

IMF STAFF DISCUSSION NOTE

The New Normal: A Sector-Level Perspective on Productivity Trends in Advanced Economies

Era Dabla-Norris, Si Guo, Vikram Haksar, Minsuk Kim, Kalpana Kochhar, Kevin Wiseman, and Aleksandra Zdzienicka

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The New Normal: A Sector-Level Perspective on Growth and Productivity Trends in Advanced Economies

Prepared by Era Dabla-Norris, Si Guo, Vikram Haksar, Minsuk Kim, Kalpana Kochhar, Kevin Wiseman, and Aleksandra Zdzienicka^{*1}

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Authors' E-mail Addresses: edablanorris@imf.org; sguo@imf.org; vhaksar@imf.org;
mkim@imf.org; kkochhar@imf.org; kwiseman@imf.org;
azdzienicka@imf.org;

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EXECUTIVE SUMMARY

“Productivity isn’t everything, but in the long run it is almost everything.”

– Paul Krugman (1994)

The anemic recovery more than half a decade after the global financial crisis challenges the conventional understanding of countries’ economic potential and the assessment of future sources of growth. This note goes beyond aggregate trends by focusing on a more detailed sector-level analysis of growth, factor accumulation, and productivity trends across advanced countries before the crisis. This more granular analysis allows for determining which sectors had the largest productivity gaps even before the onset of the crisis, exploring the degree of inefficiencies across sectors, and more robustly identifying areas where potential payoffs from reforms could be large.

Main Findings

- Trend growth in advanced economies has been slowing, driven by a slowdown in human and capital accumulation and declining total factor productivity (TFP). The decline in TFP before the crisis reflected not only the reallocation of resources to sectors where productivity growth was slower, but also declining productivity growth within those sectors which increasingly account for the bulk of employment and economic activity.
- Policy distortions are a major source of inefficient resource allocation across sectors. In most advanced economies, the agriculture and personal services sectors have the most distortions, possibly reflecting the effect of subsidies, preferential policies, and the lack of competition.
- There is no one-size-fits-all policy prescription for all country circumstances and growth experiences. Reform priorities depend on country-specific settings, including the scale of particular policy distortions and the distance from the technology frontier.
- Significant payoffs can be realized with product market reforms, especially in some parts of the services sector, which is the largest sector overall. Moreover, productivity gains from these reforms increase over time. Liberalizing entry into regulated services sectors can also be an important source of job creation and output growth.
- Investments in knowledge capital and innovation (labor skills development, information communication technology capital, and research and development) can boost productivity, especially in countries closer to the technology frontier that generate large global productivity spillovers. The productivity payoffs from investments in infrastructure are significant, but there are more immediate employment and output benefits.
- The productivity impact of labor market reforms is more difficult to discern, reflecting the particular complexity of gauging policies in this area. There is some evidence that reducing labor tax wedges is associated with higher productivity growth over time. In general, labor market reforms tend to matter more for employment, with modest effects on productivity, suggesting the need to avoid either excessive regulation or excessive neglect of labor conditions.
- Reforms can have short-term costs in terms of employment and output, suggesting the need for compensation mechanisms. But there is some evidence of positive effects of reforms even in the short run, which is useful to consider when judging policy priorities at a time of weak demand.

I. CONTEXT

1. **A new mediocre?** Global growth has been anemic in the wake of the balance sheet recessions that rocked advanced economies during 2008–12. The malaise has spread from advanced economies to many emerging markets. Not only are recoveries more protracted in spite of large policy stimulus, questions are being raised about future sources of growth. This, in turn, raises uncertainty about the understanding of potential output. As a result, the policy debate on dealing with the weak recovery has been fraught. Attention has shifted from an early focus on demand stimulus, which is still needed in some key economic areas, to measures to boost global supply amid slowing trend growth and large persistent output losses (IMF, forthcoming).

2. **Should we be surprised?** The current debate on the slow recovery could benefit from a longer-term perspective. While variation exists across countries and time, one clear mega-trend emerges. Underlying output and productivity growth in advanced economies had already been slowing well before the global financial crisis. The ups and downs associated with the financial cycle, along with periods of productivity gains from the adoption of new technologies and efficiency-enhancing reforms, may have masked this trend. Still, the finding is in line with economic theory that suggests that some deceleration in economic growth in advanced economies is inevitable as countries get closer to the technology frontier. Indeed, the experiences of advanced economies that exhibited convergence in the past (Japan in the 1970s) suggest that during the transition to higher income levels, catch-up gains from capital deepening, learning and technology transfer, and structural transformation diminish, and productivity and growth slows. Moreover, working-age population growth has slowed and old-age dependency ratios have increased. Prospects for boosting medium-term growth in advanced economies via increasing factor accumulation alone are likely limited.

3. **The challenge to enhance productivity.** Increasing productivity growth must remain a priority for advanced economies to revive growth and maintain living standards. This implies tackling market and institutional rigidities, and boosting infrastructure and innovation to spur productivity growth and maintain competitiveness. This is reflected in the increased emphasis in domestic policy debates on reforms to support productivity and efficiency. This was echoed at the global level in the Fall 2014 Global Policy Agenda presented by the IMF Managing Director, which emphasized measures to help increase productive capacity (IMF 2014a). This is a complex and multidimensional task, requiring reforms and, hence, a granular approach to policy analysis and application.

4. **Focus of this Note.** Cross-country narratives of the growth slowdown and future prospects have focused on aggregate trends in growth, factor accumulation, and productivity. This study focuses on sector-level productivity developments before the global financial crisis, examining the period from 1970 to 2007 in order to highlight trends already in progress before the onset of the crisis and to provide evidence on underlying productivity developments. This allows for identifying key sector sources of total factor productivity (TFP) gaps that existed even prior to the crisis, exploring issues of misallocation of resources across sectors, and, importantly, more robustly

identifying policy requirements than would be possible with aggregate cross-country data. The work here is based on a unique and rich industry-level dataset across advanced economies.² The database provides harmonized input and output series suitable for cross-country productivity analysis. But as with any cross-country datasets, measurement issues and scope of country coverage, particularly at the detailed industry level, are important caveats.

5. **Roadmap.** Section II examines trends in aggregate and sectoral growth, productivity, and structural transformation across advanced economies. This is a useful starting point to see how economies and the associated growth bottlenecks evolved even prior to the crisis. Section III presents a quantitative thought experiment on how improved factor allocation across sectors could boost output levels—the scope for gains by reducing such inefficiencies is large, especially in slow-growing economies. Section IV then examines how policies—which run the gamut from product market and labor market reforms to boosting technology development and adoption—matter for productivity growth across countries. The section also assesses the dynamic effects of reforms on output and employment as a way of examining potential trade-offs. Policy priorities are derived from this work to boost productivity and offset the secular slowdown apparent in advanced economies.

II. GROWTH AND STRUCTURAL TRANSFORMATION

A slowing pace of human and physical capital accumulation and declining TFP contributed to lower trend growth in the years immediately preceding the global financial crisis. The aggregate decline in TFP reflected the reallocation of resources to sectors where productivity growth was slower, as well as declining productivity growth within those sectors, which increasingly account for the bulk of employment and economic activity. Large sectoral TFP-level gaps across countries, however, point to opportunities for boosting growth.

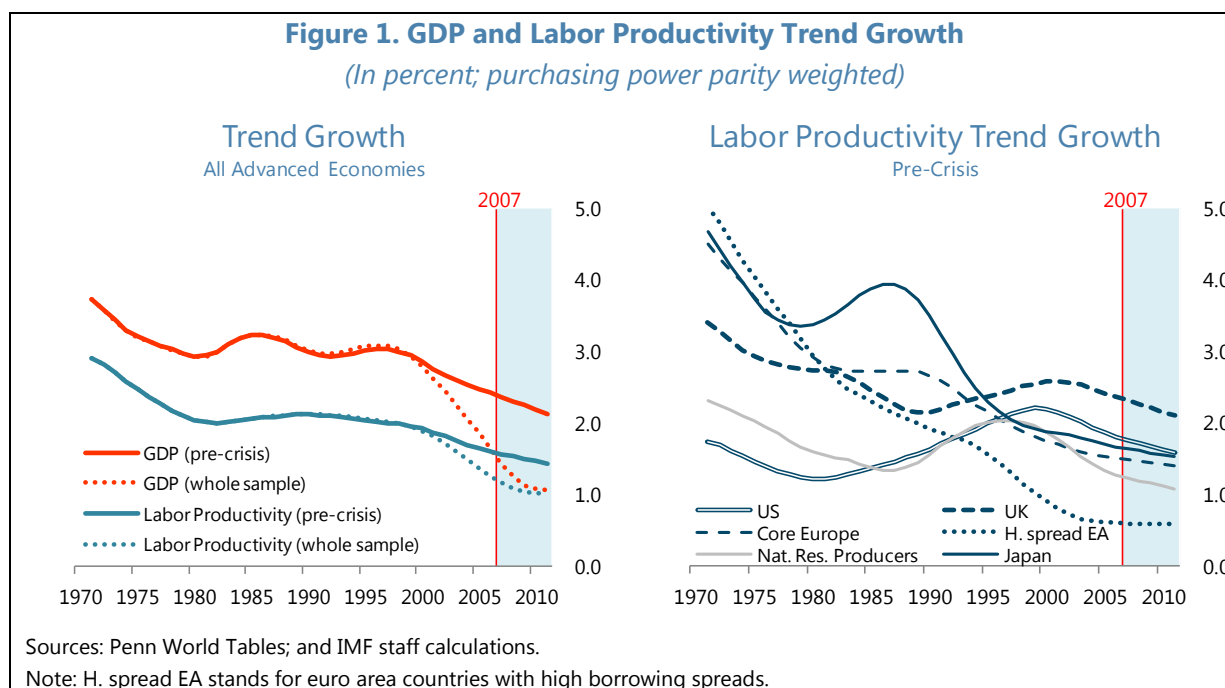
A. The Aggregate Story

6. **Secular decline in output and productivity growth.** Advanced economies have experienced a secular decline in growth and average labor productivity over the last four decades. These trends are evident even in pre-crisis data, and were further magnified by the global financial crisis. Figure 1 shows long-run trend declines in output growth and labor productivity growth before the crisis.³ Output growth declined from an annual average of more than 3½ percent in the 1970s to less than 2½ percent in the mid-2000s just before the crisis. This decline was largely driven by labor productivity. Trend growth in output per hour worked declined from about 3 percent annually in

² The EU KLEMS database is compiled as a product of a research project financed by the European Commission (O'Mahony and Timmer 2009).

³ Estimating the trend on the whole sample, and ending roughly at the trough of the economic cycle, biases the trend growth rates down. By the same token, the pre-crisis sample ends at a cycle peak, meaning that the trends are biased *upward*. The true underlying trend is likely to fall somewhere between these two estimates. Figure 1 plots the growth rates of output- and productivity-level trends, estimated with an HP filter using a smoothing parameter of 100.

1970 to less than 1½ percent in 2007. Trend growth extended to encompass the period of the crisis is, not surprisingly, even gloomier.

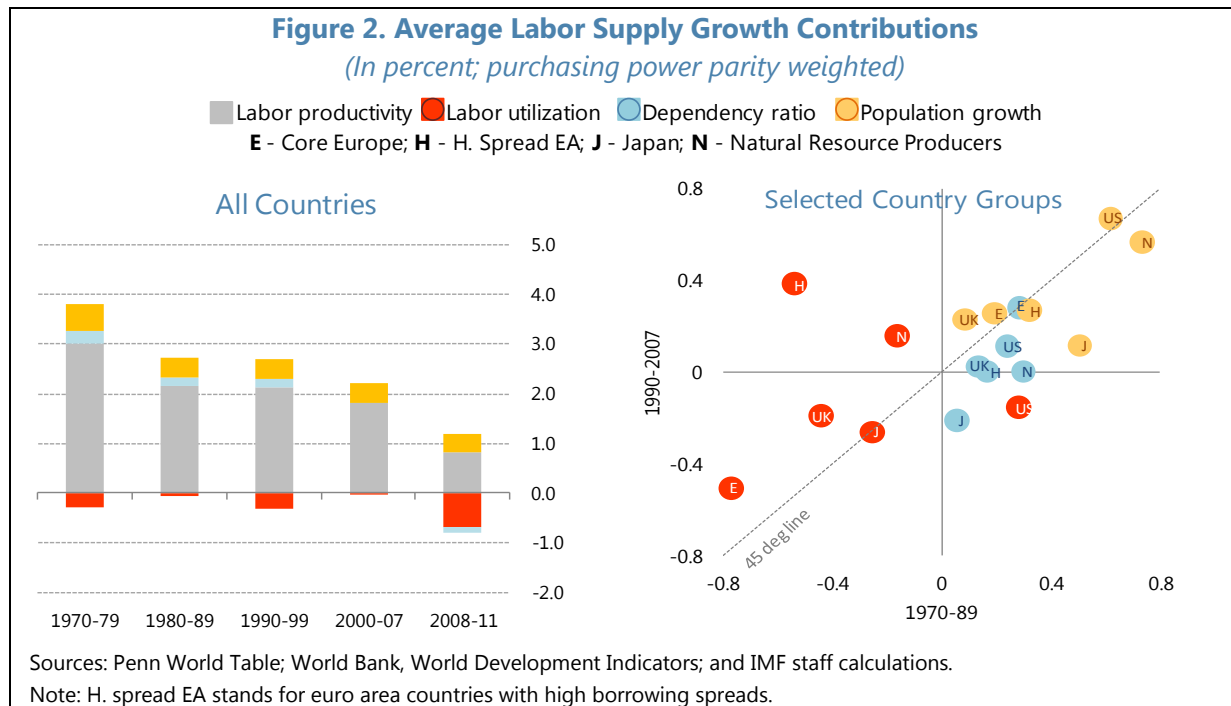


7. **Cross-country heterogeneity.**⁴ This secular decline in labor productivity growth applies to a range of advanced economies, albeit with significant variation. The slowing trend was most marked in core Europe and in euro area countries with high borrowing spreads (van Ark, O'Mahony, and Timmer 2008; Blanchard 2004), where growth fell from the high levels achieved in the recovery following World War II. The decline moderated in the 1980s due to significant reforms, but resurfaced again by the mid-1990s. Japan saw similar high and sustained catch-up growth through the end of the 1980s, but trend labor productivity growth fell to the advanced economy average by the late 1990s. The United States saw a mini-boom as information and communication technologies (ICT) sparked a productivity surge (Jorgenson, Ho, and Stiroh 2008). The surge, which occurred primarily from 1995–2003 (Fernald 2014), temporarily offset the long-run decline and was waning by the time of the crisis. After an extended period of lackluster growth, labor productivity in the United Kingdom grew faster than in most countries from the mid-1990s.

