DOI: 10.1007/s10272-018-0724-9

Alexander Herzog-Stein and Gustav A. Horn

The Productivity Puzzle: It's the Lack of Investment, Stupid!

In recent years, advanced economies around the globe have experienced a pronounced slowdown in productivity growth. This phenomenon and especially this recent aggravation are not yet well understood, and there is no consensus on the reasons for this slowdown. Since productivity growth is the main driver of economic growth, it is essential to improve our understanding of this productivity puzzle and, if possible, to draw some lessons for crafting policies which can improve productivity growth in Europe.

This paper takes a medium-run approach to the productivity puzzle by focusing on the development of labour productivity and its components in a small sample of six advanced economies before and after the global economic and financial crisis of 2007-2009. We address two major questions about the productivity puzzle: What are the drivers of labour productivity in advanced economies? And what are the factors behind the slowdown in productivity growth observed after 2007? At this stage, our humble aim is to improve our understanding of the recent productivity puzzle, without claiming that our findings and explanations are exhaustive. We find, first, that a lack of investment is one of the two major factors behind the labour productivity slowdown since the start of the Great Recession. Our results confirm Furman's finding of an investment-driven productivity slowdown since 2007.[1] Second, not surprisingly, a decline in total factor productivity (TFP) is the second major factor behind the slowdown in labour productivity growth. At this stage, this is more difficult to understand, since it is unclear whether this slowdown in TFP growth is permanent or not.

1 Jason Furman was chairman of President Obama's Council of Economic Advisers from August 2013 to January 2017. See J. Furman: Productivity Growth in the Advanced Economies: The Past, the Present, and Lessons for the Future, Remarks given at the Peterson Institute for International Economics, 9 July 2015, pp. 5ff., available at https://obamawhitehouse.archives.gov/sites/default/files/docs/20150709_productivity_advanced_economies_piie.pdf.

Alexander Herzog-Stein, Macroeconomic Policy Institute (IMK), Dusseldorf, Germany.

Gustav A. Horn, Macroeconomic Policy Institute (IMK), Dusseldorf, Germany.

Our small sample of countries consists of five European economies – France, Germany, Italy, Spain and the United Kingdom – and the United States. With the inclusion of France, Germany, Italy and Spain in our sample, we also get a good sense of productivity developments in the eurozone, since the combined GDP of these four economies made up three-quarters of the eurozone GDP in 2016. For our analysis, we use the growth accounting module of the Conference Board Total Economy Database (TED-2). It provides information on GDP growth as well as on the various sources of growth, such as labour quantity and quality, capital services, and TFP. Unfortunately, at the time of writing, annual international comparative data on growth and labour productivity accounting from TED-2 are only available through 2016.[2] Hence, we have to restrict our comparative analysis to the nine-year period since the start of the Great Recession (2007-2016) and use the nine years prior to the financial crisis (1998-2007) as our reference period.

Productivity growth in Europe and the United States

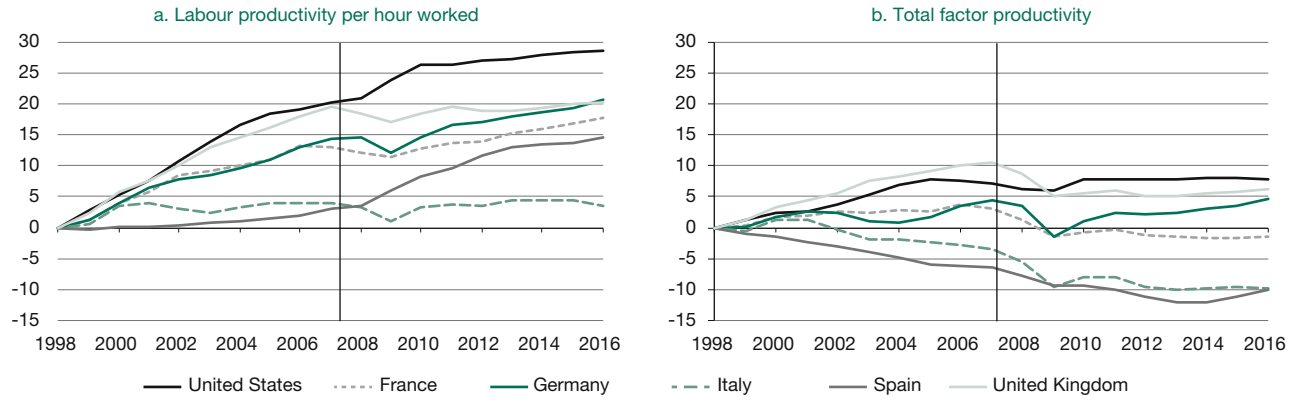
Relative to the time period 1998-2007, labour productivity growth slowed markedly in five of the six advanced economies in the period since the Great Recession (Figure 1a). The exception is Spain, where the considerable reduction in economic growth went hand in hand with a strong increase in the average rate of labour productivity growth. In the period 2007-2016, the average rate of labour productivity growth in Spain was four times larger than the rate before 2007. The productivity slowdown is particularly pronounced in the UK, where average labour productivity growth per annum is 2.1 log points lower since the start of the Great Recession (at 1.3 log points lower, the US is only marginally better).[3] In Italy, average labour productivity growth has been more or less stagnant since 2007.

