

CHAPTER 1

Global Productivity Trends

Labor productivity growth in emerging and developing economies (EMDEs) has undergone various surges and declines since the 1980s, each of increasing magnitude over time. The COVID-19 pandemic threatens a further fall of EMDE productivity growth, which could be the largest and most broad-based yet and would compound a trend slowdown in labor productivity growth that was already underway since the 2007-09 global financial crisis (GFC). Multiple decomposition methodologies provide insights into the causes of the deceleration of productivity growth. Globally, investment weakness accounted for the majority of the slowdown after the GFC; in EMDEs, it reflected weak investment and total factor productivity growth in broadly equal measure, as well as fading gains from factor reallocation toward more productive sectors. Cyclical factors explain a substantial share of the synchronized productivity slowdown during the GFC. However, the degree of post-GFC scarring on productivity varies significantly across EMDES, suggesting a role for policy. Previous global recessions suggest that both advanced economies and EMDEs are likely to face a further decline in labor productivity growth due to the COVID-19 shock.

Introduction

Even before the collapse in global activity due to the COVID-19 pandemic, a broad-based slowdown in labor productivity was underway. In emerging and developing economies (EMDEs), the slowdown that followed the 2007-09 global financial crisis (GFC) made achieving the Sustainable Development Goals more difficult. The pace of convergence slowed as labor productivity gaps with advanced economies remained substantial, with workers in the average EMDE producing less than one-fifth of the output of those in advanced economies.

The synchronized nature of the productivity slowdown after the GFC raises questions about the role of common factors or spillovers, and the extent to which they will again operate during the pandemic-driven recession in 2020. The nature of the post-GFC slowdown and its drivers have proved controversial. Some have attributed the weakness in productivity growth to waning technological progress as innovations regarded as “low-hanging fruit” have already been developed, leaving only innovations with lower marginal gains (Gordon 2012; Gordon and Sayed 2019). Others regard the slowdown in productivity growth as a “pause,” given the time delay between radical new digital technologies being developed and then incorporated into production processes (Brynjolfsson, Rock, and Syverson 2019). A third argument is that the broad-based weakness has been driven by deficient demand (Summers 2015).

Note: This chapter was prepared by Alistair Dieppe, Sinem Kilic Celik, and Gene Kindberg-Hanlon. Research assistance was provided by Khamal Clayton, Aygul Evdokimova, Yi Li, Awais Qureshi, and Xinyue Wang.

Against this backdrop, this chapter presents a comprehensive examination of the evolution of productivity over the past four decades, with an emphasis on the scarring effects of the GFC, in order to take stock of productivity developments ahead of what could be a major decline in global productivity growth due to COVID-19. Productivity growth is decomposed into contributions from factor inputs and total factor productivity (TFP), as well as sectoral growth and reallocation. This chapter also examines the role of demand influences in driving the post-GFC productivity slowdown and their role in driving synchronized global productivity fluctuations. More generally, this chapter provides context for the analysis in the remainder of the book, which will more closely examine the primary drivers of productivity growth and convergence, assess the risks to productivity growth from a range of shocks, and explore the likely long-run impacts of the COVID-19 crisis.

Specifically, the chapter addresses the following questions:

- How has productivity growth evolved over the last four decades?
- What factors explain developments in productivity, and in particular, the slowdown since the 2007-09 global financial crisis?
- How synchronized are productivity developments?

Contribution and framework

The chapter makes several contributions to the literature and policy debate on labor productivity.

- *EMDE focus.* Thus far, the literature has focused on trends in subsets of countries such as advanced economies, OECD economies, or specific regions.¹ This chapter is the first to provide both an overarching global and in-depth EMDE view of productivity developments, with a particular focus on the decline in productivity growth following the GFC.
- *Productivity decompositions.* This chapter undertakes a thorough assessment of the sources of the slowdown since the GFC across a broad range of countries by decomposing productivity into factor inputs—capital deepening, human capital, and TFP. This chapter is the first to remove cyclical and other demand-side components from labor productivity for a broad range of economies.
- *Synchronization.* This chapter is the first to assess the synchronization of productivity growth across a broad range of countries for multiple measures of productivity. In addition, it documents the role of cyclical productivity drivers in generating broad-based global productivity developments. The existing literature has focused on advanced-economy synchronization, whereas this chapter study also considers EMDEs (Imbs 1999; Levchenko and Pandalai-Nayar 2018).

¹ For details, see Fernald (2012), Adler et al. (2017), Fernald and Inklaar (2020), OECD (2015), ADB (2017), Dabla-Norris et al. (2015), Cusolito and Maloney (2018), and World Bank (2018a).

Main findings

The following findings emerge from the chapter:

- *Diverse range of productivity trends.* Global labor productivity growth has been resilient, in general, over the past four decades. While experiencing several surges and declines, global productivity growth averaged 1.8 percent in the 1980s and 1990s and the post-GFC period. However, this masks divergent trends among advanced economies and EMDEs. Advanced economy labor productivity growth has halved since the 1980s, in a declining trend that was accelerated by the GFC. In contrast, EMDE productivity growth accelerated rapidly in the runup to the GFC following the stagnation of the 1980s. The GFC ended a period of rising productivity growth, and the ensuing slump risks becoming an entrenched deceleration.
- *Sharp decline and subdued recovery following the GFC.* The labor productivity growth decline following the GFC was the steepest, longest, and broadest multi-year productivity slowdown yet. The post-GFC slowdown has been broad-based, affecting 70 percent of economies and over 80 percent of the global extreme poor as well as reaching all EMDE regions. Commodity-exporting EMDEs—which account for almost two-thirds of EMDEs—have been the worst affected.² Synchronized declines in productivity growth have become steeper, and recoveries shallower since 1980, pointing to risks ahead of what is expected to be the largest contraction in global output since World War II due to COVID-19 (World Bank 2020).
- *Accounting for the post-GFC slowdown.* Investment weakness accounted for the lion's share of the post-GFC (2013-18) slowdown in productivity growth in advanced economies from pre-GFC averages (2003-08). In EMDEs, subdued investment and slowing TFP accounted, in approximately equal measure, for the post-GFC productivity growth slowdown. Fading gains from factor reallocation toward more productive sectors also played a role. The long-run consequences of weak investment growth on productivity point to a need for robust support from public investment and to create the conditions for increased private investment.
- *Large role for cyclical factors in productivity synchronization.* The synchronization of productivity across countries increased sharply during the GFC. After removing cyclical factors from labor productivity growth, the correlation across economies is negligible during the GFC. Common productivity developments are therefore largely a business-cycle phenomenon. This pattern is likely to be repeated as a result of the COVID-19 crisis, given the magnitude of the cyclical and demand-driven factors at play. The ultimate scale of the slowdown following the GFC varied widely

²In commodity-exporting EMDEs, annual productivity growth slowed by 4.0 percentage points between 2010 and 2015, compared with 2.2 percentage points in commodity-importing EMDEs.

across EMDEs, highlighting the important roles that cross-country differences in the fundamental drivers of productivity, such as education and institutional quality, have played in generating productivity growth (Chapters 2 and 4). Reinvigorating these underlying drivers of productivity growth will therefore be key in limiting long-term damage from the pandemic-driven recession in 2020.

