Is Slow Economic Growth the 'New Normal' for Europe?

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Abstract

This paper considers future European growth prospects in the light of a new productivity paradox, namely, the co-existence of a productivity slowdown and exciting new technologies. Several potential explanations are reviewed. It is argued that while some are unpersuasive it is too soon to be sure which carry the most weight. This has the implication that while the slowdown is real it is not necessarily permanent. A key, hotly disputed, issue is the future economic impact of technological progress on which forecasts differ dramatically. Supply-side reform could have a strong positive effect but this is not likely to happen.

Keywords: Growth projections; productivity paradox; supply-side policy; technological progress.

JEL Classification: E24; N14; O47.

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Introduction

At the turn of the century, in the excitement of the so-called 'new economy', optimism abounded about the prospects for future economic growth. Alan Greenspan (2000) said in a speech that "When we look back at the 1990s from the perspective of, say, 2010 ... we may conceivably conclude ... that, at the turn of the millennium, the American economy was experiencing a once-in-a-century acceleration of innovation which propelled forward productivity ... at a pace not seen in generations, if ever."[1] Within a few years, this was revealed to be (widely shared) wishful thinking. Now, prompted by Larry Summers (2014), the talk is of 'secular stagnation' and the future is feared to be one of slow growth in which productivity advance will be very weak. This is understandable given the productivity slowdown in the OECD countries since the onset of the financial crisis. The level of labour productivity, both in Europe and in the United States, is well below what would have been expected on the basis of pre-crisis trends.

Current mainstream projections for medium-term growth in the United States and Western Europe are displayed in Table 1 and placed in the context of earlier, pre-crisis growth rates. Although recovery from the dismal performance of the least few years is envisaged, the scaling down of projected growth compared with pre-2007 is quite marked. Compared with growth during the years 1995-2007, future American and European growth of real GDP per person is seen as likely to be halved or worse. In each case, a serious weakening of labour productivity growth is expected. Compared with the 'golden age' of the 1950s and 1960s, the slowdown is even more pronounced, especially for Europe.

It is, of course, not unknown for economists to make inaccurate predictions about future growth or to be slow to appreciate the scope for improved productivity performance. Alvin Hansen (1939), the founding father of the idea of secular stagnation, is a spectacular example. He thought technological progress was too weak to generate economic growth at a rate that would encourage investment and avert a future of sustained high unemployment. In fact, the halcyon period of American economic growth in the post-war economic boom was on the horizon in an economy which was already experiencing very rapid total factor productivity (TFP) growth. In 1987, on the eve of the ICT revolution, Robert Solow lamented that paradoxically you could see the computer everywhere except in the productivity statistics.

A similar disconnect seems to be around at present. Excitement about (or fear of the consequences of) robots is apparent from a casual reading of the newspapers. And the academic world has some well-known techno-optimists including Erik Brynjolfsson and Andrew McAfee (2014) who stand out for their projections of the implications of what they call the 'second machine age' based on artificial intelligence, robotics and the digital revolution. They suggest that this will have a larger impact than anything since the industrial revolution and will deliver an unprecedented rate of technological advance.

There are several possible explanations for this new productivity paradox which I shall examine in what follows. These include measurement issues, implications of the financial crisis, changes in

[1] It is fair to point out that Greenspan noted that it was not possible to rule out the alternative that there was a massive speculative bubble, but the speech makes clear that he was a true believer that it was a productivity miracle.

supply-side policy, unreliability of productivity-growth projections, the absence of great inventions, and lack of business dynamism. Evaluating these competing hypotheses is central to beliefs about future European growth prospects.

Growth is Under-Estimated

Despite scepticism in some quarters, the accounting framework of GDP remains an appropriate measure of flows of production. It is not a measure of well-being or of non-market production both of which may be augmented considerably by the new technologies of the digital age. It is probably fair to say, however, that the practical difficulties of compiling the national accounts have increased in the recent past (Ahmad and Schreyer, 2016).

Even though the conceptual approach of national income accounting is still valid, in practice it is not well measured in particular because of the difficulties of deflating estimates in current prices into constant prices. These are in large part a consequence of technological change together with the quality change and new goods and services that it delivers. There is general agreement that true inflation tends to be over-estimated and, accordingly, real GDP growth is under-estimated, possibly quite significantly, by the practices currently used by government statistical offices. The literature which mainly concerns the United States, has, for example, highlighted not taking quality change in most of the economy seriously (Feldstein, 2017), the use of inappropriate imputation of prices where old goods are replaced by new goods (Aghion et al, 2017), and failures adequately to track declines in the prices of IT equipment and IT services (Byrne and Corrado, 2017a) or to incorporate well new aspects of consumption such as digital services (Byrne and Corrado, 2017b). It is not difficult to think that the growth rate of real GDP in the United States is of the order of 1 percentage point per year faster than officially stated.