The slowdown in the growth rate of TFP was even more noticeable (Figure 1b). TFP is equal to the so-called Solow

2 See K. de Vries, A.A. Erumban: Total Economy Database – A detailed guide to its sources and methods, The Conference Board, November 2017, available at https://www.conference-board.org/retrievefile.cfm?filename=TED_SMDetailed_nov2017.pdf&type=subsite.

3 Throughout this paper, growth rates are approximated by log points, i.e. the growth rate of x in per cent is $g_x \approx \Delta \ln x * 100$. Growth of one log point is equal to a growth rate of approximately one per cent. The exact relationship is $g_x = 100 * (exp(\Delta \ln x) - 1)$.

Figure 1
Productivity growth in Europe and the US, 1998-2016
in log point change (x100)



Source: The Conference Board Total Economy Database™, November 2017; authors' calculations.

residual, usually obtained from growth accounting.[4] According to Robert Gordon, TFP growth "is the best proxy available for the underlying effect of innovations and technological change on economic growth".[5] However, since TFP is a residual, it also includes measurement errors, and in a medium-run perspective it may also vary as a consequence of the business cycle. In four of the six countries, average TFP growth per annum was negative in the period since the start of the Great Recession. In the US and Germany, average TFP growth was more or less stagnant. However, Germany was the only economy where TFP growth improved again in the years after the Great Recession. Spain and Italy were already experiencing negative TFP growth in the time period before 2007.

Labour productivity growth and its components

As described in the previous section, the slowdown in labour productivity growth since the Great Recession in five of the six investigated countries went hand in hand with a further deterioration in the TFP growth rate. We now take a closer look at factors driving productivity growth with the help of a decomposition analysis of the factors contributing to labour productivity growth based on the growth accounting approach. We also examine the development of the various production factors before and after the start of the Great Recession.

Labour productivity decomposition

The concept of labour productivity refers to the quantity of output produced from the quantity used of only one factor of production, the quantity of labour. Therefore, a change in labour productivity is related to changes in the quantities used of other production factors. "Accordingly, one can decompose growth in labor productivity into three components: growth in investment per hour worked (or 'capital deepening'), the quality of labor writ large, and total factor productivity (TFP)."[6] The data in TED-2 further allow us to distinguish between changes in the intensity of ICT capital and non-ICT capital services used per hour worked in the economy, i.e. capital deepening.[7]

More specifically, the information contained in TED-2 enables the following decomposition of labour productivity growth:

$$\Delta \ln \pi_t = \Delta \ln A_t + s_t^{L} \Delta \ln LQ_t + s_t^{ICT} \Delta \ln k_t^{ICT} + s_t^{NICT} \Delta \ln k_t^{NICT}, \quad (1)$$

where $\Delta \ln \pi_t$ denotes labour productivity growth, k_t^{ICT} and k_t^{NICT} are ICT and non-ICT capital deepening, $\Delta \ln LQ_t$ denotes labour quality growth and $\Delta \ln A_t$ is TFP growth. Furthermore, s_t^{L}, s_t^{ICT} and s_t^{NICT} denote the shares of labour compensation and of ICT capital and non-ICT capital in-

