Recent Trends in Europe's Output and Productivity Growth Performance at the Sector Level, 2002-2015

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ABSTRACT

Using the latest release of sector-level growth and productivity data up to 2015 from the EU KLEMS database, evidence is mounting that the global financial crisis (2008/09) and the Euro Area recession (2011/12) have significantly damaged the growth potential of European economies across the board. None of the countries in the 12 EU member states included in the analysis have recovered to growth rates anywhere near to what they were in the decade before the crisis. Slow productivity growth which was already visible in most market services sectors before the crisis has broadened to the goods-producing sector for most European economies since the crisis. The manufacturing sector was particularly hard hit, and has only partially recovered. The dynamics of the global and Euro Area crises and their impact seem still to be in full swing, making it too early to judge whether output and productivity growth rates can still recover to the pre-crises rate or whether growth in Europe will end up as a slower long-term trend.

Despite recent modest improvements in growth, the global economic and financial crisis in 2008-09 and the ensuing recession in 2011 and 2012 in Europe have raised concerns about the region's ability and potential to restore its long-term growth to pre-crisis rates. In the decade before the global financial crisis, between 1999 and 2006 real GDP growth grew at a 2.3 per cent average annual for the Euro Area and 2.6 per cent for the EU-28. It slowed to 0.6 per cent and 0.9 per cent respectively between 2007 and 2016. For both periods, Europe's average growth performance was below that of the United States which recorded an average GDP growth of 3.4 per cent in the 1999-2006 period and 1.5 per cent in the 2007-2016 period (The Conference Board, 2017a).

Earlier research has documented that productivity growth, which is an important metric of the long-term growth potential of an economy, has been an important cause of the growth slowdown in Europe since the mid-1990s (van Ark *et al.*, 2008, 2013a, Timmer *et al.*, 2010, Mas and Stehrer, 2012). For example, in the United States total economy GDP per hour increased 2.9 per cent per year, on average, from 1999 to 2006 compared to 1.5 per cent in the Euro Area and 1.9 per cent in the EU-28. In 2007-2016, the average annual growth rate of output per hour worked slowed to 0.6 per cent for the Euro Area and 0.7 per cent for the EU-28, even though a modest improvement in labour productivity growth has been recorded for 2015 and 2016. Strikingly, the slowdown in productivity growth for the United States has been even larger as it dropped to 1.2 per cent in 2007-2016 without any recovery in the most recent years (The Conference Board, 2017a).

Recent analysis has shown that the global financial crisis and the Euro Area recession have exacerbated the growth slowdown since 2008-09 because of slowing demand, weak investment and structural rigidities in product, labour and capital markets (van Ark, 2016a; van Ark and O'Mahony, 2016). In addition, while creating major business opportunities, the complex characteristics of the New Digital Economy, characterized by the combined shifts to mobile technology, cloud computing and storage and ubiquitous access to broadband, have created major business challenges in how to leverage these new technologies to drive productivity growth (van Ark, 2016b, van Ark *et al.*, 2016).

What has been less known so far is how the post-crises productivity dynamics in Europe have played out at the sector level. In this article we employ the latest update of the EU KLEMS Growth and Productivity Accounts with updated estimates to 2015 which has been published recently on www.euklems.net.[2] The new data provide a unique opportunity to analyze eight years of productivity growth for the aggregate (total) economy and two major sectors in the economy (manufacturing and market services) since the beginning of the Global Financial Crisis for 12 European economies. Taken together those 12 economies (Austria, Belgium, Czech Republic, Denmark, Germany, Finland, France, Italy, the Netherlands, Spain, Sweden and the United Kingdom) will be called the EU-12. They accounted for 90 per cent of the European Union's nominal GDP in 2015.

Since the new estimates, which are based on the new European System of Accounts (ESA 2010), do not go back to the mid-1990s for some countries, we can only currently provide an integrated look at labour productivity growth for the period 2002-2015. In our analysis we divide this period into three sub-periods: the pre-crisis period (2002-2007), the global financial crisis itself and the immediate recovery (2008-2010), and the post-crisis period (2011-2015).[3] It should be emphasized that most EU countries and the Eurozone as a whole experienced another recession (the Eurocrisis) in 2011/2012, which is included in the most recent period.

In addition to estimates of output and labour productivity growth (Table 1), we decompose output growth into the contributions of growth in hours worked, labour composition, ICT-capital, non-ICT capital, and total factor productivity for the aggregate (or total) economy, manufacturing, and market services (which

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2　For an earlier review of EU KLEMS with data up to 2011/12, see Bart van Ark, Vivian Chen, and Kirsten Jäger (2013a).

3　Average annual compound growth rates use as a base for the calculation the year before the start of the period. Hence 2001 serves as the base for the 2002-2015 period, 2007 as the base for the 2008-2010 period, and 2010 as the base for the 2011-2015 period.

excludes the entire health care, education and government sectors of the economy) (Tables 2-4).[4]

Based on our analysis, it is fair to say that with sector data covering the first eight years since the beginning of the global financial crisis, the impact of the crisis on growth is still visible. It is therefore too early to make a final judgment on whether output and productivity growth in Europe can recover to the pre-crises growth rates or whether Europe is ending up with a slower trend as predicted by many in recent years. However, so far the services sector and especially the manufacturing sector have not returned to pre-crisis or historical growth rates for output and productivity in most EU countries. Furthermore, projections for the aggregate economy for the next ten years from The Conference Board Global Economic Outlook suggest a partial return to that pre-crisis trend at best (The Conference Board, 2016).

The remainder of this article is organized as follows. In section 2 we briefly discuss the history of the EU KLEMS database and the characteristics of the latest update. In section 3 we highlight some of the important growth differences between two sectors (manufacturing and market services) in the EU-12 as well as between countries, looking separately at the larger economies (France, Germany, Italy, Spain and the United Kingdom) and the smaller ones (Austria, Belgium, Czech Republic, Denmark, Finland, the Netherlands and Sweden). Finally, in section 4 we conclude and discuss how growth and productivity in Europe might evolve over the next decade.

The EU KLEMS Project in the Post-Financial Crisis Period

The EU KLEMS project goes back to the late 1990s when the first initiatives were undertaken to develop productivity measures at the industry level for the European Union, following the seminal works by Jorgenson, Gollop and Fraumeni (1987) for the United States, Jorgenson, Kuroda and Nishimizu (1987) for Japan, and Conrad and Jorgenson (1985) for Germany. "KLEMS" refers to the decomposition of output growth into contributing factor inputs — capital (K) and labour (L) — and intermediate inputs — energy (E), materials (M), and service inputs (S).

