dummies as control variables. The baseline regression is given by:

$$\Delta pcGDP_i^{95-10} = \alpha + \beta_1 x_i + \beta_2 log(pcGDP_i^{95}) + \sum_{c=1}^{C} \gamma_c dum_i^c + \varepsilon_i \quad (1)$$

where $\Delta pcGDP_i^{95-10}$ indicates the average annual growth rate of per capita GDP between 1995 and 2010 in region i, x_i is the respective explanatory variable, $\log(pcGDP_i^{95})$ is a control variable for log per capita GDP at the beginning of the observation period, and $\sum_{c=1}^{C} \gamma_c dum_i^c$ is a set of dummy variables for country c. The set of country-dummies implies that, generally, within-country effects are estimated. This ensures that the estimates are not affected by country-wide developments that are unrelated to regional characteristics. It is furthermore a way of dealing with the problem of shocks that are clustered on the country-level and which could lead to a severe underestimation of the estimated standard errors. Control-

Table 1: Average annual per capita GDP Growth and Size of the Largest FUA within a Region

	(1)	(2)
Agglomeration >500,000	0.23*** (0.10)	
Agglomeration >2,000,000		0.54** (0.26)
Agglomeration 500,000-2,000,000		0.28*** (0.10)
Agglomeration 200,000-500,000	0.16** (0.07)	0.16** (0.07)
Per Capita GDP in 1995	-0.65** (0.24)	-0.67*** (0.24)
Constant	9.25*** (2.60)	9.43*** (2.61)
Country-FE	YES	YES
N	603	603

Note: ***/**/* indicates a statistically significant coefficient at the 1%/5%/10% level

ling for initial GDP is required in many cases to avoid that estimates are biased by regression to the mean.

Regions that contain an urban agglomeration above 500,000 inhabitants had a per capita income that was approximately 21 per cent larger than the respective country average in 1995. Nevertheless, regions that contain such agglomerations had a much higher per capita GDP growth over the subsequent 15 years. Table 1 shows how the presence of a large urban agglomeration affects regional per capita GDP growth. The explanatory variables are specified as dummy variables that take on the value 1 if a region contains a FUA with the respective size and 0 otherwise. Regions that contain urban agglomerations 200,000 - 500,000 inhabitants grew 0.16 per centage points faster than regions without such urban agglomerations. For regions with urban agglomerations above 500,000 inhabitants, the difference in annual per capita growth rates is approximately 0.2 per centage points (column 1) and for those with urban agglomerations above 2 million inhabitants it is more than 0.5 per centage points (column 2).

The previous estimates have shown that regions containing large urban agglomerations have been growing faster between 1995 and 2010. This section estimates whether a correlation between economic growth and proximity to large urban agglomerations also exists. It is in spirit similar to Veneri and Ruiz (2013) who analyse the effects of proximity between rural and urban regions, but differs from their analysis by using a larger set of distance measures and considering only large urban agglomerations.

Table 2 presents the results of a series of regressions that show the effect of travel times and geographical distance on economic growth. Column (1) shows the estimate for the following specification:

$$\begin{aligned} \Delta pcGDP_i^{95-10} = & \\ & \alpha + \beta_1 I_i^{45-90} + \beta_2 I_i^{90-180} \\ & + \beta_3 I_i^{180-300} + \beta_4 I_i^{>300} \\ & + \beta_5 log(pcGDP_i^{95}) + \\ & \sum_{c=1}^{C} \gamma_c dum_i^c + \varepsilon_i \end{aligned} \tag{2}$$

It includes four dummy variables that indicate whether a region is within the given number of minutes by car from the nearest urban agglom-

Table 2: Distance to Urban Agglomerations with at Least 2 Million Inhabitants

	Full Sample			Restricted Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
45-90 Min	-0.50* (0.29)					
90-180 Min	-0.62** (0.29)					
180-300 Min	-0.79** (0.31)					
>300 Min	-0.87*** (0.32)					
Log Travel Time		-0.02 (0.08)		-0.22** (0.097)		-0.17* (0.10)
Log Distance			-0.07 (0.05)		-0.14** (0.06)	-0.08 (0.06)
Log p.c. GDP 95	-0.81*** (0.21)	-0.00** (0.00)	-0.80*** (0.22)	0.000 (0.000)	-0.61** (0.29)	-0.64** (0.29)
Constant	11.63*** (2.05)	3.86*** (0.505)	11.17***(2.08)	4.122*** (0.868)	9.71*** (3.30)	10.66*** (3.47)
Cut-off Time	--	--	--	0-480 Min	0-480 Min	0-480 Min
Country FE	YES	YES	YES	YES	YES	YES
N	545	545	545	385	385	385

Note: ***/**/* indicates a statistically significant coefficient at the 1%/5%/10% level

eration with at least 2 million inhabitants. The base category is regions that are within less than 45 minutes of such urban agglomerations. It shows that cities that are within 45 to 90 minutes of such agglomerations have been growing approximately half a per centage point slower per year than those that are within less than 45 minutes. For regions that are further away from large urban agglomerations, the negative difference in growth is even larger.

Specification (2) also estimates a relation between travel time and economic growth but uses a log-linear specification of travel time instead of a set of dummy variables to model the relation between the two variables. The estimated coefficient on travel time is small and insignificant. The reason behind this result is that the negative relationship between travel time and economic growth breaks down at more than roughly 400 minutes travel time. Specification (4) takes this into account by restricting the sample to regions that are within 8 hours (a day's drive) by car to an urban agglomeration with 2 million inhabitants. It shows that for distances below that threshold a robust negative relationship between distance and economic growth exists. A doubling in travel time is associated with an annual per capita GDP growth rate that is approximately 0.2 per centage points lower.

Specifications (3) and (5) repeat the exercise but use the natural logarithm of geographic distance to the next urban agglomeration of more than 2 million inhabitants as explanatory variable. Although less pronounced, the emerging pattern is similar: while there is an overall negative relationship, a statistically significant result can only be found for regions that are not too far away from the next large urban agglomeration.

Finally, specification (6) compares the explanatory power of travel time and distance for per capita economic growth by including both variables. When controlling for distance, the interpretation of the travel time coefficient changes somewhat. Conditional on distance, travel time becomes a measure of road connectivity. In this specification, the coefficient on log-travel time remains significant at the 10 per cent level and is exactly twice as large as the coefficient on log-

distance, which turns insignificant. Both point estimates on the two coefficients are directly comparable in their magnitude because both variables are in logarithmic terms. Therefore, the coefficients can be interpreted as the effect of a per centage change of the explanatory variable on the outcome. As both variables also have similar standard deviations, a fixed per centage change has a comparable importance for both variables. Therefore, the difference in the estimated coefficients implies that actual distance is of lower importance than travel time for economic growth.

Although travel time between regions and large urban agglomerations is strongly correlated with economic growth, the picture is less clear with respect to smaller urban agglomerations. While some specifications (not shown) suggest that closeness to small and medium-sized urban agglomerations had a positive effect on economic growth between 1995 and 2010, coefficients are imprecisely estimated and typically not statistically significant.

Several issues potentially bias the estimates above. One potential source of bias is attenuation bias, since expected travel time from regional centroid to centroid of the FUA is only an imperfect measure of actual travel times. Another source of bias is related to reverse causality. Travel time was measured in 2013, after the end of the observation period. If policy makers respond to expected or actual growth rates by investing in infrastructure, it is possible that the differences in travel time are at least partly caused by per capita GDP growth. If fast growing regions receive more infrastructure investments, the estimate on travel time would be negatively biased (i.e. its effect would be overestimated). Correspondingly, if slow growing regions receive more infrastructure investments, the effects would be underestimated.

Furthermore, travel time might be correlated to other factors that affect growth rates over the observation period. Such factors would introduce omitted variable bias in the estimates. Especially in sparsely populated regions, for example, the actual investment into road construction can have a sizable impact on per capita GDP. It might therefore be the case that part of the higher growth in better connected regions comes from the investment that made them better connected in the first place. In this case, the coefficient on travel time would be positively biased.

Agglomeration Economies in Functional Urban Areas

To understand the role of agglomeration economies and the importance of cities for the production in a country, the productivity premium needs to be separated into two parts. The first part is productivity that is attributable to the worker. For example, larger cities have a larger per centage of highly educated workers. If these workers were to move to another city, this city would become more productive, not because of agglomeration economies, but because inherently more productive workers "sorted" into the city. This sorting is not random. Typically, inherently more productive workers sort into larger cities. This part of the productivity premium therefore needs to be separated from the second part, the agglomeration economies that arise through a larger population being concentrated in an area. These economies appear as an externality to the worker, something they cannot take with them when they move to a smaller city.[12]

12 Several recent papers highlight that workers actually do retain some of the benefits when moving from a larger to a smaller city, in line with arguments that highlight the importance of networks and experience they can gain during the time they live in the larger city (e.g. de la Roca and Puga, 2016, for Spain).

Methodology

Empirical work attempting to quantify agglomeration economies, while accounting for selective sorting, has followed two paths. The first is based on the equilibrium location decisions of firms — under the assumption that firms will locate where they are most productive (e.g. Ellison and Glaeser, 1997; Rosenthal and Strange, 2003). The second strand of empirical work, the one followed in this article, focuses instead on the productivity of workers. Empirical work along these lines has found a relation between urban density and productivity — proxied by wages — that continues to hold after controlling for both observable and (permanent) unobservable individual characteristics (e.g. Glaeser and Maré, 2001 or Combes, Duranton and Gobillon, 2008).[13]

In our research, the analysis follows a common empirical strategy applied across five OECD countries. This not only ensures that the individual country results are comparable, but allows for pooled regressions on the full sample of cities from five countries. The latter aspect is of critical importance, given the limited number of cities in each country. Pooling helps create a sample with mass not only among small and medium-sized cities or administratively congruent cites, but also among large or very fragmented cities. The harmonized approach is made possible through the use of an internationally comparable definition of "city" that is based on economic linkages, rather than administrative boundaries.

Administrative and functional definitions of cities do not always coincide. Many people who work in central London, for example, commute to work from London's surrounding municipalities. Likewise, manufacturing plants that are located on the outskirts of a city could require workers to commute out. According to an administrative definition, such commuting workers would not live and work in the same urban area, whereas a functional definition avoids this bias. More generally, a sole focus on the central administrative unit of a city will underestimate the population size of an urban area, overestimate the density, and might over- or underestimate its productivity. The empirical analysis of this article therefore employs the Functional Urban Area (FUA) definition of cities (see section 2).

While it is possible to consider aggregate productivity at the FUA level, e.g. per worker GDP (Chart 2), the evident positive slope combines agglomeration economies with other sources of higher productivity in larger cities. Crucially, productivity in larger cities is higher because they tend to attract more skilled and productive workers. To disentangle the agglomeration component and this non-random sorting of skilled individuals, a two-step empirical approach is applied separately to national microdata surveys for the five countries in the study.[14] While it is possible to estimate agglomeration benefits directly in the microdata, the confidential nature of the datasets used would not allow pooling all 5 samples. Instead, the estimation is split into two parts, estimating productivity differences across cities in each country and then explaining these differences in a pooled sample based on city characteristics. An important caveat that remains despite the two-step estimation is that the sorting that can be taken into account is only the sorting of individ-

13 Much of the literature uses wages as a proxy for productivity. Under standard wage setting mechanisms, the marginal product of labour should be reflected in wages. Even if higher wages are offset by larger commuting and housing costs (from the perspective of the worker), if there were no productivity advantages in urban areas firms would move to low-wage locations.

14 See Combes *et al*. (2011) for a theoretical discussion of this methodology and Combes *et al*. (2008) for earlier implementations of the empirical methodology.

uals based on observable factors such as education or age.

In the first step, the functional EU-OECD definition of cities is matched with large-scale administrative or survey-based microdata of workers from each of the five countries. The resulting data sets are then used to estimate productivity differentials — net of individual skill differences and other individual level observables — across cities using an OLS regression of the natural logarithm of wages on individual level characteristics and a set of fixed effects for each city-year combination.[15]

$$y_{ia(c)t} = \beta X_{ia(c)t} + \gamma_{a(c)t} d_{ia(c)t} + \varepsilon_{ia(c)t} \quad (3)$$

$y_{ia(c)t}$ denotes the natural logarithm of wages for individual i in city a in country c at time t, X a vector of individual characteristics, d a vector of dummy variables (one for each city and year) that take the value 1 if the individual resides in city a at time t, and ε denotes an error term. The coefficient vector of interest, γ, captures the productivity differential across cities, net of (observable) skill differences.

Since the primary concern in this study is to create comparable estimates for all five countries (Germany, Mexico, Spain, United Kingdom, and United States), the specific controls that can be included are limited to the controls available in all five data sets. Not all variables are available in all countries and the different data sources include both panel data and repeated cross-sections. The common set of controls selected includes age (and its square to allow for decreasing returns to experience), education (dummies for degree categories), occupation (dummies for occupational categories), gender (dummy) and an indicator for part-time work (dummy) to account for possible level differences in wages of part time and full time workers, in addition to the city-year fixed effects.[16]

The city-year fixed effects obtained in the first step capture city productivity differentials, net of the observable skill-relevant characteristics of the urban workforce for each of the five countries (c). The estimated productivity differentials $\hat{\gamma}_{a(c)t}$ are used as the dependent variable in the second step, in which they are regressed on indicators for structural and organisational determinants of city productivity — both time varying $Q_{a(c)t}$ and non-time varying $Z_{a(c)}$. Additional country-year fixed effects d_{ct} control for time-fixed differences across countries, national business cycles and country specific inflation (the first step estimates nominal productivity differentials).

$$\hat{\gamma}_{a(c)t} = \delta Q_{a(c)t} + \mu Z_{a(c)} + \theta d_{ct} + \upsilon_{a(c)t} \quad (4)$$

The estimates are based on a balanced panel of all cities for the three years that are available for all five countries (2005-2007). The standard errors in the OLS estimations are clustered at the city level to allow for heteroscedasticity and arbitrary autocorrelation over time (for each city) in the error term.[17]

15 This model follows the seminal work by Mincer (1974) and the large body of empirical literature that followed it. The German data is right-censored, which introduces a bias in OLS estimation. However, comparing the results from a Tobit model, which accounts for censoring, and the OLS model shows that the bias is negligible (Ahrend and Lembcke, 2016).

16 Panel data are only available for three countries (Germany, Spain, and United Kingdom). The common specification can therefore not account for individual specific unobserved skill differences in the first step. While this would be an important improvement, it comes at a cost: identification of productivity differentials would only rely on individuals who move between cities, a group that is likely highly selected as mobility is costly (Combes *et al.*, 2011). In addition if agglomeration benefits are persistent (de la Roca and Puga, 2016), recent movers will have lower/higher productivity than the average comparable worker in the FUA if they moved from a smaller/larger FUA.

The two-step estimation accounts for selective sorting based on observable characteristics, but other aspects might influence productivity in cities, resulting in biased estimates. One concern is reverse causation, which could result in either upward or downward bias. For example, a positive productivity shock can result in increased job opportunities, attracting new residents to a city, which would result in an upward bias in the estimated agglomeration economies. One small step to reduce the possibility of reverse causality is a definition for Functional Urban Areas that is based an earlier time period (2001) than the estimated city-year productivity differentials (2005-2007), which ensures that potential changes in the boundaries of successful cities are not influencing the results.