Mismeasurement of real GDP growth does not, however, explain much if any of the productivity slowdown. This is because the problems outlined above are not new and, in some cases, were more serious in earlier years, or their impact is too small to account for much of the productivity shortfall (Byrne et al., 2016). Thus, the 'missing growth' estimated by Aghion et al. (2017) rose from 0.52 in 1983-2005 to 0.69 per cent per year in 2006-13 compared with a decrease in real GDP growth from 2.06 to 1.59 per cent per year while the corrections to ICT prices proposed by Byrne and Corrado (2017a) would add 0.4 percentage points to American growth between 1995 and 2006 but only 0.2 percentage points between 2006 and 2015. The unmeasured consumer gains from internet-linked technologies probably equate to less than 5 per cent of the reduction in the level of GDP in 2015 compared with what might have been expected in the absence of the productivity slowdown (Syverson, 2016).

In other words, measurement issues can help to explain part of the new productivity paradox. Real GDP growth is significantly understated by the national accounts and, as is always the case, some of the welfare gains from technological change occur outside the scope of GDP. However, it seems unlikely that mismeasurement is the reason for the recent marked decline in productivity growth. The evidence relates to the United States but there is every reason to think that the same analysis also applies to Western Europe.

Implications of the Financial Crisis

Labour productivity growth in Europe has persistently been very weak since the crisis began, as can be seen in Table 1. This raises the question of the extent to which disappointing performance reflects a one-time adjustment to a lower level of potential output or a 'new normal' lower trend rate of growth of productivity. It is well-known that financial crises can have permanent adverse direct effects on the level of potential output. Thinking in terms of a production function or growth accounting, there may be direct adverse effects on capital inputs as investment is interrupted, on human capital if skills are lost, on labour inputs through increases in equilibrium unemployment, and on TFP if R & D is cut back or if innovative firms cannot get finance.

Based on past experience, the orthodox view predicts a significant levels effect but no impact on future trend growth such that log labour productivity will maintain a trend path parallel to what would have been expected in 2007. This was the explicit assumption of OECD (2012, ch. 4), which stated that the levels effect would on average be about 2.5 per cent. Furceri and Mourougane (2012) estimate that for OECD countries a severe banking crisis reduces the level of potential output by about 4 per cent while Oulton and Sebastia-Barrel (2016) find an impact for all countries of 1.1 per cent per year that the crisis lasts. A later analysis by OECD economists found that the median impact in 2014 had reached 5.5 per cent (Ollivaud and Turner, 2015), of which about 2.2 percentage points came through TFP, but how close an approximation this might be to the permanent levels effects is not clear.

The transition period while the levels effect materializes may be quite long. Moreover, recovery is often slow (Reinhart and Rogoff, 2014) such that output is below trend levels for some time. This could imply that recent labour productivity performance basically reflects a large levels effect resulting from the financial crisis. A more pessimistic interpretation would be that it is partly the result of a slowdown in trend labour productivity growth. A more optimistic interpretation would be that some of what is feared to be a permanent effect will actually be regained as the economy returns to normal. At this point, it is too soon to know but it seems unlikely that a levels effect from the crisis plays no part in explaining the new productivity paradox.

It should also be recognised that the architecture of the Eurozone has precluded the use of either fiscal stimulus or unconventional monetary policy to escape the liquidity trap and eliminate the output gap. This can be seen in the design of the ECB and the priority given to fiscal consolidation in the face of high levels of public debt. In particular, a credible commitment by the ECB significantly to raise the rate of inflation and thereby lowering real interest rates is not possible. The central bank was designed for normal times rather than to deal with the policy issues raised by a depressed economy.