The study of European growth accounts received a significant boost from the work by a Europe-wide consortium between 2004 and 2008 which culminated in several key publications on Europe's productivity performance (van Ark et al., 2008; Timmer et al., 2010; and Mas and Stehrer, 2012).[5] The original EU KLEMS database, which was published in 2008 and which is still available from www.euklems.net, covers long-term series of output, input (including intermediates) and productivity measures at the industry level, based on official national accounts as well as secondary data going beyond official data. The original data series ran up to 2005 and included 72 industries.

Since 2008 several updates of the EU KLEMS accounts were published on www.euklems.net for a smaller number of European economies, for value added and capital and labour inputs only, and for a smaller number of industries: 34 down from the original 72 industries. The latest update was done in 2012/2013 by the University

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4 Manufacturing and market services together make up an average of 58 per cent of aggregate (or total) economy nominal GDP for the 12 countries between 2010 and 2015 in the dataset, and exclude the primary sector (agriculture and mining), utilities, construction, and the public sector. The health care and the education sectors are entirely excluded from market services, as most organizations in those sectors are government-owned or largely funded by the government. Market services is therefore not precisely equivalent to services which are part of business sector in the United States and Canadian accounts, which would include all privately owned businesses. For more detailed estimates for all 34 industries, see www.euklems.net.

5 See Timmer et al. (2011) for an easily accessible summary version of Timmer et al. (2010).

of Groningen, with updates mostly to 2009 (and in a few cases to 2010, 2011 or 2012) for 12 countries, including the United States (Van Ark *et al.*, 2013a).

The new estimates for 12 European countries, presented in this article and also available from www.euklems.net, have been developed with a research grant from the European Commission to bring the accounts up to 2014/2015, to transfer the estimates to the new European System of Accounts (ESA 2010), which is part of the broader 2008 revision of the System of National Accounts under the auspices of the United Nations, and to make the accounts as consistent as possible with the official national accounts estimates for European countries.[6] European national statistical institutes (NSIs) now all produce industry-level data based on the NACE 2 industry classification, which is consistent with the international standardized ISIC Revision 4 industry classification. The NACE 2 data used in this release are based on Eurostat insofar available.[7]

An important change between ESA 2010 and the previous national accounts system dating back to 1995 concerns the boundaries of physical assets in the national accounts. The inclusion of more assets in the definition of Gross Fixed Capital Formation (GFCF) required a significant revision to the structure of the non-financial assets classification in EU KLEMS. In previous EU KLEMS versions, ICT capital was classified in three categories, namely computing equipment (IT), communication equipment (CT) and software. The asset composition in the 2016 EU KLEMS version of the accounts is as follows:

- Computer hardware which is defined as computing equipment (IT) and telecommunications equipment (CT) together comprise ICT equipment. The series are comparable to what has been available under ESA 95.

- Computer software now includes databases and is therefore not entirely comparable to what was measured as software in the previous EU KLEMS datasets.

- Computer software and databases are now a subcomponent of intellectual property products (IPP), which also includes research and development and other intellectual property products (OIPP) consisting of mineral exploration and artistic originals (formerly known as other assets). OIPP is not readily available from Eurostat and has therefore been calculated by deducting computer software and databases and research and development from intellectual property products.

- Investment in cultivated assets (including livestock for breeding, dairy and draught, and vineyards, orchards and other plantations of trees) accounts for only a minor share in total GFCF as they are almost exclusively found in agriculture, forestry and fishing. Cultivated assets were part of 'other assets' in previous EU KLEMS releases and are treated as a separate asset type in the 2016 release to retain as much detail as possible.

The main methodological difference between the current release and previous EU KLEMS releases concerns the measurement of capital stocks and capital services. Prior to the 2016 release, capital stocks were calculated by applying the standard Perpetual Inventory Method (PIM) with consistent assumptions over time and across countries about the pattern of depreciation, the length of asset lives and the deflators for each of the assets. This so-called analytical

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6   For a more detailed methodological analysis of the latest release, see Jäger (2016).

7   In addition to those 12 EU countries, additional partial productivity and input data up to 2015 for other EU member states, and the United States are also available from www.euklems.net.

module of the EU KLEMS database represented a deviation from the official estimates of capital stocks.

The new EU KLEMS release deviates from this previous practice as it uses capital stocks by industry and asset type which are directly obtained from Eurostat to ensure that official data are being used to the maximum extent. In addition, the computation of capital services, which are critical for the estimation of the capital contribution to growth, is not part of ESA (2010). For the calculation of capital services we therefore continue to rely on previous EU KLEMS practices of using geometric depreciation rates and internal rates of return. This approach creates an internal inconsistency as the depreciation rates used for the capital stock calculations by the national statistical offices may be different from the depreciation rates we use in the capital services calculations.[8] We therefore recommend using the growth accounting data from the current release primarily for period averages, rather than year to year changes, and at more aggregate sector levels – as we do in this article – rather than for individual industries. The output and labour productivity estimates are not affected by this measurement issue.

The national accounts data from ESA 2010 which are used for the current EU KLEMS release span a shorter time period than the previous estimates which were available under ESA 1995. Earlier releases of the EU KLEMS databases provide time series back to 1970 and growth accounting decomposition with estimations of total factor productivity (TFP) growth generally starting in 1980. Back-casts of the time series of output and labour data back to 1970 were made for the 2017 release through linkages to former EU KLEMS files to the extent possible.

Finally, unfortunately most EU countries are no longer providing detailed estimates of intermediate inputs broken down into value and prices for energy, material and services inputs by industry. To obtain such data one would need to estimate the inputs on the basis of input-output techniques. In order to preserve consistency with the published national accounts, we have therefore refrained here from producing estimates for energy, manufacturing, and services intermediates by industry.

Growth Performance Across European Economies

Table 1 provides an aggregate analysis of growth rates of output (measured as real GDP and real value added by industry) and labour productivity (measured as real value added per hour worked) for the total economy, manufacturing and the market services sector. Using a growth accounting framework, Tables 2-4 decompose the growth of aggregate value added into the contributions of labour quantity and quality, capital quantity and quality, and TFP for the total economy, manufacturing, and market services for the pre-crisis period (2002-2007), the global financial crisis itself and the immediate recovery (2008-2010), and the post-crisis period (2011-2015). It should be emphasized that most EU countries and the Eurozone as a whole experienced another recession in 2011/2012, which is included in the last period.[9]

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8   To check the importance of this problem, we tried using the implicit depreciation rates from official data. While the implicit depreciation rates are generally close to the standard EU KLEMS depreciation rates, they can fluctuate substantially from one year or industry to another and sometimes even turn negative. Hence we decided to continue to rely on the standard EU KLEMS depreciation rates for all countries to calculate capital services (Jäger, 2016).