4 The seminal work on growth accounting is R.M. Solow: Technical Change and the Aggregate Production Function, in: Review of Economics and Statistics, Vol. 39, No. 3, 1957, pp. 312-320.
5 R.J. Gordon: The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War, Princeton and Oxford 2016, Princeton University Press, p. 73.
6 J. Furman, op. cit., p. 6.
7 ICT capital is computer hardware, software and communication equipment. Non-ICT capital consists of transport equipment, residential and non-residential construction, intellectual property products, as well as all other non-ICT machinery categories. For more details, see K. de Vries, A.A. Erumban, op. cit., pp. 21ff. and especially Table 6.

come in nominal GDP, averaged over the current and the previous year.[8]

As Equation (1) shows, there is a one-to-one relationship between labour productivity growth and TFP growth. A slowdown in innovation or in technological progress that reduces the TFP growth rate also reduces labour productivity by the same magnitude. The slowdown of TFP growth is the main driver responsible for the reduction in labour productivity in the very long run.[9]

Figure 2 indicates that, as expected, slower TFP growth was also a major factor behind the recent slowdown in labour productivity growth since the start of the Great Recession. The only exception is Spain, where the average TFP growth rate was slightly less negative in 2007-2016 than in the prior period (-0.4 versus -0.7 log points per annum), with the largest improvement occurring after 2010 (Figure 2f). In all the other economies, slower TFP growth had a negative impact on labour productivity growth, most notably in the UK (Figure 2b). There, slower TFP growth contributed on average -1.7 log points per year to the slower rate of labour productivity growth since 2007 in relation to the period before the Great Recession. In France, the negative relative impact was -0.8 and in the US -0.7 log points per annum (Figures 2d and 2a).

Interestingly, TFP growth improved in all economies but the US after 2010. There, average TFP growth between 2010 and 2016 was even worse. Given that the US economy is the leading global economy with respect to innovations and technological progress, this development could become a major concern if TFP growth does not improve significantly in the near future. In stark contrast to the US development – and also different from the developments in France, Italy and the UK – the slowdown in TFP growth in Germany seems to have been only of a temporary nature and mainly as a consequence of the global economic and financial crisis (Figure 2c). In 2010-2016, average annual TFP growth in Germany recovered and was even slightly higher than it was in the time period before the Great Recession (0.6 log points versus 0.5 log points per annum). At this stage, the development in Germany and in the majority of the other countries might be an indication to be careful not to overemphasise the reduction in TFP growth, since there is clearly some temporary variation in TFP growth. However, with the exception of Spain and Germany, the TFP growth rates in the other four economies were lower in 2016 than they were in the period before the Great Recession.

Much more surprising is the second factor behind the recent labour productivity slowdown. As shown in Figure 2, reduced capital deepening noticeably slowed labour productivity growth in four of the six economies. The exceptions are Spain and to some extent France (Figure 2f and 2d). In Germany, the US and Italy, the deceleration in the growth of capital intensity is the main factor responsible for the slackening of labour productivity growth since the Great Recession. This is especially true when we compare the time period since 2010 to the period before 2007. In Germany, for example, the contribution of capital deepening to labour productivity growth was 0.5 log points lower per annum since the start of the Great Recession than in the previous period, 1998-2007. If we look at the more recent period of 2010-2016, the reduction was even larger, equal to 0.7 log points per annum.

Before the Great Recession, capital deepening contributed to the growth in labour productivity in a range between 1.2 (US) and 0.5 log points (Italy) per annum. In the time period 2010-2016, the average annual contribution to labour productivity growth declined in five of the six countries, falling to values ranging from 0.6 log points in France to -0.1 log points in the UK. Only Spain managed to avoid a slowdown in capital deepening; in fact, it actually increased there, albeit by just 0.1 log point. Given that capital deepening is the rate at which capital intensity increases over time, this slowdown is an indication of slack in investment. This reaffirms and substantiates Furman's finding of an "investment-driven slowdown" in productivity growth in the G7 economies.[10]