8. **Labor supply played a secondary role.** Narratives of long-run growth decline in advanced economies often focus on labor supply issues—moribund fertility rates, aging populations, and a declining employment ratio (falling labor force participation—reported below as labor utilization—and rising unemployment). These, however, did not significantly slow the long-run growth trend.

⁴ Countries in the sample are Japan, the United States, the United Kingdom, Core Europe (Austria, Belgium, France, Germany, and the Netherlands); euro area countries with high borrowing spreads (Greece, Italy, Ireland, Portugal, and Spain); and Natural Resource Producers (Norway, Canada, and Australia).

Figure 2 shows a clear secular decline in the contribution of labor productivity to total growth as driving the broader trend.

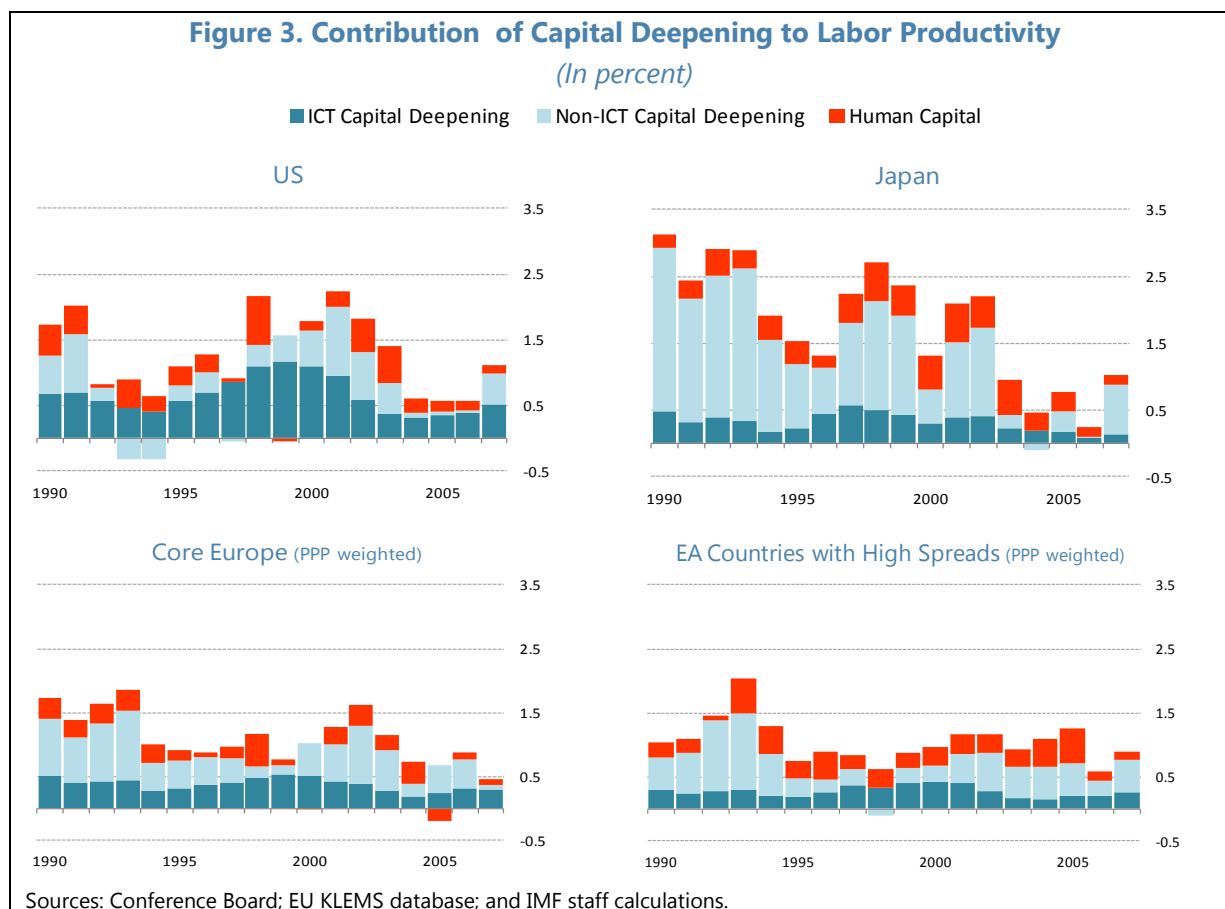


9. **Demographic headwinds loom.** The right-side panel of Figure 2 indicates the labor supply components that have impeded growth for different country groups. Observations below the 45 degree line contributed to the growth slowdown, exerting a greater drag in more recent periods. The rising dependency ratio (more retirees and children per working-age person) is a clear example of a factor exerting downward pressure for most countries. Japan, in particular, has seen a major increase in old-age dependency since the 1990s, with population growth also turning negative. Changes in labor utilization (the fraction of the working-age population in the work force) were less of a drag after 1990 than before, reflecting increasing female labor participation in some countries. Demographic factors will, however, bear down on future growth prospects as population growth follows the dependency ratio down, and as aging populations dissave in retirement and seek lower-risk investments.

10. **Capital deepening struggled.** The decline in the growth of human and physical (both ICT and non-ICT) capital per worker since the 1990s has been an important contributor to the overall labor productivity decline in advanced economies (Figure 3).⁵ ICT-capital deepening, widely regarded as giving the United States a labor productivity edge over European economies, retreated from the peak reached in the mid-1990s, particularly in the United States. The decline in non-ICT capital deepening in many advanced economies also predated the crisis, reflecting in part a long-

⁵ Australia was an exception, as contributions from capital deepening, particularly in the mining sector, have been a key feature of labor productivity growth since the early 1990s, although prospects here may be more mixed with the ending of the commodity super-cycle.

run decrease in public investment (IMF 2014b). Moreover, educational attainment, measured by average years of schooling, also appears to be close to plateauing in most economies. In fact, for cohorts born after 1950 in the United States, the rise in educational attainment slowed markedly and has ceased for the most recent cohort (Fernald and Jones 2014).

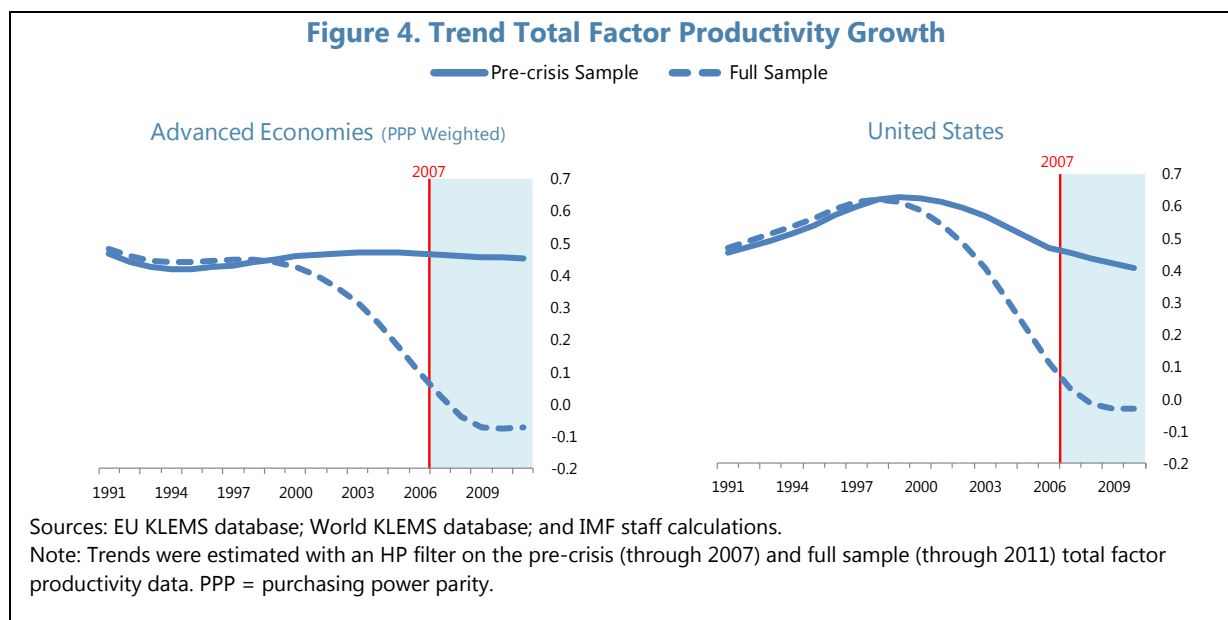


11. **TFP growth stagnated or declined in most of the developed world.**⁶ TFP growth fell dramatically throughout the crisis but was stagnant even at the pre-crisis peak across all economies (Figure 4).⁷ TFP growth fell most dramatically in euro area countries with high borrowing spreads, registering a half percentage point decline on average every decade. The slowdown in TFP growth in the United States, commonly regarded as the world technology frontier, also started well before the

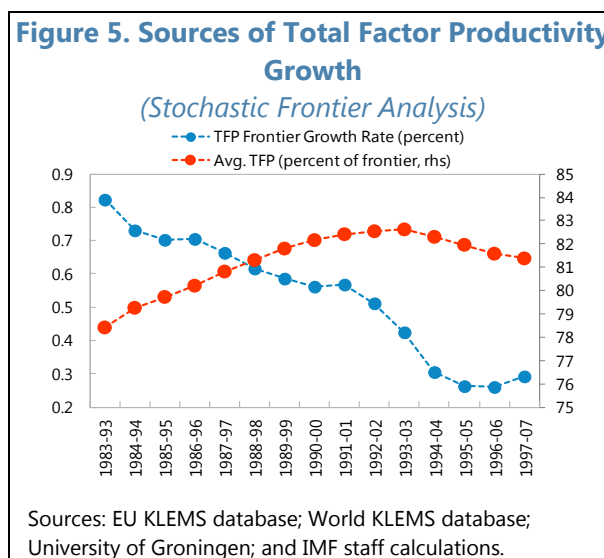
⁶ TFP growth depends on advances in technology and also captures the efficiency with which labor and capital are combined to generate output. This depends not only on businesses' ability to innovate, but also on the extent to which they operate in an environment that fosters competition, imposes less onerous administrative burdens, provides modern and efficient infrastructure, and allows easy access to finance (Sverson 2011). TFP is measured as a residual, and any measurement errors in the labor and capital series will be captured in the estimates. Extensive robustness checks were performed using alternative data sources to assess whether the broad patterns across countries and over time were broadly consistent.

⁷ Controlling for capacity utilization, which tends to be cyclical, makes the post 2000 decline in TFP across advanced economies even more apparent (IMF, forthcoming).

crisis (Fernald 2014). Japan was a rare success story, with TFP growth bouncing back from negative territory reached in the 1990s, reflecting firm-level restructuring. Core European countries were also rationalizing their business models in the 1990s and 2000s, facilitated by labor market and other reforms in Germany and smaller economies (e.g., Sweden, Finland). Natural resource economies, which experienced commodity booms, experienced a big drop in aggregate TFP growth in the pre-crisis 2000s.⁸



12. Technological progress versus efficiency. An alternative way to analyze TFP growth across advanced economies is to examine contributions from technological progress and improvements in efficiency. We apply stochastic frontier analysis (SFA) to estimate a TFP frontier across all advanced economies, representing the maximum possible TFP levels under current technologies (see Annex 1). We also estimate a distance from the frontier for each country, which represents the efficiency with which global technological know-how is being implemented domestically. In this framework, technological progress shifts the production frontier upward for all industries



⁸ Cross-country productivity estimates often find extractive industry productivity to be negatively correlated with commodity prices, due to decreasing returns to scale, and challenges with measuring the quality of resource inputs and outputs (Zheng and Bloch 2014).

and all countries, while an improvement in technical efficiency moves countries towards the production frontier.

