Solving the Productivity Puzzle: The Role of Demand and the Promise of Digitization

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Abstract

What is behind exceptionally weak productivity growth across many developed economies? We analyze seven countries (United States, Germany, France, UK, Italy, Spain, and Sweden) across six sectors (automotive, technology, retail, electric power, tourism, and finance) and examine supply and demand factors in the period from 2010 to 2014 compared to 2000 to 2004. For each sector, we combine economic analyses with McKinseys industry expertise to shed light on the microeconomic causes behind industry productivity performance. We find three waves collided to drive productivity growth across sectors: the waning of the impact of the 1990s information technology revolution; financial crisis aftereffects, including weak demand and uncertainty; and digital disruption which offers substantial opportunities to boost productivity growth but comes with lags and transition costs. We calculate that the first two waves dragged down productivity growth by 1.9 percentage points across countries since the mid-2000s, from 2.4 per cent to 0.5 per cent. As financial crisis aftereffects recede and more companies incorporate digital solutions, we expect productivity growth to recover, with productivity growth potential of at least 2 per cent per year across countries over the next decade.

A decade into recovery from the Great Recession, labour productivity growth rates remain near historic lows across many advanced economies. Productivity growth is crucial to increase wages and living standards and helps raise the purchasing power of consumers to grow demand for goods and services. Therefore, slowing labour productivity growth heightens concerns at a time when aging economies depend on productivity gains to drive economic growth (Manyika *et*

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2 Note that in this article, we often refer to labour productivity as simply "productivity"; we specify other types of productivity, such as total factor productivity, when referring to them.

al., 2015).[2] Yet in an era of digitization, with technologies ranging from online marketplaces to machine learning, the disconnect between disappearing productivity growth and rapid technological change could not be more pronounced.

In this article, we shed light on the recent slowdown in labour productivity growth in the United States and Western Europe and outline prospects for future growth.[3] We find that three waves collided to produce a productivity-weak but job-rich recovery: the waning of a the impact of the first IT revolution that began in the 1990s, financial crisis aftereffects, and digitization. The first two waves have dragged down productivity growth by 1.9 percentage points on average across countries since the mid-2000s, from 2.4 per cent to 0.5 per cent. In particular, financial crisis aftereffects include weak demand, uncertainty, excess capacity, contraction and expansion of hours, and, in some sectors, a boom-bust cycle. The third wave, digitization, is fundamentally different from the first two because it contains the potential to reignite productivity growth but the benefits have not yet materialized at scale. This is due to adoption barriers and lag effects as well as transition costs. As financial crisis aftereffects recede and more companies incorporate digital solutions, we expect productivity growth to recover; the good news is that we are seeing an uptick today in productivity and GDP growth across many countries.

We calculate that the productivity-growth potential could be at least 2 per cent per year across countries over the next decade. However, capturing the productivity potential of advanced economies may require a focus on promoting both demand and digital diffusion in addition to more traditional supply-side approaches. Furthermore, continued research will be needed to better understand and measure productivity growth in a digital age.

This article contains five main sections. The first section outlines the methodology used to assess productivity trends and drivers. Section two provides an overview of the micro-patterns of slower productivity growth in seven advanced economies. The third section analyzes productivity developments from the angle of three waves or drivers of productivity: the waning of the ICT revolution and restructuring and offshoring; financial crisis aftereffects, including weak demand and heightened uncertainty; and the missing benefits of digitalization. The fourth section takes a sector view on the productivity slowdown in the seven advanced economies. The fifth and final section discusses how best to capture the productivity potential, largely by promoting both demand and digital diffusion.

3 This article draws from Remes *et al.* (2018).

The McKinsey Global Institute Productivity Methodology

We analyze the productivity growth slowdown across a sample of seven countries: France, Germany, Italy, Spain, Sweden, the United Kingdom, and the United States. These countries were chosen to cover a large and diverse portion of GDP in advanced economies, representing about 65 per cent.[4]

In addition to country aggregate analysis, we analyzed six sectors across our sample of economies to identify what patterns are similar across sectors and what features are sector-specific, in order to understand what drives aggregate productivity trends. We chose these sectors – automotive manufacturing, finance, retail, technology, tourism, and utilities – because they represent a large and diverse share of the economies in our sample countries and played a significant role in explaining the recent slowdown.

In our analysis across countries and sectors, we assess the evidence for today's leading explanations for the productivity growth slowdown.[5] We find evidence of a non-measurement-related productivity growth slowdown and therefore focus our work in this report on explaining the productivity slowdown as measured.[6]

We take an integrated analytical approach across supply and demand to assess the linkages and "leakages" around the virtuous cycle of economic growth (from production of goods and services, leading to incomes for households and profits for companies, in turn resulting in continued demand for goods and services). This allows us to diagnose why productivity growth has slowed, particularly as many of the leading explanations today take a supply-focused view rather than an integrated one.

In our analysis, we often compare the turn of the century (2000-04) – a five-year period before the start of the recent productivity growth slowdown in the United States that encompasses the late boom of 2000, recession of 2001, and recovery period – with the post-recession years (2010-14), a somewhat stable period a decade later (though encompassing the double dip recession in Europe). Looking closely at the recent slowdown allows us to identify short-term factors behind the productivity-growth slowdown that are likely to be resolved, as well as long-term trends that are likely to remain in place, helping us

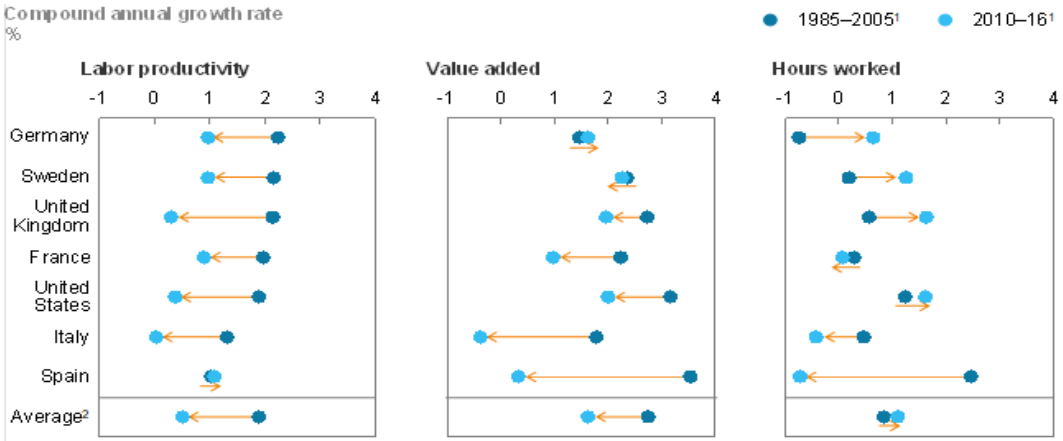
4 We do not include any analysis of emerging markets, which have a different productivity growth dynamic compared to mature markets.

5 These include: mismeasurement; financial crisis-related factors such as weak investment postcrisis and the rise of zombie firms; and structural shifts such as the rate of technological diffusion, the increasing concentration of businesses, and declining business dynamism together with a growing divergence of productivity among firms, a mix shift toward less productive sectors, a maturation of global supply chains, and secular stagnation. For more detail about each explanation, see Chapter 1 of Remes *et al.* (2018).

6 For more details, see Chapter 1, Box 3 of Remes *et al.* (2018).

7 While we are aware that choosing specific years involves some degree of arbitrariness, after assessing the pros and cons of multiple periods, we determined that concentrating on the period following the crisis allowed us to isolate different factors at the sector level across many different countries more easily. We also conduct

Chart 1: Trend in Labour Productivity, Value-added and Hours Worked in Advanced Economies, 1985-2005 and 2010-2016



1 Looking at these periods allows us to identify short-term factors behind the productivity-growth slowdown that are likely to be resolved, and long-term trends that are likely to remain in place.
2 Weighted average across France, Germany, Italy, Spain, Sweden, United Kingdom, and United States, based on 2016 GDP (2016 $ million).
NOTE: Order of countries based on fastest to slowest productivity growth in the 1985–2005 period.

SOURCE: The Conference Board (May 2017 release); McKinsey Global Institute analysis

to determine the potential for productivity growth in the future.[7]

While our methodology allows us to provide a much better understanding of the productivity growth slowdown and the implications for the future, questions for further research surely remain such as how to better measure the digital economy and understand the economic impact of digital transitions.