There is a stark contrast with the recovery made by the United States in the 1930s which confounded Alvin Hansen's pessimism. The key was 'regime change'. Leaving the gold standard was a clear signal that the deflationary period was over. Roosevelt's several actions on taking office, comprising leaving gold, announcing an objective of restoring the prices to pre-Depression levels, and implementing New Deal spending amounted to a credible policy that delivered a major change in inflationary expectations which drove down real interest rates and raised the expected money supply, i.e., the classic recipe for escaping the liquidity trap based on 'unconventional' monetary stimulus (Eggertsson, 2008). A key feature of the period was the Federal Reserve Bank lost its independence and became subservient to the Treasury after the exit of the United States from the gold standard (Meltzer, 2003).

Supply-Side Policy

Modern growth economics recognizes that supply-side policy can influence long-run growth performance (Aghion and Howitt, 2006). The main thrust is that growth depends on investment in tangible and intangible capital, in education and training, and on innovation. Decisions to invest and innovate respond to economic incentives such that well-designed policy which addresses market failures can raise the growth rate a bit. This implies governments need to pay attention to making investments that complement private sector capital accumulation, for example in infrastructure, to supporting activities like education and research and development where social returns exceed private returns, to avoiding the imposition of high marginal direct tax rates, to recognising that regulations can undermine productivity, and to fostering competitive pressure on management to develop and adopt cost-effective innovations.

If European supply-side policy has moved in the wrong direction recently, this could potentially explain weak productivity growth despite promising technological opportunities. A danger might be that the financial crisis has provoked, or that its legacy of populism and Euro-scepticism will yet encourage, retrograde steps. This would echo the experience of Britain in the 1930s where big economic shocks led to protectionism and a retreat from competition with long-lasting adverse effects on productivity performance (Crafts, 2012). In fact, it seems that there has been a slowing down in the rate of improvement of supply-side policy but relatively little evidence of deterioration. This is reflected in the indicators reported in Tables 2 through 4.

Regulations can inhibit innovation or slow down adjustment to new technologies or changes in comparative advantage. Empirical studies indicate that product market regulations that create barriers to entry (Nicoletti and Scarpetta, 2005) and employment protection that makes reorganization of the labour force costly (Caballero et al., 2013) have a significant cost in terms of foregone productivity growth. Both aspects of regulation have been shown to retard the diffusion of ICT (Cette and Lopez, 2012). The most commonly used indices which are reported in Table 2, PMR and EP, are those constructed by OECD. For PR, the picture is one of quite rapid reform pre-2008 which subsequently slowed considerably but was not reversed in the next 5 years. With regard to EP, progress has generally been slow throughout with the notable exception of Southern Europe post-2008.

Reforming taxation with a view to increasing the growth rate would generally entail reducing marginal direct tax rates, especially on corporate income, and increasing indirect and property taxes. Calculations of Effective Average and Effective Marginal Tax Rates (taking into account capital allowances) are reported in Table 3. On average tax rates fell before and after 2007 but more rapidly in the pre-crisis period; for example, the average fall in EATR was 3.4 versus 1.9 percentage points. Estimates by OECD economists suggest that that the impact of this slowdown in tax-cutting on labour productivity growth would be modest (Johansson et al., 2008).

There is consensus in the literature that R & D has a strong impact on TFP growth (with an elasticity of perhaps 0.15) and has a very high social rate of return, on average 2 to 3 times as high as the median private rate of return of around 20 to 25 per cent (Frontier Economics, 2014). More generally, the process of innovation is exposed to market failures and there is a strong prima facie case for government intervention. The news from Table 4 is encouraging – in all countries except Finland and Sweden the proportion of GDP spent on R & D increased between 2005 and 2015.

On the basis that supply-side policies will continue slowly to improve and that productivity growth in the leading economy, the United States will continue at a respectable pace, OECD (2014) made growth projections using the framework of a catch-up growth model. These are summarized in Table 5 which shows that the implications are much more optimistic than the inferences drawn from econometric analysis by Havik et al. (2014). Indeed, it would be possible to be more bullish if policy reform speeded up since there is considerable scope for improvement in supply-side policy in many European countries if only political obstacles could be overcome (Barnes et al., 2011).

The new productivity paradox is not explained by new failures of supply-side policy but successful reform would help to ensure that slow growth is not the 'new normal'. It must be said that the likelihood of such change has not been increased by recent political developments which seem to be motivated by desires for greater government intervention, protectionism and redistribution.