13. **Advances in both the technology frontier and the pace of catch-up to the frontier stalled.** Our results show the pace of technological change in secular decline, while technical efficiency (the average country's distance to the frontier), after some initial convergence, also stalled (Figure 5). Rolling window estimates of the SFA model during the period 1983–2007 suggest that the growth rate of the productivity frontier declined at about a third of a percentage point per decade (the blue line in Figure 5). Estimated technical efficiency also stalled in our estimates over time, with the average country moving away from the frontier (the red line in Figure 5). These trends warrant a more in-depth examination of the factors underlying TFP growth.

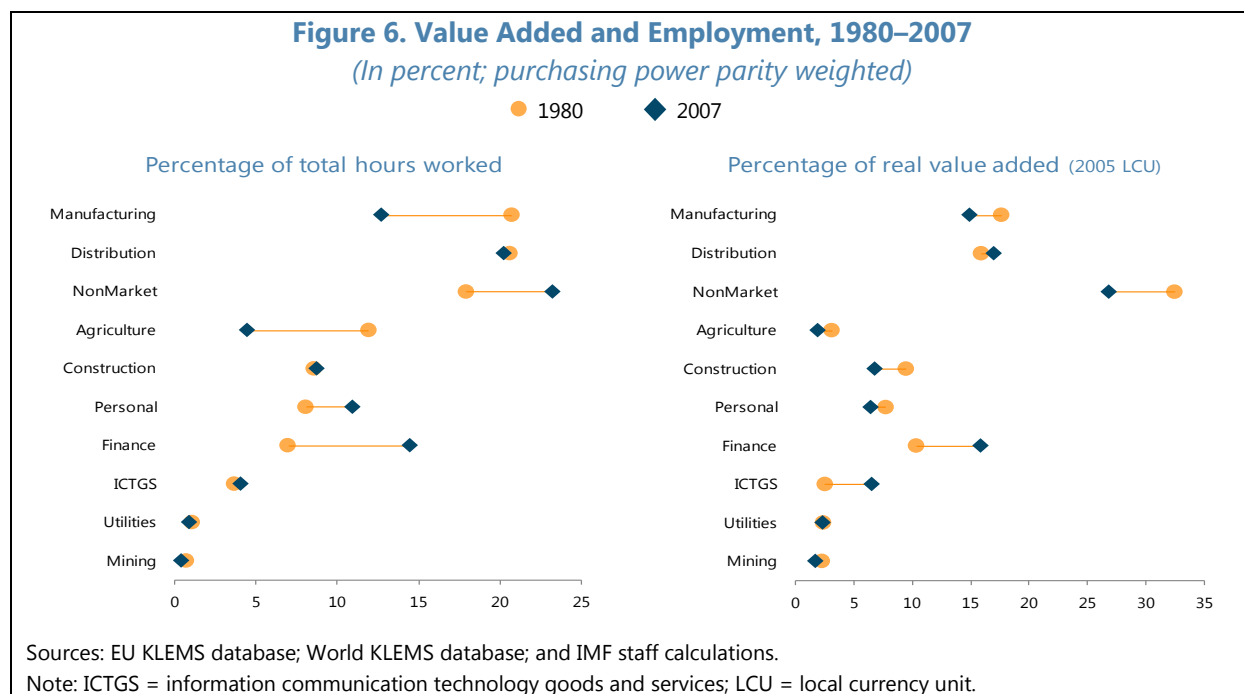
B. Sectoral Productivity Dynamics

14. **Sectoral perspective.** Stagnant and declining TFP growth at the aggregate level, reflected in declining technological progress, can be indicative of slowing human and physical capital accumulation, a falling pace of sector-specific innovation, and structural shifts to lower productivity sectors. At the same time, the stalled pace of catch-up to the frontier can be reflective of limited technological spillovers from the frontier, the waning impact of past reforms, and institutional and regulatory rigidities that stifle competition and induce slower uptake of existing technologies. This subsection takes a sectoral perspective to assess the drivers of underlying aggregate productivity performance before the crisis.

15. **Structural transformation**—the reallocation of factors of production across sectors and activities and sectors—can lead to higher growth if driven by technical change and efficient factor allocation. Yet, different forces have been driving this process within advanced economies. Globalization, for instance, has been accompanied by the outsourcing of some high-productivity manufacturing in many advanced economies. Consumer preferences also change as incomes rise, increasing demand for services (Herrendorf, Rogerson, and Valentinyi 2013). At the same time, technological changes, such as the ICT revolution and the shift into more skill-intensive output, have had profound implications for production structures. Indeed, over the last four decades, advanced economies experienced a well-documented shift away from agriculture and manufacturing and into services. Currently the services sector is dominant, accounting for more than three-quarters of the total labor share. Hence the dynamics of output and productivity within the sector are more important quantitatively (Jorgenson and Timmer 2011).

16. **Shifts within the services sector.** An analysis of employment and value-added shares within the services sector and the underlying shifts between 1980 and 2007 points to a number of commonalities across advanced economies (Figure 6). The increase in value-added and employment shares in finance and business services—sectors that experienced a pre-crisis boom—was universal, and particularly marked in the United Kingdom, where the labor share in finance and business services was the highest among advanced economies. Personal services (e.g., hotels, restaurants, social, and personal services) and nonmarket services (e.g., public administration, education, health, and real estate) also gained labor share in most economies. Productivity growth in these services

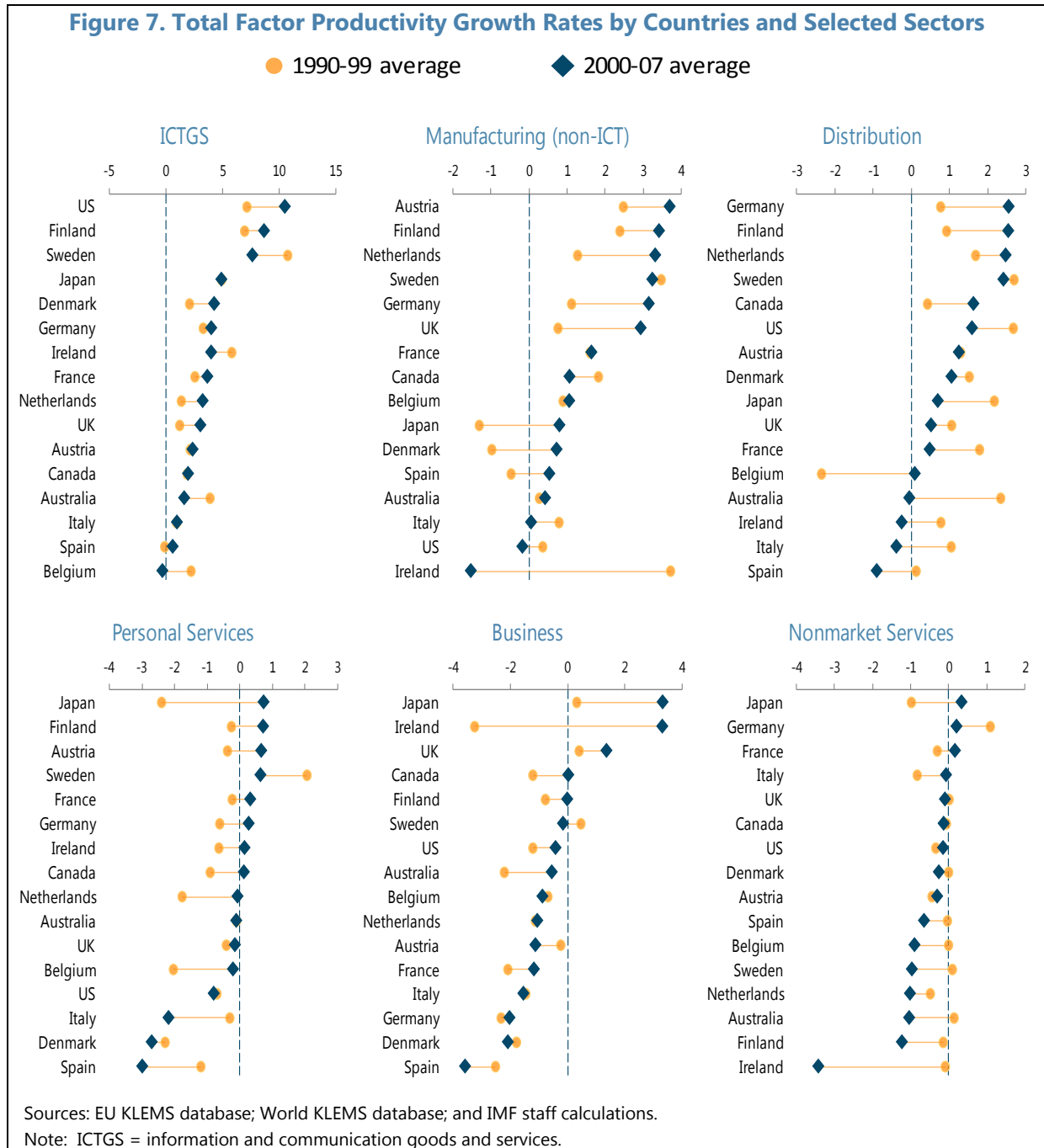
was much lower than in the rest of the economy due to limited scope for innovation and technical change (Baumol, Blackman, and Wolff 1985). The growth in labor shares in nonmarket services in euro area countries with high borrowing spreads was particularly striking in this regard. Yet other services, such as distribution and ICT services, experienced falling prices and rising labor productivity growth, gaining real value-added share while shedding labor.

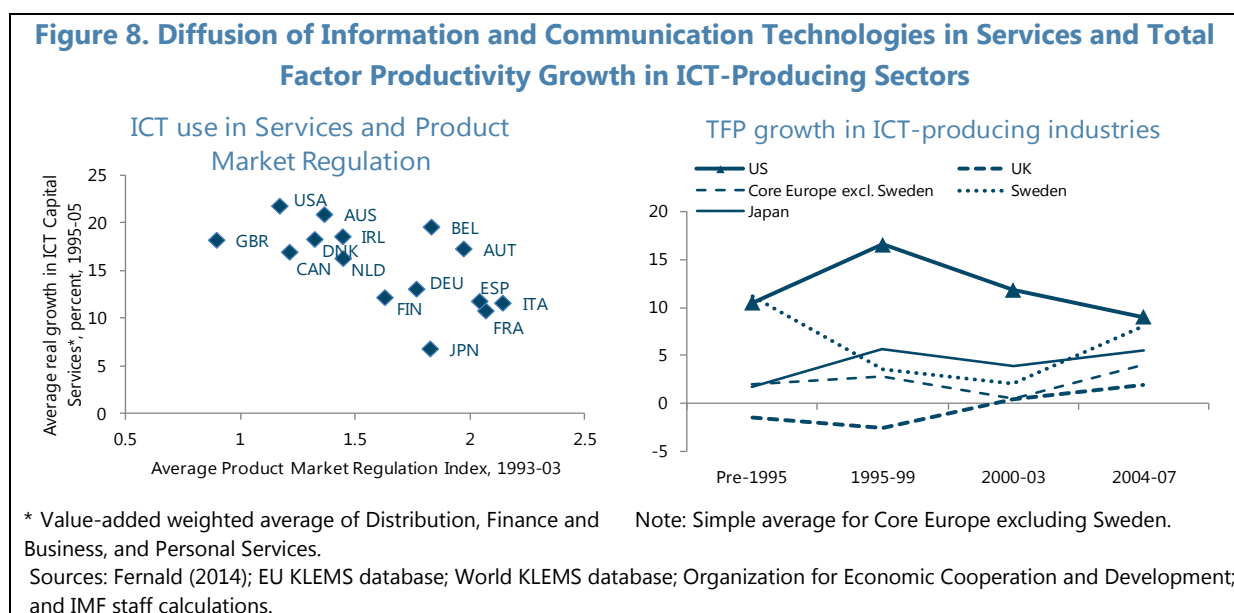


17. **TFP growth within individual sectors.** The aggregate decline in TFP growth in many advanced economies prior to the crisis was driven not only by the reallocation of resources to sectors where productivity growth was slower, but, more importantly, by a decline in productivity growth within those sectors, which increasingly account for the bulk of employment and economic activity. Figure 7 shows TFP growth within selected sectors averaged over 1990–99 and 2000–07. Relatively protected services sectors that are often closed to competition (OECD 2014), such as nonmarket, personal, and business services (which accounted for a growing majority of jobs), were the heaviest drags in terms of TFP growth for many countries (and strongly negative in Italy and Spain).

18. **ICT productivity growth on the wane?** ICT has had a broad-based effect on aggregate TFP through its role as a general-purpose technology that fosters complementary innovations, including business reorganization in other services. As shown in Figure 7, average TFP growth in ICT goods and services (ICTGS) led all sectors during the 2000–07 period, particularly in the United States and the Nordic countries, while Japan, core Europe, and euro area countries with high borrowing spreads lagged. The role in spurring productivity growth in other sectors was even more significant, particularly in the United States. Indeed, slower ICT adoption and diffusion within the services sector in Europe (Finland and Sweden were exceptions) is widely cited as a key driver of the productivity gap between the United States and Europe, reflecting, in part, differences in flexibility of product markets (left-side panel of Figure 8). Yet, the positive effect of ICT on aggregate

productivity growth may have already peaked. Figure 8 (right-side panel) shows a slowdown of TFP growth in IT-producing sectors in the United States in advance of the crisis (Fernald 2014). These trends have led some commentators to note that the productivity frontier is likely to return to slower growth rates last seen in the early 1990s (Gordon 2012).