Concepts. Throughout this chapter, productivity is defined as output (GDP) per input of a unit of labor. To ensure as large and comparable a sample as possible over time and across countries, this chapter uses the number of people engaged rather than the number of hours worked as the measure of labor input.³ A second measure, TFP, is also featured in the chapter, which measures the efficiency with which factor inputs are combined and is often used to proxy technological progress (Box 1.1). This results in annual labor productivity, TFP, and capital services data for 103 economies, of which 74 are EMDEs and 29 are advanced economies, for 1981-2018.

Evolution of productivity

Since 1980, global productivity growth has gone through a series of peaks and troughs. In all cases, the troughs for productivity growth have coincided with global recessions or slowdowns (Figure 1.1). In advanced economies, these surges and declines have centered around a declining trend, which was accelerated by the GFC. However, in EMDEs, while the surges and declines have been larger, until the global financial crisis, they were accompanied by a rising trend. The global financial crisis, the largest and most synchronized downturn since World War II, therefore marked a significant turning point for global labor productivity growth.

Global productivity. From its pre-GFC peak in 2007, global productivity growth slowed drastically in 2009 to -0.4 percent. The GFC resulted in lasting damage to global productivity growth, which remains 1.0 percentage point below its pre-crisis peak, at 1.8 percent in 2018, below both pre-crisis and longer-run averages (Figure 1.1). This post-GFC slowdown from pre-GFC averages was broad-based, affecting two-thirds of economies, both among advanced economies and EMDEs. Those economies with slower post-GFC productivity growth than during the pre-GFC period account for 90 percent of global GDP and of the global extreme poor.

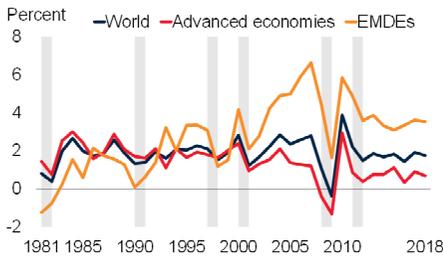
Advanced economies. The slowdown following the GFC in advanced-economy productivity growth continues a trend that has been underway since the late 1990s, following a brief resurgence from an even longer-running declining trend. The slowdown has been attributed to a declining contribution from information and communication technology (ICT) intensive sectors in the United States, and slow adoption of ICT technologies, and restrictive product market regulations in parts of

³Number of people engaged includes employees and self-employed. Alternative measures such as hours per worker might better capture labor input but have insufficient coverage for EMDEs (Box 1). In countries with large informal sectors, both employment and output may be subject to sizable measurement error.

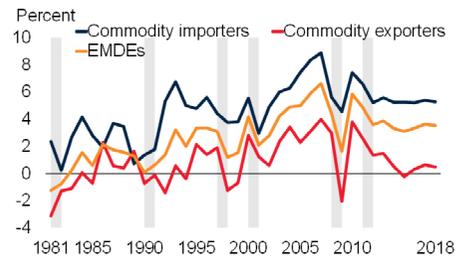
FIGURE 1.1 Evolution of global productivity growth

In advanced economies, productivity growth has experienced a long-run decline over the past 40 years, while in general, EMDE labor productivity growth has trended up over the same horizon until the GFC. In EMDEs, labor productivity growth has declined from pre-crisis levels in the longest and most-broad based multi-year decline since the 1980s. EMDE commodity exporters have had the weakest average productivity growth since 2013. Productivity growth in commodity importers and LICs has been more resilient, although the post-crisis slowdown has affected all regions.

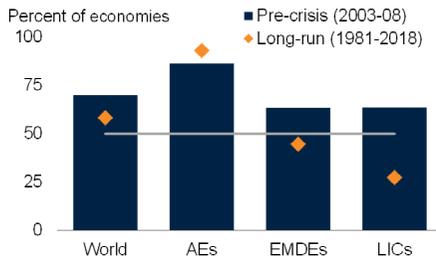
A. Global, AE, and EMDE productivity growth



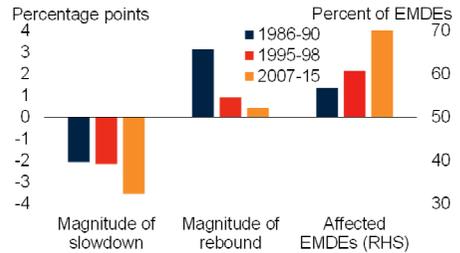
B. EMDE productivity growth



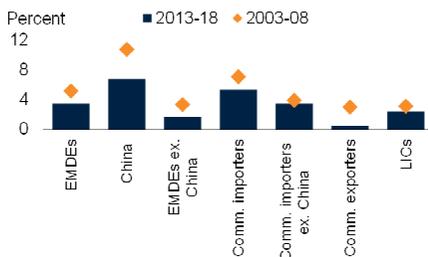
C. Share of economies with 2013-18 productivity growth below historical averages



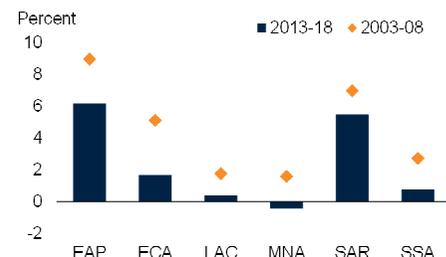
D. Magnitude and extent of multi-year EMDE productivity slowdowns and recoveries



E. EMDE productivity growth, pre- and post-crisis



F. Productivity growth in EMDE regions



Source: Conference Board; Penn World Table; World Bank, World Development Indicators.

Note: Productivity is defined as output per worker in U.S dollars (at 2010 prices and exchange rates). Sample of 29 advanced economies (AEs) and 74 emerging market and developing economies (EMDEs), including 11 low-income countries (LICs), as of 2019 World Bank classifications, 52 commodity exporters and 22 commodity importers. Aggregate growth rates are GDP-weighted at constant 2010 prices and exchange rates.