Micro-Patterns of the Productivity Growth Slowdown: An Overview

Any explanation of the productivity puzzle should take into account the micro-patterns of the slowdown and not just the headline aggregate productivity numbers. We find three major micro patterns. First, the recovery from the financial crisis has been "job-rich" and "productivity-poor" with low "numerator" (value added) growth accompanied by robust "denominator" (hours worked) growth.[8] Chart 1 on this page shows that in many countries the exceptionally low productivity growth in the post-recession 2010-2016 period reflects slower value-added growth combined with robust growth in hours worked. The broad-based pattern of job-rich but productivity-weak recovery across most countries raises the question of why companies are increasing employment without corresponding increases in productivity growth. It also highlights the

robustness tests to assess how much these years impact our results. See the technical appendix of Remes *et al.* (2018) for a detailed discussion of our methodology.

8 That is not to say economies experienced a jobs boom but that solid job growth continued over a long time through and beyond the period from 2010 to 2014. While some considered this recovery "jobless" early on (see, for example, Kolesnikova and Liu, 2011), because it took so long for unemployment to recover, we find that hiring has been exceptionally steady over a long period. The time periods in this exhibit were chosen to allow us to compare a long-term trend (1985 to 2005, ending prior to the crisis, to eliminate the impact of the crisis) with the most recent trends in the recovery (the period of the particularly low productivity growth).

importance of examining demand-side drivers for slow value-added growth and low productivity growth.

Second, looking across more than two dozen sectors, we find few "jumping" sectors today, and the ones that are accelerating are too small to have an impact on aggregate productivity growth.[9] For example, only 4 per cent of sectors in the United States were classified as jumping in 2014, compared with an average of 18 per cent over the last two decades, and they contributed only 4 per cent to value added.[10] The distinct lack of jumping sectors we have found across countries is consistent with an environment in which digitization and its benefits to productivity are happening unevenly.

Third, since the Great Recession, capital intensity, or capital per hour worked, in many developed countries has grown at the slowest rate in postwar history. Capital intensity indicates access to machinery, tools, and equipment and is measured as capital services per hour. An important way productivity grows is when workers have better tools such as machines for production, computers and mobile phones for analysis and communication, and new software to better design, produce, and ship products. But capital deepening has not been occurring at past rates. Chart 2 shows that from a growth accounting decomposition of labour productivity shows that slowing growth of capital per hour worked contributes about half or more of the productivity growth decline in many countries.[11]

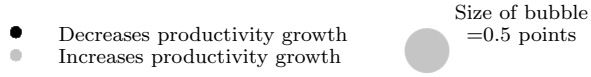
While labour productivity growth has been declining across the United States and Western Europe since the boom in the 1960s, it decelerated further after the financial crisis to historic lows (Chart 3). We focus here on the slowdown since the early 2000s and identify three major patterns of the productivity growth slowdown across our sample of countries: low "numerator" (value added) growth accompanied by robust "denominator" (hours worked) growth, creating a job-rich but productivity-weak recovery across most countries; too few and too small "jumping" sectors; and the critical importance of declining capital intensity growth across countries. These patterns indicate that the productivity-

9 A sector is classified as "jumping" in year Y if its compound annual growth rate of productivity for years Y-3 through Y is at least three percentage points higher than it was for 1995 to 2014 as a whole (a "long-term" average).

10 Similar trends are also seen in Europe. Less than 5 per cent of sectors in France, Germany, Sweden, and the United Kingdom are classified as jumping today. See Chapter 2 of Remes *et al.* (2018) for more details.

11 We acknowledge that this analysis represents a decomposition and is not a causal analysis and is sensitive to the underlying growth accounting formulation. The choice of time periods reflects both the specific trends we want to highlight and constraints from data availability. Comparing the productivity growth in the 2000 to 2004 period with the recent slowdown (2010 to 2014 period) allows us to identify short-term factors behind the productivity-growth slowdown that are likely to be resolved, helping to determine the potential for productivity growth in the future. We were also constrained by a longer-term comparison due to data availability issues across countries in EU KLEMS. For further details, see the technical appendix of Remes *et al.* (2018). Other researchers have also found large contributions from capital intensity growth and total factor productivity growth in the United States, for example Murray (2017).

Chart 2: A Growth Accounting Perspectives on the Labour Productivity Slowdown in Seven Advanced Economies – Contribution to the Change in Labour Productivity Growth, 2000-04 Versus 2010-14 (percentage points per year)



	Spain	France	Germany	Sweden	Italy	United States	United Kingdom
Labour productivity growth (as measured), 2000-04 (per cent)	0.0	1.5	1.7	2.9	0.0	3.6	2.3
Change in capital intensity growth							
Change in labour quality growth							
Change in total factor productivity growth							
Change in mix effect							
Labour productivity growth (as measured), 2010-14 (per cent)	1.4	1.0	0.9	0.9	0.6	-0.2	-0.2

1 See technical appendix in Remes *et al.* (2018) for details on methodology.
2 EU KLEMS data on total factor productivity (TFP) was significantly different compared with other data sources such as The Conference Board and Penn World Tables. Hence, we take the average TFP of the three databases and calculate labour quality as a residual.
3 In Italy, the period analyzed is 2010-13 instead of 2010-14 due to data limitations.
4 US data are for the private business sector only. Europe data are for total economy.
NOTE: Order of countries based on fastest to slowest productivity growth in 2010-14.

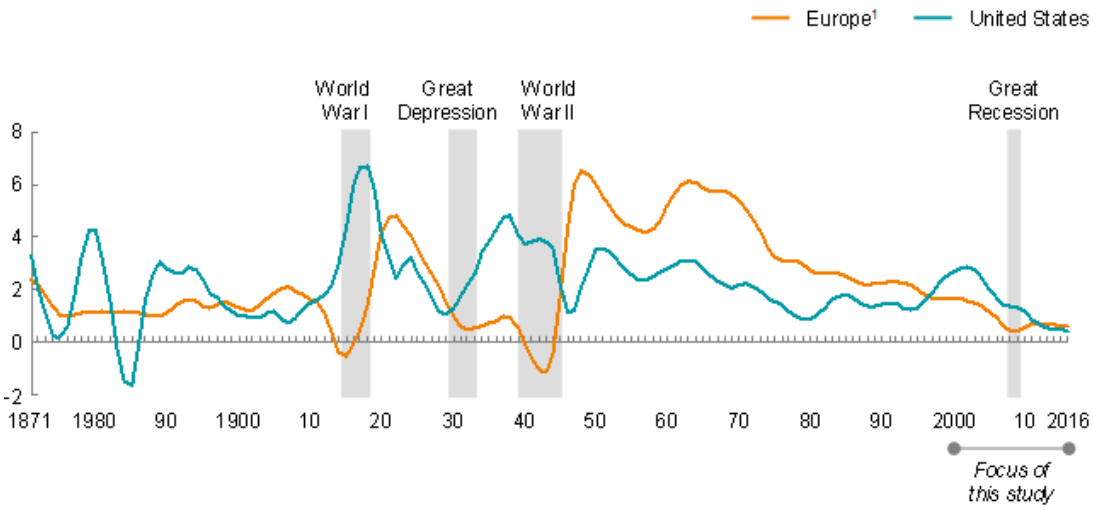
SOURCE: EU KLEMS (2016 release); BLS Multifactor Productivity database (2016 release); McKinsey Global Institute analysis.

growth slowdown is broad-based across countries and sectors, point to a set of common, overarching factors at work, and reveal the importance of demand-side as well as supply-side factors.

While we find many similar patterns of the productivity-growth slowdown across our sample of countries, there are also notable differences. Sweden and the United States experienced a strong productivity boom in the mid-1990s and early-2000s followed by the largest productivity-growth decline, and much of that decline predated the financial crisis. France and Germany started from more moderate levels and experienced less of a productivity-growth decline, with most of the decline occurring after the crisis. Productivity growth was close to zero in Italy and Spain for some time well before the crisis, so severe labour shedding after the crisis actually accelerated productivity growth, as seen in Chart 2.

While many key economic variables such as GDP growth and investment as

Chart 3: Long-term Trends in Labour Productivity Growth in the United States and Europe



[1] Simple unweighted average of France, Germany, Italy, Spain, Sweden and the United Kingdom.
Note: Productivity defined as GDP per hour worked. Calculating using Hodrick Prescott filter. Drawn from similar analysis in Baily and Montalbano (2016).
Source: Bergeaud *et al.* (2016).

a share of GDP, as well as productivity growth, have started to pick up recently in the United States and Europe, productivity growth remains low relative to historical rates, with many countries in our sample seeing around 1 per cent per year productivity growth or less.