19. **Distribution services rode the coattails of the ICT revolution.** Distribution services (e.g., wholesale and retail trade and transportation), one of the largest sectors in terms of aggregate employment and output shares that benefited from innovations in ICT (e.g., in sales, inventories, and supply chains), recorded above-average TFP growth in most economies (Figure 8).⁹ However, the United States, among the leaders in the 1990s, and euro area countries with high borrowing spreads (e.g., Italy, Spain), saw a marked TFP growth slowdown in the sector on the eve of the crisis. The slowdown in the United States could reflect the fact that once retailing was reorganized to take advantage of faster information processing, the gains may have become more incremental.

20. **Other “boom” sectors.** While measured TFP growth can have a strong procyclical element—likely exacerbated in the upswing of financial cycles such as that before the global financial crisis—the performance of sectors commonly associated with the pre-crisis boom was mixed. For instance, finance was a high-productivity sector, with the United Kingdom and some European countries, in particular, registering strong TFP growth in the run-up to the crisis. Considering the events of the crisis, however, it remains to be seen how durable these gains will be. In contrast, TFP growth in the construction and real estate sectors disappointed across the board even prior to the crisis, particularly in the United States, Japan, and euro area countries with high borrowing spreads. Similarly, productivity growth in extractive industries slowed prior to the crisis, possibly as increasingly marginal and less productive resource extraction opportunities were pursued in response to booming commodity prices.

21. **Large gaps in TFP levels across industries.** The similarity among advanced economies in aggregate TFP levels masks dramatic variations across individual sectors.¹⁰ As suggested by Figure 9,

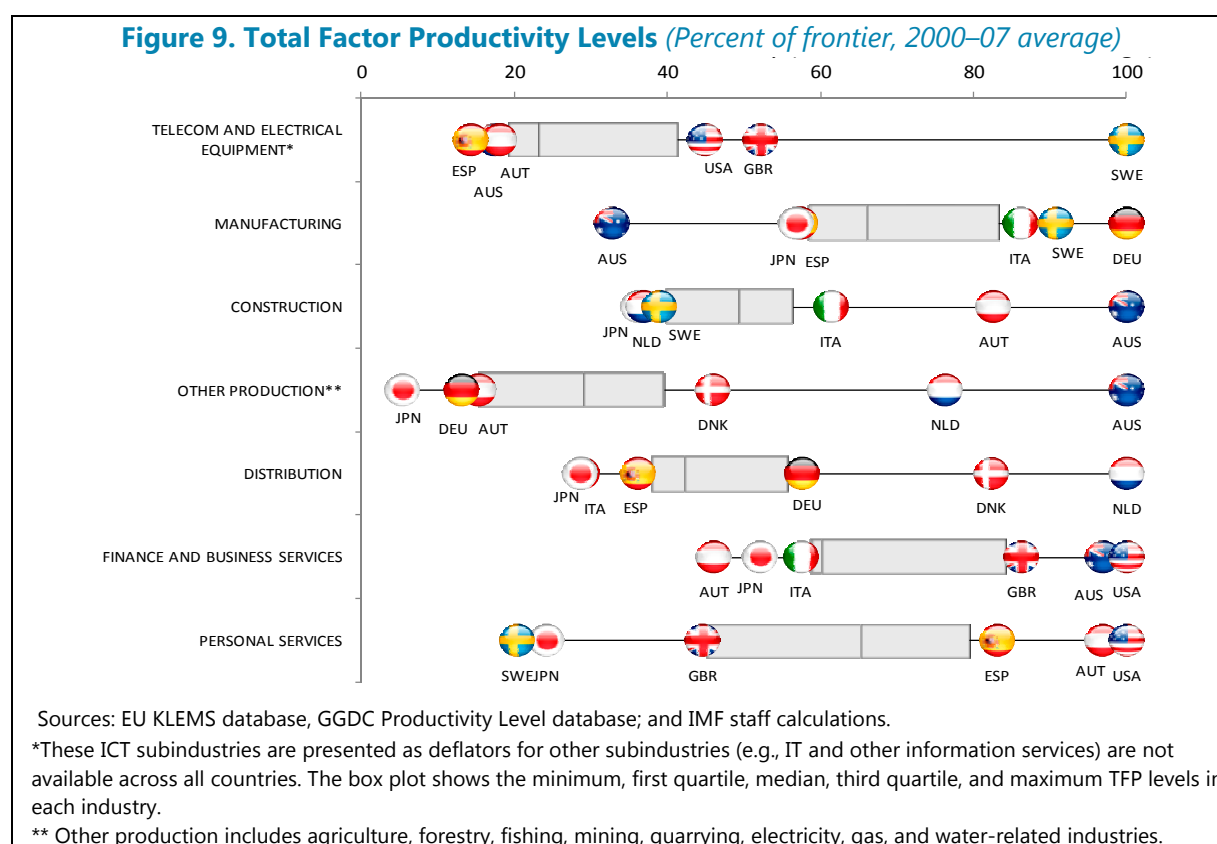
⁹ For instance, companies such as Walmart and Amazon transformed retailing in the United States, pushing through operational and technological improvements as they gained market share (Lewis 2005).

¹⁰ The TFP level estimates were obtained by linking the TFP growth estimates from the EU KLEMS database with the Groningen Growth and Development Centre (GGDC) Productivity-Level database, which provides the PPP-adjusted

(continued...)

even the most technologically advanced countries may have had TFP levels in some sectors that were more than half that of the leader. Indeed, the frontier economy varies from sector to sector. Germany, for instance, led in manufacturing, but lagged in services sectors. A similar story emerges for the United States, which represented the technology frontier in finance, business, and personal services. Those sectors accounted for the bulk of the aggregate productivity gap with the euro area (see also O'Mahony and Timmer 2009), but the United States lagged in non-ICT manufacturing.

22. **Room for reforms.** Natural advantages in some sectors (e.g., mining in Australia) and agglomeration spillovers in others (e.g., manufacturing in Germany) play a role in explaining the observed TFP gaps across countries. Measurement issues are also an important caveat, as errors due to industry misclassification, cross-country comparability of hours worked, and capital services used can be larger in the levels data. As such, differences in TFP levels reported in Figure 9 should be viewed with care. Still, the data suggest the existence of large gaps in sectoral TFP levels across countries prior to the crisis, pointing to room for policy and structural reforms to facilitate catch-up by improving resource allocation (allocative efficiency) and the use of productive inputs (productive efficiency). For countries already at, or close to, the production possibility frontier (e.g., the United States in personal services, the Netherlands in distribution), innovations in products and processes could help boost productivity.



industry TFP levels in 1997 for our sample countries (Inklaar and Timmer 2008). The use of sector-specific price indices allows for meaningful comparisons of the level of productivity in different sectors across countries.

III. RESOURCE ALLOCATION AND PRODUCTIVITY

Significant policy-induced distortions prevented efficient allocation of factors of production across diverse industries and economic sectors even prior to the global financial crisis. Reducing these distortions and achieving more efficient resource allocation could have a substantial impact on boosting productivity.

23. **Resource allocation.** Aggregate TFP in an economy depends not only on the efficiency of individual firms or industries but also on how inputs are allocated across them. Indeed, economic theory suggests that more productive firms should have a greater incentive to innovate, and be more able to attract labor and capital inputs, relative to less efficient firms. Over time, less productive firms are forced to become more efficient or exit.¹¹ This process brings about capital and labor reallocation, which shows up in measured TFP and output. Misallocation of resources, however, can arise if impediments exist to the movement of factors between heterogeneous firms and sectors. This can give rise to persistent rates-of-return differentials across firms and sectors, undermining aggregate TFP growth.

24. **Impediments to efficient allocation.** Impediments to the efficient allocation of capital and labor in advanced economies take various forms. Exemptions of certain producers from regulations or taxes, heavily-subsidized agricultural sectors, and “size-dependent policies” (e.g., size of retail establishments in Japan, and employment protection policies in Italy and France that only take effect beyond a certain size threshold) are distortions that induce a misallocation of factors. Labor and product market rigidities, market structure, and imperfect competition also influence factor reallocation, innovation, and firm restructuring.¹² Examples of capital misallocation include financial frictions that increase the cost of capital, and distort investment decisions, including in technology-enhancing capital.¹³ These distortions lead firms to make inefficient capital and labor choices, thereby lowering aggregate TFP (Restuccia and Rogerson 2008; Hsieh and Klenow 2009).

25. **Within-sector productivity.** Substantial TFP gains can accrue from reducing resource misallocation and improving efficiency even within narrowly-defined industries of the economy. Indeed, industry and firm-level evidence confirms the presence of substantial misallocation of factor

¹¹ For example, Baily, Hulten, and Campbell (1992) find that 50 percent of the growth in manufacturing productivity in the United States in the 1970s and 1980s can be attributed to the reallocation of factors across plants and firm entry and exit (see Foster, Haltiwanger, and Syverson 2008). Similarly, Barnett and others (2014) find that labor reallocation across firms explained 48 percent of labor productivity growth for most sectors in the U.K. economy in the five years prior to 2007.

¹² Hopenhayn and Rogerson (1993) showed that labor market firing taxes distort the allocation of labor across establishments and that empirically reasonable values for this tax could generate TFP losses on the order of about 5 percent. In a related study, Lagos (2006) shows how policies such as unemployment insurance and employment protection affect TFP via selection effects. See also Garicano, Lelarge, and Van Reenen (2013).

¹³ Gilchrist, Sim, and Zakrajsek (2013) relate financial frictions, measured as an increased dispersion in borrowing costs, to capital misallocation across U.S. manufacturing firms even prior to the crisis.

inputs as well as cross-country differences in establishment-level productivity and points to their potentially important role in generating large losses in aggregate productivity (Restuccia and Rogerson 2013; Hopenhayn 2014). For instance, Dias, Marques, and Richmond (2014) find that a better allocation of resources across firms within services industries in Portugal could boost measured TFP by about 40 percent. Similarly, Bartelsman, Haltiwanger, and Scarpetta (2013) find large effects on aggregate TFP from the presence of idiosyncratic distortions, predicting that output could be improved by as much as 15 percent in some European countries by improving the allocation of resources across manufacturing establishments.

26. **Measuring misallocation across sectors.** While within-industry misallocation accounts for the bulk of cross-country productivity differences, reducing misallocation across broad economic sectors can also spur aggregate productivity and output. Following Aoki (2012), and using data on sector-level value-added outputs, factor inputs, and input payments from the EU KLEMS database for 12 advanced economies over 2000–07, we assess the size of the potential labor and capital frictions (or equivalently “wedges”) that must be in place for the data to be an equilibrium outcome of the distorted economy (see the Technical Appendix for the theoretical model). We then undertake a counterfactual exercise to assess aggregate productivity and growth gains from eliminating these distortions (Box 1). Given stylized model assumptions, the estimates are indicative of what can be achieved from reducing distortions, rather than precise productivity payoffs.