TFP Growth is Unpredictable

An important reason for pessimism about future growth prospects is econometric evidence based on various time-series methods that trend growth of labour productivity both in Europe and also the United States is now considerably lower than at the start of the 21st century. For example, two influential papers which provide estimates for the Euro area are by Antolin-Diaz et al. (2017) and Ollivaud et al. (2016). The former finds that trend labour productivity growth was 1.6 per cent per year in 2000, 0.9 per cent in 2007 and 0.7 per cent in 2015 while in the latter the decline is from 1.2 per cent in 2000 to 0.7 per cent in 2007 and 0.3 per cent in 2015. In both studies, a sizeable decline was apparent before the crisis.

Technological change is the ultimate source of sustained growth of labor productivity and thus of long-run increases in living standards. In a conventional neoclassical growth model, it will be represented by the growth of total factor productivity (TFP). Here the rate of growth of the capital stock is endogenous and, in the steady state, is equal to the exogenous natural rate of growth. Thus, a rise in the TFP growth rate induces capital accumulation and the steady-state rate of labour productivity growth is proportional to TFP growth. So, for projections of the rate of growth of potential output, the future TFP growth rate is the fundamental building block. In a world-leading economy (United States) this will be largely based on domestic innovative activity but in follower economies (Western Europe) mainly on technology transfer to exploit opportunities arising from TFP growth at the frontier.

If future American TFP growth is a key determinant of future trend labor productivity growth in Europe, how easy is it to forecast and is recent trend TFP growth a good guide to future medium-term performance? As Figure 1 underlines, the answers are 'extremely difficult' and 'definitely not'. The 10-year-ahead projection for TFP growth which graphs the average TFP growth rate over the next ten years shows considerable variability within a range from 2.0 to 0.3 per cent per year. Also plotted in the graph are estimates of trend TFP growth at the same time using an unobserved components model with data from the previous 20 or 25 years. Forecasting on this basis would have missed the productivity slowdown of the 1970s, the 'new-economy' acceleration of the mid-1990s, and the slowdown of recent years – in other words, all the major episodes during the period!

The implication is that an econometric estimate of current low trend productivity growth does not necessarily rule out a productivity surge in the near future. The precedent of the 1990s is witness to this. Econometrics is inherently backward looking and gives no weight to information about future technological progress. A techno-optimist should not feel too dismayed by the results of time-series analysis.

Great Inventions Make the Difference?

A possible explanation for the new productivity paradox is that there is a great deal of much-remarked innovative activity but it will have only a relatively weak economic impact, i.e, only a modest effect on TFP growth or labor productivity growth. This view has been strongly advocated by Robert Gordon (2016) who argues that the phase of rapid American TFP growth in the 20th century was based on the 'great inventions' of the second industrial revolution and that nothing of similar importance is in the offing. Gordon sees TFP growth of about 0.4 per cent per year in the business sector over the next 25 years. This is a stark contrast with Brynjolfsson and McAfee (2014), the techno-optimists, who suppose TFP growth of at least 2.0 per cent per year.

Both parts of Gordon's argument deserve to be challenged. Several serious research studies see substantial productivity potential in new technologies such as artificial intelligence and robotics which they expect to materialize in the next 20 years or so. Their explanation of the paradox is that it will be resolved by a future acceleration of productivity growth. Indeed, the history of general purpose technologies is that their main impact on productivity growth takes time. For steam this only came in the mid-19th century (Crafts, 2004) and for electricity it took until the 1920s (David, 1991). Widespread diffusion depends on cost-effectiveness. Over time this improves as the technology evolves and its potential is better understood. In the early stages, the use of the technology is too limited to have a big effect on macro productivity.

Frey and Osborne (2013) estimated that 47 per cent of 2010 employment in the United States has at least a 70 per cent chance of being computerized by 2035. Future advances will come in machine learning which will be applied in mobile robotics as hitherto non-routine tasks are turned into well-defined problems, in particular using big data which will allow substitution of (much cheaper) robots for labour in a wide range of low-wage service occupations. Arntz et al. (2016) adapt the Frey and Osborne approach to consider tasks rather than occupations and see relatively few jobs (perhaps 9 per cent) as completely automatable but, nevertheless, estimate that between 35 and 45 per cent of tasks in European countries will be susceptible of automatibility. If either of these estimates is correct, the upside is that this technology alone could deliver labour productivity gains equivalent to, say, 1.5 per cent per year over the next 20 years. A wider perspective which encompasses driverless cars, universal multi-jointed robots and data-driven expert systems sees labor productivity growth of 2.5 per cent per year as attainable (Bartelsman, 2013).