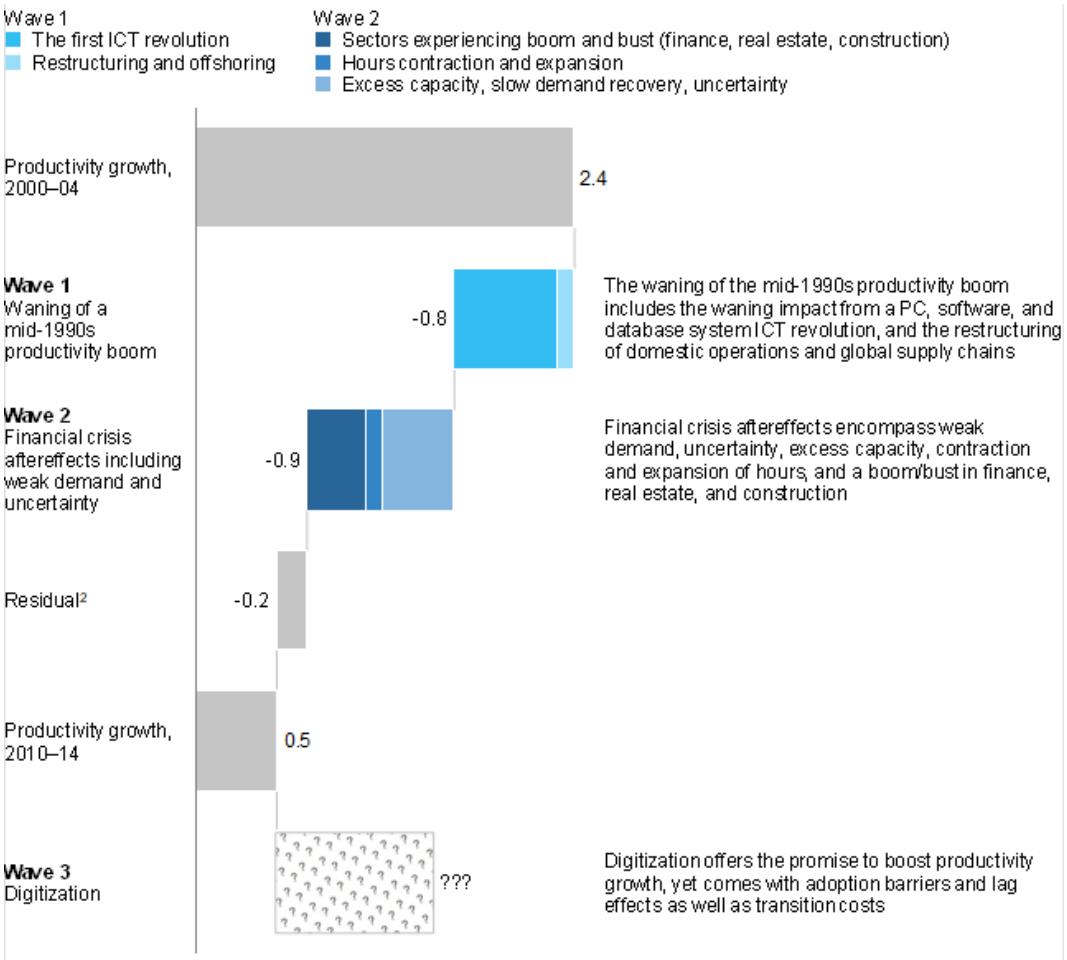
Productivity Developments: A Detailed Analysis of the Three Waves

This section of the article provides a detailed discussion of productivity developments in seven advanced economies using the MGI methodology outlined earlier, which has identified three productivity wavers or drivers. Chart 4 shows that the first two waves have dragged down productivity growth by 1.9 percentage points on average across countries since the mid-2000s:

The waning of a boom that began in the 1990s with the first information and communications technology (ICT) revolution, and a subsequent phase of restructuring and offshoring, which reduced productivity growth by about one percentage point. Financial crisis aftereffects, including weak demand and uncertainty, reduced it by another percentage point. A third wave, digitization, contains the promise of significant productivity-boosting opportunities but the benefits have not yet materialized at scale. This is due to adoption barriers and lag effects as well as transition costs; the net effect on productivity in the short term is unclear. We do not attempt to quantify the impact of digitization. Today we find that companies are allocating substantial time and resources to changes and innovations that do not yet have a direct and immediate impact on output and productivity growth.

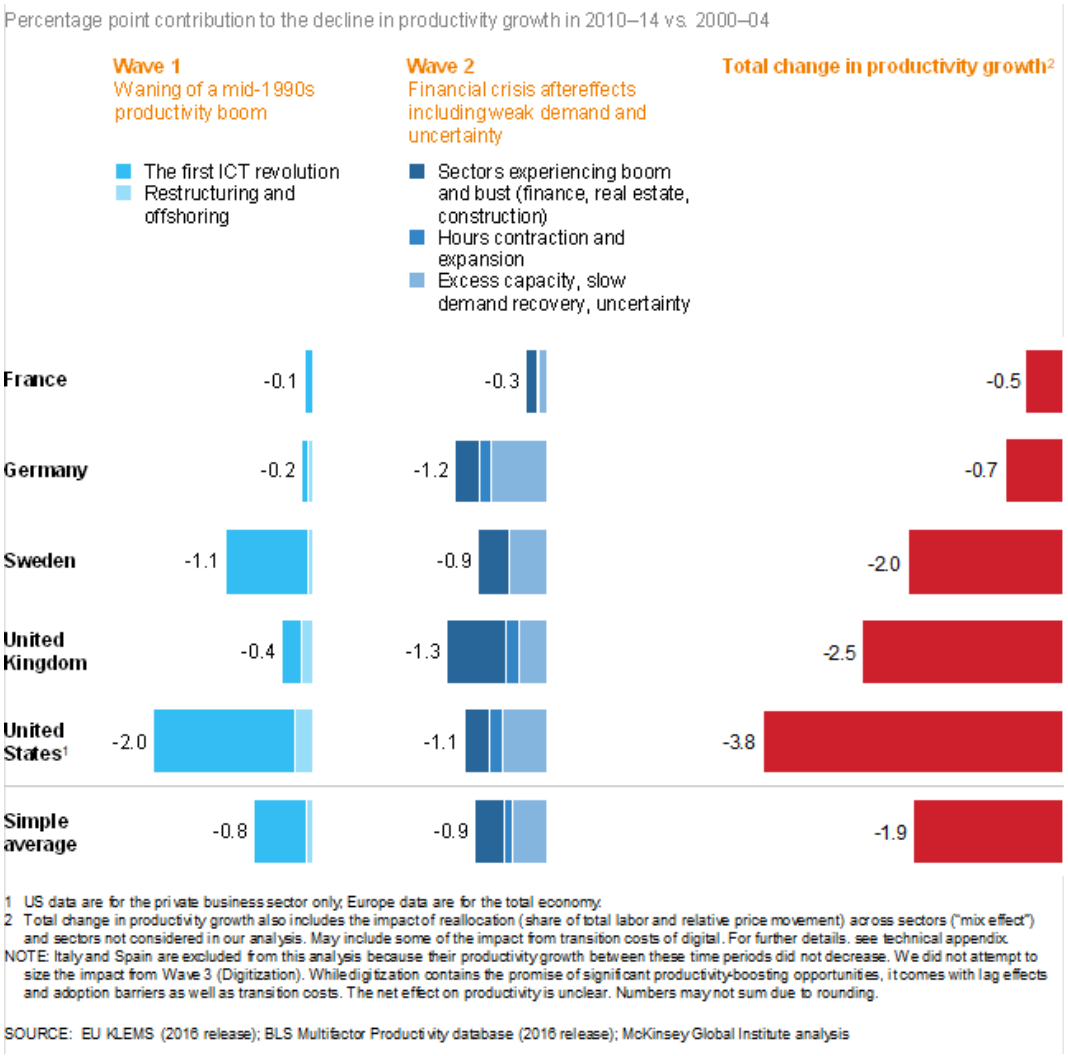
The importance of these waves was not equal across countries (Chart 5).

Chart 4: The Impact of the Three Waves on Productivity Growth in Seven Advanced Economies (contribution to the decline in productivity growth in 2010-14 vs. 2000-04[1])



1 US data are for the private business sector only. Europe data are for the total economy.
2 Includes impact of reallocation (share of total labour and relative price movement) across sectors ("mixed effect") and sectors not considered in our analysis. May include some of the impact from tarnsition costs of digital. For further details, see technical appendix.
NOTE: Italy and Spain are excluded from this analysis because their productivity growth between these time periods did not decrease. We did not attempt to size the impact of Wave 3 (Digitalization). While digitalization contains the promise of significant productivity-boosting opportunities, it comes with lag effects and adoption barriers as well as transition costs. The net effect on productivity is unclear. Numbers may not sum due to rounding.
Source: EU KLEMS (2016 release); BLS Multifactor Productivity database (2016 release); McKinsey Global Institute analysis.

Chart 5: Productivity by Country (percentage point contribution to the decline in productivity growth in 2010-14 vs. 2000-04)



1 US data are for the private business sector only; Europe data are for the total economy.
2 Total change in productivity growth also includes the impact of reallocation (share of total labor and relative price movement) across sectors ("mix effect") and sectors not considered in our analysis. May include some of the impact from transition costs of digital. For further details, see technical appendix.
NOTE: Italy and Spain are excluded from this analysis because their productivity growth between these time periods did not decrease. We did not attempt to size the impact from Wave 3 (Digitization). While digitization contains the promise of significant productivity-boosting opportunities, it comes with lag effects and adoption barriers as well as transition costs. The net effect on productivity is unclear. Numbers may not sum due to rounding.