A.B. Shaded regions indicate global recessions and slowdowns (1982, 1991, 1998, 2001, 2009, and 2012), as defined in Kose and Terrones (2015) and Kose, Sugawara and Terrones (2020).

C. Share of economies for which average productivity growth during 2013-18 was lower than the long-run (1981-2018) average or the pre-crisis (2003-2008) average. For advanced economies, the pre-crisis growth is calculated as the average during 2003-07.

D. "Magnitude of slowdown" is the cumulative decline in EMDE productivity growth from the peak of the episode to the trough for episodes lasting more than two years. "Magnitude of rebound" is the cumulative increase in EMDE productivity growth from the trough of the episode to three years later. "Affected EMDEs" is the share of EMDEs that experienced a slowdown.

F. Sample of 8 EMDEs in East Asia and Pacific (EAP), 10 EMDEs in Europe and Central Asia (ECA), 18 EMDEs in Latin America and the Caribbean (LAC), 10 EMDEs in the Middle East and North Africa (MNA), 2 EMDEs in South Asia (SAR), and 26 EMDEs in Sub-Saharan Africa (SSA).

[Click here to download data and charts.](#)

Europe.⁴ During the global financial crisis, productivity growth in advanced economies plunged and never recovered to pre-crisis levels. At 0.8 percent on average during 2013-18, it was one-half its long-term average and 0.7 percentage points below its pre-crisis average. This slowdown relative to long-run averages affected around 90 percent of advanced economies.

EMDEs. Productivity growth in EMDEs has slowed sharply from its 2007 peak of 6.6 percent to a low of 3.1 percent in 2015 and, since then, has inched up to 3.5 percent in 2018. The post-GFC slowdown from pre-crisis averages affected over 60 percent of EMDEs and, in nearly half of EMDEs, productivity growth has fallen below its long-term (1981-2018) average. The slowdown has been particularly pronounced in China, where a policy-guided decline in public investment growth has been underway for several years, and in commodity exporters, which have been hit hard by the commodity price plunge of 2014-16. Weak post-GFC productivity growth follows on the heels of a major productivity surge during 2003-08 when EMDE productivity growth more than doubled from 1990s averages.

While EMDE productivity growth has always slowed sharply during global recessions and slowdowns, previous *multi-year* slowdowns—in 1986-1990 and 1995-1998—preceded global recessions (1991) or global slowdowns and EMDE crises (1998). However, the multi-year slowdown since 2007 has been the most prolonged, steepest, and broadest-based yet (Figure 1.1).⁵ In contrast to previous episodes, the current productivity slowdown has persisted.

Large differences in the scale of slowdown. Aggregate EMDE productivity growth in 2018 remained above its average in the 1980s and 1990s. However, the scale of the post-GFC slowdown has varied significantly across regions, highlighting different degrees of vulnerability and resilience to major shocks. In commodity importing EMDEs, average productivity growth in 2013-18 has remained more than twice its 1980s average and one-quarter above its 1990s average. Excluding China, labor productivity growth in commodity importers has slowed by just 0.4 percentage point relative to the pre-GFC period. In commodity-exporting EMDEs, the post-GFC commodity price plunge has returned productivity growth from 2.9 percent to just 0.5 percent, rates which are only just above the growth rates of the 1980s. The forecast plunge in global output due to COVID-19, therefore, presents a heightened risk in these economies of returning to the

⁴For a summary of the effects of the ICT slowdown on U.S. productivity in the 2000s, see Duval, Hong, and Timmer (2017), and Jorgenson, Ho, and Stiroh (2008). In Europe, the trend decline in productivity has been ascribed to sectoral misallocation due to cheap credit in southern Europe (Gopinath et al. 2017), a failure to adopt ICT and associated technology to the same extent as the United States (van Ark, O'Mahony, and Timmer 2008), and restrictive product market regulations (Haltiwanger, Scarpetta, and Schweiger 2014).

⁵The most recent slowdown in productivity growth has lasted eight years—compared with the four years of 1986-90 and the three years of 1995-98—and, from peak to trough, has been 50 percent steeper than the slowdowns in the late 1980s and the late 1990s. It has affected over 70 percent of EMDEs, more than the slowdown in the 1990s (61 percent) and 1980s (57 percent).

poor performance of the 1980s, particularly if it increases the likelihood of financial distress and lower-for-longer commodity prices (World Bank 2020).

LICs. Over one-half of low income countries (LICs)—and especially the larger ones among them—have productivity growth that remains above long-run averages. On average, LIC productivity growth has fallen only modestly to 2.4 percent during 2013-18, substantially above the negative rates of the 1980s and the 1990s.

Regions. Productivity growth decelerated in all EMDE regions during 2013-18 from their pre-GFC (2003-08) averages (Chapter 5). The most pronounced slowdown (by 3.4 percentage points to 1.7 percent in 2013-18) occurred in Europe and Central Asia (ECA), where the global financial crisis and subsequent Euro Area debt crisis caused severe economic disruptions. Productivity growth also fell steeply in Latin America and the Caribbean (LAC), the Middle East and North Africa (MNA), and Sub-Saharan Africa (SSA), to below 1 percent. All four regions have major energy exporters which were negatively affected by the 2014-16 oil price collapse. Productivity growth declined substantially in East Asia and Pacific (EAP) and to a smaller extent in South Asia (SAR) from pre-crisis levels, but it continued to be robust in both regions, remaining above 5 percent.

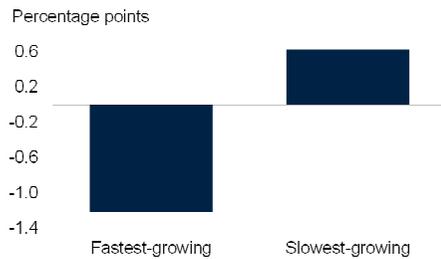
Missed opportunities. The one-quarter of EMDEs with the fastest productivity growth have reduced their extreme poverty rates by an average of more than one percentage point per year since 1981, while poverty rates rose in EMDEs in the lowest quartile of productivity growth (Figure 1.2). The steep productivity growth slowdown since the global financial crisis implies considerable output losses relative to a counterfactual of productivity growth continuing at its pre-GFC trend and therefore a missed opportunity for more rapid poverty reduction. Output per worker in advanced economies would be 9 percent higher today had productivity growth continued at its average pace ahead of the GFC (2003-08). Losses relative to the exceptionally high rate of productivity growth in EMDEs ahead of the GFC are closer to 14 percent, and higher still at 19 percent for EMDE commodity exporters. The further decline in productivity growth that will likely be driven by the COVID-19 pandemic will lead to further losses and decelerate the pace of poverty reduction.