9   For more detailed estimates for all 34 industries, the reader is referred to the EU KLEMS website (www.euklems.net).

Table 1: Value Added and Labour Productivity in 12 EU Member States, 2002-2007, 2008-2010, and 2011-2015 (Average annual per cent change)

		EU-12	Austria	Belgium	Czech Republic	Denmark	Finland	France	Germany	Italy	Nether-lands	Spain	Sweden	United Kingdom
Total Economy														
Gross Value Added	2002-2007	2.0	2.5	2.2	4.6	1.4	3.0	1.8	1.5	1.0	1.9	3.4	3.2	2.7
	2008-2010	-0.6	-0.3	0.5	0.1	-0.9	-1.8	-0.2	-0.4	-1.7	0.0	-0.7	-0.1	-1.0
	2011-2015	1.0	1.1	1.0	1.6	1.1	-0.3	1.0	1.5	-0.6	0.9	-0.2	1.4	1.9
Labour Productivity (value added per hour)	2002-2007	1.1	1.7	1.5	3.8	1.0	2.2	1.2	1.5	-0.2	1.7	0.0	2.7	1.5
	2008-2010	0.2	0.1	0.4	-0.1	0.3	-0.9	0.4	0.1	-0.1	0.3	1.6	-0.3	-0.3
	2011-2015	0.7	0.8	0.4	1.6	1.1	0.2	0.8	0.9	0.5	0.8	1.2	0.7	0.1
Manufacturing														
Gross Value Added	2002-2007	2.2	3.6	2.2	8.9	0.2	5.8	1.8	2.7	1.3	2.2	1.7	5.5	0.3
	2008-2010	-2.9	-2.4	-2.3	1.9	-3.2	-7.2	-2.3	-2.2	-4.8	-2.8	-4.6	-1.4	-2.7
	2011-2015	1.3	2.5	2.1	2.8	3.4	-3.0	1.2	2.5	-0.5	0.8	0.6	-0.8	0.5
Labour Productivity (value added per hour)	2002-2007	3.7	3.9	4.1	8.6	3.1	6.8	3.8	3.9	1.3	4.3	2.5	7.2	4.5
	2008-2010	0.7	0.3	1.9	4.8	3.8	-1.7	1.4	-0.4	0.7	-0.7	0.9	2.0	1.6
	2011-2015	1.4	2.1	3.2	1.5	3.6	-1.2	2.0	1.2	1.4	1.5	3.4	0.8	0.1
Market Services														
Gross Value Added	2002-2007	2.6	3.0	3.0	5.0	3.2	3.0	2.4	1.6	1.3	2.5	3.9	4.1	4.0
	2008-2010	-0.8	0.6	0.7	-0.8	-1.1	-0.5	0.1	-1.4	-1.1	-0.4	-0.5	1.0	-1.6
	2011-2015	1.6	0.9	1.1	1.2	1.8	0.9	1.4	1.8	-0.6	1.4	0.6	2.9	3.0
Labour Productivity (value added per hour)	2002-2007	1.4	2.0	2.3	3.9	2.3	1.3	1.4	0.6	-0.2	1.8	-0.1	3.7	3.2
	2008-2010	-0.5	1.0	0.2	-2.0	0.0	-0.6	-0.3	-1.2	-0.5	0.4	-0.3	-0.3	-0.3
	2011-2015	0.9	0.4	0.5	1.0	1.3	0.7	0.7	1.3	0.0	1.0	1.1	2.2	0.8

Notes: EU-12 refers to the value added weighted average of the 12 countries. Data from the 2011-2015 period end in 2014 for Italy, Czech Republic, and Sweden. All rates of change are expressed in log terms so that the growth rates are fully additive. The base year for the 2002-2007 period is 2001, for the 2008-2010 period it is 2007, and for the 2011-2015 period it is 2010.

Data source: EU KLEMS 2017 release, available at www.euklems.net.

Average EU-12 performance

Focusing on the EU-12 as a whole first, it can be observed that there has been a large drop in economy-wide output growth from 2.0 per cent per year on average in 2002-2007 to -0.6 per cent in 2008-2010, followed by recovery to 1.0 per cent in 2011-2015 which is well below the pre-crisis average. Labour productivity growth has shown more moderate swings from 1.1 per cent per year from 2002 to 2007 to 0.2 per cent from 2008 to 2010 back to 0.7 per cent from 2011 to 2015. This implies that labour hoarding, while employed in some countries during the crisis (such as in Germany) has been limited. Total hours worked declined 0.8 per cent on average per year from 2008-2010, and recovered at only 0.3 per cent per year from 2011-2015. Hence the output recovery since 2011 has been largely driven by a recovery in hours worked.

Following two back-to-back recessions, one might have expected a pro-cyclical productivity recovery to mostly benefit the manufacturing sector as companies wait before increasing their inputs (such as labour and investment) until they see whether the output recovery is sustained. While manufacturing productivity growth for the EU-12 recovered to 1.4 per cent on average in 2011-2015, following the collapse to only 0.7 per cent during the crisis (2008-2010), it is still just over one-third of the pre-crisis growth of 3.7 per cent (2002-2007).

In contrast to manufacturing, one normally expects the services sector to first boost employment in response to rising demand, as service productivity growth is usually harder to achieve in the short-term. Although the contribution of employment, in this study measured as total hours worked, to output growth in market ser-

Table 2: Contributions to Value Added Growth in the Total Economy in 12 EU Member States, 2002-2007,2008-2010, and 2011-2015 (percentage points per year)