SOURCE: EU KLEMS (2016 release); BLS Multifactor Productivity database (2016 release); McKinsey Global Institute analysis

The first wave mattered more in Sweden and the United States, where the productivity boom had been more pronounced, while financial crisis aftereffects were felt more broadly across countries.[12]

The First Wave: Waning of the ICT Revolution and Restructuring and Offshoring

An initial ICT-enabled productivity boom, starting in the second half of the 1990s, was particularly strong in Sweden and the United States. The productivity boom in the ICT sector itself reflected a wave of rapid innovation in semiconductor design and manufacturing processes that raised productivity in the sector significantly and translated into higher-quality and higher-value prod-

12 For an overview of the methodology used to conduct this sizing, see technical appendix of Remes *et al.* (2018). This analysis ends at 2014 due to lack of data availability across countries after that date. Note that this analysis is based on sector-level data. Firm-level trends can also play a role in influencing productivity growth.

ucts of downstream computer equipment producers. It also benefited sectors like retail, as large-format retailers like Walmart used technology to transform supply chains and the rest of the industry followed (McKinsey Global Institute, 2002).

The global industry restructuring following the 2001 tech downturn helped sustain productivity gains across manufacturing as production shifted to Asia and nearshore assembly locations in Mexico and Eastern Europe, and manufacturing production employment declined in the United States and Western Europe. In addition, rapid declines in ICT equipment prices encouraged an investment boom in other sectors such as professional and business services, as well as strong growth in the ICT services and software sector and boosted productivity growth as these industries integrated new technology into their business processes and systems.

By the mid-2000s, the productivity-growth benefits from that first wave of ICT innovation had matured. The retail and wholesale supply chain revolution had largely run its course. Productivity growth in the tech sector itself declined by roughly 14 per centage points in the United States from 2000-04 to 2010-14. The composition of the tech industry had shifted toward skilled, labour-intensive, less scalable software services. And tech manufacturing became more fragmented and innovation more complex as the proliferation of electronic devices and applications broadened the demands on performance beyond just processor speed.[13]

For example, the shift in demand toward smartphones requires managing sometimes dozens of sensors from fingerprint recognition and GPS to multiple cameras, all requiring efficient power consumption to save battery time. Virtual world gaming, artificial intelligence, and autonomous driving have dramatically expanded the performance demands on Graphics Processor Units (GPUs). The breadth and depth of innovation is vast, making it harder both to accurately measure improvements and to achieve past pace of improvements given the scale in many specialized chips is lower and cost declines slower.[14]

At the same time, the productivity gains from globalization and offshoring as well as efficiency gains from restructuring post-2001 were plateauing. While we found this trend had a smaller impact on productivity growth across countries than the waning of the ICT-enabled boom, it did affect certain sectors. In the auto sector in the United States, the productivity improvements from restructuring and job declines after the 2001 downturn and of regional footprint optimization across NAFTA tapered off by the

13 Some researchers also question whether Moore's law still holds or takes more effort. See, for example, Flamm (2017); Bloom *et al.* (2017); and McKinsey & Company (2013).

14 Other research has also pointed to the importance of the waning of this first ICT-enabled boom. See, for example, Fernald and Wang (2015). Others have questioned whether mismeasurement could explain the productivity-growth decline, given the exceptionally thorny challenges of measuring output of rapidly changing tech industries. For a good overview, see Byrne, Oliner and Sichel (2017).

mid-2000s. In Germany, regional offshoring to Eastern European countries continues today.

The Second Wave: Financial Crisis Aftereffects Including Weak Demand and Heightened Uncertainty

Demand for goods and services across countries and industries dropped sharply during the financial crisis as employees lost jobs, income contracted, and the credit impulse reversed.[15] For example, in the United States, light-vehicle production fell by 47 per cent between 2007 and 2009,[16] while in retail demand growth slowed by roughly 1 percentage point compared with the pre-crisis period (data from BLS). This fall in demand for goods and services resulted in significant excess capacity and a pullback of investment. At the same time, in many countries, companies reacted to the demand shock by cutting hours worked, particularly in sectors like manufacturing, retail, finance, and construction. The contraction of hours was so dramatic in the United States that it briefly increased productivity growth in 2009 and 2010.

By the end of 2009, the crisis reached a turning point, with GDP levels bottoming out in the United States. However, the depth of the crisis, deleveraging by households and corporations, weak animal spirits, and structural demand drags such as rising inequality and the declining labour share of income resulted in a prolonged recovery that by some measures continues today.

A combination of factors in this slow recovery period created a dynamic of declining productivity growth: a slow increase in demand, excess capacity, and economic, political, and regulatory uncertainty, all in an environment of low wage growth. This cocktail contributed to the trend of weak growth in productive capital coupled with a rebound in hours worked growth. The decline in the growth rate of capital intensity, the lowest in the postwar period, reflects a substantial decline in equipment and structures investment during the crisis with a slow recovery while intangible investment, such as R&D and software, recovered more quickly after a brief and smaller dip in 2009.[17]

As hours worked had significantly contracted during the crisis and capacity was underutilized, companies met slowly rising demand by filling excess capacity and adding hours. For example, in the auto sector in the United States, growth in hours worked surged after 2010, but total hours still remained below pre-crisis levels in 2015 (based on data from the BLS).

Across the economy, once capacity utilization picked up, a reason for continued weak investment was the persis-

15 The credit impulse is measured as acceleration or deceleration in debt-to-GDP ratios and thus indicative of the role of borrowing in impacting demand. See, for example, Biggs and Mayer (2013).

16 Data from IHS Markit, 2017 for light-vehicle production.

17 Companies typically see R&D investment as longer term. In many industries with a rapid pace of technological change, competitive pressure kept investment a priority for companies.

tent slow recovery in demand. Normalizing capital-to-output ratios across countries indicates that the investment recovery kept pace with the recovery in demand, but since demand growth was weak, capital services growth also remained weak.[18]

Slow wage growth dampened the need to substitute capital for labour. Low wages in retail in the United States, for example, seem consistent with comparatively slow investment in technologies like automated checkouts and redeploying freed-up resources in low-productivity occupations like greeters.[19] In addition, stagnant wages had implications for limiting demand growth. In our sector analysis, we found weak demand dampened productivity growth through other channels than investment (Box 1).

The slow recovery, together with political and regulatory uncertainty in the aftermath of the crisis, may be continuing to restrain investment today.[20] There is debate around how far the recovery has progressed. For instance, while we have witnessed an extended period of job growth, employment rates are still well below pre-crisis levels in some countries, notably the United States, where the unemployment rate is around historic lows but labour force participation has not fully recovered.[21] Household investment remains subdued, and business investment as a share of GDP has only slowly recovered to rates seen before the crisis, and has still not fully recovered in parts of Europe. Real investment in structures and equipment remains below trend lines in many countries. Indeed, the latest economic data highlight the fact that capital intensity growth remains noticeably weak across countries.

Demand and uncertainty are key drivers of these trends. We have found from our global surveys of business that 47 per cent of companies that are increasing their investment budgets are doing so because of an increase in demand, yet 38 per cent of respondents say risk aversion is the key reason for not investing in all attractive opportunities (McKinsey Quarterly Survey, March 2017).

The Third Wave: The Missing Benefit of Digitalization

The first wave of ICT investment starting in the mid-1990s was mostly

18 For other explanations of the slowdown, see IMF (2015), Adler *et al.* (2017), ECB (2016), Erber, Fritsche and Harms (2017), Anzoategui *et al.* (2016), Borio (2017), and van Ark and Jäger (2017).

19 See, for example, Vanderzeil, Currier and Shavel (2017). For a review of findings related to the role of minimum wages on employment, see Neumark (2014). Interestingly, even when retailers are investing in automation, they have tended to move existing workers to other jobs such as food service to keep store service levels up and improve customer engagement.

20 For a measure of uncertainty, see the Economic Policy Uncertainty Index (2018) and Baker, Bloom and Davis (2016). Research has also shown that long-run uncertainty, which is influenced by policy uncertainty, influences both investment and hiring, but the former is more affected than the latter. This is due to lower depreciation rates and higher adjustment costs of investment relative to hiring. See Barrero, Bloom and Wright (2017).

21 One reason why the aggregate participation rate is still below its pre-recession peak is the aging of the population (Yagan, 2017).