Box 1. Estimating TFP Gains from Improved Across-Sector Resource Allocation

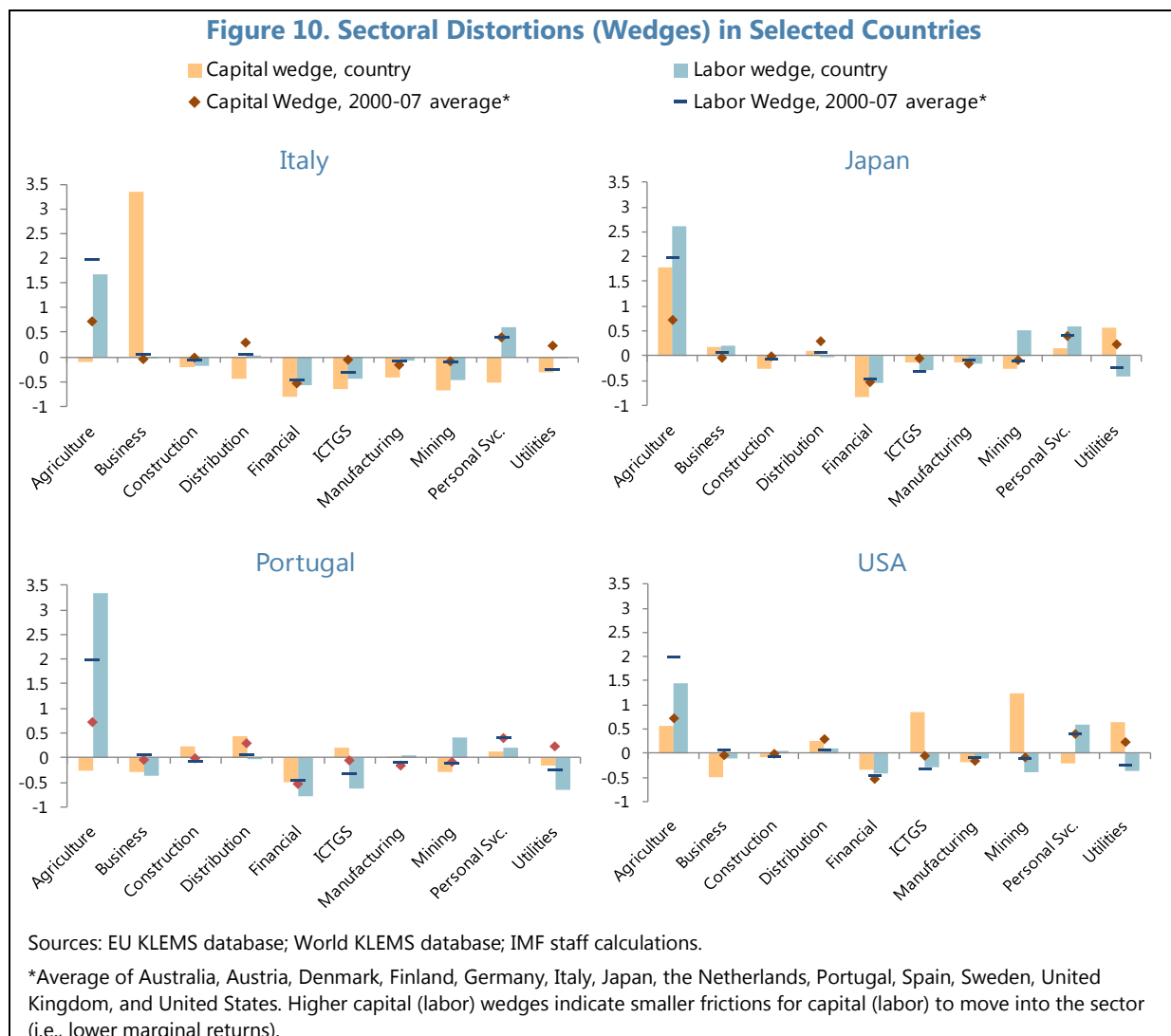
This exercise calculates the TFP gain that could accrue if each country were to adopt a better allocation of its productive inputs across sectors. In an environment without any frictions, the optimal allocation of factor inputs across productive sectors requires the equalization of marginal revenue. Deviations from this outcome represent a misallocation of resources and translate into lower aggregate productivity and output.

The quantitative exercise includes the following steps:

- Building a static general equilibrium model with multiple sectors (see Technical Appendix), where each sector is subject to frictions. Our framework abstracts from specific frictions by assuming that the distortions ultimately affect the effective cost of capital and labor.
- For each country, measuring the sectoral TFP for each year from the data. We also measure labor and capital frictions in each sector by estimating the cross-sector differences in marginal returns to inputs from the data. With these frictions, the equilibrium sectoral input allocation and output in our stylized model should exactly replicate the allocation and output measured in the data.
- Fixing other elements of the model (technology, aggregate labor and capital stock, consumer preferences, etc.), calculating the counterfactual aggregate TFP in an economy with identical frictions in all sectors. This allows us to derive the potential TFP gain if the country were to adopt the (Pareto) efficient allocation.
- Also considering changes only to capital (or labor) frictions. This allows us to identify the contributions of reallocating labor (capital) to the aggregate TFP gain.

One noteworthy issue arises from the measurement of labor inputs. The easiest way to measure labor input is to consider the total hours worked by employees without distinguishing workers’ skill levels (our baseline measure of labor inputs). However, this measure could be problematic, as high-skilled workers tend to provide more effective labor services than low-skilled workers. Therefore, we also constructed a labor index as a weighted sum of hours worked by different skill groups. We report the results of our counterfactual exercise for both the baseline (without labor skill heterogeneity) and the scenario with labor skill heterogeneity.

27. **Sectors with the highest distortions.** In most advanced countries, the agriculture sector is “favored,” with lower marginal returns to capital and labor than in other sectors. This can be seen in Figure 10, which indicates that the labor and capital wedges in the agriculture sector are positive in selected economies (i.e., the user cost of inputs is lower in the agriculture sector than in other sectors), particularly in Japan and Portugal. The underlying distortion stems from subsidies or other preferential policies favoring the agriculture sector. This pattern holds even after accounting for cross-sector heterogeneity in labor skill composition. Furthermore, labor distortions in the personal services sector are usually higher than in other sectors, indicating low marginal returns to labor in this sector. This could be reflective of lack of competition or labor market regulations, as policies, market failures, or location advantages favor this sector for reasons other than relative productivity (Duarte and Restuccia 2010).



28. **Cross-country heterogeneity.** Apart from the “favored” agriculture and personal services sectors, the pattern of factor input misallocation varies across countries. For example, in Italy, a positive capital wedge in the business sector indicates an over-accumulation of capital, and low

capital returns to the sector. In Portugal, low labor wedges in the financial and ICTGS sectors indicate significant barriers to entry and/or other frictions, which limit the size of employment in these sectors. In the United States, misallocation stems from capital distortions, particularly in mining.

29. **TFP gains from eliminating distortions.** The payoffs from improved factor allocation across sectors, while illustrative, are potentially large. Table 1 shows that a reallocation of capital and labor such that distortions are eliminated could substantially increase TFP and output.¹⁴ TFP gains average around 9 percent across all countries, ranging from 3.8 percent in Germany to nearly 20 percent in Italy (Column 1). If labor inputs are measured as skill-weighted hours worked, TFP gains are even larger (Column 2), indicating that labor misallocation includes not only the allocation of working hours but also skill mismatches in the labor force. For instance, accounting for labor skill composition, efficiency gains for the United States could be as high as 6 percent. This is lower than in other advanced economies, potentially reflecting a relatively more flexible labor market and lower skill mismatches than in other countries, but still sizable. Moreover, the relative contributions of labor and capital allocations vary across countries. For Austria and Portugal, the contribution from adjusting labor allocation is substantially higher than the gain from adjusting capital allocation alone. By contrast, the benefit from the adjustment of capital allocation is larger in Italy.¹⁵

Table 1. TFP Level Gain from Adjusting Input Allocation across Sectors (Percent)				
	(1) Baseline (Pareto)			(2) With Labor Skill Composition¹
	Full Adjustment	Adjust Labor Allocation Only	Adjust Capital Allocation Only	
Austria	9.9	6.3	3.3	10.2
Australia	7.2	3.7	3.3	8.7
Denmark	9.8	5.1	4.4	10.7
Finland	10.9	5.2	5.4	17.9
Germany	3.8	1.9	1.9	8.1
Italy	19.5	4.5	14.3	36.4
Netherlands	7.4	5.3	2.0	12.1
Portugal	13.7	12.0	1.5	-
Sweden	4.4	2.1	2.2	-
Spain	6.2	3.2	2.9	11.0
United Kingdom	5.3	3.1	2.1	12.9
Japan	9.2	4.5	4.4	13.7
United States	6.7	3.2	3.4	6.2

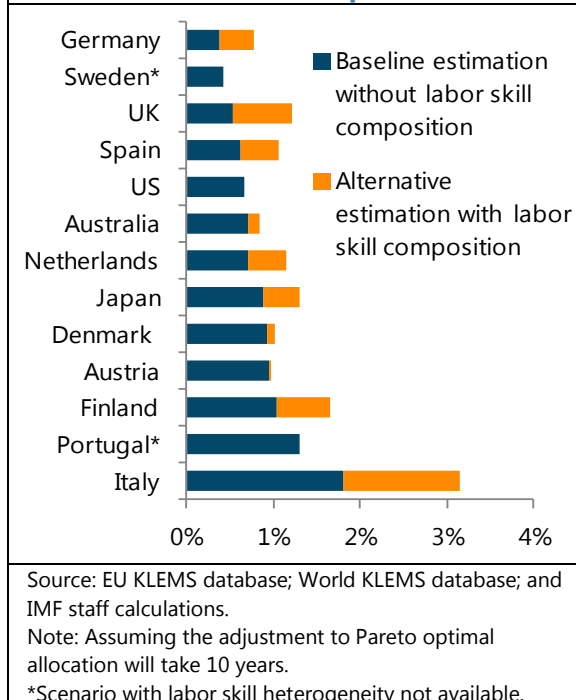
Sources: EU KLEMS database; World KLEMS database; and IMF staff calculations.
 Note: Calculated as TFP after counterfactual inputs allocation adjustment/"actual TFP" -1. Results are reported as averages for 2000–07 (or the latest year upon data availability) average. Country coverage reflects data availability.
¹ Results are reported as 2000–05 average.

¹⁴ The Pareto efficient allocation requires that the marginal return to capital (or labor) be identical across sectors. A larger cross-sector dispersion of input marginal products thus implies a less efficient input allocation, and hence lower aggregate TFP.

¹⁵ Note that our analysis ignores the heterogeneity of capital and its effect on measurement of frictions. Systemic differences in the composition of capital stock across countries could affect our results.

30. **Growth implications.** A better allocation of productive inputs could thus have sizable growth effects. Although input reallocation only explains a part of the measured TFP gap across countries, the potential impact on growth could still be significant. For example, assuming Italy and Portugal eliminate distortions (achieve the Pareto efficient allocation) within the next 10 years, their annual growth rates of TFP (and GDP) could potentially increase by 1.8 and 1.3 percent per annum, respectively, over the decade (Figure 11). While these potential gains appear substantial, it is useful to recall that the underlying distortions themselves are significant and that the exercise assumes that these are completely eliminated. Moreover, since this calculation only considers cross-sector reallocation of inputs (and not cross-industry or cross-firm level reallocation), our estimates only capture a lower bound of the overall gains from reducing misallocation.

Figure 11. Annual Total Factor Productivity Growth from Better Input Allocation



IV. WHAT REFORMS WILL ENHANCE PRODUCTIVITY?

The examination of sector-level productivity developments and the distance of each country and sector from the “technology frontier” allows for identifying country-specific reform priorities. The analysis of how reform payoffs evolve over time also allows for assessing short-run costs to reforms, thus pointing to where compensatory measures may be needed to make reforms palatable.

31. **Which reforms?** There is an extensive literature documenting how policy and structural reforms can lead to improvements in resource allocation, productivity, and growth both in the near term and longer term (Nicoletti and Scarpetta 2003; Barkbu and others 2012; Mc Morrow, Werner, and Turrini 2010; Boursès and others 2013; Bouis and others 2012). In addition to the economy-wide misallocation of resources discussed above, TFP growth of an economy can be influenced by various within-industry structural settings that constrain the allocation of factors and returns to innovation. The attempt here is not to provide an exhaustive list of reform priorities. Instead, the focus is to step away from one-size-fits-all policy messages and empirically explore the determinants of TFP growth, and to assess the dynamic effects of policy and structural reforms.

A. Drivers of Total Factor Productivity Growth

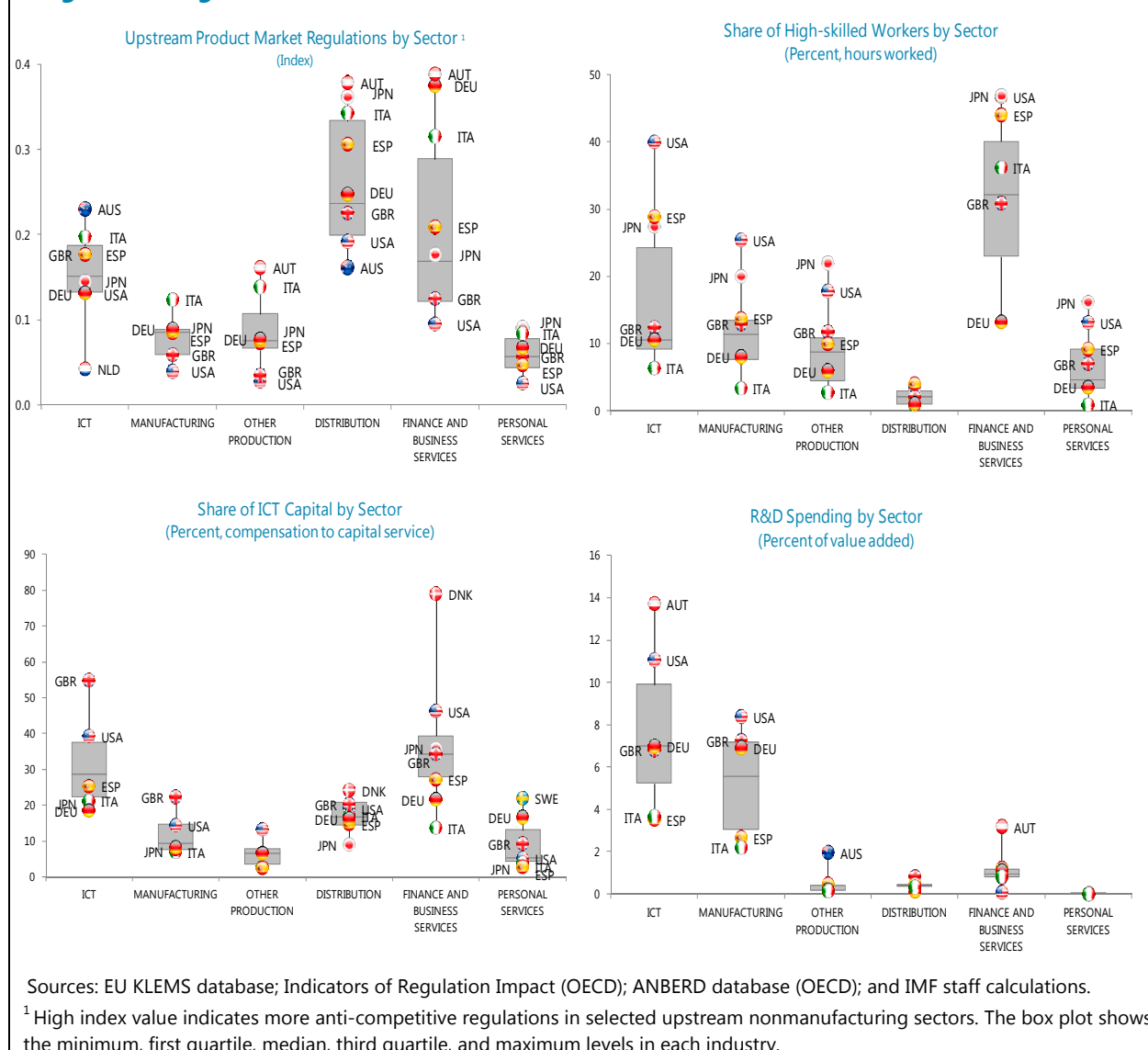
32. **Conceptual framework.** The conceptual framework of “distance to the technology frontier” (Aghion and Howitt 2006, 2009; Acemoglu, Aghion, and Zilibotti 2006) is employed to empirically assess the determinants of TFP growth across different industries and countries.¹⁶ Economic theory distinguishes between two types of innovation activity: adoption of existing vintage technologies (“imitation”) and introduction of new state-of-the-art technology (“innovation”). The key intuition is that countries that are farther away from the global technological frontier tend to grow mainly through technology adoption and imitation, whereas countries closer to the frontier rely more on innovation. Therefore, the set of policies aimed at sustaining productivity growth across industries and countries could vary depending on their locations vis-à-vis their technological frontiers.