A recent paper quantifies sectoral contributions to American TFP growth before World War II (Bakker et al., 2017). It concludes that the great inventions made a strong but not dominant contribution. Their absolute impact was actually not very different from the IT sectors in the last 40 years while the proportion of TFP growth that they contributed was lower (see Table 6).[2] Compared with recent years, the striking feature of the pre-war American economy is actually how broadly-based TFP growth was and how much accrued from the non-great-invention sectors. Indeed, with TFP growth at 1.87 per cent per year in the period 1929-41, there was a strong antidote to Hansen's secular stagnation.

So, great inventions do matter but they do not make all the difference and they may not all be in the past.

Lack of Business Dynamism

A number of writers have recently suggested that business or economic dynamism has decreased in the United States, especially since the start of the 21st century, with adverse implications for productivity growth. The symptoms of the problem are declining rates of business start-ups, job turnover, and lower responsiveness in shifting resources in response to productivity shocks. These are the underpinnings of TFP growth beyond the impact of great inventions. A decline in the contribution of entry of new firms and reallocation of employment shares between firms accounts for most of the fall in productivity growth after 2000 (Decker et al., 2017). As these authors note, here is another potential explanation of the new productivity paradox.

At present, there is no convincing explanation for declining dynamism nor is it clear whether this is a temporary or a permanent phenomenon. Similar analyses are not available for European countries. However, the process of creative destruction clearly works much less well in many European countries than in the United States as is witnessed by processes of entry and exit of firms and the much stronger growth rate of successful American start-ups (Encaoua, 2009). A corollary of this is that, on average, countries in the European Union, especially in Southern Europe, are much inferior to the United States in shifting employment away from less productive towards more productive firms and this may account for as much as 20 percentage points of the labour productivity gap between the EU and the USA (see Table 7). For the EU as a whole, allocative efficiency in services was only 0.036 in 2005 (Andrews and Cingano, 2014).[3]

Bartelsman (2013) in his optimistic growth scenario in which he thought 2.5 per cent per year labour productivity growth in Europe was possible emphasized that this would require policies which encouraged economic dynamism. In particular, he noted that a massive reallocation of workers would be required and that displaced workers would need to be redeployed rather than become unemployed. It seems quite possible that the issue that Europe really confronts is actually not so much slow technological progress but that the skill-bias of new technologies has a big downside in terms of a serious adjustment problem in the labour market. The data reported in Table 8 suggest that many, if not all, European countries are more vulnerable to the technology shocks associated

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[2] The calculations reported in Table 6 offer two variants depending on whether distribution is classified as a great-invention sector (as Gordon does) or not. Gordon's classification appears to be based on the assumption that TFP growth in this sector relied on spillovers from the development of motor transport which allowed supermarkets to replace corner stores. This would presumably be an upper bound and the sector would not be included in a conventional account of the inventions of the second industrial revolution.

[3] The OP gap is defined as the difference between the weighted and unweighted average of labor productivity across firms. A completely random allocation of employment across firms would imply that the AE = 0. A higher value connotes a greater level of allocative efficiency.

with ICT and robotics than the United States. The symptoms are relatively high proportions of workers with less than upper-secondary education, more generous replacement rates, and higher levels of employment protection.[4] There will be a premium on 'flexible' labor markets which are absent in much of Europe and may be harder to promote in a populist era.

Conclusions

I have reviewed six hypotheses that might explain the paradox of apparently rapid technological progress co-existing with slow productivity growth in the United States and Europe. Three of these, namely, adverse changes in supply-side policy, an absence of great inventions with economic impact, and a loss of economic dynamism in the private sector, could singly or in combination imply that slow economic growth has indeed become the 'new normal'. On the other hand, finding reasons to discount current estimates of trend productivity growth or thinking that temporary effects of the crisis are still undermining performance are interpretations of the paradox which might entertain the idea that economic growth will revive in the medium term. Finally, if growth is badly measured, the productivity slowdown could be a statistical artefact.

My reading of the evidence is as follows. First, economic growth is faster than is captured by the national income accounts. This is not new, however, and it seems unlikely that the productivity slowdown is the result of errors in the data. Second, the financial crisis has reduced the level of potential output and its effects have lingered. There is no compelling reason to believe that it has affected the trend rate of growth but it has meant a lost decade. Third, supply-side policy in most European countries leaves a lot to be desired but it has not significantly deteriorated in recent years, although populism is a threat. Fourth, econometric estimates of recent trend productivity growth are not always a good guide to the future; in particular, they cannot take account of future technological change. Fifth, there are plausible reasons to believe that new technologies which could eventually have a large impact on productivity are about to deliver but it is too soon to tell. Sixth, a sustained decline of business dynamism would be a problem. In principle, it could probably be addressed by reforms to regulation and increased competition but, in practice, this may be 'too difficult' politically.