To further reduce the potential confounding factors additional controls are introduced to the specification. These include a capital city and port city dummies[18] and indicators that capture the industrial and skill structure of cities, calculated from the five estimation samples. To capture the industrial structure, the indicators are the share of employees working in 1-digit industries, with manufacturing split into four categories based on technology intensity, and the Herfindahl index of employment shares at the 2-digit industry. The Herfindahl index is defined for each city as the sum of the squared employment shares in each industry.[19] For human capital, the share of university degree holders among the 25-64 year old workforce in the city is used. Summary statistics for each of the indicators are presented in Ahrend *et al.* (2014), which also includes further descriptions of the data sets.[20]

Results

As a benchmark, it is useful to put numbers to the suggestive trends for agglomeration economies in the descriptive graph of Section 2. Country-by-country regressions show productivity to be higher in larger cities across all five countries in this study. When city productivity differentials are regressed on city population, the estimated elasticities range from 0.015 (United Kingdom) to 0.063 (United States). That is, a worker in an U.S. city with a population that is 10 per cent larger than that of another comparable U.S. city is, on average, about 0.63 per cent more productive.[21] The main results from the pooled regression,

17 As the specifications include country fixed effects the standard errors should ideally be clustered at the country level. With 5 countries in the sample this is not feasible and spatial autocorrelation in the error could be a source of bias in the standard errors. In order to affect the statistical significance of the estimates, unobserved shocks to the productivity level in a city would have to be strongly correlated with shocks to nearby cities. While some correlation is undoubtedly present and possibly sizeable in some cases (e.g. the smaller FUAs surrounding London are benefitting from the capital's pull), the effect would need to be large in general to create concerns for the statistical significance of the key results presented here.

18 Port cities based on Lloyd's List "Ports" (http://directories.lloydslist.com/, accessed 01.07.2013).

19 Spain and Germany are exceptions. For Spain, internal OECD estimates for city population are used. For Germany, only total employment can be observed; after the results from the last German census, municipality level population data became unavailable. To estimate population in German FUAs the ratio of employment to population for 2000 (OECD estimates) is used to rescale the observed employment levels for all years.

20 Despite the additional controls, the specification remains the estimation of a partial equilibrium. In a general equilibrium, residents might be willing to accept lower productivity (and therefore wages) if they are compensated by lower cost of living or higher amenities (e.g. in the Rosen-Roback model; Roback, 1982). This might create a bias if larger cities are associated with higher (dis)amenities, resulting in (upward) downward biased estimates.

21 Interpreting the elasticity multiplied by 100 as the per cent increase in productivity associated with a "doubling in city size" is commonly used in the literature to give an idea of the size of the impact. The interpretation is not exact as the log-approximation error is only negligible for small changes. The exact marginal effect for a doubling in city size is the product of the estimated coefficient and the natural log of 2 (approximately equal to 0.693).

Table 3: Agglomeration Economies in Five OECD countries, 2005-07

	(1)	(2)	(3)	(4)	(5)	(6)
ln(population)	0.038***					
	(0.005)					
ln(density)		0.037***	0.048***	0.037***	0.034***	0.016**
		(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
ln(area)		0.038***	0.064***	0.062***	0.058***	0.036***
		(0.006)	(0.008)	(0.009)	(0.010)	(0.008)
ln(number of municipalities)			-0.032***	-0.036***	-0.036***	-0.029***
			(0.006)	(0.006)	(0.006)	(0.005)
ln(pop. in catchment area)				0.018**	0.017**	0.012*
				(0.008)	(0.008)	(0.007)
% University Graduates				0.283***	0.258***	0.275***
				(0.077)	(0.075)	(0.073)
Capital				-0.011	-0.000	0.028
				(0.037)	(0.038)	(0.030)
Port				0.027**	0.027**	0.039***
				(0.011)	(0.011)	(0.010)
Herfindahl Index					-0.698*	-0.704***
					(0.358)	(0.266)
Agriculture						0.0808
						(0.257)
High-tech Manufacturing						1.104***
						(0.234)
Med. High-tech Manufacturing						0.840***
						(0.135)
Med. Low-tech Manufacturing						0.494***
						(0.146)
Low-tech Manufacturing						0.082
						(0.149)
Electricity						-0.931**
						(0.463)
Trade						0.223
						(0.171)
Catering						0.472**
						(0.230)
Transport & Communication						-0.126
						(0.200)
Finance						0.878***
						(0.181)
Real Estate & Business						0.410**
						(0.176)
Public Administration						0.057
						(0.261)
Educ., Health & Social Work						-0.120
						(0.154)
Other Services						0.535*
						(0.275)
R-Squared	0.760	0.760	0.779	0.791	0.794	0.854
Observations	1,290	1,290	1,290	1,290	1,290	1,290
FUAs	430	430	430	430	430	430

Note: Includes an interaction control of country and year fixed effects (Country x Year FE). ***/**/* indicates a statistically significant coefficient at the 1%/5%/10% level

reported in Table 3, present equally strong evidence for sizeable agglomeration benefits.[22] They indicate that, a city with 10 per cent more residents is associated with 0.38 per cent higher productivity (specification 1).

The source of agglomeration economies can be further disentangled by a specification that uses both population density and surface area of the city. The coefficient of (the natural logarithm of) population density gives the elasticity of city productivity with respect to its population size, holding constant the surface area covered by the city. The coefficient on (the natural logarithm of) city surface area captures the impact of an expansion of city limits while population density remains constant; that is, when population and area expand at the same rate. Finally, the difference between the area and the density coefficients gives the estimated impact of increasing the surface area covered by a city while holding the total population constant (i.e. decreasing density with the given population spreading out over a larger surface).

Interestingly, coefficients for population density and area are similar (Table 3, specification 2), indicating that both an increased population for a given surface area, and an increased spatial extent, while population density remains constant, have similar productivity effects. However, an increase in the surface area — for a given population — does not increase productivity, as suggested by the difference of the two coefficients that comes to zero. The introduction of additional city characteristics as controls leads to estimated agglomeration elasticities ranging from 0.02 to 0.05, with highly statistically significant coefficients in all specifications (Table 3, remaining specifications). The number of municipalities within a city, a measure of administrative fragmentation, is negatively correlated with productivity. It indicates that between two cities of the same size, in the same country, if one has twice the number of municipalities within its functional boundaries it is on average about 2-4 per cent less productive.

Aggregate human capital, measured by the share of university graduates in the city, increases productivity. A 10 per centage point increase in the share of university graduates is associated with a 2.8 per cent increase in productivity. It is important to note that this result does not indicate the direct impact of human capital on productivity, but only the externality associated with working in a city with a large share of university graduates in the workforce. And, while port cities exhibit higher productivity — on average port cities are 2.7-3.9 per cent more productive than comparable cities without a port — there appears to be no evidence that capitals differ systematically from other cities.

Industrial specialization, measured by the normalized Herfindahl Index of employment shares at the 2 digit industry level, has a negative and weakly significant impact. This suggests that a diversified industrial structure has a positive impact on productivity. However, variation in estimates across specifications suggests that this finding is not overly robust.

Moreover, clear evidence can be found that cities with a large share of employees in specific industries exhibit higher productivity. The base category in the regressions is the share of employees in construction, such that when an increase in an industry share is considered, the share of employees in construction is reduced by the same amount. The results (specification 6 in Table 3) indicate that a 1 per centage point increase in the share of high-tech manufacturing workers (and a concomitant 1 per centage point decrease in the share of construction workers) is,

22 Pooling estimates has the advantage of creating a sizeable sample that allows the introduction of additional controls, the price for this advantage is that the estimated elasticity is assumed to be the same in each country.

on average, associated with 1.1 per cent higher productivity in the city. This productivity premium gradually reduces with the technological intensity of the manufacturing industry: it is 0.8 and 0.5 per cent for medium-high-tech and medium-low-tech manufacturing, respectively, while it becomes insignificant for low-tech manufacturing.

The productivity premium for financial intermediation is estimated at 0.9 per cent for a 1 per centage point increase in the employment share, while that of business services and real estate activity is 0.4 per cent. Interestingly, it is not only the knowledge-intensive services that yield a productivity premium, but also technology-intensive manufacturing.

The final variable considered to determine productivity is the proximity of a Functional Urban Area to other cities (population in the catchment areas). The variable aims to incorporate the idea that the exchange of people, ideas and goods is greatly simplified by close connections between places. The indicator measures the number of people that residents of a given city can directly interact with, within a "reasonable" amount of time, the idea being that a meeting of several hours can take place going back and forth within a day. It is defined as (the natural logarithm) of all inhabitants in other Functional Urban Areas within a 300 kilometre radius around a city, divided by the distance.

For the sample of all cities the estimates in Table 3 indicate that, ceteris paribus, a 10 per cent increase in the (distance weighted) number of city residents within 300km is associated with 0.1-0.2 per cent higher productivity. While this effect suggests that cities benefit from proximity to other urban agglomerations, it is unlikely to capture the full impact of the position of a city within its local network of cities and rural areas. For example, estimates by Partridge *et al.* (2009b) for the United States show that the impact on earnings differs for counties with cities of different sizes and that it is the distance to large agglomerations that create the strongest benefits, rather than general market potential.

Conclusion

This article provides cross-country estimates of agglomeration economies for functional urban areas that are independent of administrative boundaries. Using an internationally harmonized definition developed by the EU and the OECD allows pooling comparable FUAs from five OECD countries. We find strong support for the presence of agglomeration economies. Estimates indicate that for two comparable workers living in functional urban areas that differ by 10 per cent in terms of population size, productivity is, on average, between 0.2 per cent and 0.5 per cent higher for the worker living in the larger city. This effect is sizeable; it implies that a worker in the metropolitan area of Hamburg with 3 million inhabitants is expected to be 6-14 per cent more productive than a comparable worker in the functional urban area of Bayreuth which has less than 200 thousand inhabitants. Thus, the article provides an important addition to the existing literature on agglomeration economies, which generally provides estimates of similar magnitudes but study much narrower contexts.

Furthermore, the article highlights that the presence of large cities translated into higher regional growth over the 1995 to 2010 period. Regions that contain a city of at least 500,000 inhabitants experienced annual per capita growth rates that were approximately 0.2 per centage points higher than those of regions without cities of this size. Regions that contained cities of more than 2 million inhabitants even grew by 0.3 to 0.5 per centage points per capita and year more than those without cities of this size. The presence of big cities plays a role for regional growth even if cities are some distance away. Among regions that do not contain a

large functional urban area with more than 2 million inhabitants, those that are closest to one (typically within 45 to 60 minutes by car) grew the fastest. Each doubling of travel time reduces average regional per capita GDP growth by 0.2 per centage points per year.

More generally, the article demonstrates the important role that cities play in determining productivity and economic prosperity not just for their own residents, but also far beyond their boundaries. By concentrating economic activity in space, cities increase the productivity of their residents and make it possible to provide specialized services that would not be economically viable otherwise. Surrounding regions benefit from these services. Due to this influence, cities matter for the economic performance of large regions and helping cities to achieve strong economic performances can benefit the entire country.

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Challenges in the Measurement of Public Sector Productivity in OECD Countries

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ABSTRACT

Productivity is one of the main engines of economic growth. While most existing work on productivity has focused on the private sector, there is great value in better understanding productivity in the public sector, given government's important role in the provision of goods and services and its substantial contribution to overall GDP. However, the measurement of public sector productivity as a first step towards better understanding its dynamics is fraught with challenges, as the public sector differs substantially from the private sector in some of its key characteristics. This article examines current country practices and challenges to measure public sector productivity and identifies five areas to further enhance measurement efforts: (i) improvements to input measurement and cost accounting, (ii) standardization and comparability of measures, (iii) output measurement beyond the education and health sectors, (iv) a typology of activities at the micro level, and (v) intra-governmental co-ordination on productivity measurement. The article also calls for further research on the policy drivers for public sector productivity to delve deeper into how governance frameworks can be mobilized to achieve greater public sector productivity in support of effective public governance and ultimately the well-being of citizens.

Productivity, understood as the volume of output produced for each unit of input, is one of the main engines of economic growth. While most OECD work on productivity developments has focused on the private sector, there is great value in better understanding productivity in the public sector, given that government is a main provider of goods and services to citizens and government production is responsible for a substantial share of GDP. However, understanding public sector productivity poses several challenges. The public sector differs substantially from the private sector in some of its key characteristics.

This article examines current practices and challenges to measure and improve public sector productivity and suggests ways forward to address measurement challenges and delve deeper into how governance frameworks and processes can be mobilized to achieve greater

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public sector productivity that supports effective public governance and ultimately the well-being of citizens.

Productivity refers to how much output is produced for each unit of input, calculated as the ratio of a volume measure of output to a volume measure of input use (OECD, 2016a).[2] Raising productivity — the ability of economic actors to produce more outputs with better-combined inputs, or use fewer inputs to provide the same outputs — is the engine of economic growth.

Improving public sector productivity is high on many countries' political agendas.[3] OECD countries are facing significant demographic challenges with their aging populations and increasing dependency ratios that will affect both the demand for public services and the capacity to deliver them. In order to accommodate these developments, either more resources are needed or the productivity of the public sector has to increase. Also, most OECD countries are still experiencing fragile public finances with high debts and continuing deficits, so there is still a need for retrenchment over the medium term. Public managers are obliged to maximize the return to the public, including making the most out of the available talent in the public sector, and are accountable to the citizens for the efficient operations and results achieved of the public sector.

UK estimates show that different rates of growth in public sector productivity have significant effects on the public sector debt relative to GDP (DCLG, 2015). Moreover, trust in government is also declining in OECD countries, especially in those countries that were the hardest hit by the last economic and financial crisis. The provision of better quality public services through better resource utilization — which means increasing productivity — could help improve citizens' views on government, and more specifically on the public institutions providing these services.

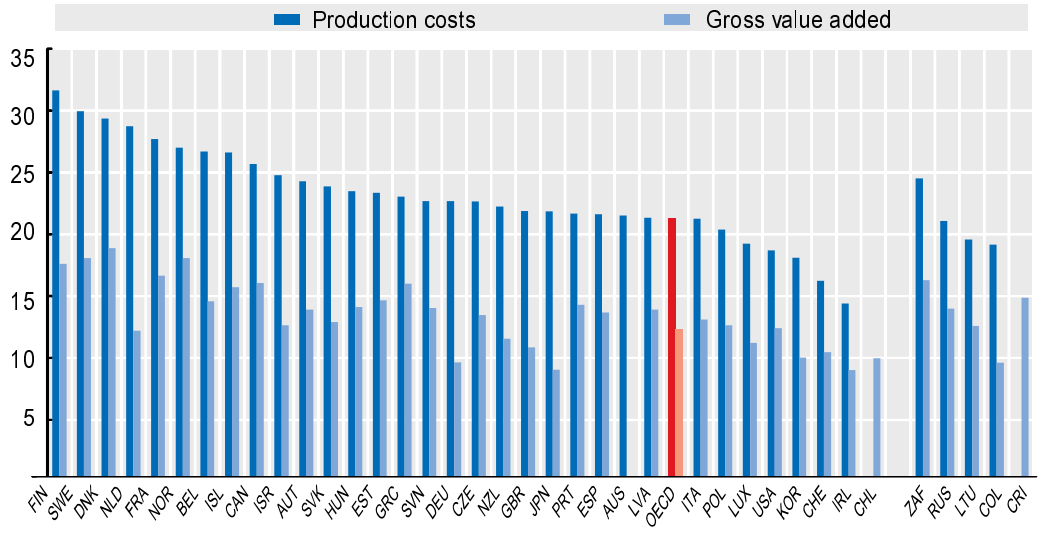
Public sector productivity has a significant impact on the performance of the national economy and societal well-being. First and foremost, the public sector is a major direct producer of goods and services: on average government production costs represents 21.9 per cent of GDP across OECD countries and gross value added of government amounted to 12.3 per cent of GDP in 2015 (Chart 1).[4] Governments are the main, and sometimes only, providers of key goods and services, such as education, health, social services, transportation and infrastructure. In fact, OECD governments are responsible for 70 per cent of final consumption expenditures[5] on health goods and services and for 84 per cent of final consumption expenditures on education. In addition, the public sector is a key enabler of the

2 As such, the concept of productivity is distinct from related concepts like "value for money", which "implies that reforms must lead to better quality of services for citizens and businesses or to savings, or to both" (OECD, 2015c), or cost-effectiveness, which refers to the extent to which an activity attains its desired objectives (OECD, 2013).