TOTAL ECONOMY	EU-12	Austria	Belgium	Czech Republic	Denmark	Finland	France	Germany	Italy	Nether-lands	Spain	Sweden	United Kingdom
2002-2007													
GROSS VALUE ADDED GROWTH	**2.0**	**2.5**	**2.2**	**4.6**	**1.4**	**3.0**	**1.8**	**1.5**	**1.0**	**1.9**	**3.4**	**3.2**	**2.7**
Contribution of													
Labour input growth	0.6	0.5	0.6	0.7	0.5	0.7	0.5	-0.1	0.8	0.6	1.9	1.5	0.7
Total hours worked	0.4	0.3	0.4	0.3	0.2	0.6	0.4	-0.1	0.6	0.3	1.9	0.2	0.4
Labour composition	0.2	0.2	0.1	0.4	0.2	0.1	0.1	0.0	0.3	0.3	0.1	1.3	0.3
Capital input growth	1.0	0.9	1.0	1.7	0.7	0.6	1.0	0.7	1.0	0.4	1.8	1.3	0.9
ICT capital	0.2	0.1	0.3	0.2	0.2	0.2	0.2	0.3	0.1	0.2	0.4	0.3	0.2
Non-ICT capital	0.7	0.8	0.7	1.5	0.5	0.4	0.8	0.4	0.9	0.2	1.4	1.0	0.6
Total factor productivity growth	0.5	1.0	0.7	2.2	0.2	1.8	0.3	0.8	-0.8	1.0	-0.4	0.4	1.1
2008-2010													
GROSS VALUE ADDED GROWTH	**-0.6**	**-0.3**	**0.5**	**0.1**	**-0.9**	**-1.8**	**-0.2**	**-0.4**	**-1.7**	**0.0**	**-0.7**	**-0.1**	**-1.0**
Contribution of													
Labour input growth	-0.2	-0.2	0.3	0.3	-0.3	-0.4	0.2	0.1	-0.8	0.1	-0.9	0.5	-0.2
Total hours worked	-0.5	-0.3	0.1	0.0	-1.1	-0.5	-0.2	-0.2	-0.9	-0.1	-1.4	0.1	-0.6
Labour composition	0.3	0.1	0.3	0.3	0.8	0.2	0.4	0.4	0.1	0.2	0.4	0.4	0.4
Capital input growth	0.5	0.5	0.6	2.0	1.1	0.4	0.5	0.6	0.4	0.3	1.1	1.3	-0.1
ICT capital	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.3	0.0	0.2	0.2	0.3	0.1
Non-ICT capital	0.4	0.4	0.4	1.9	1.0	0.3	0.4	0.4	0.4	0.2	0.9	1.1	-0.1
Total factor productivity growth	-1.0	-0.6	-0.5	-2.3	-1.8	-1.8	-0.9	-1.1	-1.2	-0.4	-0.9	-2.0	-0.7
2011-2015													
GROSS VALUE ADDED GROWTH	**1.0**	**1.1**	**1.0**	**1.6**	**1.1**	**-0.3**	**1.0**	**1.5**	**-0.6**	**0.9**	**-0.2**	**1.4**	**1.9**
Contribution of													
Labour input growth	0.4	0.2	0.6	0.2	0.4	0.1	0.6	0.5	-0.5	0.2	-0.3	0.5	1.4
Total hours worked	0.2	0.2	0.4	0.0	0.1	-0.1	0.1	0.4	-0.6	0.0	-0.8	0.5	1.0
Labour composition	0.3	0.0	0.2	0.2	0.3	0.2	0.5	0.1	0.1	0.2	0.4	0.0	0.4
Capital input growth	0.4	0.6	0.3	2.3	0.3	0.1	0.4	0.4	-0.1	0.2	0.3	0.7	0.5
ICT capital	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
Non-ICT capital	0.3	0.5	0.2	2.1	0.2	0.0	0.2	0.3	-0.1	0.1	0.2	0.6	0.4
Total factor productivity growth	0.2	0.3	0.1	-1.0	0.4	-0.4	0.0	0.6	0.0	0.4	-0.2	0.2	-0.1

Notes: For EU-12 composition, see Table 1. Italy, Czech Republic and Sweden exclude 2015, and the EU aggregate for 2011-2015 therefore only includes the average growth rate for those three countries from 2011-2014 instead of 2011-2015. All rates of change are expressed in log terms so that the growth rates are fully additive. The base year for the 2002-2007 period is 2001, for the 2008-2010 period it is 2007, and for the 2011-2015 period it is 2010. Data source: EU KLEMS 2017 release, available at www.euklems.net.

vices has improved since 2011, and average labour productivity growth recovered to 0.9 per cent (2011-2015), the latter remained less than two thirds of the pre-crisis (2002-2007) productivity growth rate in the sector, as well as two thirds of the manufacturing productivity growth rate from 2011-2015.

When decomposing the sources of growth (capital, labour and total factor productivity growth) for the aggregate EU 12 into the performance for the aggregate economy (Table 2), manufacturing (Table 3) and market services (Table 4), we find confirmation that the two recessions (2008/09 and 2011/12) seriously impacted the growth of total hours worked in Europe. In manufacturing, the collapse in hours worked contributed more than three quarters to the overall contraction of output in 2008-2010.

In market services, where labour hoarding has been more common, the hours worked contribution was only modestly negative during the crisis period. From 2011 to 2015 the growth in hours worked returned to a positive contribution of less than half of the aggregate output growth in market services, while it remained negative for manufacturing.

Capital input has been a positive driver of growth in all three sub-periods, but also a major source of slower growth in the post-crisis period. While the contribution of capital input to output growth shrank during the crisis, it remained modestly positive even then. However, capital input has not seen any significant improvement since 2011 reflecting the weak recovery in investment in Europe. Especially in manufacturing, the contribution of capital has been less than 10 per cent of aggregate output growth in 2011-2015, and in market services only about one third of output growth. At the aggregate level, the contribution of non-ICT capital was three times as high as the ICT contribution from 2002-2007, a ratio which has remained roughly the same since.

Finally, TFP growth remains the Achilles' heel of Europe's growth performance. Even during the pre-crisis period (2002-2007) TFP in the total economy increased by only 0.5 per cent per year on average, and during the crisis period (2008-2010) the decline in TFP growth (at -1.0 per cent) was larger than for the other sources of growth sources, labour (-0.2 per cent) and capital (0.5 per cent). While the TFP recovery during the most recent period (2011-2015) was stronger than the rebound in the contributions of labour and especially capital, the TFP growth rate for the EU-12 has only just recovered to positive territory (0.2 per cent). The weak pace in TFP growth characterizes the slow diffusion of technology and innovation largely related to the weak growth of ICT capital and other important investments in productivity-related

capital, such as the stagnancy in the updating of equipment, and slow growth in parts of intangible capital, including R&D, training and economic competencies such as brand equity and organizational improvements.

While the broad trends of productivity slowdown and recovery apply to most individual countries, there are important cross-country differences. In the remainder of this section we review those differences between two groups of countries: the five larger economies (France, Germany, Italy, Spain and the United Kingdom) and seven of the smaller more open economies (Austria, Belgium, Czech Republic, Denmark, Finland, the Netherlands and Sweden).