Productivity gaps remain. The slowdown in productivity growth in EMDEs since the GFC and the renewed threat to productivity growth from COVID-19 is particularly disappointing in the context of large outstanding productivity gaps with advanced economies. EMDE productivity levels are less than one-fifth of the advanced-economy average, falling to just 2 percent of the advanced economy average in LICs (Figure 1.2). In some large EMDEs, such as China and India, productivity is growing substantially faster than in advanced economies, resulting in productivity catch-up. However, on average, EMDE productivity growth is just half a percentage point faster than in advanced economies, requiring more than a century to halve outstanding productivity gaps (Chapter 4).

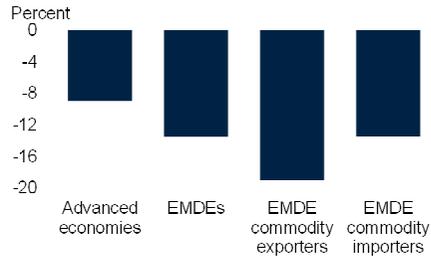
FIGURE 1.2 Poverty, productivity, and missed opportunities

Poverty declined by more than 1 percentage point on average per year in the one-quarter of EMDEs with the highest productivity growth during 1981-2015, while poverty rose in EMDEs with the lowest productivity growth. The slowdown in productivity growth relative to pre-GFC trends presents a large missed opportunity for further poverty reduction. EMDE productivity growth remains far below the levels at the advanced economy frontier and will require significantly stronger growth to rapidly close this gap. On average, productivity in EMDEs is less than one-fifth of the advanced-economy average, and in LICs it is just 2 percent.

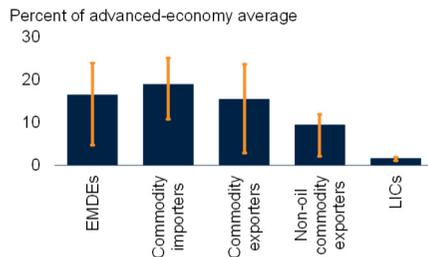
A. Annual change in the poverty rate in EMDEs, by productivity growth



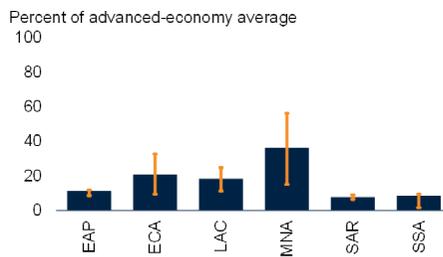
B. Cumulative labor productivity losses relative to pre-GFC trend



C. EMDE labor productivity levels, 2013-18



D. Labor productivity relative to advanced economies by region, 2013-18



Source: Conference Board; Penn World Table; PovcalNet; World Bank; World Development Indicators.

Note: Labor productivity is defined as output per worker in U.S. dollars (at 2010 prices and exchange rates). Unless otherwise indicated, data is from a sample of 29 advanced economies and 74 EMDEs.

A. Unweighted averages using annual data during 1981-2015. Fastest-growing EMDEs are those in the top quartile by productivity growth; slowest-growing EMDEs are those in the bottom quartile of labor productivity growth. Poverty rate defined as the share of the population living on less than \$1.90 a day (2011 PPP).

B. Percent fall in productivity level by 2018 relative to a counterfactual scenario where productivity continued to grow at its 2003-07 average growth from 2008 onwards for advanced economies, and 2003-08 average for EMDEs from 2009 onwards.

C. The samples include 22 commodity-importing EMDEs and 52 commodity-exporting EMDEs. Blue bars indicate the unweighted average output per worker during 2013-18 relative to the advanced-economy average. Whiskers indicate interquartile range relative to the advanced-economy average.

D. Unweighted average productivity during 2013-18 relative to the average advanced economy by region (2013-18). Includes 8 EMDEs in East Asia and Pacific (EAP), 10 EMDEs in Europe and Central Asia (ECA), 18 EMDEs in Latin America and the Caribbean (LAC), 10 EMDEs in the Middle East and North Africa (MNA), 2 EMDEs in South Asia (SAR), and 26 EMDEs in Sub-Saharan Africa (SSA).

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Sources of the slowdown in labor productivity growth after the GFC

Aggregate labor productivity growth can be decomposed into i) factor inputs and the efficiency of their use, or ii) sectoral contributions. These decompositions help to diagnose the sources of the post-GFC productivity growth slowdown in EMDEs.

Factor inputs and the efficiency of their use

Approach. In the first step, productivity growth is decomposed into contributions from individual factor inputs (physical capital and human capital) and the effectiveness of their use (total factor productivity), assuming a Cobb-Douglas production function (Box 1.1). Capital deepening directly increases labor productivity, while human capital improvements (for example, education and training) enhances the quality of labor input and therefore the resulting quantity of output produced. TFP measures the efficiency with which all factors are employed and is often considered a proxy for the technology behind the production process.⁶

Factor inputs versus the effectiveness of their use. Globally, the post-GFC (2013-18) slowdown in labor productivity growth from pre-GFC (2003-07/08) averages amounted to half of a percentage point, the majority of which was a result of a slowdown in capital accumulation (both public and private; World Bank 2019b; Figure 1.3). In advanced economies, TFP did not contribute to the decline after GFC in labor productivity growth, in part due to a structural slowdown before the GFC.⁷ In EMDEs, however, it accounted for about one-half of the slowdown in labor productivity growth.

- *Advanced economies.* Investment weakness accounted for virtually all of the slowdown (0.6 percentage point) in productivity growth from pre-GFC averages in advanced economies. From 2008, investment growth slowed sharply in response to weak and highly uncertain growth prospects, heightened policy uncertainty, and credit constraints in the aftermath of the global financial crisis.⁸ Investment contracted by an average of 6 percent per year between 2008-09. While investment *growth* has recovered close to pre-GFC rates, it has been accompanied by strong rates of employment growth, such that the growth of capital per worker has remained subdued (ECB 2017). TFP growth had already declined in the 1990s and pre-GFC period (2003-07) to low levels relative to the 1980s, primarily due to a

⁶The decomposition above is an accounting framework that does not control for dynamic interactions between TFP and investment growth. However, there is evidence that weak underlying TFP and investment growth reinforce each other, which could have amplified the post-crisis productivity slowdown.