3 Public sector in this analysis refers to "general government" as defined in the System of National Accounts, which does not include public corporations that produce primarily for the market. It encompasses central government, state and regional government, local government and social security funds. "Government units are unique kinds of legal entities established by political processes that have legislative, judicial or executive authority over other institutional units within a given area. Viewed as institutional units, the principal functions of government are to assume responsibility for the provision of goods and services to the community or to individual households and to finance their provision out of taxation or other incomes, to redistribute income and wealth by means of transfers, and to engage in non-market production (EC, IMF, OECD, UN and World Bank 2009:4:17).

4 Production costs encompass compensation of employees, goods and services used and financed by government (e.g. outsourcing) and other production costs, which include the consumption of fixed capital (depreciation of capital) and other taxes on production less other subsidies on production. Gross value added is the difference between gross output and intermediate consumption.

Chart 1: Government Production Costs and Gross Value Added as Percentage of GDP, 2015



Source: OECD National Accounts Statistics (database). Data for Australia are based on a combination of Government finance statistics and OECD National Accounts data provided by the Australian Bureau of Statistics.

Note: The full names of the non-OECD countries are: ZAF: South Africa, RUS: Russian Federation, LTU: Lithuania, COL: Colombia, CRI: Costa Rica. Please note that the country codes used are official ISO codes, which are available at: https://www.iso.org/obp/ui/#search.

Both numerator and denominator of Chart 1 are in nominal terms. Thus, the GDP is in nominal terms. The OECD average is calculated as a weighted average where the weight is represented by the denominator of the ratio (i.e. the GDP of the countries).

proper functioning of the economy and society. For example, investment in education and in infrastructure both impact the productivity of the economy as a whole. A well-performing public sector also contributes to higher overall productivity through good quality regulation, the absence of corruption, and sound public financial management.

Public sector productivity cannot be understood without the ability to measure it, which requires good quality and, if possible, internationally comparable input and output measures of public sector services. Considerable progress has been made in the last two decades in the measurement of public sector inputs and outputs in the framework of the System of National Accounts by National Statistical Offices (NSOs), governments and their departments, national Productivity Commissions, international organizations, such as Eurostat or the OECD. But there is still much to be done.

To date, the lack of measures to appropriately capture public sector productivity building on, and going beyond, the System of National Accounts, has meant that major policy decisions are being taken without adequate understanding of their implications for the economy as a whole. Too often, improving public sector productivity is equated simply with spending or staff cuts. The term productivity is often misused as a syn-

5 Final consumption expenditure represents the amount spent by governments, non-profit institutions and households on goods and services consumed. The corporate sector does not incur any final consumption expenditure because it only produces final goods for sale in the market. Expenditures are attributed to the institutional unit (government, non-profit institution or household) that bears the costs (note that non-profit institutions represent a very small portion of the total consumption). Compared to total expenditures, final consumption expenditures exclude spending on goods and services not consumed during the year, such as investment goods, and exclude social benefits provided to households which are not tied to the consumption of specific goods and services, such as pension payments.

onym for austerity program, rather than searching for strategic agility, improving the mix and use of inputs, and enhancing the quality of outputs for better public outcomes. A better understanding of public sector productivity measurement challenges can therefore provide insights into how public sector productivity can be improved.

This article is based on a short survey carried out by the OECD at the end of 2016 and early 2017 on country practices in productivity measurement.[6] The survey was designed as a mapping exercise to collect basic information on countries' general efforts to measure public sector productivity from a managerial perspective. Data presented are self-reported and aim at capturing countries' (exploratory) managerial efforts to measure public sector productivity rather than measuring public sector productivity in their national accounts systems. The survey was sent to senior budget officials and productivity commissioners in OECD member and partner countries to collect information on (i) the methodologies applied to measure public service productivity, (e.g. use of cost accounting and quality adjustment); (ii) targeted sectors, organizations and functions; (iii) main organisations responsible for this work; and (iv) the use of productivity measures in government. Thirty OECD member and two partner countries responded to the survey.

The article first presents an overview of existing efforts to measure public sector productivity, followed by an analysis of the specificities of productivity measures for the public sector. It concludes with five concrete suggestions to enhance existing measures of public sector productivity and reflects on the role of measurement to support further research on ways to improve public sector productivity.

Which Aspects of Public Sector Productivity Be Measured?

Productivity in the public sector can be measured at several levels depending on the focus of the inquiry. At the macro level, the productivity of the whole public sector is calculated, which allows for the estimation of the public sector's contribution to the performance of the whole economy and to a more accurate estimate of GDP growth. At the meso level, the focus is on the productivity of the various policy sectors, such as education or health. At the micro level, the performance of individual organizations — e.g. ministries, agencies, hospitals, schools, municipalities — as well as key activities and functions, e.g. shared services, procurement or waste collection etc. — can be compared not only within countries but also across countries. Measurement on all three levels face similar methodological challenges, such as the identification of the concrete services provided, separating out the inputs expended on those services and effective ways to capture changes in quality over time, etc. A recent OECD survey has collected information on countries' current efforts to measure public sector productivity on the different levels.[7]

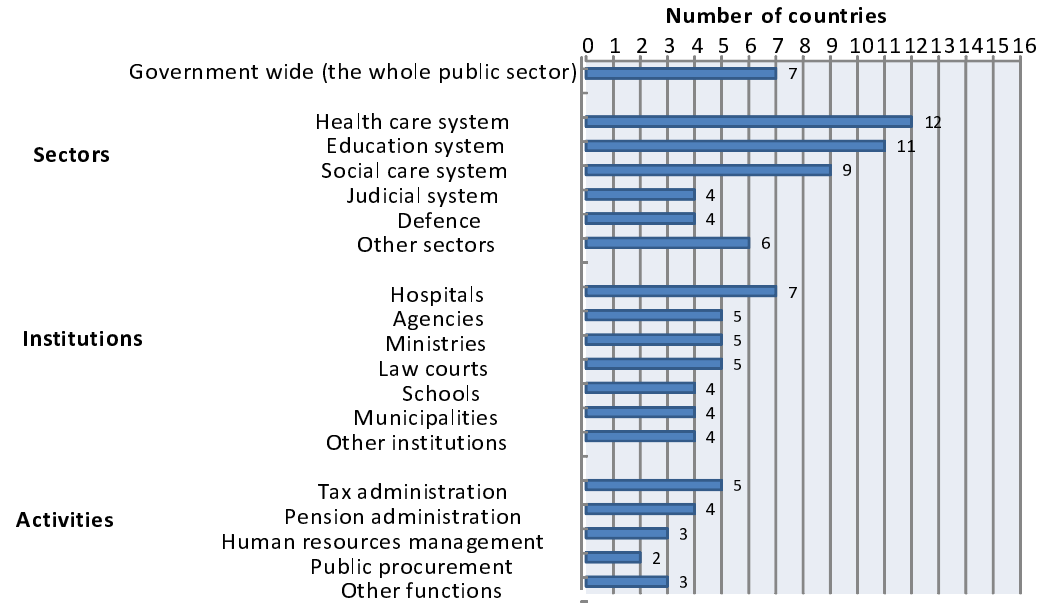
Macro level

Macro level measurement of productivity is useful to establish trends over time in one country, and also compare those trends across countries. It is less useful for management purposes, as macro-level data encompasses a diverse set of activities of numerous units. Given its aggregate

6 The artcile also draws on a review of recent developments in the measurement of public sector productivity commissioned by the OECD (Robano, 2016) and a paper prepared for the Meeting of the Performance and Results Working Party (Dunleavy, 2016).

7 See Box 1 in the online Appendix available at: http://www.csls.ca/ipm/32/Lau%20Appendix.pdf

Chart 2: Measurement of Public Sector Productivity at Different Levels



Source: 2016 OECD Survey on Measures of Productivity in OECD and Partner Countries

nature, it also masks countervailing developments in different parts of the public sector and, as a result, it is not actionable as it cannot clearly be attributed to a particular part of the public sector.

The productivity of the whole public sector[8] is measured only in a few OECD countries according to the OECD survey.[9] In 2015, only seven countries (Australia, Denmark, the Netherlands, New Zealand, Portugal, South Africa and the United Kingdom) reported measures of the productivity of the whole public sector (Chart 2). The UK released the first total public sector productivity estimate in 2009 (for current measurement efforts, see Box 1) and Denmark started its measurement in 2014 (for details, see Box 1). Finland has stopped measuring productivity of the whole public sector and concentrates on measuring it only for the municipalities, where the greatest productivity gains can be realized.

Meso level

At this level, most efforts to identify direct output measures by countries and by international organizations have focused on two policy sectors that provide individual services: education and health.[10] Direct output indicators allow the measurement of productivity of these services. These indicators facilitate the understanding of the contribution of these policy sectors to the productivity of the public sector

8 Please note that the OECD mapping survey does not distinguish between individual and collective services when referring to the public sector.

9 At the same time, many OECD countries indicated that they have some form of measurement of the outputs of government or specific sectors of government. This is due in part to the Eurostat requirement for EU member countries to measure and report the outputs of their non-market services. Although such measures do not represent full-fledged productivity measures that relate outputs to the inputs used to generate them, this is an important first step towards measurement of public sector productivity.

10 See Box 1, Table 1 and 2 in the online Appendix available at: http://www.csls.ca/ipm/32/Lau%20Appendix.pdf

Box 1: Report on Public Sector Efficiency - United Kingdom

The UK government carried out its first comprehensive review of public sector efficiency in 2014-2015. Based on UK and international experience, the review gathered existing evidence on efficiency trends and drivers and identified areas for achieving further efficiency improvements.

The report defines public sector productivity as a key component of public sector efficiency. Public sector efficiency refers to the "entire process of turning public money into desired outcomes." It can be divided into "technical efficiency", which focuses on "doing things right", e.g. by doing things at lower costs or producing more outputs from what is currently done at the same cost; and "allocative efficiency", concentrating on "doing the right things", i.e. finding ways of achieving desired outcomes at less cost. Public sector productivity is defined as the relation of "how much output is produced for each unit of input", and hence forms part of technical efficiency.

The analysis shows that public sector productivity growth is essential for delivering fiscal consolidation. Although market sector productivity growth has outstripped productivity growth in the public sector between 1997 and 2010, public sector productivity has grown by 3.7 per cent since 2010. A one per cent increase in annual public sector productivity would imply a reduction in public sector net debt of 64 per cent of GDP by the first quarter of 2060. The report presents productivity trends in all areas of public sector activity, including a wide range of frontline services. Output measures are quality-adjusted for some health and education services.

The analysis revealed a number of problems and challenges in measuring public sector efficiency. These include a lack of comprehensive and comparable evidence, the definition and measurement of output quality, and the attribution of changes in outcomes to changes in outputs. According to the report, sharing evidence, examples and best practice across government has proved useful for informing action to further improve efficiency. The report also recommends the use of triangulation, i.e. to not rely on a single measure, but to draw on a range of evidence when analyzing public sector efficiency. As a result, the UK government has produced an Efficiency Toolkit providing guidance on improving efficiency in the public sector, and a number of practical steps to disseminate the report's findings and induce follow-up conversations on the topic are suggested.

Source : Department for Communities and Local Government (DCLG) (2015); Robano (2016)

and the whole economy. Furthermore, countries' performances can be benchmarked through international comparisons.

In 2015, 11 countries reported measuring the productivity of education, and 12 countries measuring the productivity of health care services. Among the countries that reported measuring public sector productivity, only Israel, Poland and Portugal report not having undertaken measurement efforts in either of these sectors according to the OECD survey. With the spread of output measurement in these sectors in OECD countries and advances in price measurement and further successful standardization efforts, the education and health sectors are ripe for productivity measurement in a standardized way.

Micro level

Governments are also interested in how well — i.e. how effectively and efficiently — their organizations work and carry out their key functions. Productivity measurement at the micro-level is most useful for managerial purposes, as managers should be accountable only for the performance of units that they control. It is also

Box 2: Measurement of Government Outputs and Productivity in Denmark

The Government of Denmark in 2014 moved from the use of an input-based method to an output-based method for measuring the volume of general government production. A total of 18 volume indicators have been constructed to measure individual non-market services in the areas of health care, social protection, education, and recreation and culture. Only for collective services (e.g. defence, public order and safety, environmental protection), which account for about a fourth of general government output, is the input-based method still used. This implies that for collective services, any potential changes in productivity levels are not captured, as the output volume is measured by the volume of inputs.

The volumes of non-market services calculated based on the input- and the output-based method clearly differ from each other. Between 2008 and 2014, the volume growth is higher in five out of the seven years using the output method. This may suggest an increase in productivity, as the volume of services provided by the general government (output) increases more quickly than the volume of resources it consumes (input). However, the Government of Denmark points out that this conclusion may be misleading in the short run, as phenomena like changes in legislation may lead to rapid changes in output levels implying productivity increases (e.g. new legislation resulting in greater numbers of students) that are not matched immediately by the corresponding necessary input-resources (e.g. buildings, teachers).

Results based on the output-based method show that general government contributes significantly to general economic activity in Denmark. General government production represents about 15 per cent of the whole economy. Labour productivity, measured as the gross value added per hour worked without quality adjustments, increased by 1.0 per cent in general government over the 2005-2014 period, while it increased in the market economy by 5.2 per cent.

Statistics Denmark worked in close co-operation with the Ministry of Finance and the responsible line ministries, such as the Ministry of Education and the Ministry of Health, to select, develop and validate the output indicators. Academic experts were also involved in the elaboration of the methodology.

Eurostat is another important partner for Denmark in their work on measuring government output. Participation in Eurostat task forces on the development of measurement methodologies have been an important input for Statistics Denmark's approach to measuring the volume of government services. In line with EU requirements, the Government of Denmark is currently not applying quality adjustments to the volume measures used. However, Denmark is involved in efforts to scope methods for quality adjustments in the future through a working group in Eurostat as well as within Statistics Denmark.

Source: Statistics Denmark (2013), "General Government Output and Productivity 2008-2014." http://www.dst.dk/en/Statistik/Publikationer/VisPub?cid=18684.

useful for making comparisons over time and for target setting within an organization. It allows comparing their performance to each other within a government and to similar organizations in other governments. Certain functions — such as tax or pension administration or foreign policy — are carried out only by a single organization in each country, so bench-

marking them can only be done internationally.

Considerable work has been done for example on the international comparison of tax administrations since 2006 in OECD countries (OECD, 2015b). However, while the mandate of these tax administrations might be similar, their functioning and productivity is largely dependent on the tax policies and the tax codes that they administer. As a result, international comparisons of their efficiency/productivity could pinpoint changes that might be necessary not only in tax administration, but also in tax policy.

In the same vein, the productivity of a hospital is strongly dependent on its case and function mix, the socio-economic background of its patients and other factors, and not just on how efficiently it carries out disease treatments. This is why comparisons of performance on disease treatments across hospitals should be interpreted with caution. However, the collection of productivity data for schools, hospitals or municipalities could also produce greater insights into the possible causes for their differences in performance. With the increase of the number of observations, more sophisticated econometric techniques can be applied, such as fixed effects regression analysis and stochastic frontier analysis (Dunleavy, 2016).