The large European economies

While consumption and investment account for a large part of GDP in Europe's largest economies, these economies are quite distinct in terms of their external exposure and their policy responses to the global crisis. For example, according to the World Bank, the trade-to-GDP ratios (defined as the sume of exports and imports of goods and services measured as a share of gross domestic product) among the five largest economies in the EU-12 range from 57 per cent in the United Kingdom to 86 per cent in Germany. Related to this, the specialization patterns and industrial policy frameworks have differed among European countries, ranging from deep labour market reforms to boost employment growth (Germany, Spain and the United Kingdom) to more protectionist policies to support industrial growth and retain high wage levels across the economy (France and Italy).

Manufacturing sector performance

Germany, which is Europe's largest economy, stands out among the EU-12 for its relatively strong manufacturing performance. While Germany was the growth laggard during the pre-cri-

Table 3: Contributions to Value Added Growth in Manufacturing in 12 EU Member States, 2002-2007,2008-2010, and 2011-2015 (percentage points per year)

MANUFACTURING	EU-12	Austria	Belgium	Czech Republic	Denmark	Finland	France	Germany	Italy	Nether-lands	Spain	Sweden	United Kingdom
2002-2007													
GROSS VALUE ADDED GROWTH	**2.2**	**3.6**	**2.2**	**8.9**	**0.2**	**5.8**	**1.8**	**2.7**	**1.3**	**2.2**	**1.7**	**5.5**	**0.3**
Contribution of													
Labour input growth	-0.7	0.2	-0.9	0.6	-1.5	-0.2	-0.8	-0.8	0.6	-0.7	-0.7	-0.6	-2.6
Total hours worked	-1.1	-0.2	-1.2	0.2	-1.9	-0.5	-1.2	-0.8	0.0	-1.2	-0.5	-0.8	-3.2
Labour composition	0.3	0.4	0.3	0.4	0.4	0.3	0.5	0.1	0.6	0.5	-0.1	0.2	0.6
Capital input growth	0.5	1.0	0.4	2.5	0.5	0.6	0.4	0.3	0.6	0.3	0.7	1.0	0.3
ICT capital	0.1	0.1	0.2	0.1	0.1	0.2	-0.1	0.1	0.0	0.1	0.2	0.2	0.0
Non-ICT capital	0.4	0.9	0.2	2.4	0.3	0.4	0.5	0.2	0.6	0.2	0.5	0.9	0.3
Total factor productivity growth	2.4	2.4	2.7	5.8	1.2	5.4	2.2	3.2	0.1	2.6	1.7	5.1	2.6
2008-2010													
GROSS VALUE ADDED GROWTH	**-2.9**	**-2.4**	**-2.3**	**1.9**	**-3.2**	**-7.2**	**-2.3**	**-2.2**	**-4.8**	**-2.8**	**-4.6**	**-1.4**	**-2.7**
Contribution of													
Labour input growth	-2.1	-1.5	-2.3	-1.1	-4.4	-2.6	-1.9	-0.9	-3.3	-0.6	-2.9	-1.8	-3.7
Total hours worked	-2.4	-1.5	-2.6	-1.6	-4.7	-2.9	-2.4	-1.2	-3.7	-1.2	-3.4	-1.7	-3.4
Labour composition	0.3	0.0	0.3	0.5	0.3	0.3	0.5	0.3	0.4	0.6	0.5	-0.1	-0.3
Capital input growth	0.2	0.8	-0.4	2.2	0.6	-0.2	0.1	0.4	0.2	0.1	0.2	0.7	-0.4
ICT capital	0.1	0.1	0.1	0.1	0.1	0.2	-0.1	0.1	0.0	0.1	0.2	0.2	0.0
Non-ICT capital	0.2	0.7	-0.5	2.1	0.6	-0.3	0.2	0.3	0.3	0.0	0.0	0.5	-0.5
Total factor productivity growth	-1.0	-1.7	0.5	0.8	0.6	-4.5	-0.4	-1.7	-1.7	-2.2	-1.9	-0.4	1.4
2011-2015													
GROSS VALUE ADDED GROWTH	**1.3**	**2.5**	**2.1**	**2.8**	**3.4**	**-3.0**	**1.2**	**2.5**	**-0.5**	**0.8**	**0.6**	**-0.8**	**0.5**
Contribution of													
Labour input growth	0.2	0.4	-0.3	1.0	0.2	-0.9	0.2	1.1	-0.9	-0.2	-1.3	-0.6	0.6
Total hours worked	-0.1	0.2	-0.7	0.7	-0.1	-1.1	-0.5	0.9	-1.2	-0.4	-1.7	-0.7	0.3
Labour composition	0.3	0.2	0.4	0.2	0.3	0.3	0.7	0.2	0.3	0.2	0.5	0.0	0.4
Capital input growth	0.1	1.0	-0.4	0.8	0.5	-1.2	0.2	0.3	-0.1	0.0	-0.5	0.2	-0.3
ICT capital	0.1	0.1	0.0	0.4	0.2	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1
Non-ICT capital	0.0	0.9	-0.4	0.5	0.2	-1.2	0.1	0.3	-0.1	-0.1	-0.5	0.1	-0.3
Total factor productivity growth	0.9	1.0	2.8	1.0	2.8	-0.9	0.8	1.1	0.6	1.0	2.4	-0.3	0.1

Notes: For EU-12 composition, see Table 1. Italy, Czech Republic and Sweden exclude 2015, and the EU aggregate for 2011-2015 therefore only includes the average growth rate for those three countries from 2011-2014 instead of 2011-2015. All rates of change are expressed in log terms so that the growth rates are fully additive. The base year for the 2002-2007 period is 2001, for the 2008-2010 period it is 2007, and for the 2011-2015 period it is 2010. Data source: EU KLEMS 2017 release, available at www.euklems.net.

sis period, significant labour market reforms in the early 2000s, together with a strong focus on integrating the manufacturing sector into global value chains (van Ark *et al.*, 2013b), helped the economy to recover relatively rapidly from the crisis years. In 2011-2015, GDP increased at 1.5 per cent per year compared to 1.0 per cent for the EU-12. Much of this recovery came from faster output growth in the manufacturing sector (2.5 per cent compared to 1.3 per cent for the EU-12 in 2011-2015). Strikingly, a large part of

the manufacturing growth advantage in Germany originated from a strong performance in hours worked. Germany was among only four European countries with a positive and by far the highest (0.9 per cent) contribution from total hours to manufacturing output growth (Bellman *et al.*, 2016). However, in 2011-2015 labour productivity as well as TFP growth rates in German manufacturing were still much lower than in 2002-2007, and not very different from the EU-12 average (Tables 1 and 3).