33. **Structural drivers of TFP growth.** The focus here is on assessing how regulatory characteristics affect efficiency and convergence and other factors that drive expansion of the technological frontier and foster technology adoption, such as education, innovation, and ICT use. The degree of market flexibility, entry barriers, and competition in an economy is captured by the stringency of product market and employment protection regulations.¹⁷ As can be seen in Figure 12, rigidities in product markets vary across industries and countries, with services among the most heavily regulated industries in most countries, especially in Italy and Japan. The wide dispersion in services regulation across peers suggests a potential upside to reforms. An economy’s capacity for innovation and absorption/adoption of new technologies is captured by the intensity of use of high-skilled labor, ICT capital inputs, and research and development (R&D) spending. The United States appears to lead its peers in most sectors in innovation and the intensive-use of high-skilled labor (Figure 12). Moreover, as can be seen in Figure 12, unlike the manufacturing and ICT sectors, innovation in services does not stem from R&D spending. Instead, investment in tangibles (particularly automation and ICT) and nontangibles (e.g., business processes, organizational structure) are important sources of productivity growth in many services (Uppenberg and Strauss 2010).

¹⁶ We conduct an industry-level panel study for 23 market industries in 11 advanced economies using annual data over 1970–2007 (see Technical Appendix for details). Our empirical specification controls for country-industry specific characteristics and common factors affecting TFP growth, as well as the TFP gap with respect to the “global frontier”—defined as the highest level of TFP in a specific industry in a given year.

¹⁷ For the product market regulation measure, we use the industry-specific OECD Indicators of Regulation Impact, which capture the extent of anti-competitive regulations in upstream industries. For labor market regulations, the OECD’s Employment Protection Legislation indicator is used as the proxy. Unlike other explanatory variables used in the empirical analysis, the employment protection indicator is only available at the economy-wide level. See Technical Appendix for more details.

Figure 12. Regulation, Skill, ICT, and R&D Indicators across Industries and Countries, 2007



34. **Catch-up convergence and technology spillovers.** Tables 2 and 3 illustrate how changes in structural indicators have a material impact on TFP growth, also depending on the distance from the technological frontier.¹⁸ We find evidence that productivity growth across industries is driven by a catching-up process associated with the gradual adoption of newer technologies (Table 2). In particular, the pace of convergence in “follower” industries increases with the distance to the technological frontier (measured by the negative coefficient of the TFP gap). Furthermore, TFP growth across industries is also spurred by developments at the technological frontier (captured by the positive coefficient of TFP growth at the frontier), suggestive of significant productivity-enhancing knowledge spillovers from the technological leaders.

¹⁸ The baseline results reported in Tables 2 and 3 are broadly robust to alternative specifications and the sample periods considered (see Technical Appendix).

Dependent Variable: TFP Growth Rate (Percent, Annual)	All Industries			Manufacturing	ICT-related ¹	Services
	1	2	3	4	5	6
TFP Growth Rate at the Frontier	***	***	***	***	*	.
TFP Gap w.r.t. the Frontier	***	***	***	**	*	**
Product Market Regulation	.	.	*	.	.	***
Labor Market Regulation	.	.	.	.	.	.
Product Market Regulation X TFP Gap				.	.	***
Labor Market Regulation X TFP Gap			.	.	.	.
Product Market Regulation X MFG		.	**			
Product Market Regulation X SVC		***	***			
Product Market Regulation X TFP Gap X MFG			.			
Product Market Regulation X TFP Gap X SVC			***			
Number of observations	4,646	4,646	4,646	2,424	1,616	1,414
R ²	0.2	0.2	0.2	0.2	0.3	0.2

Source: IMF staff calculations.

Note: The symbols *, **, and *** represent panel-corrected robust standard errors at 10, 5, and 1 percent statistical significance. W.r.t. = with respect to.

¹ Industries that produce ICT goods or employ ICT goods intensively.

35. **Product market reforms.** Removing product market rigidities can lift productivity growth, particularly in the more heavily regulated services sectors (e.g., distribution, business, and personal services). Indeed, our empirical results suggest that higher product market regulation in the services sector is associated with lower TFP growth (Table 2). Moreover, the negative impact of stringent product market regulations on TFP growth is more severe the closer the industry is to the technology frontier. Differences in the flexibility of product markets and the business environment also explain observed differences in the uptake and diffusion of ICT between advanced economies (Collecia and Shreyer 2002). This suggests that increasing competition in the services sector by eliminating entry barriers, constraints to business operations, and red tape and administrative burdens would provide a needed productivity boost to services sectors. Indeed, the empirical results suggest that the productivity gains associated with these reforms could be significant. For example, if Italy were to reduce its product market regulation to the level in the Netherlands (e.g., the frontier economy in distribution services in Figure 9), the TFP growth gain within the services sector could amount to about 0.4 percent per year.

36. **Labor market rigidities.** As is common in many similar studies, the extent of economy-wide employment protection is not found to have significant explanatory power for industry-level TFP growth. Among other factors, this reflects the failure to capture the sheer diversity of institutions, underlying distortions, and misallocations in labor markets across countries and the fact that the effect of reforms may take time to materialize (as seen below). But in general, improving labor market institutions can have beneficial effects, with some evidence suggesting that mandatory dismissal regulations have a depressing impact on productivity growth in industries where layoff

restrictions are more likely to be binding (Bassanini, Nunziata, and Venn 2009). Other studies found that longer and more generous unemployment benefits, high labor tax wedges, and collective bargaining systems that are more favorable to wages than employment affect employment negatively (Nickell, Nunziata, and Ochel 2005; Bassanini and Duval 2009). However, studies do not always agree on the role of specific institutions, and cross-country evidence on their productivity impact is less clear-cut (OECD 2007). In general, firm-level evidence points to stronger productivity effects, with less stringent labor market institutions and a more efficient use of human capital (e.g., reducing labor skills mismatches) facilitating the movement of labor to more productive firms, and fostering creative destruction (firm entry and exit) (Henrekson 2014).

37. **Productivity impact of knowledge capital and innovation.** More intensive use of high-skilled labor and ICT capital inputs and higher spending on R&D activities is associated with higher productivity growth (Table 3). The channels through which these factors affect TFP growth, however, differ. A highly skilled labor force can foster the development of skill-intensive industries and the diffusion of new technologies. For example, the results in Table 3 suggest that increasing the share of high-skilled workers in the United Kingdom to the level of Japan could boost productivity growth by an additional 0.7 percent per year. More intensive and widespread use of ICT can support more efficient organizational structures and business processes within firms, leading to efficiency gains. Greater R&D spending creates new efficiency-enhancing technologies. These results clearly support an important public policy role for improving educational attainment, fostering ICT diffusion, and encouraging innovation in advanced economies.

38. **Varying sectoral effects.** Investments in human capital and R&D can play a significant role in spurring TFP growth in ICT-related industries (and services in the case of skilled labor), with the strongest productivity effects for countries closer to the frontier.¹⁹ Trade and technology spillovers imply that reforms in leading economies not only have large productivity effects within these countries, but also generate important positive spillovers. Within the services sector, however, the impact on TFP growth of more intensive use of ICT is highest for countries with lagging productivity in the sector. This suggests an important role for fostering greater ICT investment and diffusion in services, including by eliminating barriers to trade and foreign direct investment, particularly in countries that have important productivity gaps with respect to peers.²⁰

¹⁹ This finding is consistent with previous studies that find that differences in TFP growth rates across industries are linked to persistent cross-country differences in R&D intensity. The empirical literature has identified three set of factors as potential determinants of industry variation in research intensity and productivity growth: technological factors affecting the efficiency of research; the extent to which R&D benefits the innovator; and demand, which influences the returns to research (Ngai and Samaniego 2011).

²⁰ OECD (2001) finds that firms in the United States and Canada enjoyed considerably lower costs of ICT investment goods in the 1990s than firms in European countries and Japan. Barriers to trade, in particular nontariff barriers related to standards, import licensing, and government procurement, may partly explain cost differentials. The difference in the timing of the technological boom in ICT and the regulatory reform process in Europe is also considered a key factor hindering effective accumulation of ICT capital, particularly in services industries where deregulation has been much slower to take place (Arnold, Nicoletti, and Scarpetta 2008).

Dependent Variable: TFP Growth Rate (Percent, Annual)	All Industries					Manufacturin	ICT-related ¹	Services
	1	2	3	4	5	6	7	8
TFP Growth Rate at the Frontier	***	***	***	**	***	***	*	.
TFP Gap w.r.t. the Frontier	***	***	*	.	***	***	***	***
ICT Capital	***			**	.	***	.	*
High-skilled Labor		***		*	***	.	***	***
R&D Expenditure			***	*	***	***	***	.
ICT Capital X TFP Gap					.	**		**
High-skilled Labor X TFP Gap					***	.	***	***
R&D Expenditure X TFP Gap					.	.	***	.
Number of observations	6,923	6,402	2,950	2,685	2,685	1,707	849	487
R ²	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2

Source: IMF staff calculations.
Note: The symbols *, **, and *** represent panel-corrected robust standard errors at 10, 5, and 1 percent statistical significance. W.r.t. = with respect to.
¹ Industries that produce ICT goods or employ ICT goods intensively.

39. **Bringing it together.** What is the economic significance of these results? Using the TFP level estimates in Figure 9, Table 4 presents the potential TFP growth gain associated with improving each structural variable from the 25th percentile to the best-practice level. For the median country, improvements in structural variables could generate additional TFP growth gains of ¼ to ½ a percentage point annually across all industries. Moreover, the table suggests that the sectors through which these improvements affect TFP growth vary. In the case of product market regulations, TFP gains accrue largely within the services sector, while for R&D spending the largest gains are seen in the ICT sector. Better human capital (labor skills) and more intensive use of ICT appear to have broader productivity-enhancing effects, indicating their relative importance in driving aggregate TFP growth.

Sector	Manufacturing	Services	ICT	All
Product Market Regulations	-	0.1	-	0.1
Labor Skill	-	1.4	1.2	0.4
ICT Capital	0.7	0.7	-	0.3
R&D Expenditure	-	-	1.9	0.2
	<0.5	<1	>=1	

Source: IMF staff calculations.

Note: For each indicator, an "improvement" is defined as closing the gap between the highest-ranked country and the 25th percentile country. In each sector, we assume the median TFP level of sample countries over 2000–07.

B. Dynamic Effects of Reforms on Productivity

40. **Reform payoffs evolve over time.** The preceding section considered how institutional rigidities and investments in knowledge capital and innovation are associated with productivity performance. As reforms could result in adjustment costs that potentially vary across sectors, it is useful to assess their dynamic (short- and medium-term) impact. Moreover, the overall productivity gains are likely to depend on the magnitude of reforms undertaken. As a result, this section focuses on large changes in structural indicators and examines their impact on productivity, employment, and output over various time horizons (see Technical Appendix for details).²¹ We also investigate how the productivity impact depends on the distance from the technological frontier, initial settings, and prevailing economic conditions.