Governments may also want to compare how productive certain functions/practices are. This type of measurement is in its infancy. The selection of the functions for which analysis should be carried out could be based on the following principles:

- the functions are carried out by most governments;
- they contribute substantially to the productivity of the public sector;
- inputs and outputs of the function can be defined;
- administrative data on these inputs and outputs are readily available; and
- different models exist on how the function is carried out.

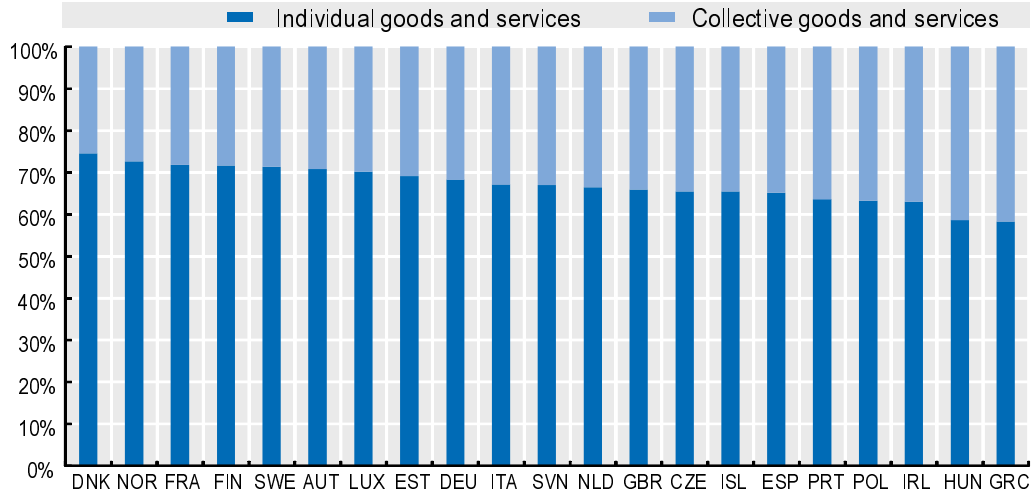
An area that fits these principles is the public procurement function. A pilot project on how to measure the productivity/value for money of the public procurement function is planned in a number of OECD countries as part of the OECD work on Civil Service Effectiveness.

Opinions on the usefulness of measuring the productivity of agencies diverge. Dunleavy (2016) advocates strongly for measuring productivity at the agency level and comparing productivity paths (trends over time). He considers transactional services the most promising area for productivity measurement and makes the case that the measurement of productivity of collective services — e.g. defence or police — is not insurmountable. He also argues that the long-run inability to develop widely used measures of government productivity reflects on one hand a considerable failure of imagination and focus in economics and public management studies, and on the other hand some very sustained resistance by civil servants, public sector professionals and some politicians to the application of 'crude' and 'limited' measures of government activities.

Specificities of the Public Sector and its Impact on Productivity Measurement

The measurement of public sector productivity is rife with considerable difficulties that emanate from the specificities of the public sector. First, the public sector provides mainly services — such as education, health, social services, policing, etc. — and the measurement of service output is more complicated than the measurement of the production of goods, even in the private sector. Services are also heavily reliant on intangibles and tacit knowledge and are often process-based. Furthermore, a large share of government services are not bought and sold,

Chart 3:Government Expenditures on Individual and Collective Goods and Services in EU Countries as Percentage of Total Expenditures, 2011



Source: OECD National Accounts Statistics (database).

e.g. they are non-market goods and services and, as a result, market prices do not exist. Finally, a significant part of government services — representing close to 30 per cent of public spending — are collective goods which cannot be consumed individually (e.g. defence, police, environmental protection) (Chart 3).

Outcomes like societal well-being, economic growth and social inclusion are the ultimate goals of any public policy making. The measurement of policy outcomes is not particularly difficulties in many cases (e.g. citizens' health status, education levels of pupils). However, it is much more challenging to establish a clear link between public policy action and policy outcomes, as outcomes can be influenced by a range of other external variables beyond output changes that are difficult to track. For the time being, the European System of Accounts specifically excludes output measures adjusted for quality based on outcomes, in order to preserve the international comparability of results (EU, 2016: 38).

Input Measurement

Input indicators measure the amount of resources used for the production of outputs. Major input categories are compensation of employees, use of capital goods, use of intermediate goods (intermediate consumption) and taxes net subsidies. The basis of productivity measurement for the public sector and the underlying policy sectors is the data provided by the System of National Accounts (SNA) on inputs and outputs. Here, it is important to note that both measures need to be adjusted for price changes to arrive at an appropriate measure of productivity change, which refers to the change in the volume of outputs, as compared to the change in the volume of inputs. It should also be acknowledged that volume changes should reflect both changes in the quantity and changes in the quality of the inputs/outputs under consideration.

In the public sector, measurement of government inputs (Box 3) remains difficult for three main reasons:

- In most countries budgets are prepared on a cash basis and full overhead costs (including capital consumption and occupancy costs

Box 3: Measurement of Government Inputs

For inputs, the major methodological issues relate to the appropriate calculation of volume measures, especially for labour (compensation of employees) and the consumption of fixed capital.

The quantity of employee labour is defined as "an hour's work of a given type of level of skill" (EU, 2016). The price of labour includes all changes in compensation that are not related to skill-adjusted hours worked. The European Union (2016) suggests two methods for estimating volume changes for labour: (i) directly by measuring the quantity of hours worked, or (ii) deflating money wages and salaries. While the European Commission recommends using the latter approach, most countries use the quantity of hours worked as a measure of labour volume. The most significant challenge is adjusting the change of the labour volume measures for the different skill levels of the employees.

The measurement of capital inputs used by government is not widespread among. Schreyer and Mas (2013) note that, while capital depreciation is accounted for when measuring non-market output, no other capital input, such as the returns on capital invested, is computed.

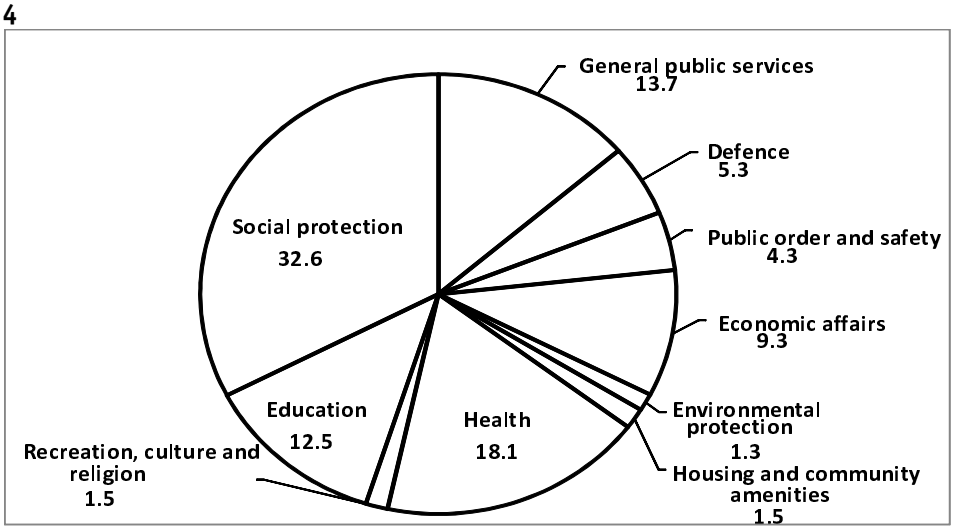
Accurate measurement of inputs at any level requires cost accounting, which in turn builds on an accrual-based accounting system that registers costs and not only cash-flows. By 2016, around three quarters of OECD countries have adopted full accrual accounting (Moretti, 2016). For costs to be apportioned to outputs, it is not only necessary to maintain a system of accrual accounting, but also to have a management accounting system that allocates costs to the different outputs. This requires a financial administration at the agency level that records the costs of all outputs produced, which are also needed for the calculation of output volumes.

for public buildings) incurred by government entities are not measured. Even for those countries that have adopted accrual budgeting or accounting, some assets (historical buildings) and the costs related to the increase of liabilities regarding future pensions and benefits to public servants may not be recorded in the accounts.

- Accounting rules are not consistent across government. Government entities do not always use the same rules in accounting for their operations; hence there exists little consistency in measuring costs.
- Cost accounting is little developed. Cost accounting consists of attributing costs (commonly called expenditures) to core outputs. Difficulties commonly arise in the public sector because: i) spending is presented in budget documents by administrative units or by nature of expenditure, instead of being allocated to outputs; and ii) significant costs, such as public infrastructure investment, are difficult to allocate to a specific administrative unit, and even more so, to a specific output (for example, IT systems).

Despite these difficulties, a number of countries have made significant progress in measuring inputs and linking them with outputs, either at the micro level (for example, the UK, see Box 2) or at the macro level (for example, France). For example, modern methods to estimate labour input include direct measures of hours worked, hours worked by the 'full-time equivalent' number of employees, or the hours paid. Using the total number of employees is not considered to be a suitable indicator. There are also several methods to adjust labour input measures for the different skills of employees, e.g. skill levels for certain types of work can be classified by educational level, occupation, salary or grade (EU, 2016:66).

Chart 4: Structure of General Government Expenditures by Function in OECD Countries, 2014



Source: OECD National Accounts Statistics (database); Eurostat Government finance statistics (database). Data for Australia are based on Government finance statistics provided by the Australian Bureau of Statistics.

Output Measurement

Outputs are the goods and services produced (e.g. number of hours children are taught). For productivity calculations final outputs should be measured (e.g. the products or services that are produced for the public or business) in order to avoid double counting. However, it is not easy to identify final outputs due to the absence of prices. Due to the peculiarities of the public sector, productivity was long considered constant based on the convention that in the public sector inputs equal outputs. With this convention, until not that long ago OECD countries measured the volume (i.e. economic value) of non-market services by the input-based method. This has changed in recent years with an increased interest and focus of policy makers on performance of the public sector.

Many countries measure activities now that reflect what the non-market units actually do with their inputs (ONS, 2005), but these are imperfect measures. For example, the treatment of appendicitis used to require an operation and a two-week hospital stay. Now, patients only need to stay in hospital for three days following the operation. Using an activities-based approach to measuring output, this would imply a decrease of output and productivity when it is clearly not the case.

In addition, the quantities of different outputs need to be added together using data on prices or, in the absence of prices, average unit costs. In current practice, aggregation of outputs is usually based on average costs to facilitate measurement. However, recently it has been suggested that replacing average costs by the time used to produce the output could better reflect marginal utility to consumers (Diewert, forthcoming). Such an approach, however, would require detailed and accurate information of the time needed to produce outputs.

With advances both in input and output measurement — and with the introduction of the output-based method,[11] some countries (e.g. the United Kingdom, Finland, New Zealand, and Australia) started measuring public sector productivity estimates. This is especially the case in some key policy sectors like education and health care, which provide services for individuals where outputs can be identified. However,

for collective services, the identification of outputs is extremely complicated, and the use of input method is still common practice (EU, 2016). Similarly, a lack of standardized methodologies presents a challenge to international comparisons of public sector productivity at one point in time. For now, only developments in public sector productivity over time within countries can be compared.

The Atkinson Review (ONS, 2005) was undertaken in the UK and pioneered important methodological developments that constituted a significant advance in the measurement of public sector outputs. Since 2006 Eurostat has been requiring EU members to measure and report the outputs of their non-market services, a prerequisite of productivity measurement. The OECD has also been working on providing advice on how to measure the volume of output for education and health services (OECD, 2010) in a first attempt to internationally standardize output measures for these two sectors, and to develop output price indexes for some services (e.g. health).

Government's spending on health care and education in OECD countries represented on average 18.1 per cent and 12.5 per cent of total government expenditure respectively in 2014 (Chart 4). These services also are very important for economic growth as well as for individual well-being. The data required to identify and measure the outputs are commonly based on administrative sources, for the most part readily available, but in some countries also complemented by survey data. Direct output volume measurement requires information on prices, or in the absence of prices unit costs — average costs per unit of output[12] — and quantities of homogeneous products.

The measurement of volumes has three dimensions: it needs to take account of variations in quantities, variations in the composition of the aggregate product, and variations in the quality of goods and services (EU, 2016). There are different practices followed by OECD countries to apply quality adjustment.[13]

Output measurement is critical to productivity measurement. While outputs refer to goods and services produced by the public sector, from a performance perspective, what really matters are the outcomes, i.e. the results that policy makers intend to achieve through the production of those public goods and services. Countries often have important differences in their definition of outputs and/or outcomes for the same activities. For example, in the case of education, in some countries the output is identified as the number of pupils; in others, the number of hours children are taught. But children go to school to learn. As a result, the outcome for education is considered to be the performance of students, in practice measured by standardized tests, such as PISA.

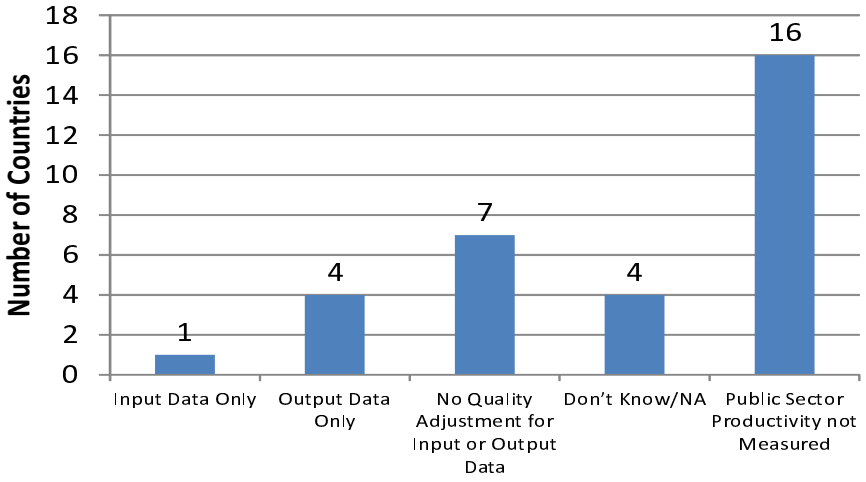
While the quality adjustment of outputs may seek to take achievement of outcomes into account in the measurement of outputs, in practice, it is often hard to delineate outputs and outcomes and even harder to identify outcomes that can be solely attributed to public sector activities and their outputs. For example, the achievement of students on standardized tests are not solely the results of the number of hours they are

11 In the output-based method units of quantity for non-market services are defined. By doing this, it is possible to apply the general principles for calculating volume indices for those services. This can be done in two ways: directly by calculating a weighted average of quantity changes in a homogeneous number of representative outputs/activities (i.e. direct volume) or by deflation, using as deflator of a price index and unit cost index (i.e. indirect volume).

12 The average costs per unit of output does not include changes in the prices of intermediate products (Lorenzoni, 2015).

13 See Box 2 in the online Appendix available at: http://www.csls.ca/ipm/32/Lau%20Appendix.pdf

Chart 5: Use of Quality Adjustment for Government Input and Output Measurement in OECD Countries



Note: The countries for 'not measured' include: Austria, Belgium, Canada, Costa Rica, Czech Republic, Estonia, Italy, Japan, Latvia, Luxembourg, Mexico, Norway, Slovenia, Spain, Sweden and Switzerland. 'Don't know' is comprised of countries: South Africa, Netherlands, Israel and Finland. 'No quality adjustment for input or output data' countries include: Portugal, Poland, Germany, France, Denmark, Chile and Austria. While 'input data only' is New Zealand and 'output data only' countries include: UK, Slovak Republic, Ireland and Hungary.