Chart 1: Share of Hours Worked in Manufacturing as % of Total Economy Hours Worked
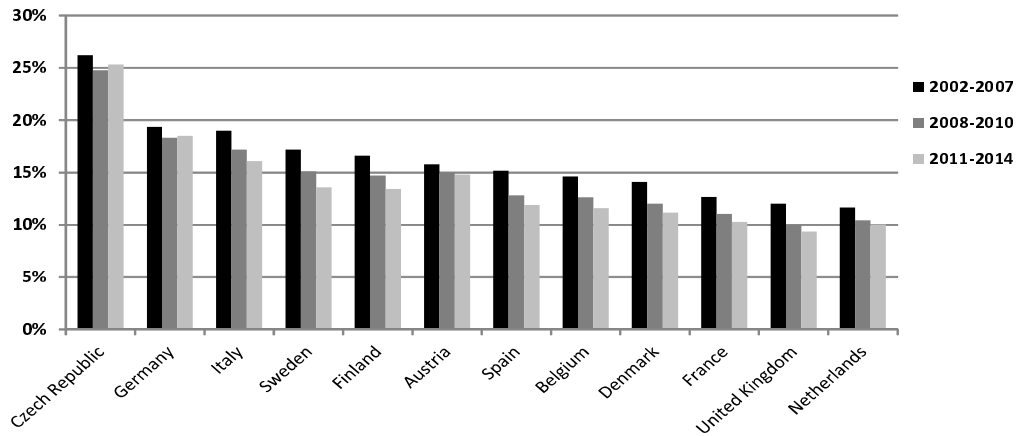
Notes: Countries are ranked on the basis of the largest share of manufacturing working in 2002-2007.
Data source: EU KLEMS 2017 release, available at www.euklems.net.

The strongest contrast to Germany's manufacturing performance can be seen in France. While manufacturing output in France increased at about two thirds of the rate in Germany from 2011-2015, labour productivity growth was much better at 2.0 per cent compared to 1.2 per cent in Germany. This is mainly because working hours growth in manufacturing in France have contracted throughout the 2002-2015 period, and France has seen one of the lowest manufacturing share in total hours worked (Chart 1). Even though French manufacturing workers make a strong output contribution from skill improvements, as seen by the above average contribution from labour composition, TFP growth in French manufacturing was only 0.8 per cent per year in 2011-2015 versus 1.1 per cent in Germany (Table 3).

In the United Kingdom the manufacturing sector had already shrunk significantly before the crisis years. Manufacturing output grew at only 0.3 per cent in 2002-2007 versus 2.2 per cent for the EU-12. In terms of the share in total hours worked, the UK has had the smallest manufacturing sector across the EU-12 since the beginning of the crisis (Chart 1). Since the crisis, UK manufacturing output growth has somewhat

recovered but it has been clearly driven towards more labour intensive manufacturing activities, as the growth in hours worked increased while the growth of capital input has remained negative since then (Table 3).

The manufacturing sectors in Italy and Spain have suffered much more from the crisis than the other three large economies as they experienced the deepest cuts in output during the crisis. An important difference between the two countries, however, is that manufacturing output and labour productivity growth recovered much more strongly in Spain than in Italy. While both Italy and Spain made deep cuts in total hours worked, the manufacturing sector in Spain restructured much faster as total factor productivity increased at 2.4 per cent per year in 2011-2015 vis-à-vis 0.6 per cent in Italy (Table 3). However, despite below-average growth, there are signs that Italy does benefit more from its manufacturing sector to support its recovery than in many other economies. Notably Italy still has the third largest manufacturing sector (after Czech Republic and Germany) among the EU-12 (Chart 1), and (together with Spain) saw a better TFP growth rate in 2011-2015 compared to 2002-2007 (Table 3).

Table 4: Contributions to Value Added Growth in Market Services in 12 EU Member States, 2002-2007,2008-2010, and 2011-2015 (percentage points per year)

MARKET SERVICES	EU-12	Austria	Belgium	Czech Republic	Denmark	Finland	France	Germany	Italy	Nether-lands	Spain	Sweden	United Kingdom
2002-2007													
GROSS VALUE ADDED GROWTH	**2.6**	**3.0**	**3.0**	**5.0**	**3.2**	**3.0**	**2.4**	**1.6**	**1.3**	**2.5**	**3.9**	**4.1**	**4.0**
Contribution of													
Labour input growth	1.0	0.9	0.8	1.1	1.2	1.3	0.9	0.4	1.1	0.8	2.8	1.1	1.2
Total hours worked	0.8	0.7	0.5	0.6	0.7	1.3	0.7	0.5	1.0	0.6	2.7	0.3	0.6
Labour composition	0.2	0.2	0.3	0.6	0.5	0.0	0.2	-0.1	0.1	0.2	0.1	0.8	0.6
Capital input growth	1.1	0.9	1.3	1.7	0.8	0.0	1.2	1.1	1.1	0.1	2.0	1.6	1.0
ICT capital	0.4	0.2	0.5	0.4	0.3	0.3	0.4	0.6	0.1	0.3	0.6	0.5	0.4
Non-ICT capital	0.7	0.6	0.8	1.3	0.4	-0.4	0.8	0.5	0.9	-0.1	1.4	1.2	0.6
Total factor productivity growth	0.5	1.2	0.9	2.1	1.3	1.7	0.3	0.1	-0.9	1.5	-0.9	1.4	1.8
2008-2010													
GROSS VALUE ADDED GROWTH	**-0.8**	**0.6**	**0.7**	**-0.8**	**-1.1**	**-0.5**	**0.1**	**-1.4**	**-1.1**	**-0.4**	**-0.5**	**1.0**	**-1.6**
Contribution of													
Labour input growth	0.1	0.3	0.7	1.0	0.2	0.0	0.8	0.3	-0.4	-0.1	0.3	1.1	-0.4
Total hours worked	-0.2	-0.2	0.3	0.6	-0.9	0.1	0.3	-0.2	-0.4	-0.5	-0.2	0.8	-0.9
Labour composition	0.4	0.5	0.3	0.4	1.1	-0.1	0.5	0.4	0.0	0.4	0.5	0.2	0.5
Capital input growth	0.5	0.3	0.6	3.0	0.8	-0.1	0.7	0.9	0.2	0.0	0.8	1.4	0.1
ICT capital	0.2	0.1	0.3	0.2	0.2	0.1	0.3	0.5	-0.1	0.2	0.2	0.4	0.1
Non-ICT capital	0.3	0.2	0.3	2.9	0.6	-0.2	0.4	0.4	0.2	-0.2	0.6	1.0	-0.1
Total factor productivity growth	-1.5	0.1	-0.6	-4.9	-2.1	-0.5	-1.4	-2.5	-0.9	-0.3	-1.5	-1.5	-1.3
2011-2015													
GROSS VALUE ADDED GROWTH	**1.6**	**0.9**	**1.1**	**1.2**	**1.8**	**0.9**	**1.4**	**1.8**	**-0.6**	**1.4**	**0.6**	**2.9**	**3.0**
Contribution of													
Labour input growth	0.7	0.5	0.7	0.2	0.8	0.4	1.1	0.4	-0.4	0.7	0.1	0.6	1.9
Total hours worked	0.5	0.4	0.4	0.1	0.5	0.2	0.5	0.3	-0.4	0.4	-0.3	0.5	1.6
Labour composition	0.3	0.1	0.3	0.2	0.3	0.3	0.7	0.1	0.0	0.3	0.4	0.1	0.3
Capital input growth	0.4	0.5	0.2	2.5	0.0	0.0	0.5	0.4	-0.2	-0.1	0.5	0.8	0.5
ICT capital	0.2	0.1	0.2	-0.1	0.2	0.1	0.3	0.2	0.0	0.2	0.2	0.2	0.2
Non-ICT capital	0.2	0.4	0.1	2.5	-0.2	-0.2	0.2	0.2	-0.2	-0.3	0.2	0.6	0.4
Total factor productivity growth	0.4	-0.1	0.1	-1.5	1.0	0.5	-0.2	1.0	0.0	0.8	0.1	1.5	0.5