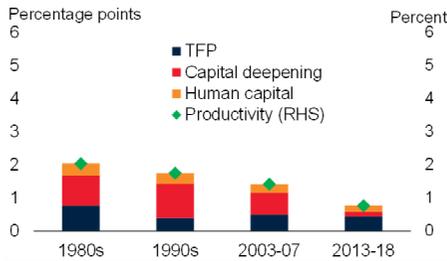
⁷The finding of a longer-running decline in TFP growth is largely due to a long-run decline in Europe. In the United States, TFP growth enjoyed a brief resurgence due to the ICT boom during 1996-2004 (Adler et al. 2017; Fernald et al. 2017).

⁸ See for details Duval, Hong, and Timmer (2017) and Ollivaud, Guillemette, and Turner (2016).

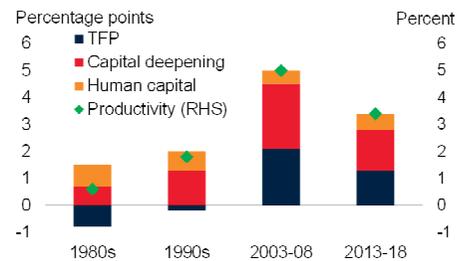
FIGURE 1.3 Growth accounting decomposition

Almost three-quarters of the post-crisis slowdown in global productivity growth from pre-crisis averages—and virtually all in advanced economies—reflected a slowdown in capital deepening. The post-crisis slowdown in EMDE productivity growth from pre-crisis averages reflected, in approximately equal measure, investment weakness and slowing TFP growth. In LICs, strong investment has supported post-crisis output and productivity growth.

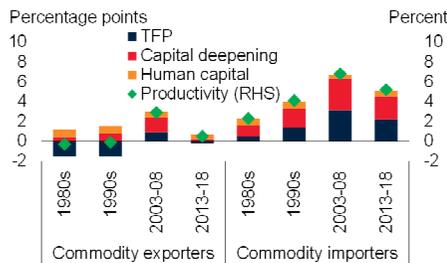
A. Contributions to productivity growth in advanced economies



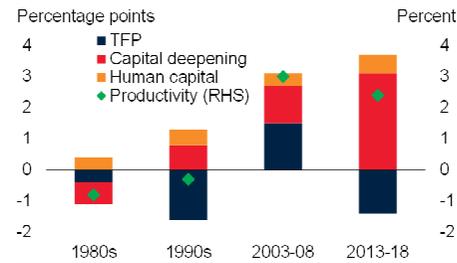
B. Contributions to productivity growth in EMDEs



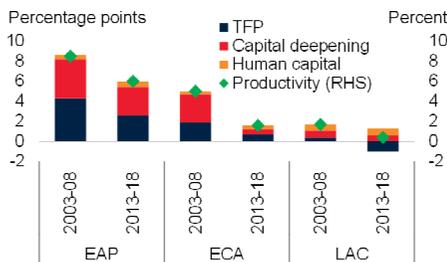
C. Contributions to productivity growth in EMDE commodity exporters and importers



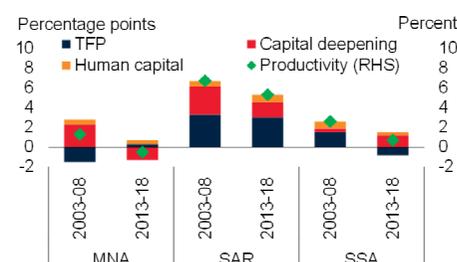
D. Contributions to productivity growth in LICs



E. Contributions to regional productivity growth: EAP, ECA, LAC



F. Contributions to regional productivity growth: MNA, SAR, SSA



Source: Barro and Lee (2015); International Monetary Fund; Penn World Tables; United Nations; World Bank; World Development Indicators.

Note: Productivity defined as output per worker in U.S. dollars (at 2010 prices and exchange rates). Growth accounting decomposition methodology described in Box 1.1. Aggregate growth rates calculated using constant 2010 US dollar weights. The sample includes 29 advanced economies, and 74 emerging market and developing economies including 11 low-income countries, 52 commodity exporters, 22 EMDE commodity importers, 8 East Asia and Pacific (EAP), 10 Europe and Central Asia (ECA), 18 Latin America and the Caribbean (LAC), 10 Middle East and North Africa (MNA), 2 South Asia (SAR), and 26 Sub-Saharan Africa (SSA) economies.

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BOX 1.1 Productivity: Conceptual considerations and measurement challenges

Concepts. There are two primary ways of measuring productivity: labor productivity and total factor productivity (TFP). Throughout this book, productivity is defined as output (GDP) per input of a unit of labor. To ensure as large and comparable a sample as possible over time and across countries, this book uses the number of people engaged rather than the number of hours worked as the measure of labor input.¹ A second measure, total factor productivity (TFP), is also featured in the book, which measures the efficiency with which factor inputs are combined and is often used to proxy technological progress. TFP may also incorporate wider factors such as organizational and institutional characteristics. This box reviews definitions and conceptual considerations, and different techniques and challenges of these different productivity measures and explains how they are tackled in this study.

Labor productivity. For the purposes of this book, labor productivity is measured as output per worker, with the number of employees used as the unit of labor input. This has the advantage of wide availability across countries. Its disadvantage rests in the failure to account for the quality and intensity of labor input:

- *Comprehensiveness.* Labor input is intended to capture all of those involved in the production process. Thus, total employment figures include self-employment, which accounts for a large proportion of informal employment in EMDEs (World Bank 2019a). However, difficulties in measurement of the informal sector creates uncertainty and increases the potential for inconsistency across countries around the productivity level, particularly in EMDEs with high shares of informal employment (Fajnzylber, Maloney, and Montes-Rojas 2011).² Nonetheless, many national statistics offices estimate the size of the informal sector and adjust their GDP estimates accordingly (Charmes 2012; SNA 2008; UNECE 2008).
- *Quality of labor input.* The effectiveness of labor input may be influenced by the level of education, training, and health of workers. These aspects of human capital can be addressed by estimating the average years of schooling of the workforce and life expectancy to proxy workforce health. However, the quality of formal education and health, and the effects of on-the-job training provided outside of the education system is difficult to measure consistently.

Note: This box was prepared by Sinem Kilic Celik. Research assistance was provided by Yi Li.

¹ Number of people engaged includes both employees and self-employed. Alternative measures such as hours per worker might better capture labor input but have insufficient coverage for EMDEs. In countries with large informal sectors, both employment and output may be subject to sizable measurement error.

² The direction of the bias depends on how national statistics offices adjust their employment and official GDP to cover the informal sector, which may vary across countries (UNECE 2008).