Source: 2016 OECD Survey on Measures of Productivity in OECD and Partner Countries.

taught; other factors, such as the income level and educational attainment of the parents, the quality of teachers, and class size, also having an impact. This is the called the attribution problem that is associated with identifying the contribution of outputs to outcomes in the public sector.

The OECD survey on public sector productivity measurement asked countries whether they are carrying out explicit quality adjustment (i.e. applying a numerical correction to the level of outputs based on the resulting outcome(s)) to their input and output measures. Quality adjustment does not constitute a widespread practice among OECD countries (Chart 5). Only 5 of the 16 countries that measure public sector productivity report making use of quality adjustment. Hungary, Ireland, the Slovak Republic and the United Kingdom apply quality adjustments to output data, while New Zealand reports using quality adjustment for input measures.

Future Steps in Government Productivity Measurement

The examples of countries that have undertaken steps to measure productivity in the whole public sector show that while the task is very difficult and complicated, it can be done. However, without proper output and input volume measurements, productivity cannot be calculated. Future OECD work could focus on the following five areas: (i) improvements to input measurement and cost accounting; (ii) standardization and comparability of measures; (iii) output measurement beyond the education and health sectors; (iv) a typology of activities at the micro level; and (v) intra-governmental coordination on productivity measurement.

The standards for input measurement are better developed than for output measurement, although even in this area more work can be done. The key to measuring productivity in the public sector at any of the three levels — macro, meso and micro — is the existence of a reliable

cost accounting system that is able to separate out the input costs to the various outputs. Different steps can be taken to move this agenda forward: i) harmonizing accounting methods in the public sector, in order to ensure consistency in measuring costs; ii) designing new public sector financial IT systems not only as accounting tools, but as enablers for productivity measurement; iii) using feedback/knowledge of public managers to understand which cost data are meaningful and useful to improve productivity in their specific area of work.

Much more effort can be undertaken with regards to output measurement. Given that it is easier to identify the final outputs for individual services for individuals, it is most developed for education, health care and social care services. Next steps to be taken include broadening output measurement to other individual services. Developing methodologies to measure collective service outputs still seems a rather distant goal and will take a considerable amount of resources and time. Mixed methods using the output method for some key services and the input method for the remainder can provide interim solutions.

A standardization of measurement practices would also be useful to enhance comparability. International organizations, such as the European Commission and the OECD, have contributed to developing a methodology for price and volume measurement in national accounts. The work is the most advanced for the health care and education services. In order to compare productivity in these sectors across countries, further standardization of input and output measurement is needed. This might require some countries to change the indicators they currently use, e.g. from the number of pupils to the number of pupil hours taught.

There is little known about how countries measure productivity at the microlevel, i.e. the organization/function level. Most frequently, existing micro level measurements exist in the education and health area in the form of league tables comparing the performance of individual schools and hospitals. However, the measurement of productivity or value for money of various government functions would be equally beneficial. There is great interest from countries in this microlevel measurement and great scope for learning from each other. The UK example (see Box 2) shows how this could be carried out. The OECD Secretariat is planning case studies to look at how productivity/value for money can be measured for the procurement function and for digitalization.

Finally, intra-governmental co-ordination is essential to advance measurement efforts. Institutional responsibilities for measuring public sector productivity are different across countries. Frequently, efforts are led by National Statistical Offices with the involvement of line ministries, who are in the best position to decide on the most important final outputs to be counted in their area. The assignment of clear responsibility for public sector productivity measurement to a specific institution and providing it with adequate resources to fulfil this task can help clarify roles and facilitate co-ordination of data collection. Productivity Commissions, as for example in Australia and New Zealand, or Productivity Boards have measured productivity in specific public sector domains (Dougherty and Renda, 2017), and could also play a useful role in co-ordinating and promoting productivity measurement in the public sector.

Conclusion

The drivers of public sector performance and productivity are manifold. While this presents a number of challenges, it also means that governments can mobilize various tools and improve different processes to increase public sector productivity. This article lays the groundwork for

further OECD research to better understand public sector productivity and how it can be improved. It suggests several ways forward to address measurement challenges and to delve deeper into how governance frameworks and processes can be mobilized to achieve greater public sector productivity.

As a first step, efforts should be made to accurately measure the productivity of the public sector to help focus attention on public sector productivity as a policy objective, to support benchmarking and to identify and compare possible strategies to improve productivity. Further development and standardization of measures of government output and the inputs used to generate them beyond the education and health sectors are worthwhile. Furthermore, there is great value and interest in assessing public sector productivity in greater detail on the microlevel, i.e. evaluating closely the productivity of individual government organizations and functions.

Additional research on the policy drivers for public sector productivity is also required. These include implementing digital government strategies, strategic human resource management, creating an enabling environment conducive to innovation, and understanding better the impact of budgeting and regulatory practices. New approaches should be able to consider the complexity of trade-offs and tensions. An example is associated with the increasing uptake by public sectors of new technologies that go beyond pure financial decisions, such as convenience and personal data protection, or leveraging the economies of scale inherent to cloud computing. And there are ways to assess the impact on productivity and public value creation brought about by new forms of deploying technology (e.g. shared ICT services and how they contribute to public sector productivity) or sharing and processing data.

Only by better understanding the internal workings of the 'black box' by which governments transform inputs into outputs and ultimately public outcomes can we map the drivers of productivity, promote the diffusion of innovations to strengthen public sector productivity and improve public sector effectiveness. This task is made more difficult by the rising complexity of government relationships and partnerships, in a context of co-design and co-delivery. Boundary crossing activities and effects (for example, when productivity increases take place through the collaboration of organizations, sectors and citizens) are frequently not accounted for in current measurement systems.

So while innovation is certainly a vector for improving productivity in the public sector, as it is in the private sector, it also represents a measurement challenge as innovation projects in general can have multiple actors, at both the same and different levels of the public sector. Thus it can be difficult to isolate the specific impact and effect of particular project and/or particular organisation within a project.

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Pro-Productivity Institutions: Learning from National Experience

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ABSTRACT

This article analyses and compares ten institutions that have a mandate to promote productivity-enhancing reforms. The selected bodies include government advisory councils, standing inquiry bodies, and *ad hoc* task forces. We find that well-designed pro-productivity institutions can generally improve the quality of the policy process and political debate, and can make a significant contribution to evidence-based policy-making. Our findings also support the view that concentrating knowledge and research on productivity in one independent, highly skilled and reputed body can help create the momentum and the knowledge that are required to promote long-term productivity growth. Institutions located outside government have more leeway in promoting reforms that challenge vested interests and produce results that go beyond the electoral cycle. Smart government bodies can allow experimental policy-making and a more adaptive, evidence-based policy process. To be successful, pro-productivity institutions require sufficient resources, skills, transparency and procedural accountability to fulfil their tasks; a sufficiently broad mission, oriented towards long-term well-being and with both supply-side and demand-side considerations; policy evaluation functions; and the ability to reach out to the general public in a variety of ways.

Over the past two decades, promoting productivity growth has risen as one of the key challenges facing policy-makers around the world. Despite being widely acknowledged as an intermediate, rather than final, goal of economic policy, productivity is considered as a key driver of long-run economic prosperity. As Paul Krugman (1994) famously observed, "productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker." Against this background, economic data since 2000, and particularly since the Great Recession, show a slowdown in productivity growth that reflects a mix of cyclical and structural factors (OECD, 2016a). Explanations vary across countries, and include weak investment in

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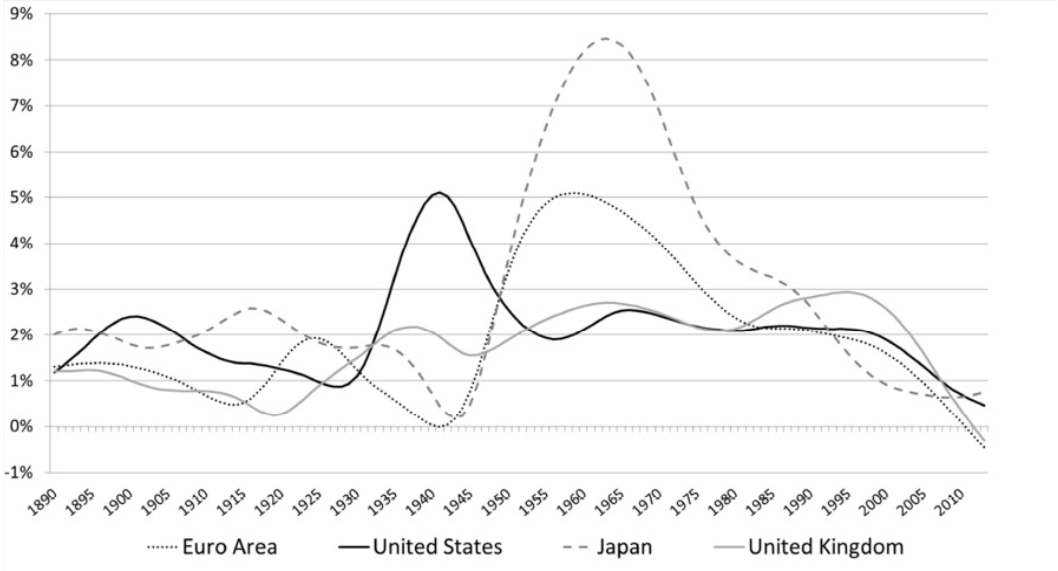
physical capital, sluggish recovery in non-residential investment, and demand-side deficiencies. At the same time, OECD analysis shows a growing dispersion of productivity performance within countries between firms and regions, which suggests that there is no real innovation deficit, but rather a diffusion deficit in many countries (OECD, 2016a; Ashford and Renda, 2016), and insufficient exit, as in the case of "zombie firms" (Andrews *et al*., 2016). Data presented in a joint event organized by *France Stratégie* (Sode, 2016), and the US Council of Economic Advisers showed a downward trend in productivity in all advanced economies over the second half of the 20th century (Chart 1).

The debate about the slowdown in productivity growth is of sufficient concern to policymakers that the OECD in 2015 created the Global Forum on Productivity. In many countries, the reflection on "secular stagnation" (Hansen, 1939; Summers, 2014; Gordon, 2015) has led to the growing recognition that important, structural changes in domestic and international economic policy are needed to reverse the trend or at least contain the current decline (Ashford and Renda, 2016). As noted by Banks (2015), very often the productivity challenge can be successfully tackled only by securing more intense market competition, entry of dynamic new market players and the exit of poor performers. Which very often clashes with the interests of incumbent players, who can exert a very powerful influence on policy choices (OECD, 2015a). At the same time, certain current trends (e.g. the internet of things, artificial intelligence, smart manufacturing) are posing new challenges for the measurement of labour and total factor productivity. Indeed, many commentators are still trying to agree on whether the current slowdown is at least partly generated by measurement problems (Byrne *et al*., 2016; Syverson, 2016).

There has been growing recognition that promoting pro-productivity policies can be a particularly daunting task. Such a task is further complicated by the fact that when it comes to productivity, there is neither a silver-bullet solution, nor a standard set of reforms that can be implemented in the same way in every country. On the contrary, the path towards enhanced

Chart 1: Productivity Waves and Recent Labour Productivity Slowdown, 1890-2013
Trend Annual Growth



Source: Banque de France (Cette *et al.*, 2017), www.longtermproductivity.com.

productivity varies according to the peculiarity of the national economy and its institutional settings. Other important factors that further challenge policy-makers include the partly demand-driven nature of the productivity slowdown, which makes traditional supply-side recipes less likely to be effective by themselves (Anzoategui *et al*., 2016); and the need to guarantee an institutional setting that is conducive to the promotion and implementation of pro-productivity reforms. In this respect, a plethora of institutions can be put to work with a view to triggering a more intense and meaningful debate on which productivity policies are most suited for a given country. When well-designed, transparently governed and adequately staffed, such institutions can serve a key function in 'neutralising' the undue influence of vested interests in key reform areas (Banks, 2015).

This debate is the focus of this article. As elaborated by Gary Banks (2015), there are a multitude of institutions directly or indirectly affecting policies impacting on productivity. Some of these institutions can be directly established by governments through legislation (e.g. competition authorities, foreign trade tribunals, auditing bodies, public think tanks; regulatory oversight bodies, central bank research units, departmental bureaus, and standing bodies that advise governments in various forms). Others, like privately funded research centres and think tanks, are stimulated by the practice of open government (e.g. the use of public stakeholder consultation on proposed legislation; or on retrospective reviews of legislation, see OECD, 2015b). As also noted by Banks (2015), these institutions appear to flourish more easily and effectively whenever countries adopt good governance practices, and in particular develop a culture of evidence-based policy, coupled with arrangements aimed at boosting the transparency and accountability of government.

In this context, this article discusses national experiences on ten selected pro-productivity institutions. It examines the contribution that such institutions can make to building consensus, convincing stakeholders, confronting vested interests, establishing credibility and educating leaders. The ten case studies are the productivity commissions of Australia, Chile, Denmark, Mexico, Norway, and New Zealand; the Irish Competitiveness Council; *France Stratégie*; the US Council of Economic Advisers; and the European Political Strategy Centre in the European Commission. We focus on current institutions at the national level, rather than intra-governmental or supra-national bodies such as the OECD itself, or earlier institutions such as the European Productivity Agency (EPA, 1952-60), which once had affiliates at the national level.[2]

As the reader will realize, these institutions differ in many respects, including their overall size (e.g. staff), date of creation, institutional location, mandate and mission, tasks and deliverables, and budget. In this respect, it is not our goal to draw comparative judgments. Some of the institutions we selected do not explicitly mention productivity in their statutes or mission statements. As a matter of fact, this wide heterogeneity observed across countries when it comes to institutional design and governance allowed only for a collection of examples of successes and challenges that have been experienced by the ten surveyed institutions.

This article is aimed at collecting and synthesizing the opinion of high-level representatives of those institutions, and also external opinions by prominent decision-makers or commentators with direct knowledge. We conducted ten in-depth interviews with staff members of the

2 More information on the EPA can be found at http://archives.eui.eu/en/isaar/40.

selected institutions between June and August 2016 as well as a number of interviews with external experts selected in agreement with the OECD, between August and November 2016. The importance of these experiences is heightened by the European Council recommendation that all Eurozone countries create or designate Productivity Boards by early 2018.[3]

This paper will proceed by first describing the main features of the ten selected institutions, and second by identifying similarities and differences among them. Finally, after considering the institutions' strengths and weaknesses, seven lessons are drawn from their experience to date.

The Ten Surveyed Institutions

Based on their names, our ten selected institutions include six productivity commissions, three advisory councils located at the centre of government and one competitiveness council.[4] However, the boundaries between these institutions are more blurred than it might seem, and the similarities within categories are also not always obvious or precise, as explained below.

The six Productivity Commissions are composed of two major sub-groups that can be identified.

- Four institutions (Australia, Chile, Mexico, New Zealand) feature a design that can be said to have been significantly inspired by the Australian experience, already extensively described in Banks (2015). However, the Australian Productivity Commission features a size and degree of independence and institutionalisation that has no equivalent in other countries.[5] In particular, in Mexico and Chile the institutions appear to rely on highly limited resources.[6] In Mexico, the Commission meets only four times per year (though the subcommittees work with continuity). The Productivity Commission of New Zealand is somewhere in the middle, with approximately 20 staff members and enough budget to perform its own research and interact with stakeholders during the conduct inquiries. Also the age of these institutions is very different: the Australian Productivity Commission was created in 1998 (and followed related institutions that have existed since the 1920s), while the other institutions were created very recently, and the Chilean Commission was appointed only in 2015.
- Two productivity commissions (Denmark and Norway) were set up as temporary ad hoc task forces, with limited in-house research capacity and strong (but not necessarily complete) multi-stakeholder representation.[7] Both institutions took the form of high-level multi-stakeholder *fora* that met regularly for a limited period of time (two

3 Infomation on the National Productivity Boards is provided in a summary prepared by the European Parliament at: www.europarl.europa.eu/RegData/etudes/ATAG/2016/574423/IPOL_ATA%282016%29574423_EN.pdf

4 See the OECD's work on centre of government institutions.

5 The Australian Productivity Commission has 163 staff members selected from the best available researchers on the marketplace, and an overall budget that allows for dealing with five large inquiries at the same time (although it currently does more than that).