Notes: For EU-12 composition, see Table 1. Italy, Czech Republic and Sweden exclude 2015, and the EU aggregate for 2011-2015 therefore only includes the average growth rate for those three countries from 2011-2014 instead of 2011-2015. All rates of change are expressed in log terms so that the growth rates are fully additive. The base year for the 2002-2007 period is 2001, for the 2008-2010 period it is 2007, and for the 2011-2015 period it is 2010.
Data source: EU KLEMS 2017 release, available at www.euklems.net.

Services sector performance

In market services, the United Kingdom has seen the best growth performance of the five large economies in the EU-12. While the financial sector was especially hurt during the crisis, output growth in market services recovered to 3.0 per cent on average in 2011-2015, well above the EU-12 average of 1.6 per cent. However, total hours worked accounted for as much as half of market services output growth from 2011-2015 (Table 4). The weakness of labour productivity growth in UK services has been widely discussed, with the most important explanation being the high absorption capacity in Britain's services sector for low-productivity jobs (Barnett *et al.* 2014; Bryson and Forth, 2016).

Market services output has recovered slightly more in Germany than in France in 2011-2015, at 1.8 per cent and 1.4 per cent respectively. However, contrary to conventional wisdom, France saw a higher contribution from labour input to market services growth, especially because of much stronger skill improvements in services sector jobs (Askenazy and Erhel, 2016). In contrast, German labour market reforms in the early 2000s may have been more favorable to

low-skill jobs. On the other hand, TFP growth in market services was much stronger in Germany than in France in 2011-2015, at 1.0 per cent and -0.2 per cent respectively (Table 4). Germany's market services sector may also have benefitted from the economy's integration into global value chains (van Ark *et al.*, 2013b)

In contrast to France, Germany and the United Kingdom, Italy and Spain have seen a much slower recovery in market services. Italy was even the only country with a negative output growth in market services in 2011-2015. The contributions of labour input to output growth were also still negative from 2011 to 2015 in Italy and just above zero in Spain compared to a positive growth contribution of 0.7 per cent for the EU-12 average. Total factor productivity growth in market services in Italy was flat from 2011 to 2015 and only 0.1 per cent in Spain (Table 4).

The small European economies

Among the seven smallest economies in the EU, a distinction can made between those economies that have relatively large manufacturing sectors (Austria, Czech Republic, Finland and Sweden) and those that have relatively large market services sectors (Belgium, Denmark and the Netherlands). These differences are determined by international specialization patterns.

Large manufacturing sectors

Among the small economies with relatively large manufacturing sectors, Finland suffered by far the hardest hit during the global recession, as it experienced a major collapse in manufacturing output and productivity. To a large extent this development reflects the demise of its communication equipment industry which flourished during 1990s and early 2000s. The share of manufacturing in total hours worked dropped strongly during the crisis after which it did not recover (Chart 1), and manufacturing output growth shrank dramatically by 7.2 per cent per year from 2008 to 2010. Finland is now significantly restructuring its manufacturing sector even though TFP growth in the sector remained negative until 2015 (Table 3).

Swedish manufacturing, which has also heavily relied on technology production, saw a much more moderate drop in manufacturing output during the crisis and was able to keep the productivity slowdown at bay. However, the recovery since 2011 has been slow, and Sweden saw one of the largest drops in its manufacturing employment share among the EU-12 economies (Chart 1).

In contrast, Austria and especially the Czech Republic retained their strength in manufacturing. The Czech manufacturing sector has by far the largest share of total hours in the EU-12 economies at more than 25 per cent while Austria has 15 per cent just behind Germany and Italy (Chart 1). While both countries saw a large drop in manufacturing labour productivity growth during the crisis, Austria saw a quick recovery when labour productivity returned to 2.1 per cent per year on average in 2011-2015. In contrast to Austria, the Czech Republic saw a much stronger recovery in total manufacturing hours worked since 2011, while labour and TFP growth dipped even below Austria's. These differences in growth dynamics largely stem from both countries' contribution to and specialization in the value chain network formed by Germany and other Central European economies (also including Poland, Hungary and Slovakia) which has functioned as a European stronghold since the crisis (van Ark *et al.*, 2013b).