In sum, it seems that the productivity slowdown is real but not necessarily permanent. The impact of technological progress is hard to predict but there is considerable potential on the upside. Fully to realize the potential of new technologies will, however, depend on better supply-side policies.

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[4] If we consider the implications of the future computerization of employment as equivalent to a an increase in the dispersion of worker productivities, then in an equilibrium search and matching labour market model, the increase in equilibrium unemployment will be greater in a setting with relatively high unemployment benefit rates and employment protection since these are labour market policies which increase the convexity of the relationship between the unemployment rate and skill. In a calibrated model, Mortensen and Pissarides (1999) estimate that a common ICT technology shock which would raise unemployment in the United States by about 0.4 percentage points during 1975-1995 would have increased unemployment by 4.8 percentage points with 'European Union' labour market policies.

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Table 1. Growth Rates in Different Periods (% per year)

	United States Real GDP/Person	***United States Real GDP/Hour Worked***	***EU 15 Real GDP/Person***	***EU 15 Real GDP/Hour Worked***
1950-73	2.5	2.6	4.0	4.9
1973-95	1.7	1.3	1.9	2.5
1995-2007	2.2	2.2	2.0	1.5
2007-2016	0.4	0.9	-0.1	0.4
2014-23			1.0	0.8
2016-26	1.0	1.4		

Note: EU 15 is the aggregate of the 15 EU member states prior to the 2004 expansion of the European Union.

Sources: The Conference Board (2016); Havik et al. (2014); United States Congressional Budget Office (2016)

Table 2. PMR (Product Market Regulation, 0-6) and EP (Employment Protection, 0-6)

	PMR 1998	*PMR 2008*	*PMR 2013*	*EP 1998*	*EP 2008*	*EP 2013*
Austria	2.12	1.37	1.19	2.75	2.37	2.37
Belgium	2.30	1.52	1.39	1.85	1.89	1.89
Denmark	1.66	1.34	1.21	2.13	2.13	2.20
Finland	1.94	1.34	1.29	2.31	2.17	2.17
France	2.38	1.52	1.47	2.34	2.47	2.38
Germany	2.23	1.40	1.28	2.68	2.68	2.68
Greece	2.75	2.21	1.74	2.80	2.80	2.12
Ireland	1.86	1.35	1.45	1.44	1.27	1.40
Italy	2.36	1.51	1.29	2.76	2.76	2.68
Netherlands	1.82	0.96	0.92	2.84	2.88	2.82
Norway	1.87	1.56	1.46	2.33	2.33	2.33
Portugal	2.59	1.69	1.29	4.58	4.42	3.18
Spain	2.39	1.59	1.44	2.36	2.36	2.05
Sweden	1.89	1.61	1.52	2.70	2.61	2.61
Switzerland	2.49	1.55	1.50	1.60	1.60	1.60
United Kingdom	1.32	1.21	1.08	1.10	1.26	1.10
United States	1.63	1.59	1.59	0.26	0.26	0.26

Note: employment protection is for regular employment. On both indicators, a higher score signifies more regulation.

Sources: OECD Product Market Regulation database and Employment Protection database.

Table 3. Effective Average and Effective Marginal Corporate Tax Rates (%) and Public Investment (%GDP)

	EATR 2000	*EMTR 2000*	*EATR 2007*	*EMTR 2007*	*EATR 2017*	*EMTR 2017*
Austria	29.1	17.9	21.6	13.1	21.6	13.1
Belgium	33.2	17.1	28.1	13.5	28.3	14.4
Denmark	28.2	19.8	22.2	15.7	19.7	14.1
Finland	26.1	19.6	23.4	17.3	18.0	12.9
France	32.0	19.2	29.3	17.5	32.4	19.9
Germany	32.8	17.0	25.9	13.3	27.0	18.2
Greece	32.3	13.5	20.2	7.0	25.4	5.2
Ireland	8.8	5.3	11.1	7.3	11.3	17.2
Italy	33.8	16.3	30.5	14.1	21.4	-0.1
Netherlands	30.4	20.4	20.9	13.1	19.1	8.1
Norway	25.6	20.5	25.9	21.5	22.2	18.1
Portugal	29.2	14.8	24.0	11.4	25.2	14.9
Spain	34.0	20.0	33.3	23.4	27.6	24.0
Sweden	24.7	17.2	24.7	17.2	19.4	13.0
Switzerland	20.5	8.7	17.5	7.1	17.4	7.1
United Kingdom	26.9	20.0	26.9	20.0	18.5	17.1
United States	34.9	23.2	34.9	23.2	34.9	23.2

Sources: Oxford University Centre for Business Taxation Corporate Tax Database.