6 The Chilean national productivity commission relies on a high-level multi-stakeholder board composed of eight members, supported by a secretariat of no more than seven researchers, and a budget that should suffice for two in depth inquiries per year (but is reportedly barely sufficient for one); the Mexican Productivity Commission is a permanent multi-stakeholder advisory platform supported by three full-time members of the economic productivity unit at the Ministry of Finance, although these members have the possibility of leveraging competence existing in their ministry and other institutions.

7 For example, the Norwegian Productivity Commission could not manage to engage workers' unions, who were very reluctant and opposed to the process.

years), without producing fresh research or new data, and ended up producing a report with a set of recommendations on how to re-launch and reform the national economy in light of existing challenges (oil price fluctuations for Norway, productivity slowdown for Denmark).

Three institutions are not explicitly framed as productivity commissions, and established as councils that primarily advise the head of government. These are France Stratégie, the US Council of Economic Advisers, and the European Political Strategy Centre (EPSC). These institutions have different sizes, and functions, and are by no means homogenous: for example, France Stratégie is involved in policy evaluation, whereas neither the CEA nor the EPSC play this role.

One institution, the Irish Competitiveness Council, was created with a specific mandate on preserving the international competitiveness of Ireland, and as such mostly looks at the possible reforms that would make the country more attractive for international investors.

Table 1 summarizes of the key features of the ten selected institutions. The degree of diversity is remarkable. However, these institutions all strive to place productivity at the centre of the debate, with different resources, strategies, tools and instruments. A review of what has proven to work and what might have been done differently could prove useful for all those countries wishing to set up similar institutions in the future.

A Fast-Changing Landscape

It is useful to locate these institutions within the broader set of pro-productivity institutions identified by Banks (2015), who identifies eleven types of pro-productivity institutions: privately funded think tanks, publicly funded think tanks, trade tribunals, competition authorities, audit bodies, regulatory gatekeepers, departmental bureaus, central bank research units, advisory councils, ad hoc task forces, and standing inquiry bodies.

Within that broad range of institutions, our choice fell on a narrow subset of examples (see Table 2): while the Australian and New Zealand Productivity Commissions and the Irish Competitiveness Council were set up as stand-alone inquiry bodies, the Mexican and Chilean institutions, together with the US Council of Economic Advisers, the EPSC and *France Stratégie*, can more properly be classified as advisory councils (in the case of Mexico, heavily supported by a departmental bureau); and the Danish and Norwegian Productivity Commissions can be classified as *ad hoc* task forces.[8] Our research broadly confirms the initial assessment contained in the institutional scorecard developed by Banks (2015), with some differences especially for what concerns advisory councils and ad hoc task forces. As will be explained in more detail below, a number of countries have recently appointed similar institutions, without endowing them with the necessary skills and research capacity.

One significant finding of our research is the growing importance and perceived usefulness of pro-productivity institutions, and more specifically productivity commissions and advisory councils.[9] The challenges faced by many governments and the horizontal, systemic nature of many of the reforms needed to boost productivity are leading countries to create independent

8 The Danish Productivity Commission focused systematically on issues of productivity, stressing that higher productivity growth is a basic driver of the long run growth in real incomes. The Norwegian Productivity Commission was more eclectic, acknowledging that some policy measures such as measures to bring low-skilled workers into may reduce labour productivity but may nevertheless improve economic efficiency and welfare.

9 Parallel work at the OECD is currently examining aspects of other types of regulatory institutions (OECD, 2016b; OECD, 2017).

Table 1: A Comparison of the Ten Selected Pro-Productivity Institutions

Institution	Type of institution	Date created	Staff	Mission	Location
Australian Productivity Commission	Standing Inquiry body	1998	163 + 12 commissioners	Promoting productivity-enhancing reforms	Independent, reports to Executive and Parliament
Chilean Productivity Commission	Standing Inquiry body	2015	7 + board of 8	Increase productivity to improve long term well-being	Independent, Reports to the Prime Minister
Danish Productivity Commission	Ad Hoc task force	2012	9 members 14 secretariat	Issue recommendations on how to improve productivity in the private and public sector	Independent, Reports to the Prime Minister
European Political Strategy Centre	Government Advisory Council	2014	40 (of which 21 admin staff)	Advice related to the Commission's ten priorities	Centre of Government, Reports to the President
France Stratégie	Government Advisory Council	2013	103 (of which 45 admin staff)	Evaluate, anticipate, debate, propose	Centre of Government, Reports to the President
Mexican Productivity Commission	Government Advisory Council	2013	21 members 3 secretariat	Propose reforms and public policies that improve productivity	Government body, chaired by the Head of Government
New Zealand Productivity Commission	Standing Inquiry body	2010	15 researchers 5 admin	Improved well-being, improved productivity	Independent, reports to Parliament
Norwegian Productivity Commission	Ad Hoc task force	2014	10 members + 5 secretariat	Enhancing productivity and improving resource utilisation	Independent, Reports to the Prime Minister
US Council of Economic Advisers	Government Advisory Council	1946	26 research 7 admin	Economic advice on the formulation of both domestic and international economic policy.	Centre of Government, Reports to the President
Irish Competitiveness Council	Government Advisory Council	1997	12 members 5 secretariat 9 advisors	National competitiveness, sustainable growth and quality of life	Independent, Reports to the Prime Minister

bodies to undertake long-term strategic policy design by incorporating inputs and evidence from various sectors of the economy, and from a variety of sources including civil society, business and academia. This "one-stop-shop" effect, which leads to a more co-ordinated and structured reflection on the future of the country's economy, is then coupled with the need to communicate effectively the institution's findings. The latter, as will be explained below, poses different challenges depending on whether the body in question is a standing inquiry body, fully independent of government, or a functionally autonomous body located within the centre of government.

Another important finding of our research that is worth highlighted at this stage is that pro-productivity institutions appear to be increasingly inter-dependent and complementary to their country's legal system. For example, especially where regulatory reform has made inroads, the surveyed bodies are extensively co-

operating with regulatory gatekeepers (in Mexico, the United States, and to a lesser extent Australia and New Zealand); in other cases, temporary task forces co-exist with other existing publicly funded think tanks or advisory councils (e.g. Denmark). And in most of the selected countries, central banks and (especially in the United States and Australia) competition authorities produce influential research, which provides support to public policy in the form of evidence and influential recommendations. The role of privately funded think tanks is most apparent in Australia, France, the European Union and the United States.[10]

Furthermore, these institutions increasingly co-operate with each other. The Australian Productivity Commission regularly co-operates with the New Zealand Productivity Commission, up to the level of producing joint reports, and has provided assistance and strategic advice also to the Mexican and Chilean productivity commissions.[11] The US Council of Economic Advisers and *France Stratégie* cooperate in the production and analysis of productivity data.[12] The Norwegian Productivity Commission capitalized on the format and experience of the Danish productivity commission, for instance by including among its members the former chair of the Danish Commission.

But overall, there is no dedicated standing network of productivity institutions such as, for example, the International Competition Network for competition authorities, or more regional networks such as the European Competition Network, or the Nordic Cooperation Agreement between the Danish, Iceland and Norway Competition Authorities. However, the recently established OECD Global Forum on Productivity includes all of these institutions as members of its Steering Group.

A Closer Look at the Selected Bodies

In this section we provide a more detailed analysis of a number of features of the ten selected bodies.[13]

Relationship with government

In terms of the relationship with government, there are two key decisions involved in the establishment of a pro-productivity body:

- *Whether the body should be single or multi-stakeholder*: whether to involve various representatives of civil society in a key decision-making function (e.g. on the board).

In our sample, the Danish, Norwegian and Chilean Productivity Commissions, the Mexican Productivity Commission and the Irish National Competitiveness Council are multi-stakeholder;[14] whereas the others are not. Multi-stakeholder institutions are sometimes public-private, sometimes organized to represent all relevant stakeholders. Typically single-stakeholder bodies tend to be more research-oriented.

- *Whether the body should be located inside government, or independent of government.* In our

10 See for instance, www2.jiia.or.jp/pdf/osirase/2015_Global_Go_To_Think_Tank_Index_Top_USandNonUS__.pdf.

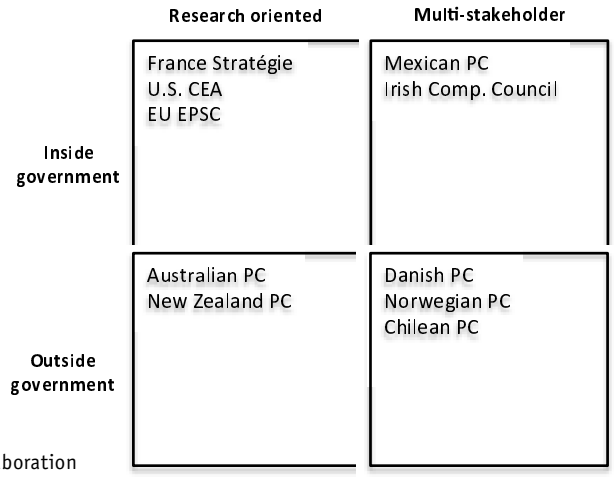
11 For additional information on the joint activities of the Australian and New Zealand Productivity Commissions. see: www.pc.gov.au/inquiries/completed/australia-new-zealand.

12 An example of this productivity data is available at www.strategie.gouv.fr/publications/solving-productivity-conundrum

13 More details on each body and each aspect covered in the currenct section are available in Renda and Dougherty (2016), which also illustrates their diversity.

14 In Chile, the members of the board are named based on their "technical" and "cross-cutting" competences. The Danish Productivity Commission was an independent expert committee, but made considerable efforts to maintain a fruitful dialogue with relevant stakeholders, although some of its recommendations generated some predictable resistance from interest groups that benefit from current anticompetitive regulations. The Norwegian body is considered as multi-stakeholder even though one important stakeholder, unions, were eventually not directly involved.

Table 2: Location and Composition of Selected Bodies



Source: Authors's elaboration

sample, as already mentioned, only the Australian, the Chilean and New Zealand Productivity Commissions are clearly independent.[15]

This, of course, does not mean that all other institutions are governmental, *i.e.* dependent on and accountable to government. However, government provides the facilities and secretariat for these organizations. There are tradeoffs related to different levels of independence. A clear advantage is that a fully independent body can depart from the short-term "tactical" needs of government, and concentrate on broader, transformative, long-term issues that are often impossible for government bodies to fully factor into the analysis, while also being less exposed to pressure from vested interests. On the other hand, those bodies that are located inside government, and especially at the centre of government, can perform a variety of very useful functions, such as contributing to policy process, validating the quality of economic analysis, contributing to evidence-based policy-making "from the inside".

Based on these two basic questions, Table 2 below shows where the bodies surveyed in this article are positioned.

Overall Mandate and Mission

Another key issue in the observation of existing pro-productivity institutions is related to their mandate and mission. The ten selected bodies have one aspect in common: they consider their mandate to be chiefly related to "long-term thinking", of the kind that governments are increasingly unable to engage in, due to resource constraints, as well as pressing short-term policy challenges.[16] By their very nature, pro-productivity institutions have to devote a significant amount of their time and resources to identifying structural reforms that would improve standards of living in the country, although the extent to which such activity takes

15 The case of Chile is hybrid as the members of the secretariat of the Productivity Commission are under the same contract as civil servants.

16 However, while all institutions consider themselves as focused on long-term issues, opinions diverge as regards the relevance of short-term work. For example, the first months of the Chilean Productivity Commission were characterized by attention to shorter-term issues, as the institution itself was also striving to establish its legitimacy and reputation in the face of government and the public opinion. And all institutions that are called upon to contribute to the evaluation of existing policies, whether ex ante or ex post, can be said to work also on short-term issues alongside longer-term subjects.

Table 3: Mandate and Focus on Long Term

	Short and long term	More long term
Narrow mandate	Mexican PC Chilean PC	Irish Comp. Council Danish PC
Broad Mandate	Australian PC New Zealand PC U.S. CEA	France Stratégie Norwegian PC EU EPSC

Source: Author's elaboration

place varies significantly across selected bodies. In addition, the scope of institutions' mandates varied considerably, with some being set up with a more narrow topical focus, while others are much broader in scope and potential policy reach.

Table 3 shows how the pro-productivity bodies surveyed in this article are placed based on the two aspects mentioned in this section

Legitimacy and Process

A very important dimension in the analysis of pro-productivity institutions is their degree of legitimacy to various stakeholders. This concept is usefully broken down into three complementary concepts: input, output and throughput legitimacy, which refer broadly to participation, performance and process, respectively (Schmidt, 2013). Input legitimacy refers to the degree of participation of stakeholders in the activities of the institution; output legitimacy is determined by the quality of the outputs produced by the institution, as well as by the extent to which they meet the consensus of stakeholders; throughput legitimacy looks at the use of stakeholder consultation and the efficacy, accountability and transparency of governance processes. All three forms of legitimacy are relevant for the purposes of this article, and are discussed below with reference to the ten selected cases.

Regarding input legitimacy, different countries have adopted different arrangements:

- *Some of the selected institutions are multi-stakeholder "by design"*, since they feature decision-making bodies that include relevant stakeholders from the business sector and/or organized labour groups (Mexico, Norway, Ireland, to a lesser extent Denmark and Chile).
- *Other institutions involve stakeholders extensively during performance of their activities* (Australia, New Zealand).
- *Other institutions occasionally involve stakeholders in the early phases of their work* (the United States, the European Union, France).

For output legitimacy, some institutions publish a wide variety of regular and occasional reports (e.g. in Australia, New Zealand, United States, the European Union, France); whereas others have focused their activity on a limited number of regular deliverables (e.g. in Ireland); and yet another group mostly produces recommendations that are addressed primarily at government policy-makers, or those of joint

interest with the private sector (e.g. Mexico, Chile, Norway, Denmark).[17]

In addition, the productivity commissions of Australia and New Zealand and the bodies surveyed in the United States, France, Ireland and the European Union feature varying degrees of capacity to produce new research, whereas the commissions established in Mexico, Norway and Denmark mostly compile existing information, without producing new knowledge through in-house research. In Chile budget constraints so far made it very difficult for the productivity commission to embark upon its own research initiatives, and on a few occasions research work was outsourced to the private sector.

Moreover, while institutions like the Australian Productivity Commission and the US Council of Economic Advisers have existed for several decades and have consolidated their reputation and prestige, virtually placing them at the same level of highly independent and authoritative institutions such as central banks, other institutions are either chiefly dependent on the personality of their chairperson (e.g. France), or are still striving to achieve a significant degree of reputation. In the case of Chile, a focus on short-term pressing issues has become almost inevitable in order to signal the salience and importance of the commission's work.

Most institutions apply techniques aimed at increasing the impact of their publications on public opinion and ensuring that employees have strong incentives to produce work of the highest quality. These include drafting blog posts and op-eds to summarize the results of research undertaken and/or explain policy recommendations (e.g. the United States, Chile, the European Union, France, Australia); and relying on third party academics to evaluate or referee the quality of specific deliverables (e.g. New Zealand). But even more powerful, in this respect, is the performance of extensive public consultation on draft reports, a practice that is typical of the Productivity Commissions of Australia and New Zealand when carrying out their sectoral inquiries.