BOX 1.1 Productivity: Conceptual considerations and measurement challenges (*continued*)

- *Intensity of labor input.* The number of people involved in the production process does not consider different work-arrangements that vary the intensity of labor input. The intensity of labor input is, for example, better captured by hours worked but these data are not available for many countries.

Total factor productivity. One of the most commonly used measures of technological enhancement to the production process is TFP growth. The standard growth accounting approach is one of the most common methodologies in the literature to estimate TFP. Following Caselli (2005), labor productivity is decomposed into contributions from several factor inputs:³

$$\text{Labor productivity} = Y_t/L_t = A_t(K_t/L_t)^{(1-\alpha)} H_t^\alpha,$$

where Y is output, L is labor input, H is human capital level, and A is TFP. Following Solow (1957), a Cobb-Douglas production function with constant returns to scale is assumed. By taking log differences, labor productivity growth can be decomposed into the following factor inputs.

$$\Delta LP_t = (1 - \alpha)\Delta k_t + \alpha\Delta h_t + \Delta a_t,$$

where $k_t = \log\left(\frac{K_t}{L_t}\right)$ and $h_t = \log(H_t)$, and a_t is the log of TFP, calculated here as a residual of labor productivity growth after subtracting the change in capital deepening and human capital indices, weighted by their respective shares in the production function ((1 - α) and α).

This approach is appealing due to its simple nature and its ease of interpretation. Being estimated as a residual, TFP depends on the assumed functional form of the production function, and is vulnerable to measurement error for factor input estimates.

- *Functional form.* TFP is defined as “a shift in the production function.” Its calculation assumes the existence of a well-behaved and stable production function which also accurately describes the technology in use (Baqae and Farhi 2018). One of the commonly used functional forms is Cobb-Douglas with constant returns to scale and unitary elasticities of substitution between capital and labor. If the assumption of constant returns to scale is not valid, TFP estimations may be biased (Dribe et al. 2017).
- *Capital measurement.* Physical capital is difficult to value accurately. Its value depends on the longevity of assets (*short-lived assets* such as computers versus

³Another way of decomposition is level accounting where the labor productivity level is decomposed into physical and human capital intensities (Hsieh and Klenow 2010; Klenow and Rodríguez-Clare 1997).

BOX 1.1 Productivity: Conceptual considerations and measurement challenges (continued)

long-lived assets such as roads) and the nature of capital (*intangible* capital such as research and development or marketing expenditures). A common way of measuring the capital stock is to apply the perpetual inventory methodology to the flow of expenditure on assets and their depreciation rates. Since data for the initial capital stock is usually not available, assumptions are made on capital to output ratio of the initial year but this ratio can be highly country-specific (Feenstra, Inklaar, and Timmer 2015). Data on capital services are from the Penn World Table 9.1 (PWT) (Feenstra, Inklaar, and Timmer 2015). In contrast to previous versions of PWT, this edition utilizes capital *services* as a measure of capital inputs instead of capital *stocks* (Inklaar, Woltjer, and Gallardo 2019). Capital services methodology allows us to relax the assumption of homogeneity of different assets by attributing appropriate weights to different types of assets (less to the short-lived assets, for example) while aggregating the capital input up.

- *Factor utilization.* Since TFP is measured as a residual, it estimates not only technological change but also any mismeasurement of capital and labor inputs (Basu, Fernald, and Kimball 2006). Capital services is a measure of the total physical capital available for production without necessarily considering how much of the existing capital is used actively in the production process (capital utilization). Similarly, labor input, even if it is finely measured as total working hours, does not account for variable labor effort. This may lead to an overly cyclical measure of productivity. One way of obtaining a “technology” series, cleaned of variable utilization of the factors of production (and other demand-driven cyclical components), is by using structural vector autoregressions (SVARs) which assume that changes in the underlying technology behind production are longer-term phenomena (Chapter 6). SVAR-derived measures of the contribution of technology to productivity, and other lasting factors such as organizational and institutional change, are included in this chapter.

Human capital (H_t). The human capital index from the Penn World Table 9.1 is used throughout the book. This measure uses average years of schooling of the working-age population in combination with an estimate of the global returns to education.⁴

Labor share estimates. The output-labor elasticity (α), proxied by the labor income share is estimated using the labor compensation to output ratio for each country, including adjustments to take account of mixed-income and wages from

⁴As one of the determinants of human capital, health should ideally be included in the human capital index but the lack of long consistent series provides a constraint (Kraay 2018; World Bank 2018b).

BOX 1.1 Productivity: Conceptual considerations and measurement challenges (*continued*)

self-employment (from PWT 9.1). This analysis uses constant labor shares over time, defined as the long-term average of labor share data from PWT 9.1.

Natural capital (N_t): In resource-rich regions and countries, natural resources are an important input to production (Chapter 5). Without taking into account natural capital in the production function it might be misspecified. Assuming a natural capital augmented production function:

$$Y_t = A_t K_t^{1-\alpha-\gamma} N_t^\gamma (H_t L_t)^\alpha$$

where N_t is capital based on natural resources and γ is the ratio of the output using natural capital in the whole economy. Based on the production function above, labor productivity growth can be decomposed into the following:

$$\Delta LP_t = (1 - \alpha - \gamma) \Delta k_t + \gamma \Delta n_t + \alpha \Delta h_t + \Delta a_t$$

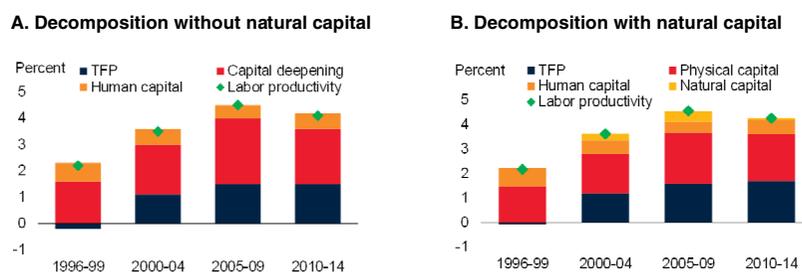
where n_t is equal to the log ratio of natural resources to labor inputs. γ is the ratio of natural resources in the total economy and measured by total natural resources rent as a percent of GDP, obtained from the World Bank's World Development Indicators (WDI). Therefore, TFP growth measures, which ignore the contribution of natural resources, is upward biased when the ratio of physical capital to labor in an economy is higher than the ratio of inputs of natural resources to labor and vice versa. Although including natural capital in growth accounting makes a non-negligible difference in TFP growth calculations in resource-abundant countries, it is not the basic focus of the chapter since the difference is not substantial in aggregate for EMDEs (Figure 1.1.1).