Table 4. R & D Expenditure (%GDP)

	R & D (GERD) 2005	*R& D (BERD) 2005*	*R & D (GERD) 2015*	*R & D (BERD) 2015*
Austria	2.38	1.66	3.07	2.18
Belgium	1.78	1.21	2.45	1.77
Denmark	2.39	1.63	2.96	1.89
Finland	3.33	2.36	2.90	1.94
France	2.04	1.27	2.23	1.45
Germany	2.42	1.68	2.87	1.95
Greece	0.58	0.18	0.96	0.32
Ireland	1.19	0.78	1.51	1.09
Italy	1.05	0.53	1.33	0.74
Netherlands	1.79	0.95	2.01	1.12
Norway	1.48	0.79	1.93	1.05
Portugal	0.76	0.29	1.28	0.60
Spain	1.10	0.59	1.22	0.64
Sweden	3.39	2.47	3.26	2.27
United Kingdom	1.57	0.96	1.70	1.12
United States	2.51	1.73	2.79	1.99

Sources: OECD, *Main Science and Technology Indicators*.

Table 5. EU 15: Future Productivity Growth (% per year)

	Real GDP Growth	***Labor Input Growth***	***Labor Productivity Growth***	***TFP Growth***
2014-23	1.1	0.3	0.8	0.5
2014-30	1.8	0.2	1.6	1.2

Note: estimates are based on hours worked in row (1) and on workers employed in row (3).

Sources: Havik et al. (2014); OECD (2014).

Table 6. Contributions to TFP Growth in the U. S. Business Sector (% per year)

a) 1899-1941

	1929-1941	***1899-1941***
TFP Growth	1.87	1.30
Great Inventions	0.82 (0.33)	0.51 (0.29)
Other	1.05 (1.54)	0.79 (1.01)

b) 1974-2012

	1974-1995	***1995-2004***	***2004-2012***	***1974-2012***
TFP Growth	0.50	1.61	0.34	0.73
IT Sectors	0.36	0.72	0.28	0.43
Other	0.14	0.89	0.06	0.30

Note: following Gordon (2016) 'great inventions' comprise technology clusters around electricity, internal combustion engine, re-arranging molecules, communications & entertainment; figures in parentheses re-classify distribution as other.

Sources: Bakker et al. (2017); Byrne et al. (2013)

Table 7. Allocative Efficiency Scores

	Manufacturing	***Services***	***Business Sector***
Austria	0.196	0.222	0.229
Belgium	0.205	-0.218	-0.012
Denmark	0.270	0.121	0.184
Finland	0.668	0.251	0.419
France	0.461	0.161	0.296
Germany	0.443	0.399	0.460
Greece	-0.056	-0.235	-0.240
Italy	0.141	-0.190	-0.039
Netherlands	0.043	-0.274	-0.137
Portugal	0.077	-0.069	0.020
Spain	0.465	-0.052	0.117
Sweden	0.672	0.253	0.379
UK	0.300	0.065	0.156
European Union	0.272	0.036	0.140
United States	0.473	0.358	0.394

Source: online appendix to Andrews and Cingano (2014).

Table 8. Exposure to Skill-Bias of Technological Change

	Low Educational Attainment (% labour force)	*Unemployment Rate of Lowly-Educated (%)*	*Employment Protection (0-6)*	*Net Replacement Rate (%)*
Austria	14	10.8	2.37	68
Belgium	25	14.3	1.89	81
Denmark	21	8.2	2.20	88
Finland	14	12.5	2.17	80
France	22	13.9	2.38	68
Germany	13	12.0	2.68	82
Greece	29	27.7	2.12	52
Ireland	20	18.7	1.40	74
Italy	39	15.2	2.68	75
Netherlands	23	10.1	2.82	80
Portugal	54	14.8	3.18	78
Spain	43	31.4	2.05	74
Sweden	17	13.2	2.61	65
UK	21	7.7	1.26	56
USA	11	10.6	0.26	52

Notes: low educational attainment is defined as less than upper secondary for ages 25-64 in 2015; employment protection is for permanent workers in 2013; net replacement rate is for household with 1 earner and 2 children on 67% average wage at initial unemployment in 2014.