Box 1: The Dampening Effect of Week Demand on Productivity During the Recovery

We identify two channels by which weak demand hurt productivity growth during the recovery in addition to holding back investment, namely economies of scale and the shape of demand, and subsector mix effect:

In finance, productivity growth declined, particularly in Spain, the United Kingdom, and the United States, due to contractions in lending volumes that banks were unable to fully offset with staff cuts due to the need for fixed labour (for example, to support branch networks and IT infrastructure). The utilities sector, which has seen flattening demand growth due to energy efficiency policies, as well as a decline in economic activity during the crisis, was similarly not able to downsize labour due to the need to support electricity distribution and the grid infrastructure.

Consumer preferences boosted productivity growth in both the auto and retail sectors from the mid-1990s to the mid-2000s through a shift to higher value-per-unit, more productive goods. Today that trend has slowed. The German and US auto sectors have experienced a trend of customers purchasing higher-value-added SUVs and premium vehicles. This boosted productivity growth by 0.4 to 0.5 percentage point in the auto sector in the early 2000s. That trend has slowed slightly in both countries, contributing only 0.3 percentage point to productivity growth in 2010-14. Similarly, in retail, we estimate that consumers shifting to higher-value goods, for example higher-value wines or premium yogurts, contributed 45 per cent to the 1995-2000 retail productivity-growth increase in the United States. This subsequently waned, dragging down productivity growth.

from using technology to deliver supply-chain, back-office, and later front-office efficiencies. Today we are experiencing a new way of digitization that comes with a more fundamental transformation of entire business models and end-to-end operations. We may be experiencing a renewal of the Solow Paradox of the 1980s, with the digital age around us but not yet visible in the productivity statistics.

There are several reasons that the impact of digital is not yet evident in the productivity numbers. These include lag effects from technological and business readiness to reaching adoption at scale; costs associated with the absorption of management's time and focus on digital transformation; and transition costs and revenue losses for incumbents that can negatively impact sector productivity during the transition. The net impact today of digitization is unclear.[22]

On the lag effects, we have found that digitization has not yet reached scale, with a majority of the economy still not digitized. MGI has calculated that Europe overall operates at only 12 per

22 See also Bughin and van Zeebroeck (2017) and Brynjolfsson, Rock and Syverson (2017).

23 Potential is defined by comparing each sector against a frontier sector defined as the US ICT sector. This analysis uses a set of 18 metrics of digitization spanning assets, usage, and labour. Our use of the term "digitization" and our measurement of it encompasses: the digitization of assets, including infrastructure, connected machines, data, and data platforms; the digitization of operations, including processes, payment and business models, and customer and supply-chain interactions; and the digitization of the workforce, including worker

cent of digital potential, and the United States at 18 per cent, with large sectors lagging in both.[23] While the ICT, media, financial services, and professional services sectors are rapidly digitizing, other sectors such as education, health care, and construction are not. We also see the lack of scale in our sector deep dives. In retail, for example, we found that the growing share of sales taking place online in the United States added roughly 0.5 percentage point to productivity growth in the sector per year in the 2010-2014 period, as those forms of retail are more productive than traditional forms yet those sales are about 10 per cent of retail volume.[24]

History shows that technological diffusion takes time and comes with barriers to adoption.[25] An MGI review of the historical rate of adoption of 25 technologies over the past half century shows that the time from commercial availability to 90 per cent adoption ranges from approximately eight to 28 years.[26] This was demonstrated by the first Solow Paradox of the mid-1970s and 1980s, for example, and the ICT boom in the 1990s. Productivity growth in the United States slowed in the former period, despite innovations at the time in the area of microelectronics and communications technology (David, 1989). Productivity gains were not automatic and did not occur in all industries that invested heavily in ICT. Instead, productivity gains required significant changes in business process, as well as managerial and technical innovation (McKinsey Global Institute, 2002).

The challenge of adoption in the current digital wave may be even harder because of the broad range of uses of digital that not only help improve current processes but fundamentally transform business models and operations. For example, in retail, the first ICT revolution was focused on getting the right goods to the right place at the right time. With digitization, the transition to online requires building a new channel with a new supply-chain structure to deliver goods directly to customers and determining what combination of stores and online presence is optimal. Digital also requires significant up-front investment and new skills in data analysis; our survey shows fear of technological obsolescence as well as gaps in digital technical and organizational capabilities as barriers. The current wave of digitization also requires customers

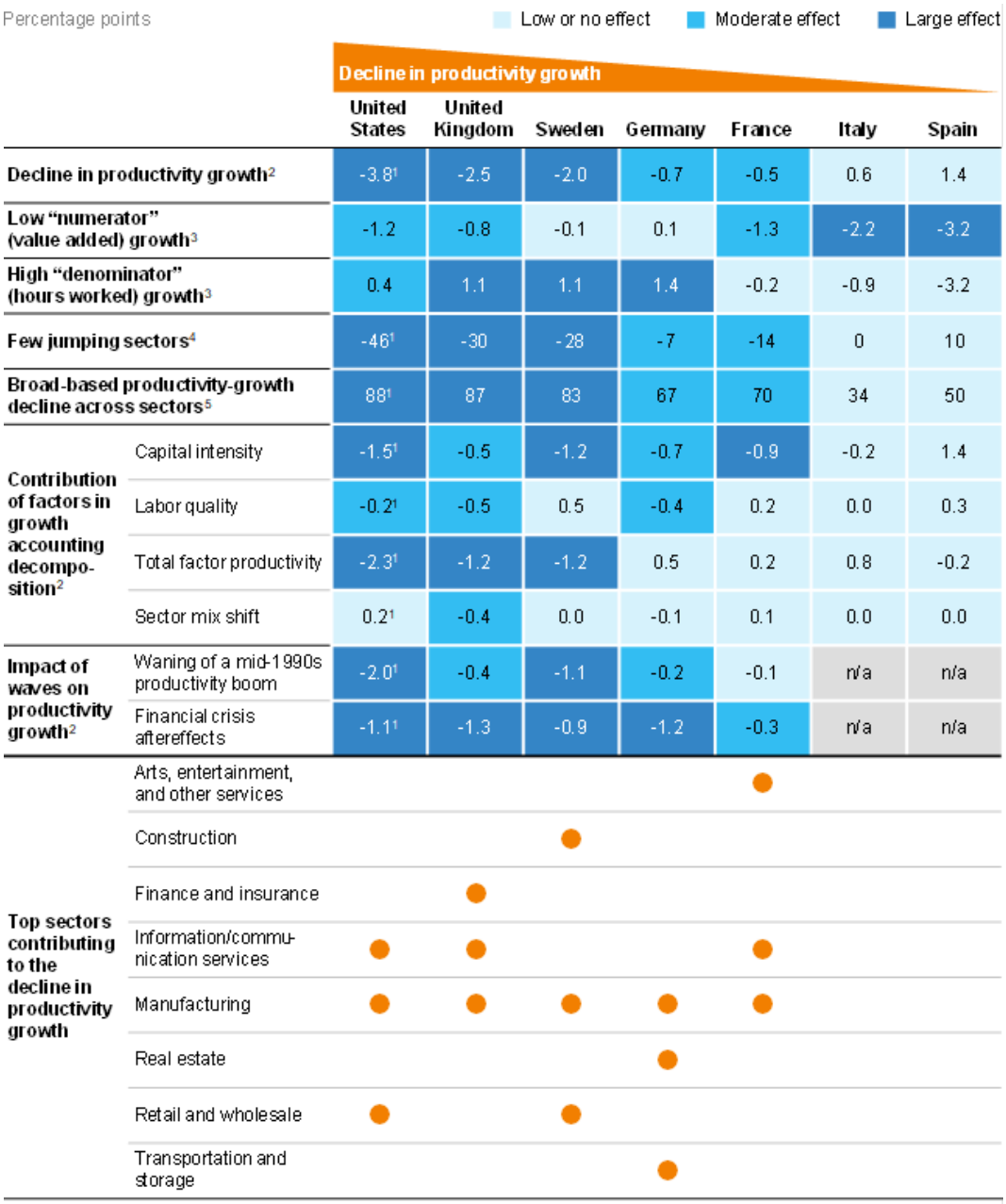
use of digital tools, digitally skilled workers, and new digital jobs and roles (McKinsey Global Institute, 2015).

24 Impact on retail productivity growth calculated based on the mix shift between online and offline retail, assuming today's level of relative productivity between the two segments. Based on data from Euromonitor International, Retailing data (2018 edition) and S&P Capital IQ.

25 See Jovanovic and Rousseau (2005). Take the advent of steam power, for example. Productivity growth was quite rapid, at 2 to 3 per cent, when steam power was introduced around 1870 but fell with the arrival of electrification in the 1890s, to 1 to 2 per cent in the United States. It was only in the period after 1915, which saw the diffusion of machines operated by stand-alone secondary motors and the widespread establishment of centralized power grids, that electricity finally pervaded businesses and households, and productivity growth began to rise. Then productivity growth rose to 3 per cent. See also David (1989).