New technologies and output mis-measurement. There have been concerns that quality improvements in information technology have not been accurately captured in national accounts measures of output. Official national accounts may have underestimated quality improvements of new devices, leading price deflators for information and communications technology to understate the true price declines in these assets, while non-market technologies such as search engines and social media provide consumer benefit without contributing to output (Brynjolfsson and Collis 2019; Hatzius et al. 2016). Mismeasurement of new IT products could, therefore, explain some of the slowdown in measured productivity growth that has occurred since the global financial crisis. Some studies find evidence of mismeasurement in both the pre and post-crisis period, such that mismeasurement explains little of the slowdown in measured productivity (Byrne, Fernald, and Reinsdorf 2016). Others find evidence of sizable mismeasurement and attribute part of the U.S. productivity slowdown to measurement biases, particularly due to the increasing share of the services sector

BOX 1.1 Productivity: Conceptual considerations and measurement challenges (*continued*)

FIGURE 1.1.1 Labor productivity decomposition and natural capital in EMDEs

The decomposition of labor productivity without taking natural capital into account could be misleading especially for resource-rich countries. On the other hand, since the bias in TFP can be either positive or negative depending on the relative growth rates of physical and natural capital, the difference becomes very small when aggregating the decomposition up for large country groups such as EMDEs.



Source: World Bank.

Note: Aggregate growth rates are GDP-weighted at constant 2010 prices and exchange rates.

A. B. Sample consists of 74 EMDE countries for the period 1996-2014.

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in output (Brynjolfsson and McAfee 2014; Feldstein 2017). Overall, while there is some evidence for mismeasurement, it is unlikely that a significant part of the broad-based slowdown in productivity growth since the global financial crisis can be explained by it alone (Cerra and Saxena 2017; Syverson 2016). Where mismeasurement has been uncovered, it has been found to be present in larger, or equally significant scale in earlier periods.

Delayed adoption. A further view is that the wave of new digital technologies that have been developed can take extended periods of time to incorporate into production processes, suggesting that productivity is likely to pick up rapidly in the future. This view notes that the industrial revolution in the early 19th century and the electrification of production in the early 20th century took decades to result in a material improvement in measured productivity, particularly TFP (David 1990). Current intangible investment in ICT technologies may, therefore, be undercounted in current national accounts and then subsequently over-accounted for as these technologies return higher production efficiency as they are incorporated into production on a broad basis (Brynjolfsson, Rock, and Syverson 2018).

slowdown in European economies, and had recovered to grow close to its longer-term pre-GFC average (0.4 percent over 1998-2007).⁹

- *EMDEs*. The post-GFC slowdown in EMDE productivity growth reflected, in approximately equal measure, investment weakness, and slowing TFP growth. In *commodity-exporters*, the contribution of capital accumulation faded almost entirely, after having accounted for about half of productivity growth before the GFC. This was compounded by contracting TFP growth, which had accounted for most of the remainder of pre-GFC productivity growth. Investment stalled or contracted in commodity exporters during the commodity prices collapse of 2011-16 (Aslam et al. 2016; World Bank 2017). In *commodity-importers*, capital deepening has slowed since the global financial crisis reflecting diminishing growth prospects and heightened uncertainty. In the early 2000s, TFP was boosted by reforms that allowed greater FDI inflows in the 1990s and China's WTO accession in 2001 which unleashed a productivity boom in China and its trading partners, while a decade of service-sector oriented reforms boosted productivity in India in the 1990s and 2000s (Bosworth and Collins 2008; He and Zhang 2010; Tuan, Ng, and Zhao 2009).
- *LICs*. In LICs, public infrastructure investment and business climate improvements supported post-GFC output and productivity growth (World Bank 2019b). This followed on the heels of a decade of heavy investment into mines and oil fields amid surging pre-crisis commodity prices. As a result, continued post-GFC strength in productivity growth reflected increased capital accumulation. Modest improvements in human capital partly offset increasingly negative TFP growth in these economies. A continued concentration in the agricultural and extractives sectors has led to low technological progress, with additional negative shocks from conflict and high levels of debt in the 1980s and 1990s also contributing to frequently negative TFP growth (Claessens et al. 1997; IMF 2014).
- *EMDE regions*. Capital accumulation accounted for virtually all of the post-GFC slowdown in productivity growth in MNA, where oil-exporting EMDEs suffered stalled or contracting investment amid the oil price collapse of 2014-16 (Stocker et al. 2018). It also accounted for most of the slowdown in ECA, whose banking systems were hard-hit by the euro area crisis and the subsequent retreat from the region of EU-headquartered banks (Arteta and Kasyanenko 2019). In EAP, a deliberate policy-guided public investment slowdown in China has been underway and slower capital accumulation accounted for about two-fifths of the slowdown in post-GFC productivity growth. In SSA, which hosts most LICs, and in LAC, the

⁹ Much of the recent discussion of advanced economy TFP growth has focused on the slowdown in the United States, where TFP weakened further since the crisis following a surge from the mid-1990s to 2000s (Fernald et al. 2017; Gordon 2018). In contrast, average TFP growth was much lower in the pre-crisis period in major European economies such as Germany and France (0.3-0.4), and even negative in Italy (-0.7), such that the post-crisis TFP slowdown is much less pronounced for advanced economies in aggregate.

slowdown was entirely driven by declining TFP growth. In contrast to other EMDE regions, TFP growth strengthened in MNA, from negative pre-GFC rates amid heavy resource investment, and it was stable in SAR, which was less affected than other regions by the disruptions of the global financial crisis.

Natural Capital: In many resource-rich countries, natural resources are an important input into production. In these cases, without taking into account the inputs of natural resources, the decomposition of labor productivity may be misleading. However, the aggregate effects of natural capital for EMDEs are small, but larger for some resource-rich economies (Box 1.1; Chapter 5).

Sectoral productivity growth

Approach. Higher aggregate productivity growth in EMDEs in the pre-GFC period was associated with a reallocation of resources towards more productive sectors in addition to productivity growth within sectors (Diao, McMillan, and Rodrik 2017). More recently, pre-GFC gains from such reallocation appear to have faded. This is illustrated in a decomposition of economy-wide labor productivity growth into within- and between-sector productivity growth for up to 103 economies during 1995-2017 (Chapter 7).