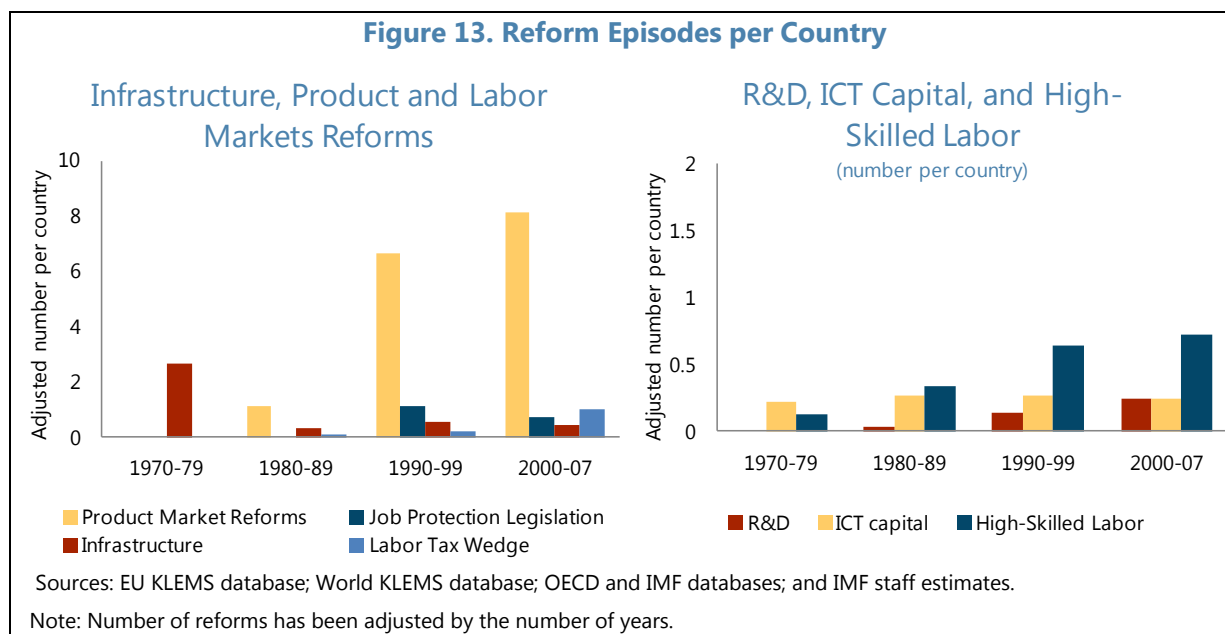
41. **Identifying reform “shocks.”** For the purposes of better identifying cause and effect, it is useful to look at “shocks” to various structural indicators. Large reforms episodes are identified as a significant improvement (in absolute terms) of a structural indicator above a certain threshold (Bouis and others 2012).²² Reforms are identified using the same set of variables described in the previous section with two additions. First, we include a measure of infrastructure, as improvements can have a positive impact on productivity over a longer horizon that goes beyond the effect of increases in the industry-specific capital stock. This is a result of economies of scale, the existence of network externalities, and competition-enhancing mechanisms. Second, we include a measure of labor tax wedges as an additional measure of labor market rigidities, as these can create disincentives to work in some segments of the labor market and affect the direction and pace of technological change.²³

42. **Shock episodes.** Figure 13 presents the number of identified reforms per country. Large infrastructure shocks that took place mainly in the 1970s have since waned, reflecting in part the declining stock of public capital as a share of output in advanced economies (IMF 2014). Product market reforms saw a spurt in the 1990s and continued at a similar pace in the 2000s (Duval 2008). However, labor market reforms, as measured by a reduction in job protection or a reduction in the labor tax wedge, have been less frequent. The frequency of positive ICT “shocks” increased since the 1970s but slowed on the eve of the crisis, as did human capital and R&D shocks.

²¹ In particular, a dynamic version of the empirical specification outlined in the previous section is used to assess the effects of reforms on TFP levels over time.

²² Specifically, a shock is identified if the change in R&D, ICT capital, and high-skilled labor is above two standard deviations of the average annual change in the indicator. Because product and labor market regulations and infrastructure do not vary as much over time, a major reform is assumed to have been undertaken when the change in the policy indicators in a given year is below (above for infrastructure) one standard deviation.

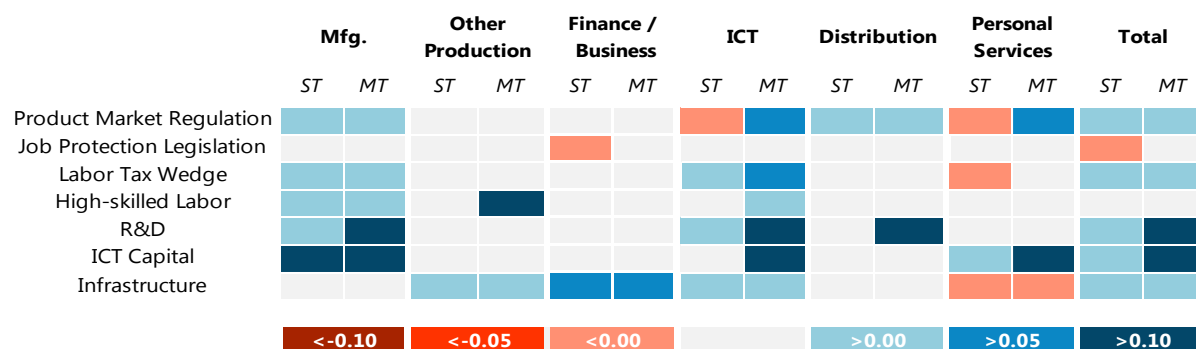
²³ The infrastructure measure is the principal component of roads, phones lines, and electricity generation capacity. For more details see IMF (2014b). The labor tax wedge is taken from the OECD Taxing Wages database, measured as a percentage of taxes and transfers paid in the share of total labor costs.



43. **Productivity impact typically grows over time.** The effects of reforms on productivity growth over the short and medium term are generally positive (Figure 14), consistent with our findings above. Product market reforms, innovation, and infrastructure shocks have a positive productivity impact that increases over time. For instance, a 10 percent shock in R&D spending boosts TFP across all industries by 0.7 percent after three years and 2 percent over five years. In contrast with our previous results, we find that a reduction in employment protection is associated with a decline in TFP after three years, potentially reflecting weaker incentives for investment in firm-specific skills through excessive job turnover.²⁴ A reduction in the labor tax wedge, however, is associated with higher productivity three years after the reform, suggesting that the efficiency impact of different labor market reforms can vary, rendering a one-size-fits-all reform recipe unsuitable. Hence, as stressed in IMF (2013), policies should attempt to stay on the “plateau” and avoid the “cliffs” of either excessive regulations or extreme disregard for labor conditions.

²⁴ Reallocation is important for productivity growth, but much productivity growth also comes from stable employment relationships, as they allow for investment in firm-specific skills (Blanchard, Jaumotte, and Loungani 2013). However, excessive protection that takes the form of complex legal and administrative restrictions on the separation process can increase the cost of adapting to new technologies and hamper the reallocation of labor into higher productivity activities, firms, or industries.

Figure 14. Short- and Medium-Term Impact of Structural Reforms on Total Factor Productivity
(Percent)



Sources: EU KLEMS database; World KLEMS database; OECD and IMF databases; and IMF staff estimates.

Note: The results show the cumulative three-year (ST) and five-year (MT) level gains in TFP. Brown and shades of red indicate a negative and statistically significant impact; shades of blue indicate a positive and statistically significant one. For instance, an ICT capital shock leads to a cumulative TFP level increase in ICT-related industries of about 30 percent after five years (i.e., two standard deviations of the average cumulative five-year change in TFP in the sample). "Other production" includes agriculture, forestry, fishing, mining, quarrying, electricity, gas, and water-related industries.

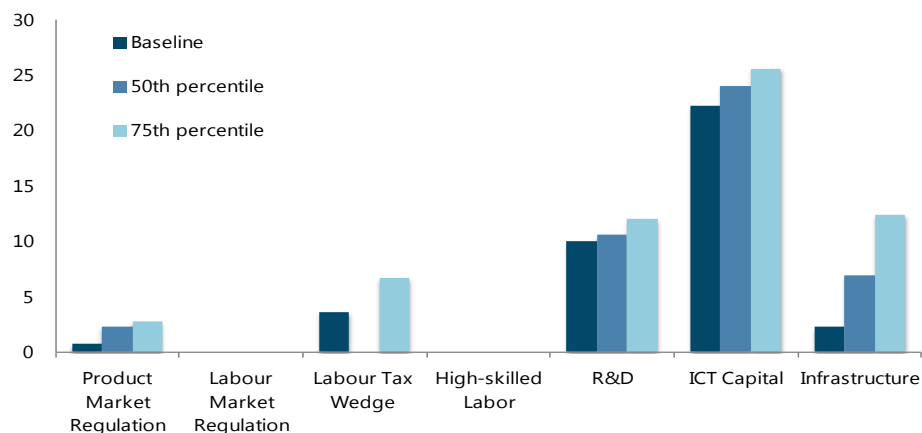
44. **The impact of reforms varies across industries and countries.** We confirm many of the insights from the previous section, including those regarding gains from product market reforms, innovation, and knowledge capital. We also confirm that effects tend to be both sector- and country-specific (in terms of distance to the frontier). Productivity gains from product market liberalization over the medium term are highest in ICT and personal services, sectors where many European countries and Japan have mostly lagged behind the United States. Lower tax wedges, higher R&D spending, and better human capital boost productivity growth in innovation-intensive manufacturing and ICT sectors. Reforms can also have short-term negative productivity effects (e.g., a negative impact of product market regulation on ICT and personal services, and of labor tax wedges on personal services), reflecting varying adjustment costs across sectors during the reform process (Blanchard and Giavazzi 2003; Gomes and others 2013). Importantly, we find a positive productivity impact from infrastructure for all countries, irrespective of their distance to the frontier.²⁵

45. **Pre-reform policy and structural settings.** The impact of reforms could differ depending on initial policy and structural settings. To assess this, we examined the productivity effects in industries with low (below the 25th percentile of the distribution), medium, and high (above the 75th percentile) initial policy and structural settings (Figure 15). We find that the largest productivity gains accrue from reducing product market regulations and labor tax wedges in highly regulated services sectors, while the impact is not statistically significant for lightly regulated industries, a result consistent with previous findings (Bourlès and others 2013). Moreover, the medium-term productivity impact of knowledge capital, innovation, and infrastructure, on average, is highest for

²⁵ While the large TFP gains associated with infrastructure shocks are likely to be driven by the fact that our measure of TFP embodies public infrastructure capital, the results are also indicative of complementarities between private and public capital (Dabla-Norris and others 2013).

industries with higher initial levels of innovation and infrastructure (e.g., manufacturing, ICT). Some differences, however, can be gleaned across industries, especially in ICT and personal services, where, the lower the initial levels of R&D spending and ICT capital use, the higher the productivity gains. This again points to the policy role of fostering greater diffusion of ICT services, particularly in economies where productivity growth has been lagging (e.g., many European countries).

Figure 15. Medium-Term Impact of Reforms on Total Productivity Growth: Conditional on Initial Settings
(Percent)

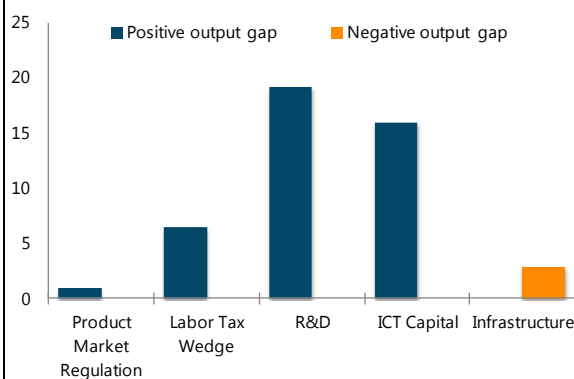


Sources: EU KLEMS database; World KLEMS database; OECD and IMF databases; and IMF staff estimates.

Note: This reports the average cumulative five-year impact of a shock on TFP levels as a function of the initial level of the structural indicator.

46. **Reform impact across the business cycle.** The impact of reforms could also depend on the business cycle position, in particular on how changes in institutional and structural settings affect supply and demand. For instance, weak demand and excess capacity conditions risk limiting the short-term output response to reforms. At present, balance sheet concerns and low confidence weigh on private sector decisions, including technology-enhancing investment choices. To assess the influence of overall economic conditions, we examined reform impacts during upturns and downturns.²⁶ The results, reported in Figure 16, confirm that infrastructure shocks are associated with

Figure 16. Impact of Reform Shocks on Total Factor Productivity across the Business Cycles
(Percent)



Sources: EU KLEMS database; World KLEMS database; OECD and IMF databases; and IMF staff estimates.

Note: The results show the average cumulative five-year gains in TFP levels as a function of overall economic conditions.