Sources: OECD, Education at a Glance; OECD Employment Protection database; OECD, Tax-Benefit Models.

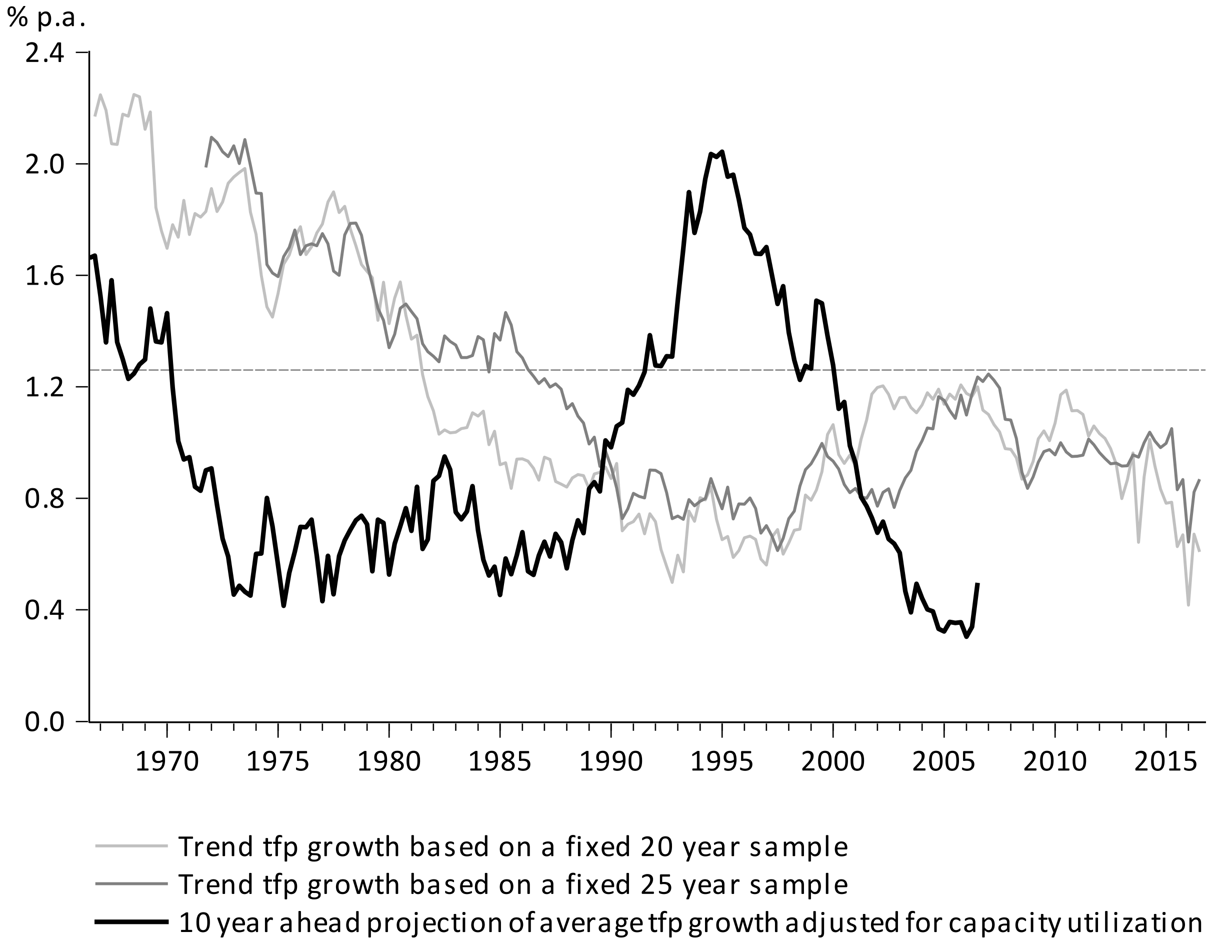

Figure 1. TFP Growth in the United States: Forecasts versus Outcomes

Source: Crafts and Mills (2017)