26 See McKinsey Global Institute (2017). See also Comin and Hobijn (2010).

Chart 6: A Diagnostic of the Productivity Growth Slowdown in Seven Advanced Economies



1 US data are for the private business sector only; Europe data are for the total economy.
2 2010–14 vs. 2000–04.
3 2010–16 vs. long-term (1985–2005).
4 Share of jumping sectors, 2014 vs. 2004.
5 Share of sectors with lower productivity growth in 2010–14 vs. 2000–04.
NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

to embrace developments such as mobile banking, online shopping, autonomous driving, and resolving questions with a bot. Finally, some incumbents have reasons to actively delay adoption, whether for fear of cannibalization or, in some cases, the challenges of large-scale transformations.

While new digital entrants as well as fast-moving incumbents may increase profits and productivity, others can experience a transition that impedes productivity. As they lose revenue to disrupters and their growing digital arms cannibalize revenues further, some companies may end up with duplicate structures and processes, and underutilized capacity in their traditional operations. For example, in retail, when firms increase their online presence and stores or entire malls suffer declining footfall, that cannot readily be remedied.[27] In a recent survey we conducted, companies with digital transformations under way said that 17 per cent of their market share from core products or services was cannibalized by their own digital products or services (McKinsey & Company, 2017). Industry productivity benefits will then materialize mostly as incumbent businesses restructure or exit, and adoption costs are outweighed by benefits as digitization reaches scale.

Chart 6 provides estimates of the impact of the first two waves on the slowdown in productivity growth between 2000-2004 and 2010-2014 for seven advanced economies. It also provides estimates of the sources of the labour productivity slowdown from a traditional growth accounting perspective (capital intensity, labour quality, and total factor productivity) and identifies the section most important in contributing to the decline in productivity growth.

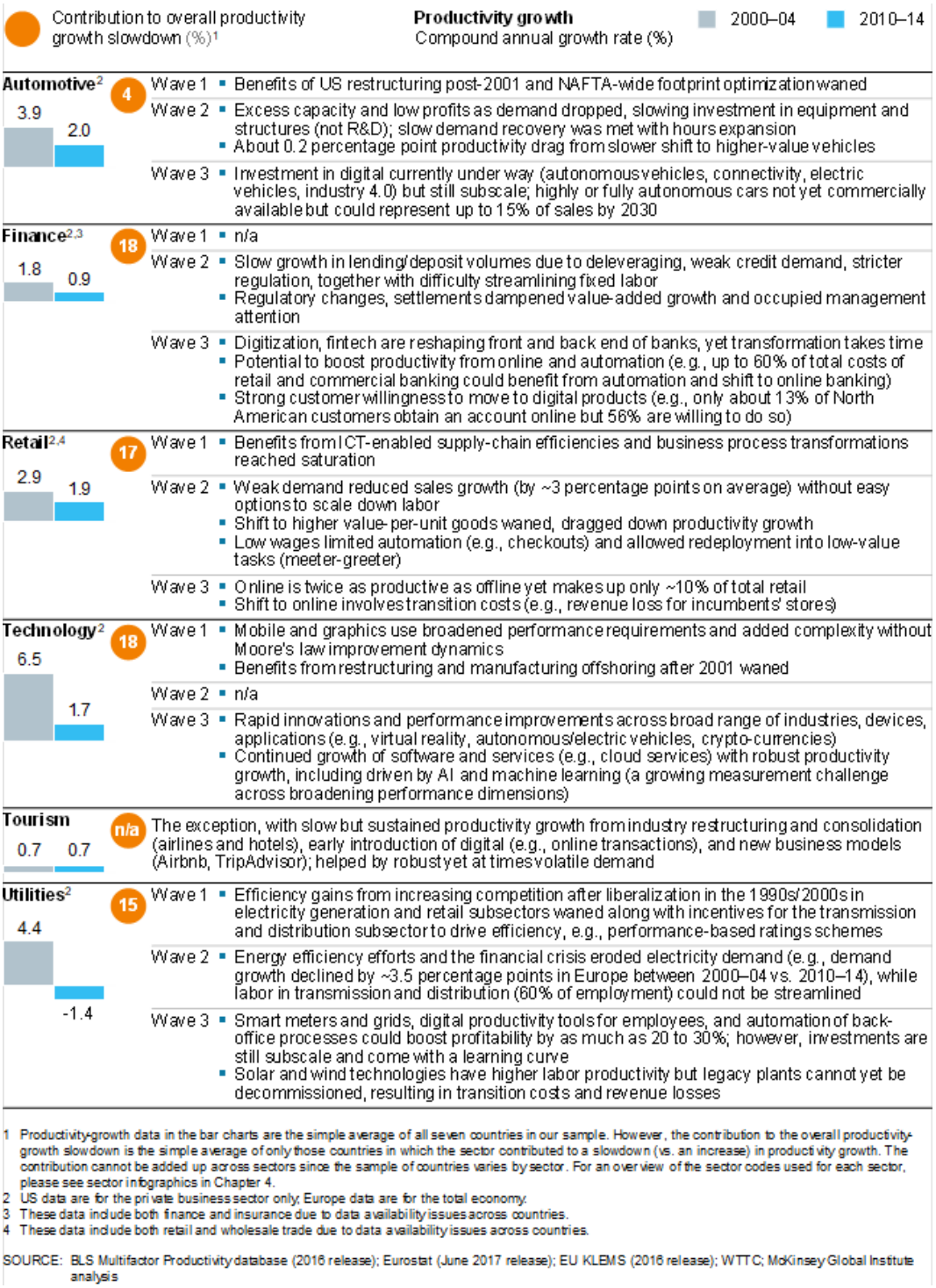
We find three broadly similar groups of countries: Sweden, the United Kingdom, and the United States, which have experienced the largest productivity-growth decline in our sample; France and Germany, which experienced a less dramatic drop in productivity growth but a continuing long-term decline; and Italy and Spain, with no decline. These variations are mainly associated with the strength of the boom prior to the financial crisis, the extent of the crisis itself, and differences in labour market flexibility.

A Sector View on the Productivity Slowdown

Our sector analysis provides an alternative lens to examine the macro trend of declining productivity growth. We find the three waves played out in different ways and to different degrees across sectors (Chart 7). Few sectors illustrate how this perfect storm impacted productivity growth across countries as well as the retail sector. By the time the crisis hit in 2007, the retail sector was at the tail end of a productivity boom that began around 1995. Then weak demand

27 See also Bughin and van Zeebroeck (2017); Bughin, LaBerge and Mellbye (2017); and Bughin and van Zeebroeck (2017).

Chart 7: The Impact of the Three Waves of Productivity Drivers for Six Sectors



1 Productivity-growth data in the bar charts are the simple average of all seven countries in our sample. However, the contribution to the overall productivity-growth slowdown is the simple average of only those countries in which the sector contributed to a slowdown (vs. an increase) in productivity growth. The contribution cannot be added up across sectors since the sample of countries varies by sector. For an overview of the sector codes used for each sector, please see sector infographics in Chapter 4.
2 US data are for the private business sector only; Europe data are for the total economy.
3 These data include both finance and insurance due to data availability issues across countries.
4 These data include both retail and wholesale trade due to data availability issues across countries.

SOURCE: BLS Multifactor Productivity database (2016 release); Eurostat (June 2017 release); EU KLEMS (2016 release); WTTC; McKinsey Global Institute analysis

resulting from the financial crisis and recovery made matters worse in two ways: through an overall reduction in sales without a corresponding reduction in labour, and a switch to lower value-per-unit products and brands. As demand began to recover and wages across countries remained low, retailers hired more than they invested. In the middle of this slow recovery and challenging demand environment, the rise of Amazon and the wave of digital disruption occurring in the retail industry added about 0.5 percentage point per year to productivity growth from the shift to more productive online channels, accompanied by transition costs, duplicate structures, and drags on footfall in traditional stores.[28]

The tourism sector provides a counterexample. It shows how productivity growth has been slow but steady across many countries from the incorporation of new technology, new business models, increasing consolidation, new competitors, and growing demand.

As financial crisis aftereffects continue to dissipate, we expect productivity growth to recover from current lows across sectors and countries. Our sector deep dives reveal significant potential to boost productivity growth both from a continuation of more typical productivity opportunities such as operational efficiency gains and from new avenues enabled by digital technologies. Digital automation is just one channel in which digitization will impact productivity growth; digital flows and platforms can also accelerate globalization and global competition, and digital features can substantially increase customer value (McKinsey Global Institute, 2014). Over all, we estimate that the productivity-boosting opportunities could be at least 2 per cent on average per year over the next ten years, with 60 per cent coming from digital opportunities.[29] While low productivity growth of today may lead to concern about the future, research indicates that past productivity performance is a poor indicator of future productivity growth (Brynjolfsson, Rock and Syverson, 2017).