Large market services sectors

Belgium, Denmark and the Netherlands have among the largest market services sectors in Europe in terms of employment share, which signals the high level of specialization in business and consultancy services in those econo-

mies. However, the three economies responded quite differently during the crisis. Whereas the market services sector in Belgium saw a significant amount of labour hoarding during the crisis, the Danish and Dutch services sector rapidly adjusted labour input to meet the challenges posed by the crisis. This led to positive contributions (Belgium) versus negative contributions (Denmark and the Netherlands) of labour input to output growth, and the opposite for labour and total factor productivity which saw higher growth rates for Denmark and the Netherlands than in Belgium (Table 4). Those divergent adjustment effects for labour and productivity contributions are typical of recovery periods. Meanwhile none of the countries has seen a recovery in market services labour productivity (0.5 per cent in Belgium, 1.3 per cent in Denmark and 1.0 per cent in the Netherlands in 2011-2015) to anywhere near their pre-crisis performance (2.3 per cent in Belgium and Denmark and 1.8 per cent in the Netherlands in 2002-2007).

Conclusions and a Forward Looking Perspective

The analysis of the latest sector-level growth and productivity data from the EU KLEMS database show that the global financial crisis (2008/09) and the Euro Area recession (2011/12) have significantly damaged the growth performance of European economies across the board. Except for Germany, none of the countries in our EU-12 group have recovered to growth rates anywhere near to what they were in the decade before the crisis. The slowing growth trend is driven by a triple combination of a modest recovery in employment growth, stagnant growth in capital input growth and a weakening in the TFP growth trend. Slow productivity growth which was already visible in most market services sectors before the crisis has broadened to the goods producing sector for most Euro-

pean economies after the crisis. The manufacturing sector was particularly hard hit by crisis, and has only partially recovered effects since the crisis.

We conclude that the global financial crisis and the Euro Area recession may have accelerated the demise of the manufacturing sector in Europe which has been losing much terrain in terms of output, investment and productivity growth. In addition, growth in total hours worked in manufacturing has hardly begun to recover by the end of the latest period in our analysis, which stops in 2015. It may of course be argued that, as the recovery has been ongoing since 2016, a further improvement in manufacturing productivity growth may have occurred since then. However, recent estimates of manufacturing labour productivity growth from the International Labour Comparisons program at The Conference Board show that growth rates for 2016 have been about the same as in 2011-2015, namely at 1.5 per cent (The Conference Board 2017b).

At the same time the services sector has increased its importance in the economy, and recovered slightly better from the crisis. Total hours worked recovered strongly in 2011-2015, and the output contribution of capital input growth in market services was in fact stronger than in manufacturing for the aggregate EU-12. Finally, TFP growth in market services, while still below that in the manufacturing sector, has recovered to the pre-crisis growth rates while this is not the case as yet for manufacturing TFP growth. However, both output and labour productivity growth rates in market services in 2011-2015 were still at about half of the 2002-2007 growth rates (Table 1).

Based on the analysis, it is fair to say that even with sector data covering the first seven years since the global financial crisis, the dynamics of the global crisis and their impact seem still to be in full swing. It is still too early to make a final

Table 5: Projections of Sources of GDP Growth in Europe, Measures as Contribution of Factor Inputs Quality and Quantity and TFP Changes to GDP Growth, 2002-2026

	2002-2007	2008-2010	2011-2016	2017-2021	2022-2026
GDP growth	**2.3**	**-0.5**	**1.1**	**1.7**	**1.2**
Quantity	*1.5*	*0.4*	*0.9*	*0.7*	*0.3*
Capital Quantity	1.1	0.8	0.6	0.5	0.5
Labor Quantity	0.4	-0.5	0.2	0.2	-0.2
Quality	*0.7*	*-0.9*	*0.2*	*1.0*	*0.9*
Capital Quality	0.4	0.3	0.2	0.2	0.1
Labor Quality	0.2	0.1	0.1	0.2	0.2
Total Factor Productivity	*0.1*	*-1.3*	*-0.1*	*0.6*	*0.5*

Notes: Europe includes European Union-28 as well as Switzerland, Iceland, and Norway.
Data source: The Conference Board Global Economic Outlook 2017, available at (https://www.con-ference-board.org/data/globaloutlook/). See also Erumban and de Vries (2016).

judgment on whether output and productivity growth can recover to the pre-crises growth rates or whether we will experience slower trend growth as predicted by many.

However, the triple weaknesses in employment, investment and productivity growth suggest that medium-term factors may still be predominant in explaining slow growth in Europe. Beyond the temporary cyclical impact from the recessions related to weak demand, the slow medium-term forces can be a sign of weakening innovation and technological change as companies hold back on new investment due to longer term concerns about demand and investment. This could point at the possibility of "secular stagnation" due to a persistent shortfall in demand and an erosion of supply-side factors as established by the long-term slowdown of potential output growth (Teulings and Baldwin, 2014).

In addition, the low interest rate policy which has been implemented by the European Central Bank might have caused increased misallocation of resources to low-productive firms. This would especially be harmful in times during which scale-dependent technologies such as communication technology require flexibility across a larger economic space. Limited scale

effects in Europe, related to fragmented markets and limited impacts from ICT utilization might have played a larger role than in the United States especially during the first decade of the century (Timmer *et al.*, 2010).

It is also possible that there is a lull in the emergence of productive technology applications. As is not uncommon with General Purpose Technologies, productivity growth during the installation phase of the New Digital Economy (which represents the combined shift to mobile technology, cloud storage and computing and ubiquitous internet access) has gone together with increased business spending on technology assets and human capital, without immediate effects on output and productivity growth. There is accumulating evidence that businesses are still in their early days of turning the opportunities offered by the New Digital Economy into significant productivity gains (van Ark, 2016b; van Ark *et al.*, 2016). The recent improvement in aggregate productivity growth — while largely cyclical — could also become a driver for a stronger technology impact on productivity.

Growth projections for the aggregate economy (Table 5), based on The Conference Board Global Economic Outlook show the challenges

ahead (The Conference Board 2016; Erumban and de Vries, 2016). A recovery in Europe to an average GDP growth rate of 1.7 per cent in 2017-2021 is heavily dependent on faster TFP growth. The latter might in part be driven by a recovery from lost terrain during the past two decades and a positive impact from new technology implementation on growth. Such a turn-around in TFP growth would be especially welcome in light of a weakening growth in labour supply as a result of an aging population in most European economies. The decline in the labour contribution to growth in the 2020s may in fact be offset by capital-intensive output growth driven by technological change. However, this will also be dependent on the ability of the European economies to shift to a larger output contribution from labour quality as measured by the average educational attainment level of the workforce, and an increased intensity of ICT relative to non-ICT capital. The latest EU KLEMS growth and productivity measures presented in this article show the need for significant action in the policy environment, as described above, to meet the challenges of future growth in Europe.

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