All in all, output quality seems to be one of the most valuable and fragile assets for a pro-productivity institution. Even one of the most established of the surveyed institutions, the Australian Productivity Commission, seems to be particularly aware of being "one bad report away" from losing its reputation. This, in turn, determines the need to secure sufficient budget, such that the institution can hire top-level researchers, and research can take place in-house, with all due peer review arrangements.

Finally, the level of throughput legitimacy of the pro-productivity institutions is heavily dependent on sound internal governance arrangements (due process), as well as the extent to which these institutions contribute to an open, transparent and accountable policy process. Against this background, a number of potential challenges have emerged from the interviews.

- On the one hand, *when the pro-productivity institution is independent of government the terms of reference have to be clearly stated*, so that responsibilities can be easily allocated between the institution and the receiving end. In some countries (e.g. Ireland, Denmark, Norway) terms of reference (TORs) have been drafted for the institution as a whole, and were made available to the public. In Australia, Chile and New Zealand TORs are specified for each inquiry. Especially in Australia and New Zealand, the

17 The Danish Productivity Commission came up with more than 100 policy recommendations many of which have found their way (sometimes in modified form) into subsequent legislation both during the previous and the current government. Overall, the commission's policy recommendations have had a significant impact and there is considerable awareness of the Danish productivity problem in policy circles.

TOR-based process is extremely transparent and inclusive, which certainly contributes to high levels of throughput legitimacy.

- On the other hand, *institutions located at the centre of government often work on the basis of a specific mandate established by an administrative act*. This is the case for the US Council of Economic Advisers (law), *France Stratégie* (decree) and the EPSC (decision). These institutions perform a number of activities, only a subset of which can be subject to a transparent, inclusive process. However, all keep track of their activities (e.g. the EPSC reports all the meetings held by its Chair with stakeholders) and reach out to a wider audience to show the content and direction of their work through notes, publications and blog posts.

But throughput legitimacy goes beyond the existence and clarity of the mandate, and encompasses also the efficacy of decision-making, and the quality of the process. These two dimensions are more difficult to capture for institutions like the ones under scrutiny in this article, compared to what occurs for institutions that are more directly involved in policy-making. However, the quality of internal governance and organization can also exert a significant impact on advisory bodies. For example, the existence of a board that is larger in number than the underlying staff was reported as potentially hampering the efficacy of the decision-making process in the Chilean National Productivity Commission.[18] A similar problem emerged in Mexico due to the very limited number of government staff working to support the activity of the productivity commission. Currently there are only three dedicated staff, whereas a reasonable number would be two or three times that number of full-time, relatively senior staff to fully support the functioning of the Commission. Budget and resource constraints also surfaced in the case of more established institutions such as the Australian Productivity Commission.[19]

Resources and skills: coping with scarcity

Many of the surveyed institutions appear to be coping with resource limitations, both in terms of funding and human talent. At the same time, several interesting practices have emerged, which help these bodies achieve results by leveraging the potential of external experts as well as government staff. The following stand out as particularly interesting and/or innovative:

- *France Stratégie* was given the mandate to co-ordinate as many as eight other existing institutions.[20] In this manner, *France Stratégie* can tap into the existing knowledge of several well-established, high quality institutions without necessarily having to hire personnel with competence in such a wide array of fields. *France Stratégie's* co-ordination function is being strengthened in light of the European Council's 2016 recommendation that all Eurozone countries create or designate Productivity Boards.
- In New Zealand, a Productivity Hub was created as a partnership of agencies, which aims to improve how policy can contribute

18 In the case of the US Council of Economic Advisers, one possible issue was the very short duration of member positions: however, such short duration reportedly helps attracting top-level scholars, who cannot leave their academic positions for more than two years.

19 Although its budget would reportedly be compatible with running as many as five inquiries at the same time, the Commission currently has nine on the table.

20 The Council for Economic Analysis; the Advisory Council on the Future of the Pension System; the Advisory Council on Employment Policy; the High Family Council; the High Council for the Future of Health Insurance; the High Council for the Financing of Social Protection; the National Industry Council; and the CEPII, a research centre in international economics.

to the productivity performance of the New Zealand economy and the well-being of New Zealanders. The Hub Board is made up of representatives from the Productivity Commission, the Ministry of Business, Innovation and Employment, Statistics New Zealand and the Treasury. Several other agencies and non-government groups are active in the partnership.

- The Mexican Productivity Commission can rely on a very small secretariat rooted in the Ministry of Finance. However, the secretariat can leverage expertise from the whole government administration. To this end, the creation of five sub-committees in charge of high priority issues has proven essential for a smooth and effective working of the institution.[21]

Independently of the resources available to them, many of the surveyed institutions face problems due to the lack of sufficient capacity or skills in those parts of administrations that receive policy recommendations and would be in charge of implementing them. Well-established productivity commissions consider the lack of capacity in their interlocutors among the key constraints they face to an expansion of their activities.

Are pro-productivity institutions plugged into the policy process?

Banks (2015) notes that pro-productivity institutions can be expected to be more effective when they are 'plugged in' to policy-making processes bearing on productive performance, or at least to be in a position to directly influence decision-making in those areas. Our analysis broadly confirms this idea, and shows that there are many ways in which an institution like the ones considered here can become plugged into the policy process at the national level. Where a culture of evidence-based policy-making is more developed, pro-productivity institutions can engage more effectively with the executive, and be involved in the regulatory governance cycle. In this respect, legal systems like Australia, Mexico, the United States, and the EU (European Commission) have a clear advantage over others, which have experimented less with better regulation tools (OECD, 2015c, 2016a). That said, the following experiences stand out as particularly relevant:

- The US Council of Economic Advisers regularly co-operates with the regulation oversight body (Office of Information and Regulatory Affairs) in the *ex ante* economic analysis of the impacts of new federal regulations, in particular when the quality of economic analysis is at stake; and it had a role also in overseeing the first steps of the retrospective regulatory reviews mandated in 2012.[22]
- *France Stratégie* is in charge of evaluating public policies for the French government. In order to fulfil this mandate, it performs *ad hoc* policy evaluation and acts also through dedicated initiatives and bodies.
- The Chilean Productivity Commission achieved a major milestone recently when President Bachelet officially endorsed the first of its 21 recommendations, which entails that all new major legislative proposals be subject to a specific productivity impact assessment.

21 All subcommittees feature a multi-stakeholder composition, with strong participation from the government side. They meet independently of the plenary sessions of the Commission, which meets normally four times per year. See www.gob.mx/cms/uploads/attachment/file/6672/Acta_sesion1_CNP.pdf.

22 The *Economic Report of the President* for 2016 observes that while macroeconomic issues continue to be an important part of the CEA's portfolio, in recent decades the CEA has devoted an increasing amount of attention to microeconomic issues that arise in the context of legislation, regulatory processes, and other administrative actions.

- The Mexican Productivity Commission cooperates extensively with the regulatory oversight body COFEMER, which participates in the sessions and works with the subcommittees in the identification of areas for the reduction of administrative burdens and regulatory costs; and carries out both *ex ante* and *ex post* evaluations of existing regulation.

Being involved in *ex post* evaluation is more difficult for those institutions which largely play an advisory role, rather than being nested in the centre of government. For example, the Danish Productivity Commission came up with more than 100 policy recommendations, many of which have found their way (sometimes in modified form) into subsequent legislation both during the previous and the current government. The Norwegian Productivity Commission issued 180 recommendations, some of which have been implemented. Both commissions did not have much time to assess the impact of their recommendations, given the broadness and complexity of their mandates. On the other hand, their main role was identifying important problems and helping to pave the way for (some) controversial reforms by influencing public opinion and the political debate. Many of the policy recommendations reportedly needed further technical analysis before they could be put into practice, but this is probably best done in the relevant ministries and government bodies and/or in other expert committees with a more narrow and specific focus.

However, there are ways to follow up on policy recommendations and put pressure on administrations to actually implement them. For example, in Ireland, the Jobs Action Plan forced administrations to report on the implementation of recommendations issued by the Competitiveness Council in its Competitiveness Challenge report on a regular basis. And the New Zealand Productivity Commission is considering commissioning external work on the actual implementation and impact of the recommendations issued.

Communication and outreach: the quest for keeping productivity under the spotlight

As already mentioned in the introduction to this article, developing an effective narrative for pro-productivity reforms is often difficult due to the distributional impacts that these reforms often create, requiring at times that powerful incumbents be subject to enhanced competition, or that entirely new business models enter the marketplace. Productivity has been termed by one of our interviewees as facing both an "awareness problem" and an "image problem". On the one hand, it is hard to communicate why productivity should be a key concern for economic policy in the long run; on the other hand, it is common to hear opinions that associate productivity-oriented reforms with of job losses and reduced safeguards for employees or other social groups. As an example, it reportedly turned out impossible to involve workers' unions in the activities of the Norwegian Productivity Commission.

Many of the interviewed institutions still face important challenges in building a convincing narrative for productivity, and keeping the issue under the spotlight in public debate. Of course, the government and politicians will continue to play a key role in communicating such narratives to the public.

Overall, it is possible to distinguish between institutions that have diversified their activities to adopt a very broad notion of productivity, most often overlapping with long-term well-being; and institutions that strive to keep productivity at the core of the activity of government. Emerging lessons include the following.

- *Focusing on long-term well-being*, rather than productivity *stricto sensu*, is important to elicit trust and signal the relevance of the institution's work. Institutions in Australia,

New Zealand, France, and the European Commission all follow this strategy, both due to their broader official mandate and also to enhance their legitimacy.

- *A balanced combination of long and short-term actions is also important, where possible, to keep the institution's mission under the spotlight*. In some cases, a focus on short-term actions has proven inevitable to very young institutions wishing to signal their relevance (e.g. Chile); in other cases, a relatively narrow focus has been combined with the need for actionable short term recommendations (e.g. Ireland); and in yet another set of circumstances the institution has been used at times also as a "crisis unit" (e.g, the US Council of Economic Advisers during the financial crisis at the end of the last decade).[23]
- *Communicating the expected impacts of proposed reforms* is essential for stakeholders to understand the relevance and salience of recommendations issued by the institution. This is leading several institutions to enter the evaluation space and also to become more visible in the media, which are often thirsty for figures to show.
- *Periodic reporting on productivity, and/or the creation of one or more landmark reports can help keeping proposed reforms under the spotlight*. This is more easily achieved when the mandate of the institution at hand is relatively narrow. For example, the Irish Competitiveness Council is becoming increasingly influential in Irish politics due to the quality and impact of its yearly reports on the Competitiveness Scorecard and on the Cost of Doing Business in Ireland.
- *A strong political commitment to follow up on the recommendations issued by the institution is essential*. The example of the Jobs Action Plan in Ireland is an important one, where the government has demonstrated the commitment to follow up on the recommendations of the competitiveness council by mandating that administrations report on their achievements on a regular basis.

In addition to these pre-conditions, the institutions interviewed are adopting a number of strategies to keep their mission on the radar of policy-makers and public opinion. This includes putting a strong emphasis on frequent public communication and engagement. In most cases this also involves the publication of blog posts; the development of user-friendly recommendations with attractive graphics; and the delivery of regular public speeches and interviews. Their mere existence in some cases exerts an impact on the private sector. For example, in Chile the creation of the productivity commission has reportedly led both the industry association and the workers' union to start considering the creation of parallel bodies. More generally, to the extent that the creation of pro-productivity institutions contributes to the diffusion of a culture of evidence-based policy-making, this can also lead academics, stakeholder groups, and think tanks to become gradually more involved in the public debate.

Emerging Lessons

This section discusses some of the emerging lessons from the interviews that were conducted for the purposes of this research. A number of these echo the more general findings of Banks (2015).

23 Under the leadership of CEA Chairs Edward Lazear, Christina Romer, and Austan Goolsbee, the CEA played a role in designing countercyclical measures that were passed in response to the 2008-09 global financial crisis and its aftermath. The Council conducted the overall macroeconomic analysis that helped identify the need for, and design of, countercyclical fiscal measures, most notably the American Recovery and Reinvestment Act of 2009. See www.whitehouse.gov/sites/default/files/docs/ERP_2016_Chapter_7.pdf.

Lesson 1: Context matters: there is no one-size-fits-all solution when it comes to pro-productivity institutions

The selected jurisdictions have adopted very different solutions in terms of overall functions, design, governance, process, and degree of transparency and stakeholder engagement for pro-productivity institutions. The impression gathered through the interviews is that context matters, and that different legal systems might find specific arrangements more appropriate than others. This, in turn, means that those institutions that can be considered as "success stories" since they managed to remain in place for several decades and are well embedded in their countries' institutional architecture, such as the Australian Productivity Commission, or the US Council of Economic Advisers, may not be easy to transplant from one legal system to another.[24]

Perhaps the clearest example in this respect is the assistance provided by the Australian Productivity Commission to governments wishing to set up similar bodies in countries like New Zealand, Mexico, Chile and Argentina (not covered in this article). It appeared clear from the outset that for various reasons none of these countries could exactly replicate the Australian model, which can be traced back to almost a century-long experience involving similar statutory bodies and can rely on a consolidated tradition of transparent, accountable, evidence-based policy process. The new productivity commissions ended up being often less financially endowed and in some cases less transparent and independent than the Australian one, but still contributed to a marked improvement in their country's policy debate.

Other countries have decided to set up pro-productivity institutions as a response to a specific shock or an emerging policy problem, as was the case for the oil crisis in Norway, evidence of a slowdown in productivity growth in Denmark, or the need to preserve cost competitiveness in Ireland. These emergency-led strategies have led to a narrower scope for the initiatives, be that in terms of duration of the mandate (Norway, Denmark) or in terms of the institution's activities (Ireland).

As a result, there is a strong need to adapt institutional and governance arrangements for pro-productivity institutions to national legal and political culture, as also flagged by the persons interviewed. This can be an iterative process, as once institutions gain more legitimacy, they may be able to pursue a more ambitious approach. To be sure, a key decision to be made is whether the pro-productivity institution to be created should be temporary or permanent in nature. Our findings suggest that there are advantages and disadvantages of both approaches. A temporary institution should however be given a narrower mandate, and possibly a narrower focus, otherwise it may end up developing too superficial policy recommendations, without reaching a sufficient level of detail.

24 Defining success is not easy for many of the institutions analysed in this article, especially since a few of them have been established very recently, and it would be premature to draw conclusions on their effectiveness in achieving their statutory mission. However, some of them have been in place for longer, and were already subject to a number of external evaluations. This is the case of the Australian Productivity Commission, as reported by Banks (2015: 19), who finds that past quantitative estimates of the gains from reforms, in particular in industry assistance and economic policy areas, "suggest big returns on the 'investment' by government in the Commission and its staff". In the case of the Council of Economic Advisers, the literature pointed at ups and downs in the influence exerted by the Council on economic policy-making in the White House (McCaleb, 1986). Recently a White House report pronounced the CEA, on the occasion of its 70th anniversary, "a durable and effective advocate for the public interest" (White House, 2016).

Lesson 2: Pro-productivity institutions are no panacea: they should be part of an effort to embrace good governance and evidence-based policy-making

In addition to institutional design and governance aspects, our work supports the view that the effectiveness of a pro-productivity institution can significantly depend on the extent to which good governance and better regulation principles are embedded in the legal system. Pro-productivity institutions can issue as many policy recommendations as they wish, but the uptake of such recommendations in the administration will largely depend on the administration's capacity to absorb and implement them, on the political commitment towards following up on these recommendations, and on the extent to which government relies on evidence to design its regulatory reform proposals.