A closer look at the two different types of capital services, ICT capital services and non-ICT capital services, reveals that ICT capital deepening decreased in all six economies. Most pronounced was the slowdown in the US, where its contribution to labour productivity fell from 0.5 log points per annum in the period before the Great Recession to 0.1 log points per annum since 2007. In the European economies, the contribution of ICT capital deepening to labour productivity growth was much lower than it was in the US before the Great Recession; it was largest in Germany and Spain, at 0.3 log points per annum. In 2007-2016, its average contribution in four of the five European countries was equal to only around 0.1 log points per year. In Italy, ICT capital deepening has de facto stagnated since the Great Recession. These findings, in combination with the overall slowdown in TFP growth, are very surprising, especially in light of the ongoing pub-

8 For details, see K. de Vries, A.A. Erumban, op. cit., pp. 20f.

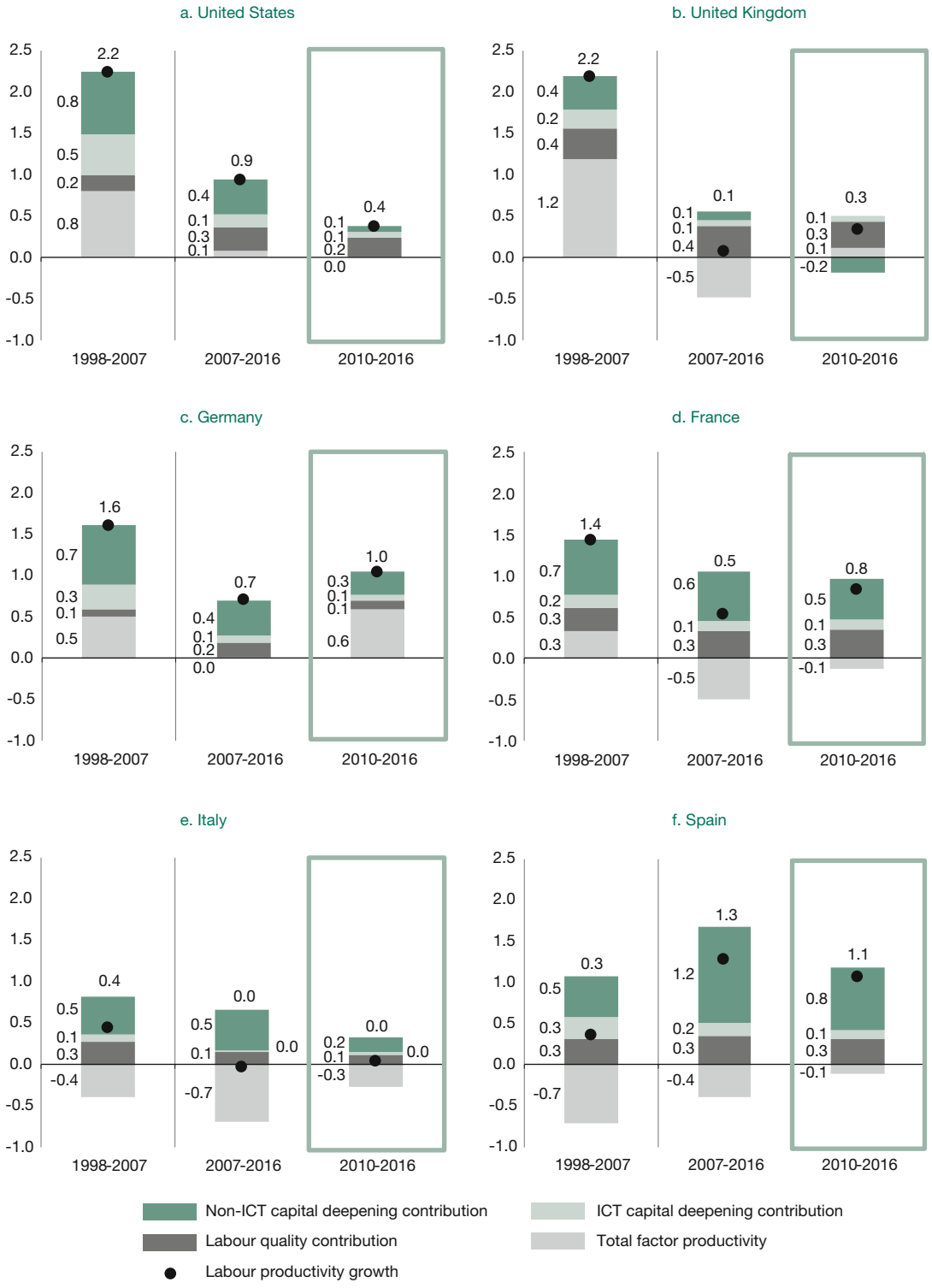
9 See e.g. A. Herzog-Stein, B. Friedrich, W. Sesselmeier, U. Stein: Wachstum und Produktivität im Gegenwind – Eine Analyse der Argumente Robert Gordons im Spiegel der deutschen Produktivitätsschwäche, IMK Report No. 124, March 2017, p. 6.