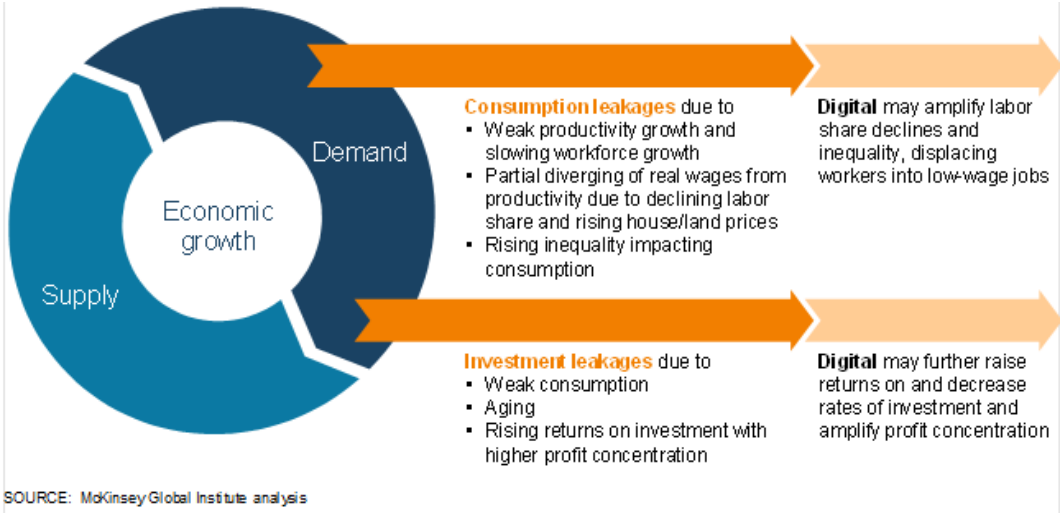
Capturing the Productivity Potential: Promoting Both Demand and Digital Diffusion

There is no guarantee that the productivity-growth potential we identify will be realized without taking action. While we expect financial crisis-related drags to dissipate, long-term drags may continue, such as a rise in the share of low-productivity jobs and slack-

28 Impact calculated based on the mix shift between online and offline retail, assuming today's level of relative productivity between the two segments. Based on data from Euromonitor International, Retailing data (2018 edition) and S&P Capital IQ.

29 Our estimate for the productivity-growth potential builds on extensive past MGI research on sector opportunities for improving productivity through technologies that are already implemented today or have a clear path to deployment at scale by 2025. These include benefits from digitization (e.g., big data, Internet of Things, automation, AI) as well as non-digital opportunities such as mix shifts in products and channels, continued consolidation, etc. See McKinsey Global Institute (2015a); McKinsey Global Institute (2015b); McKinsey Global Institute (2016); and McKinsey Global Institute (2017). See the technical appendix of Remes *et al.* for more details.

Chart 8: Long-term Demand Leakages and Links to Productivity Growth



ening demand for goods and services due to changing demographics and rising income inequality; all of these factors may be further amplified by digitization. At the same time, the nature of digital technologies could fundamentally reshape industry structures and economics in a way that could create new obstacles to productivity growth.

The Amplification of Demand Drags and the Potential Industry-Breaking Effects of Digital

While weak demand hurt productivity growth in the aftermath of the financial crisis, looking ahead, there is concern that some demand drags may be more structural than purely crisis-related. There are several "leakages" along the virtuous cycle of growth (Chart 8). Broad-based income growth has diverged from productivity growth, because the declining labour share of income and rising inequality are eroding median wage growth, and the rapidly rising costs of housing and education exert a dampening effect on consumer purchasing power.[30]

It appears increasingly difficult to make up for weak consumer spending via higher investment, as that very investment is influenced first and foremost by demand, and rising returns on investment discourage investment relative to earnings. Demographic trends may further diminish investment needs through an aging population that has less need for residential and infrastructure investment. These demand drags are occurring while interest rates are hovering near the zero lower bound. All of this may hold back the pace at which capital per worker increases, affect company incentives to innovate, and thus impact productivity growth, slowing down the virtuous cycle of growth.

Digitization may further amplify those leakages, for example as automa-

30 See Chapter 5 of Remes *et al.* (2018) for a more detailed discussion of the declining labour share of income.

tion may compress labour's share of income and increase income inequality by hollowing out middle-class jobs and may polarize the labour market into "superstars" vs. the rest. It may also raise returns on investment and thus reduce rates of investment. Cannibalization of incumbent revenues puts pressure on nominal demand. And the rate of technological labour displacement is set to rise. Unless displaced labour can find new highly productive and high-wage occupations, workers may end up in low-wage jobs that create a drag on productivity growth (Landesmann and Stehrer, 2004 and McKinsey Global Institute, 2017). Our ability to create new jobs and skill workers will impact prospects for income, demand, and productivity growth.

Digital technologies may also dampen their own productivity promise through other channels. Various digital technologies are characterized by large network effects, large fixed costs, and close to zero marginal costs. This leads to a winner-take-most dynamic in industries reliant on such technologies and may result in a rise in market power that can skew supply chains and lower incentives to raise productivity. For example, some digital platforms benefit from a growing user base, as social networks with more users allow for more connections, while larger pools of search data generate better and more targeted results. While the potential economic costs and approaches to regulation of network industries are well established, the nature of digital platforms is sufficiently different to warrant further policy consideration.

Independent of platform economies, rising corporate concentration throughout the economy may reduce competitive pressure and translate into weaker incentives to innovate and invest in raising productivity. While the empirical evidence suggests that the link between concentration and either competitive intensity or productivity growth may not be a strong one, this is another often-cited concern today (Furman and Orszag, 2015, and Gutirrez and Philippon, 2017). Importantly, in our sector deep dives, we have found no evidence that rising business concentration has hurt productivity growth so far. However, going forward, that may not be the case. There may be a tipping point where the initial benefits from industry consolidation, from factors such as economies of scale and reducing the need for staff, and from restructuring operations may give way to costs as competitive pressure declines with the rise of market power. Rising corporate concentration could also further increase income inequality and compress labour's share of income.

New digitally enabled business models can also have dramatically different cost structures that change the economics of industry supply significantly and raise questions about whether the majority of companies in the industry and the tail will follow the frontier as much as in the past. For example, in retail, productivity growth in the late 1990s and early 2000s was driven by Tier 2 and 3 retailers replicating the best practices of frontier firms like Walmart. Today, it

is unclear if many of Amazon's practices can be replicated by most other retailers, given Amazon's large platform and low marginal cost of offering additional products on its platform. On the other hand, platforms like Amazon, TripAdvisor, and Airbnb offer the potential for new, small, and niche players to compete effectively with larger players, fundamentally changing the structure of the industry. It is unclear then what the net productivity impact of such changes in industry structure and economics will be, depending, for example, on the share of the market different players are able to gain and their relative productivity levels.

Finally, digitization may reduce price transparency and market efficiency as the customization of price, product, and terms proliferates through the use of consumer data, potentially reducing the incentives for companies to focus on efficiency gains as they extract more of the consumer surplus.

Going Forward: The Need of a New Paradigm

Unlocking the productivity potential of advanced economies may require a focus on promoting both demand and digital diffusion, in addition to interventions that help remove traditional supply-side constraints such as red tape (Lewis, 2004; Taylor, 2016, Davis, 2017). To incentivize broad-based change, companies need competitive pressure to perform better, a business environment and institutions that enable change and creative destruction, and access to infrastructure and talent. Yet additional emphasis on digital diffusion and demand is warranted.

There are many opportunities today for policy makers to help boost productivity growth in advanced economies that focus on demand and digital diffusion. Demand may deserve attention to help boost productivity growth not only during the recovery from the financial crisis but also in terms of longer-term structural leakages and their impact on productivity. Suitable tools for this longer-term situation include: focusing on productive investment as a fiscal priority; growing the purchasing power of low-income consumers with the highest propensity to consume; unlocking private business and residential investment; and supporting worker training and transition programs to ensure that periods of transition do not disrupt incomes.

On digital, action is needed on the part of policy makers both to overcome adoption barriers of large incumbent business and to broaden the adoption of digital tools by all companies and citizens. Actions that can promote digital diffusion include: leading by example and digitizing the public sector; leveraging public procurement and investment in R&D; driving digital adoption by small and medium-sized enterprises (SMEs); investing in hard and soft digital infrastructure and clusters; doubling down on the education of digital specialists as well as consumers; ensuring global connectivity; and addressing privacy and cybersecurity issues. Furthermore, regulators and policy makers will need to understand the differences

in the nature of digital platforms and networks from the network industries of the past, and develop the tools to identify non-competitive behavior that could harm consumers.