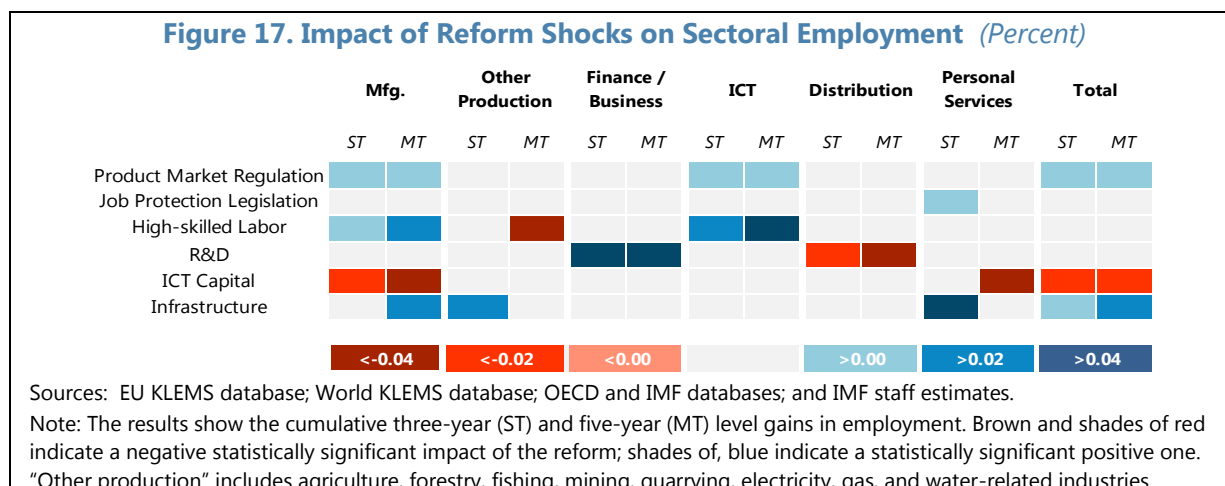
²⁶ Reform shocks are broadly equally distributed between periods of economic upturns and downturns in the data. As economic crises often facilitate reform introduction (Duval 2008), recession and crises dummies are included in the model specification.

significantly higher productivity gains during downturns (IMF 2014b), suggesting an important policy role for infrastructure investment in spurring productivity. In contrast, productivity gains from product market liberalization and, not surprisingly, innovation shocks tend to be higher during upturns. However, as seen below, product market deregulation could still be a useful tool for propelling growth. Liberalizing entry into regulated sectors, for instance, can be a significant source of investment and job creation (Figures 17 and 18).

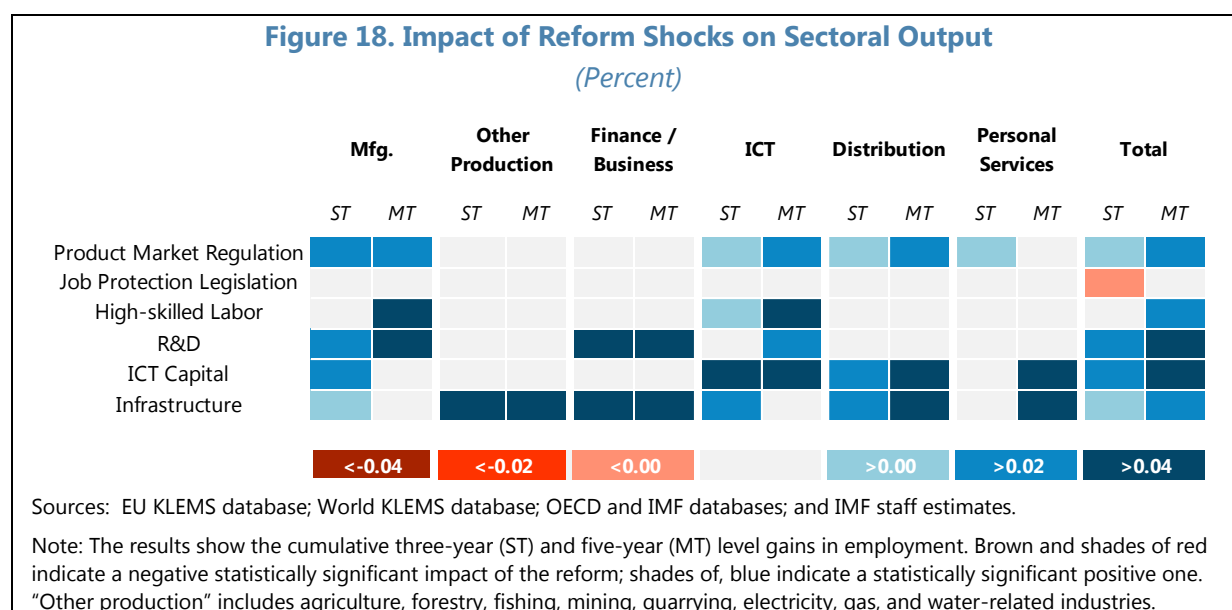
C. Dynamic Effects of Reforms on Employment and Output

47. **Short term costs of reforms?** Reforms could have a small, and in some cases even negative, short-term effect on output and employment because of costly reallocation of labor and capital and firm restructuring, with a temporary rise in unemployment and potentially high fiscal and social costs. But any potential short-term drags from these factors could be offset even in the near term to the extent that reforms enhance credibility and confidence. Fiscal policy can also play a facilitating role by bringing forward employment gains and overcoming resistance from stakeholders who risk short-term losses (IMF 2014c). Nonetheless, while the focus is on the medium-term productivity impact, it is useful to consider short term trade-offs, especially in the current context of weak recoveries in many advanced economies. To shed more light on this issue, we extend the dynamic analysis of reforms on sectoral productivity to sectoral employment and output (value added).

48. **Impact on employment.** The short- and medium-term employment impact of reforms is mostly positive (Figure 17), but can vary across type of reform and by sector. Overall, product market liberalization and infrastructure shocks have a positive and persistent impact on employment. Intensive use of skilled labor has a positive effect on employment, particularly in manufacturing and ICT industries, but is associated with lower employment in other production sectors (e.g., agriculture, utilities, and mining). Labor market liberalization boosts employment in personal services in the short term, reflecting the fact that lower dismissal costs increase employment because firms can hire more freely. ICT shocks are associated with lower employment in manufacturing and personal service sectors, and R&D shocks in distribution services, likely reflecting the labor displacement effects of increasing automation.



49. **Impact on output.** Output gains from reforms are large and materialize predominantly in the medium term (Figure 18). In particular, product market liberalization and more intensive use of high-skilled labor raise output across all industries by about 2 percent over the medium term. Effects of infrastructure and innovation shocks are even larger, increasing output across all industries by around 3 and 5 percent, respectively. Labor market liberalization, as captured by lower employment protection, has a negative aggregate short-term impact on output (though not on employment—see above), similar to its effect on TFP. Some differences are also discernible across industries, but the overall productivity impact across all industries is largely significant. Infrastructure shocks have a positive short- and medium-term output impact in almost all sectors, highlighting the role of infrastructure investment in supporting productivity, employment, and output.



50. **No one size fits all.** Productivity and growth effects of reforms depend on country-specific policy and institutional settings, suggesting the need to prioritize reforms according to individual conditions. Given the nature of statistical relationships, the empirical results should be interpreted as highlighting associations rather than revealing causation. Moreover, they are illustrative of the type of productivity-enhancing reforms that would be effective, and are not intended to suggest that these specific reforms should be implemented by all countries. For instance, the nature of product market rigidities varies across countries, reflecting outright entry barriers (e.g., in business services in Europe) in some countries or monopolistic structures (e.g., network industries) in others. Labor market institutions also vary considerably across advanced economies, suggesting that reforms should take into account different work models. Political economy considerations (e.g., how social consequences of reforms are dealt with) and implementation costs critically influence reform design strategies and effectiveness. Complementarities (e.g., between product and labor market reforms) and sequencing of reforms in different areas are also material for the realization of potential gains. These factors make it difficult to identify the causal effects of reforms on productivity and growth, suggesting that there is neither a single reform path nor a silver bullet.

V. FINAL REMARKS

51. **Headwinds.** This Staff Discussion Note has documented the secular headwinds that advanced economy policymakers face as a result of slowing pre-crisis trend growth in output and productivity. These headwinds reflect structural changes that continue to unfold as economies mature and relative factor costs adjust, with implications for the mix of inputs and structure of production. However, slowing innovation and human and physical capital accumulation, alongside policy distortions, also contribute to the challenges faced.

52. **Back to basics.** To increase growth potential, advanced economies must boost the productive capacity of their workforces, make needed investments in physical and IT infrastructure, and encourage innovation. Removing binding product and labor market rigidities that impede resource allocation toward the most dynamic sectors and firms is crucial to boosting productivity. So is augmenting human capital, including reducing skills gaps and improving the quality of education. The case for refocusing decisively on these fundamental supply drivers is even more urgent in an environment in which many economies are reaching the limits of the policy support they can provide to shore up demand. Moreover, even as some of the crisis-related effects are expected to fade, demographic headwinds loom, further strengthening the case for enhancing productivity.

53. **Investment in knowledge capital and innovation is critical.** Innovation and investments in equipment, ICT, and new ideas are vital for raising long-term trend growth. Investing in capital allows firms to adopt new technologies and can be an important part of their strategies to reorganize production processes toward global best practices. Fostering a supportive environment for investment in innovation and technology adoption is central to having a dynamic and productive economy. Competition can increase the supply of new ideas and push frontier firms to innovate and produce new technology. Well-functioning markets diffuse this technology, prompting its adoption more widely, and resources can be quickly reallocated from failing to growing firms so that the economy can reap the returns of innovation and entrepreneurs have the incentives to undertake risky projects. Since there are often market failures in innovation, the government also has a role in providing incentives for R&D and for creating wider policies to support innovation.

54. **Tailoring to economic conditions.** Where demand is weak and there is slack in the labor market, and where investment efficiency is high, product market reforms and increased investment in productive infrastructure could be prioritized to reap immediate employment and output benefits. More generally, well-designed structural reforms that minimize potential short-run contractionary effects could translate into rising output and employment.

55. **Some other key takeaways include:**

- **Services reform is a priority.** This is the most important sector—but also the most highly regulated one—across advanced economies. The variance in performance and regulations across peers suggests significant upside scope from determined efforts, especially from product market reforms, to increase competition. The potential to boost service productivity through

investment in information technology in lagging regions is also sizable. Labor market policies should attempt to avoid either excessive regulations or extreme disregard for labor conditions.

- **Spillovers can be large.** Efforts to enhance performance by technology leaders (e.g., Germany in manufacturing, the United States in ICT services) are global goods that spill over to support productivity gains in other countries. There is a lot of low hanging fruit in this area. Increasing returns to scale are evident in knowledge capital and create many opportunities for countries to boost their own and global prospects. This will support countries that are further from the frontier, but these are just the countries that need to work doubly hard to remove impediments to productivity growth.
- **Infrastructure investment has clear benefits.** Investments in transport, energy, and telecommunications are essential to improving productivity, boosting employment, and increasing output. Because they tend to be large-scale and long-term, these investments require high levels of coordination to maximize the wider benefits to society as a whole. In many cases, governments will need to play a vital role in planning, delivering, and financing these projects. At present, debt-financed projects could have large productivity and output effects, particularly if clearly identified infrastructure needs are met through efficient investment (IMF 2014b).
- **Improving resource allocation across sectors.** Reducing policy distortions that affect resource allocation across broad economic sectors could yield significant productivity payoffs. In this regard, rationalizing large agricultural subsidies and increasing competition in personal services could be important, as they create a misallocation of productive resources to relatively low-value activities.
- **Calibrating reforms.** The productivity and growth effects of reforms depend on a variety of country-specific policy and institutional settings. While some policies are applicable across all advanced economies, granularity is necessary, as there is no one-size-fits-all strategy. The divergence in productivity performance and the underlying drivers across sectors suggest that reform priorities need to be appropriately calibrated.

Annex 1. Stochastic Frontier Analysis

We use stochastic frontier analysis (SFA) to illustrate the patterns of total factor productivity (TFP) growth across countries at the sector level. The basic idea of SFA in our context is that there is a world frontier technology for each given industry or sector, which represents the most productive technology within that industry or sector. The TFP of industry (or sector) i in country c depends on the world frontier TFP level and how efficient the country can make use of the frontier technology. We choose a model specification close to Pitt and Lee (1981), that is,

$$\log(TFP_{c,t}^i) = \alpha^i + \beta^i t - u_c^i + v_{c,t}^i \quad (1)$$

$$u_c^i \sim N^+(0, \sigma_u^2), v_{c,t}^i \sim N(0, \sigma_v^2) \quad (2)$$

$TFP_{c,t}^i$ is the TFP level of industry or sector i in country c at time t . $\alpha^i + \beta^i t$ represents the world frontier productivity level, which is determined by a constant α^i and a trend component $\beta^i t$. $v_{c,t}^i$ is an i.i.d white noise. The term u_c^i represents the inefficiency level, which is the distance of country i to the world frontier technology. See Belotti and others (2012) for alternative model specifications. Most specifications differ either in the main equation (1) or the distribution of the inefficiency term.

The TFP level estimates used for the calculation were obtained by linking the TFP growth estimates from the EU KLEMS database with the Groningen Growth and Development Centre) Productivity-Level database, which provides the PPP-adjusted industry TFP levels in 1997 for our sample countries (Inklaar and Timmer 2008). We constructed productivity levels series for 23 sectors spanning the period from 1970–2007.

We use the maximum likelihood method to estimate the model specified by (1) and (2) on 10-year rolling window sectoral TFP data. For each sector i , we report the trend of frontier TFP growth (β^i) and the average TFP level in percentage of world frontier (cross-sectional mean of $(1 - e^{-u_c^i})$).

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