10 J. Furman, op. cit., pp. 5ff.

Figure 2

Decomposition of labour productivity growth in six advanced economies, 1998-2016

in log points (x100)



Note: Due to rounding differences, the sum of the numerical values of the growth contributions of the four components stated may differ from the stated growth rate of labour productivity in the graphs. Furthermore, despite equivalent rounded numbers, plotted bars can be of different magnitudes since they show the exact contributions.

Source: The Conference Board Total Economy Database™, November 2017; authors' calculations.

lic debate about potential massive productivity increases as a consequence of a fourth industrial revolution based on digitalisation and automation.[11]

Non-ICT capital deepening has also slowed markedly since the start of the Great Recession. The US experienced the largest fall (-0.4 log points), and since 2010 non-ICT capital deepening has increased at a meagre rate of 0.1 log points per year. The slowdown in the UK was of similar magnitude, and non-ICT capital intensity has been falling since 2010. In Germany and Italy, the speed of non-ICT capital deepening has more than halved since 2010 in comparison to the time period 1998-2007. France experienced a smaller reduction (-0.2 log points) in the speed of non-ICT capital deepening from the pre-Great Recession period to 2010-2016 than the other four countries. Spain is again the outlier, as it actually experienced an increase in non-ICT capital deepening. However, in light of the drastic increase in unemployment as a consequence of the economic crisis in the eurozone in the wake of the Great Recession, we must take a closer look at the development in Spain to see whether the faster non-ICT capital deepening was not in fact the result of a rapid decrease in employment (see below).

To sum up, there is clear evidence from five of the six economies which points towards weak investment in both types of capital services as one of the major reasons for the slowdown in labour productivity growth.

Finally, (measured) labour quality among employed people played a small but overall stabilising role in most economies. Italy was the only country where a slowdown in labour quality improvement had a negative impact on labour productivity growth over time. In the UK, labour quality has improved at a slightly smaller rate since 2010 than it did before 2007 (-0.1 log points). However, over the whole period since 1998, the quality of labour in the UK improved at the fastest rate of all six economies.

A closer inspection of the production factors

To fully understand which factors are actually responsible for the slowdown in labour productivity growth since the Great Recession, it is not sufficient to study only the growth contributions of the various factors. It is also necessary to take a closer look at the development of each of the production factors before and after the Great Recession (see Figure 3).

There were major differences among the six countries with respect to the development of total hours worked (Figure 3a). Before the Great Recession, total hours worked grew fastest in Spain. The average annual growth rate was equal to 3.4 log points. In contrast, total hours worked in Germany stagnated between 1998 and 2007. In the other four countries, total hours worked grew at an average annual rate of between 1.0 log points in Italy and 0.6 log points in the US.

In the nine years following the start of the Great Recession, total hours worked declined markedly in Spain and Italy. But at the end of the observation period, working hours started to grow again. At the same time, in Germany and especially in the UK, total hours worked increased faster following the Great Recession than they had before. Meanwhile, the US experienced a slowdown in employment growth, and total hours worked in France essentially stagnated between 2007 and 2016.

Labour quality improved in all countries between 1998 and 2016 (Figure 3b). No obvious differences in its development before and after the Great Recession can be identified. In Germany between 2004 and 2006, some decline in labour quality can be observed, while simultaneously total hours worked increased. This could be attributable to labour market reforms in Germany. However, this pattern was very short-lived, and after 2006 labour quality increased hand-in-hand with total hours worked. In recent years, though, labour quality has started to stagnate again.

With respect to investment and hence capital accumulation, a clear pattern is observable which supports and substantiates the finding of an investment-induced slowdown in labour productivity growth described in the previous section. In all six countries, both ICT and non-ICT capital investment slowed markedly following the Great Recession (Figure 3c and 3d). This effect was strongest in Spain and the US.