Other stakeholders have a role to play as well. How do companies, labour organizations, and even economists respond to the challenge of restarting productivity growth in a digital age? Companies will need to develop a productivity strategy that includes the digital transformation of their business model as well as their entire sector and value chain, and not just focus on operational efficiency. In addition, they may have to rethink their employee contract in order to develop a strategy, potentially together with labour organizations, where people and machines can work side by side and workers and companies can prosper together. Economists can play a key part by developing new and improved ways to measure productivity and by developing models that can assess the impact of technology on markets and prices.

Conclusion

While productivity growth in advanced economies has been slowing for decades, the sharp downturn following the financial crisis has raised alarms. We find that the most recent slowdown is the product of two waves, the waning of a 1990s ICT productivity boom and financial crisis aftereffects, while a third wave, digitization, is under way. As financial crisis aftereffects continue to recede and digitization matures, productivity growth should recover from historic lows. How strong the recovery is, however, will depend on the ability of companies and policy makers to unlock the benefits of digitization and promote sustained demand growth. There is much at stake. A dual focus on demand and digitization could unleash a powerful new trend of rising productivity growth that drives prosperity across advanced economies for years to come.

References

Adler, G., R. A Duval, D. Furceri, S.K. Celik, K. Koloskova, M. Poplawski-Ribeiro (2017) "Gone with the Headwinds: Global Productivity," IMF staff discussion note, No. 17/04.

Anzoategui, D., D. Comin, M. Gertler and J. Martinez (2016) "Endogenous Technology Adoption and R&D as Sources of Business Cycle Persistence," NBER Working Paper, No. 22005.

Baily, M.N. and N. Montalbano (2016) "Why is US Productivity Growth So Slow? Possible Explanations and Policy Responses," *The Brookings Institution*.

Baker, S.R., N. Bloom and S.J. Davis (2016) "Measuring Economic Policy Uncertainty," *Quarterly Journal of Economics*, Vol. 131, Issue 4.

Barrero, J.M., N. Bloom and I. Wright (2017) "Short and Long Run Uncertainty," NBER working paper, No. 23676.

Bergeaud, A., G. Cette and R. Lecat (2016) "Productivity Trends in Advanced Countries Between 1890 and 2012," *Review of Income and Wealth*, Volume 62, No. 3, pp. 420-444.

Bigg, M. and T. Mayer (2013) "Bring Credit Back into the Monetary Policy Framework!" *Political Economy of Financial Markets Policy Brief*.

Bloom, N., C.I. Jones, J. Van Reenen, M. Webb (2017) "Are Ideas Getting Harder to Find?" NBER Working Paper, No. 23782.

Borio, C. (2017) "Secular Stagnation or Financial Cycle Drag?" National Association for Business Economics, 33rd Economic Policy Conference, March, Washington, DC.

Brynjolfsson, E., Daniel Rock, and Chad Syverson (2017) "Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics," NBER working paper number 24001, November.

Bughin, J. and N. van Zeebroeck (2017) "Getting Digital Bucks: How the Interplay of Disruption and Types of Strategic Responses Shapes Digital Investment Payoffs and Solves the Solow Paradox," working paper, December.

Bughin, J. and Nicolas van Zeebroeck (2017) "The Right Response to Digital Disruption," *MIT Sloan Management Review*, April.

Bughin, J., Laura LaBerge, and Anette Mellbye (2017) "The Case for Digital Reinvention," *McKinsey Quarterly*, February.

Byrne, D., S. Oliner, and D. Sichel (2017) "Prices of High-Tech Products, Mismeasurement, and Pace of Innovation," NBER Working Paper, No. 23369.

Comin, D. and B. Hobijn (2010) "An Exploration of Technology Diffusion, *American Economic Review*, Volume 100, No. 5, December.

David, P. (1989) "Computer and Dynamo: The Modern Productivity Paradox in a Not-Too Distant Mirror," *The Warwick Economics Research Paper Series*.

Davis, S.J. (2017) "Regulatory Complexity and Policy Uncertainty: Headwinds of Our Own Making," prepared for Hoover Institution conference on Restoring Prosperity, Stanford University, February.

ECB (2016) "Business Investment Developments in the Euro Area Since the Crisis," *European Central Bank: Occasional Paper Series*, No. 167.

Economic Policy Uncertainty (2018) "Economic Policy Uncertainty Index," accessed at: http://www.policyuncertainty.com/

Erber, G., U. Fritsche and P.C. Harms (2017) "The Global Productivity Slowdown: Diagnosis, Causes and Remedies," *Intereconomics*, Vol. 52, No. 1.

Fernald, J. and B. Wang (2015) "The Recent Rise and Fall of Rapid Productivity Growth," *FRBSF Economic Letter*, Federal Reserve Bank of San Francisco.

Flamm, K. (2017) "Has Moore's Law Been Repealed? An Economist's Perspective," *Computing in Science & Engineering*, IEEE, Vol. 19, Issue 2, pp. 29-40.

Furman, J. and Peter Orszag (2015) "A Firm-Level Perspective on the Role of Rents in the Rise in Inequality," presentation at Columbia University, October.

Gutirrez, G. and Thomas Philippon (2017) "Declining Competition and Investment in the US," NBER Working Papers 23583, March.

IMF (2015) "World Economic Outlook - Uneven Growth: Short- and Long-term Factors," International Monetary Fund.

Jovanovic, Boyan and Peter L. Rousseau (2005) General Purpose Technologies, in Philippe Aghion and Steven Durlauf (eds.) *Handbook of Economic Growth*, volume 1B (Amsterdam: Elsevier).

Kolesnikova, N.A. and Y. Liu (2011) "Jobless Recoveries: Causes and Consequences," Federal Reserve Bank of St. Louis.

Landesmann, M.A. and Robert Stehrer (2004) "Technology Diffusion, International Competition and Effective Demand," *Revue d'economie industrielle*, No. 105.

Lewis, W. (2004) *The Power of Productivity: Wealth, Poverty, and the Threat to Global Stability*, (Chicago: University of Chicago Press).

Manyika, J., J. Woetzel, R. Doobs, J. Remes, E. Labaye, and A. Jordan (2015) "Global Growth: Can Productivity Save the Day in an Aging World?" McKinsey Global Institute.

McKinsey & Company (2013) "Moore's Law: Repeal or Renewal?" McKinsey & Company.

McKinsey & Company (2017) "McKinsey Digital Global Survey 2017: How Digital Reinventors Are Pulling Away From the Pack," McKinsey & Company, October.

McKinsey Global Institute (2002) "How It Enables Productivity Growth: The US Experience Across Three Sectors in the 1990s," McKinsey Global Institute, November.

McKinsey Global Institute (2014) "Global Flows in a Digital Age: How Trade, Finance, People, and Data Connect to the World Economy," McKinsey Global Institute, April.

McKinsey Global Institute (2015a) "Digital America: A Tale of the Haves and Have-Mores," McKinsey Global Institute, December.

McKinsey Global Institute (2015b) "Global Growth: Can Productivity Save the Day in an Aging World?" McKinsey Global Institute," January.

McKinsey Global Institute (2016) "Digital Europe: Pushing the Frontier, Capturing the Benefits," McKinsey Global Institute, June.

McKinsey Global Institute (2017a) "A Future That Works: Automation, Employment, and Productivity, McKinsey Global Institute, January.

McKinsey Global Institute (2017b) "Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation," McKinsey Global Institute, November.

Murray, A. (2017) "What Explains the Post-2004 U.S. Productivity Growth Slowdown?" CSLS Research Report No. 2017-05 (Ottawa: Centre for the Study of Living Standards). http://www.csls.ca/reports/csls2017-05.pdf.

Neumark, D. (2014) "Employment Effect of Minimum Wages," *IZA World of Labor*.

Remes, J., J. Manyika, J. Bughin, J. Woetzel, J. Mischke, and M. Krishnan (2018) "Solving the Productivity Puzzle: The Role of Demand and the Promise of Digitization," McKinsey Global Institute. https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Meeting%20societys%20expectations/Solving%20the%20productivity%20puzzle/MGI-Solving-the-Productivity-Puzzle-Report/\-February-22-2018.ashx.

Taylor, J.B. (2016) Slow Economic Growth as a Phase in a Policy Performance Cycle, *Journal of Policy Modeling*, Vol. 38, Issue 4, JulyAugust.

van Ark, B. and K. Jager (2017) "Recent Trends in Europe's Output and Productivity Growth Performance at the Sectoral Level, 2002-2015," *International Productivity Monitor*, No. 33, Fall, pp. 8-23. http://www.csls.ca/ipm/33/vanArk_Jager.pdf

Vanderzeil, S., E. Currier and M. Shavel (2017) "Retail Automation: Stranded Workers? Opportunities and Risks for Labor and Automation," Investor Responsibility Research Center.

Yagan, D. (2017) "Employment Hysteresis From the Great Recession," NBER working paper, No. 23844.