Against this background, the issue of pro-productivity institutions and reforms cannot, and should not, be kept separate from that of regulatory governance and reform. In some cases lack of commitment can result in badly designed institutions, with insufficient resources to meaningfully contribute to public debate. A well-designed productivity institution surrounded by government administrations that lack transparency and accountability arrangements, effective public management practices, and skills is doomed to remain a preacher in the desert, and represent a waste of money to taxpayers.[25]

Lesson 3: Political commitment is essential

An essential element that emerged from the interviews is that without a strong political commitment, pro-productivity institutions are unlikely to flourish or become prominent in the overall political landscape. There are various ways in which the role and work of a pro-productivity institution can be given importance and impact at the government level. They include:

- Providing a strong legal basis and both *de jure* and *de facto* independence to the institution;[26]
- Chairing a multi-stakeholder body at the highest political level (Mexico);[27]
- Appointing highly reputed academics to head standing inquiry bodies or advisory councils at the centre of government (United States, Chile, Ireland, Denmark);
- Mandating research on specific pressing policy issues, to be analysed by the institution in a transparent and in-depth manner (Australia, New Zealand);
- Committing to explicitly discuss or even to formally adopt and implement the institution's recommendations (Mexico, Ireland);[28]

25 In this context it is thus useful to compare the results of our survey with those of the OECD Regulatory Policy Outlook. www.oecd.org/publications/oecd-regulatory-policy-outlook-2015-9789264238770-en.htm.

26 For example, the Australian Productivity Commission was created as an independent authority by an Act of Parliament in 1998, whereas the New Zealand Productivity Commission was set up as an independent crown entity. In Chile, the legal basis of the Productivity Commission is now being strengthened, in an attempt to consolidate the standing and legitimacy of the institution.

27 The fact that the President of Mexico participates in one of the sessions of the productivity commission reportedly motivated all stakeholders to engage in active and fruitful involvement and participation; at the same time, such a presence is limited to one meeting to avoid that the discussion becomes too formal, and that the debate within the commission becomes less open.

28 Recommendations are being made binding for government administrations in Mexico. Some countries mandate that governments report on their adoption of recommendations on a regular basis (e.g. in Ireland, limited to the Jobs Action Plan); or that government responds to the recommendations with a communication or a motivated statement (often, in Australia and New Zealand).

- Involving the institution in the design and/or in the evaluation of policies (United States, France, Chile);
- Providing the institution with capacity to start its own research projects, in addition to responding to government requests (Australia, New Zealand).

Lesson 4: Independence is important, although its extent can vary depending on the circumstances

Most of the surveyed institutions consider their independence to be a key asset, which contributes extensively to the legitimacy of their output. At the same time, some of the institutions at hand report to their governments, rather than to parliaments or other non-governmental institutions. This can make them potentially less independent in formulating policy recommendations. However, the experience of market regulators suggests that how this reporting works in practice is critical, and other factors such as tenure, funding and transparency are at least as critical in affecting independence (Banks, 2012; OECD, 2016b; OECD, 2017). The common features that appear to be essential for a fruitful role of a pro-productivity institution are the need to avoid governmental control on the content and scope of the recommendations; aswell as the possibility to act autonomously, not just react to specific mandates issued by government.

Against this background, independence and autonomy are always destined to remain relative, rather than absolute. For example, while a number of the productivity commissions modelled on the Australian example consider themselves to be fully independent, this situation has to be qualified since in many circumstances their ability to undertake their own initiatives and research is constrained by their limited budgets, In additiion, workload commissioned by government can crowd out the possibility for independent research.

The lack of full independence is of course more likely when institutions are purely internal to the administration, even if functional autonomy is explicitly granted. It is, however, important that clear provisions are in place to secure that the fields of research and the ultimate recommendations produced by such institutions are not entirely pre-determined by the centre of government, which normally acts as the main recipient of such recommendations, and is in charge of translating them into concrete policy steps.

At the same time, institutions should remain "plugged in" to the policy-making process, in order to enhance the liklihood that recommendations will be adopted. And they should feature, whenever possible, champions from the government administration, which can increase the ownership of the reforms and guarantee continuity in the activities of the institutions they contribute to.[29] One possibility to be considered in this respect is either the sharing or the secondment of personnel from government to the independent pro-productivity institutions, which may contribute to enhancing over time the capacity of government to implement the reforms proposed by the pro-productivity institution. The impact of these practices may be greater if seconded personnel have solid technical expertise, and go back to positions of influence in the administration at the end of the secondment period, thereby increasing government's ability to understand and implement the proposed reforms.

From a slightly different angle, it is interesting to observe that the "TOR system" is more

29 This is the case, for instance, of Mexico and Chile, which however seem to rely on too small a staff of very skilled civil servants that back the activity of advisory-type bodies.

appropriate for truly independent bodies, than for "internal" advisory bodies. But even for independent bodies, TORs should not be the only way for a pro-productivity institution to produce research and policy recommendations. Within the TOR system, it is essential to ensure that stakeholders have a say on the main premises and results, in order to avoid governments exerting undue control over the results of commissioned research. More generally, quality, transparency and political commitment are all factors that result from, and also reinforce, the independence of a pro-productivity institution, and as such should be adequately considered when designing such an institution for a given legal system.

All in all, some of our interviews have cast important doubts on the ability of non-independent (or not fully independent) bodies to propose *disruptive* changes and/or *courageous* reforms. Such lack of independence undermines the role that pro-productivity institutions can play as "long term public policy design workshops," that develop systemic reforms needed to boost productivity. Accordingly, sufficient independence, particularly in developing ideas and forming policy recommendations, seems to stand out as a core requirement for the effectiveness, legitimacy and overall impact of pro-productivity institutions.

Lesson 5: Budget and human resources must be sufficient for high-quality research and quality control

The need for autonomy and independence is also reflected in the need for sufficient budget and resources to organize the institution's research work, as well as to adequately engage with stakeholders, e.g. through extensive public consultation. One aspect relates to whether budgets are determined annually, or on a multi-year basis, which can help to shield the institutions from undue influence (OECD, 2014). While certain institutions only focus on the compilation of relevant research with no ambition to produce new data and information (e.g. in Denmark and Norway,), most institutions have the ambition to be active in the production of new findings, whether through inquiries or desk/empirical research. However, the budget and human resources they are endowed with are not always compatible with this ambition.

As a consequence, if the role of a pro-productivity institution is to be taken seriously sufficient resources need to be made available to attract an adequate number of high- quality researchers, as well as to allow for peer review, public consultation, and quality control of research methodologies and results.[30]

In terms of specific expertise, while the role of economists is widely acknowledged, that of other experts, for example in, innovation, education and public administration, is often underestimated. In Denmark and Norway, several outside observers offered the criticism that productivity commissions were dominated by economists, and one of our interviewees suggested that the commissions could probably have benefited from a greater participation from political scientists with special insight into public administration, given that a large part of their agendas focused on productivity problems in the public sector.

The availability of resources is even more important when coupled with a mandate that, in addition to specific "on demand" research,

30 For example, the Norwegian Commission was well supported by competent staff from the relevant economic ministries and also drew on analytical work by Norwegian academic experts and consultants. The Danish commission had a relatively small secretariat (considering its very broad mandate) and could have benefited from having more resources, although its members tried to draw as much as possible on outside expertise and relevant academic research.

allows for the institutions own research initiatives. When this is explicitly foreseen (e.g. Australia, Chile, New Zealand), most often the budget is insufficient to leave space for spontaneous initiatives, and this is potentially weakening the pro-productivity potential of these institutions' work.

Lesson 6: Institutions should engage with stakeholders

Openness and transparency are increasingly important for pro-productivity institutions. Some institutions consult stakeholders throughout the course of their activities; others are multi-stakeholder by design, and yet other institutions meet constantly with stakeholders or reach out to the public opinion even if their core activity would be advising the government. Institutions that engaged with the private sector and labour early in the consultation process report their involvement being highly constructive, although these experiences are somewhat limited.

While the scope and design of the institution determines the best way in which it can interact with stakeholders, the need for such interaction has emerged from our analysis as an essential pillar of setting up an effective pro-productivity body. These forms of engagement might involve the use of an open government approach and open access instruments, or wiki platforms for interaction with external stakeholders. To date, however, few of the institutions have broadly embraced these new instruments.

Possible arrangements that can strengthen the level of interaction with stakeholders, include the adoption of minimum consultation standards (especially in TOR-based standing inquiry bodies); commitment or obligation to respond to submissions with a motivated statement of acceptance or rejection; the organization of workshops or online *fora* related to individual policy issues; the use of blogs with comment sections to stimulate interaction, and many more.

Lesson 7: It is important to combine short- and long-term thinking in the institution to preserve legitimacy and salience

Our analysis has highlighted that all pro-productivity institutions consider long-term thinking to be their core business. These institutions focus on structural reforms because other organizations have little time to do so. Short-termism in government is often caused by the need to preserve political consensus, the constraints exerted by the electoral cycle, and shrinking budgets (Thompson, 2010). Having an institution think about issues that require reform in the country's public policies is increasingly essential.

However, it would be naïve to imagine that an institution can at the same time be plugged into the policy process, provide influential policy recommendations to government, and stay away entirely from short-term issues. In addition, relatively new institutions often find short-term issues to be a useful opportunity to enhance their reputation and legitimacy for the wider public. In addition, reports that focus on short-term as well as long-term initiatives have proven to be very useful. Bodies can also play a useful role by "framing" short-term issues from a long-term perspective, capturing economy-wide ramifications and incorporating future social, economic and technological transitions in their analysis.

Accordingly, there seems to be reason to believe that a combination of short- and long-term research and advocacy is to be preferred to a less balanced approach, as it can increase the effectiveness and legitimacy of pro-productivity institutions, and in addition makes them more easily plugged into the policy-making process.

Lesson 8: Pro-productivity institutions should be "plugged into" the policy process

Pro-productivity institutions can represent a great complement to regulatory oversight bodies in ensuring that the economic analysis behind legislation and regulation is sound, and that the "long-term" is adequately accounted for when designing or evaluating new policy interventions. This occurs especially in the United States, but also to various degrees in Mexico and Chile. Elsewhere, the link between these institutions and oversight bodies in charge of the regulatory governance cycle is weaker.

Depending on the institutional location of the pro-productivity institution, the arrangements that might promote a further involvement in the policy process can vary. The ones that seem more effective and important include the following:

- **Coupling policy recommendations with a preliminary impact analysis, which incorporates an assessment of the distributional impacts of proposed reforms.** This could help government bodies in charge of *ex ante* regulatory impact analysis in conducting their evaluation; it would also help the data produced "speak for themselves", including for media outreach and policy advocacy purposes; and it would also incentivize pro-productivity institutions to formulate "actionable", evidence-based recommendations.
- **Carrying out early stakeholder consultation on proposed reforms.** This can lead to the collection of data and stakeholder positions in a way that facilitates government in the subsequent phases of the policy cycle.
- **Assisting regulatory oversight bodies in validating the quality of economic analysis of proposed new regulation.** Especially when pro-productivity institutions can rely on highly skilled economists, this role could prove very important for government.
- **Assisting government departments and ministries in the retrospective review of existing rules, or clusters of rules.** Pro-productivity institutions are well positioned to help governments run an in-depth evaluation of entire policy areas, individual pieces of legislation/regulation, or the performance of specific industry sectors.
- **Evaluating the functioning of the whole regulatory system**. Independent bodies that possess a consolidated reputation are well positioned to perform such an evaluation.

Concluding Remarks and Policy Implications

This article contains the results of a comparative analysis of ten pro-productivity institutions, and draws a number of lessons that could prove useful for the institutions themselves, and for governments and legislatures that are currently considering whether to create new pro-productivity institutions. The ten selected institutions can be classified as advisory councils, standing inquiry bodies or ad hoc task forces, and do not exhaust the possible choices available to a given country when it comes to stimulating and promoting the debate on pro-productivity reforms. Moreover, the peculiarity of legal systems and the importance of context in determining the optimal design, mandate, mission and governance of pro-productivity institutions limit the possible extension of individual findings to all other institutional settings.

That said, this article broadly confirms earlier work for the OECD (Banks, 2015) regarding the usefulness of setting up pro-productivity institutions, and the importance of conceiving of an overall institutional setting that leaves space for long-term thinking and strategic policy design. And while, with the exception of Australia, it is

difficult to correlate the existence of pro-productivity institutions with stronger economic performance, it is acknowledged that governance indicators and institutional capacity indicators (e.g. government effectiveness) are more correlated with growth and economic performance than most other indicators, including regulatory indicators (Han et al., 2014; Furceri and Mourougane, 2010).[31]

OECD countries face the challenge of slower productivity growth. The reforms needed to restore inclusive growth and sustainable development call on governments to adopt a long-term perspective, overcome vested interest and incumbency stances and cross-sectoral boundaries by crafting new policies that favour and promote systemic change and socio-economic transformations. One way to face this challenge is to ensure that the overall governance and institutional setting is conducive to such reforms.

The creation of pro-productivity institutions is a meaningful way to pursue this goal. When well designed, pro-productivity institutions can make a very important contribution to the economic policy debate. While not a panacea, they can orchestrate and promote a multi-stakeholder, evidence-based dialogue on the causes of the productivity slowdown in their countries, as well as on possible solutions. Resource and time-constrained governments are not as well positioned as independent, highly skilled, multi-stakeholder institutions in playing this role. However, it takes smart and effective governments to engage with independent pro-productivity institutions, to fully understand their recommendations and translate them into concrete reform initiatives.

Our analysis adds to existing knowledge in several respects. We find that, despite existing constraints, well-designed productivity commissions can generally improve the overall quality of the political debate over economic, social and environmental reforms, and contribute to evidence-based policy-making. Our results also support the view that centralizing knowledge and research on productivity in one independent and highly skilled body can help create the momentum and the knowledge required to promote long-term productivity growth. And importantly, we find evidence that while institutions located outside government have more leeway in promoting reforms that challenge vested interests and produce results over a time span that goes beyond the electoral cycle, the existence of smart government bodies can engage to a much larger extent in experimental policy-making and pave the way for a more adaptive policy process, based on evidence.

In all this, it is of utmost importance that these bodies be given sufficient resources, skills, transparency and procedural accountability to fulfil their tasks; a sufficiently broad mission, which looks at long-term well-being and at both supply-side and demand-side; policy evaluation functions, be they related to the bodies' own proposed reforms, or to existing or proposed government policies; and the ability to reach out to the general public in a variety of ways, from consultation to advocacy, use of social media, and other forms of communication.

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The Centre for the Study of Living Standards

THE CENTRE FOR THE STUDY OF LIVING STANDARDS (CSLS) is a national, independent, not-for-profit research organization which began operations in August 1995. Its objectives are twofold. First, to contribute to a better understanding of trends and determinants of productivity, living standards, and economic well-being in Canada through research. Second, to contribute to public debate by developing and advocating specific policies to improve the standard of living of Canadians.

The activities of the CSLS are motivated by the following general principles:

1) in the long run, productivity growth is the key to improved living standards;
2) in the short to medium term, elimination of any output gap is the most effective way to raise living standards;
3) the equitable sharing of productivity gains among all groups in society is an essential element of the economic growth process;
4) increased cooperation among the various groups which make up our society can contribute significantly to better living standards; and
5) reliable data are crucial to the monitoring and analysis of living standards and to the development of effective policies to increase living standards.

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	Chris Ragan	Craig Riddell
	Frances Woolley	