Interestingly, there are very apparent differences among the six countries with respect to ICT capital investment (Figure 3c). ICT capital investment over the whole time period was largest in Spain, the US and Germany. In the other three countries, ICT capital investment was markedly lower, and since 2007, Italy has experienced the lowest investment rates and the worst performance.

Given its much larger share of the capital stock in all economies, the investment rates in non-ICT capital were

11 For more information about a possible fourth industrial revolution, see e.g. N. Absenger, E. Ahlers, A. Herzog-Stein, Y. Lott, M. Maschke, M. Schietinger: Digitalisierung der Arbeitswelt!?, Mitbestimmungsreport No. 24, Report provided in cooperation with the Hans Böckler Foundation, 2016.

Figure 3
Development of labour productivity growth components in Europe and the US, 1998-2016
in log point change (x100)

Source: The Conference Board Total Economy Database™, November 2017; authors' calculations.

in general much lower than the investment rates in ICT capital (Figure 3d). The exception is Italy, where the average investment rate in non-ICT capital since 2007 has been larger than the investment rate in ICT capital (0.4 versus 0.2 log points per annum). However, investment rates in non-ICT capital have been much lower in all six economies since the start of the Great Recession as well. This shows that the investment-induced slowdown in labour productivity growth has not been limited to some types of capital services but has in fact been broad-based.

Policies to improve productivity growth in Europe

Given the above findings with respect to the productivity puzzle in advanced economies, what can be done in Europe to improve productivity growth? Although recent data show that investment is picking up in the euro area, the situation is still far from satisfactory. A trend shift to higher productivity growth requires a much more dynamic and stable investment process.

To achieve this, public investment plays a key role. Recent literature has shown that higher public investment does not just stimulate an ailing economy during a business cycle downturn. It also increases potential output to a significant extent.[12] This opens a pathway to a permanently higher productivity trend, too.

The key question in Europe is how to achieve higher public investment in an economic environment in which a reduction of the public debt burden is widely seen as a more important economic policy goal. Moreover, rules laid down in European treaties limit the leeway for a significant increase in public investment at the expense of a higher debt burden. However, some countries, notably Germany, have budget surpluses that could be used for

12 A. Fatàs, L.H. Summers: The Permanent Effects of Fiscal Consolidations, NBER Working Paper No. 22374, August 2016; and S. Gechert, G.A. Horn, C. Paetz: Long-term effects of fiscal stimulus and austerity in Europe, IMK Working Paper No. 179, May 2017.

higher public investment spending without violating these rules.[13] In addition, governments could make use of a balanced budget multiplier by shifting public spending from consumption to investment. Public investment has an immediate effect on labour productivity, as it contributes to an economy's capital stock and therefore increases the intensity of capital services used per hour worked.

Additionally, there are further ways in which public investment should have both direct and indirect impacts on productivity growth. The direct impact results from improved public infrastructure that allows for more efficient production, not least for private firms, and hence increases total factor productivity. The indirect impact arises as a consequence of complementarities between public and private investment, as higher public investment tends to serve as a trigger for private investment in due course. However, the size of this effect depends heavily on the state of the business cycle. In times of an economic boom, it will be small if not zero. But if there is slack in the economy, this indirect impact may be as large as the direct impact.[14] Hence, a public investment initiative can be the main source of revitalised productivity dynamics in the post-Great Recession era.

The effect would be particularly large if this investment could be done at the European level, where capacities are still underutilised. Furthermore, there is still significant potential for European public goods in terms of energy supply and transport infrastructure, fields in which public investment seems to be particularly promising. However, there is still no federal European institution that may claim the political ownership and responsibility for such an investment process. It remains to be seen whether the reforms put forward by the French President Macron will change that. In terms of advancing towards a higher productivity path, such an institution could prove quite useful.

13 G.A. Horn, K. Rietzler, S. Tober, A. Watt: Herausforderungen für die Wirtschaftspolitik 2018, IMK Report No. 133, January 2018.

14 G.A. Horn, S. Gechert, K. Rietzler, K.D. Schmid: Streitfall Fiskalpolitik – Eine empirische Auswertung zur Höhe des Multiplikators, IMK Report No. 92, April 2014.