Post-GFC slowdown broad-based across sectors. The post-GFC slowdown in manufacturing productivity growth in EMDEs was the largest among the nine sectors (Figure 1.4). However, the slowdown in EMDEs affected most sectors. The service sectors have grown rapidly over the past two decades, supporting aggregate productivity growth in EMDEs alongside rapid manufacturing growth. However, there has been a slowing contribution to aggregate productivity growth since the crisis, particularly from the finance and transport service sectors. LICs suffered even more than other EMDEs from a productivity slowdown in their agriculture sector, which coincided with a broad-based decline in commodity prices since 2011.

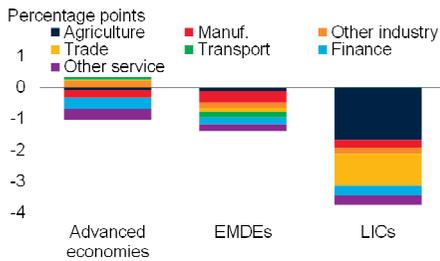
Fading gains from factor reallocation in EMDEs. In EMDEs, about one-half of the post-GFC (2013-17) slowdown in productivity growth from pre-GFC (2003-08) averages reflected fading gains from resource reallocation towards more productive sectors (Figure 1.4). In the 1990s and pre-GFC, such resource reallocation had accounted for more than two-fifth of average labor productivity growth, in line with earlier findings (Diao, McMillan, and Rodrik 2017). Productivity gains from such a reallocation were particularly large in Sub-Saharan Africa, where they accounted for more than half of productivity growth during 2003-08, amid a large fall in the share of agricultural employment.

Post-GFC, the contribution of reallocation to aggregate productivity growth fell to one-third on average in EMDEs. To some degree as countries reach middle-to high-income status, sectoral reallocation tends to become a less important driver of productivity growth (Mason and Shetty 2019; Nicola, Kehayova, and Nguyen 2018). In addition, technological and knowledge spillovers between sectors may also be diminishing

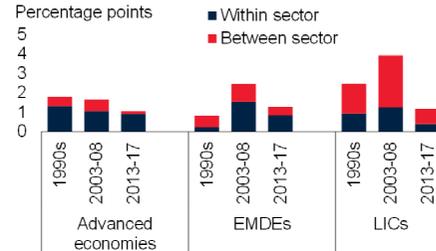
FIGURE 1.4 Sectoral contributions to the post-crisis productivity slowdown

During the post-crisis period, aggregate productivity growth slowed among EMDEs. Around half of the weakness reflected slower within-sector productivity growth in manufacturing and financial services. In LICs, the slowdown was concentrated in agriculture. In addition to weaker within-sector growth, fading gains from resource reallocation towards more productive sectors have accounted for about one-third of the post-crisis slowdown in productivity growth. Within-sector productivity growth has also slowed.

A. Contribution to productivity growth between 2003-08 and 2013-17



B. Within and between sector contributions to productivity growth



Source: World Bank.

Note: Based on samples of 54 countries during 1975-1995, 94 countries during 1995-1999, and 103 countries during 2003-2017.

A. "Other industry" includes mining, utilities, and construction; "Finance" includes business services; "Other service" includes government and personal services. For advanced economies, the pre-crisis growth is calculated as the average during 2003-07, due to the earlier crisis-related impact on productivity growth.

B. Growth within sector shows the contribution of initial real value-added weighted productivity growth rate and structural change effect give the contribution arising from changes in the change in employment share. Median of the country-specific contributions.

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(Foerster et al. 2019). However, productivity gaps between sectors in EMDEs remain substantial, suggesting that potential gains from further reallocation remain sizeable.

Fading gains from reallocation away from agriculture in LICs. In LICs, agriculture accounts for 60 percent of employment, on average, but agricultural productivity is low (Cusolito and Maloney 2018). As a result, a reallocation of employment, especially from agriculture, to higher-productivity sectors accounted for almost two-thirds of LIC productivity growth prior to the global financial crisis (Chapter 7). Since then, this engine of LIC productivity growth appears to have stalled. In part, this is due to a collapse in global industrial commodity prices, having discouraged further growth in employment in the mining and extraction sector, which have above-average productivity levels in LICs. Despite having high productivity levels, the mining and extraction sectors often offer limited scope for expanding employment outside of commodity booms, and therefore few opportunities for sustainable sectoral reallocation.

Drivers of productivity growth synchronization

Limitations of growth accounting. The standard growth accounting framework has limitations. TFP growth can be affected by factors such as technological and organizational changes, but also by changing levels of capital and labor utilization which are frequently associated with demand-side drivers (Basu, Fernald, and Kimball 2006;

Fernald and Wang 2015).¹⁰ Therefore traditional estimates of TFP may over or understate the true change in the influence of supply-side drivers on productivity. Factor inputs can be adjusted using observable proxies for factor utilization but data requirements for this approach—in particular, annual data on the sectoral distribution of hours-worked, employment, and capital—are prohibitive for most EMDEs.¹¹

Methodology. A complementary approach to the growth accounting decomposition is to estimate the underlying drivers of labor productivity having removed cyclical or demand-led components of productivity growth. Using structural vector autoregressions (SVAR), *persistent* or *permanent* variations in productivity can be identified (Chapter 6).¹² These are assumed to reflect lasting influences on productivity, such as changing production technologies, in contrast to changing factor utilization. As it is common in the literature, these components will henceforth be referred to as “technology.” However, this is a generic term that reflects new technologies and can also include a range of other persistent factors such as improved resource allocation driven by organizational or institutional changes.¹³

Removing cyclical factors from the labor productivity collapse of 2007-09. Cyclical factors such as changing factor utilization explain around half or more of the slowdown in advanced economies and EMDEs during the collapse in labor productivity growth during 2007-09 (Figure 1.5). EMDEs experienced a large surge in productivity growth in the years ahead of the global financial crisis, which suddenly receded, particularly in 2009. Longer-term, the slowdown has become dominated by non-cyclical factors. The finding that the longer-term productivity slowdown following the GFC is a largely structural phenomenon has been found in utilization-adjusted measures of TFP in the United States and several major European economies (Byrne, Fernald, and Reinsdorf 2016; Comin et al. 2019; Goodridge, Haskel, and Wallis 2018). In some cases, weaker demand due to crises has been found to generate slower technological progress over the medium-to-long term. In addition to the lasting effects of weaker investment and capital deepening, costly development and adoption of technology may be delayed or reduced, generating further scarring effects (Adler et al. 2017; Anzoategui et al. 2019). However, the extent of the fall across regions and EMDE commodity importers and exporters has varied widely.

¹⁰In the United States, one-half of TFP growth variability has been attributed to demand-driven factors (Basu, Fernald, and Kimball 2006).

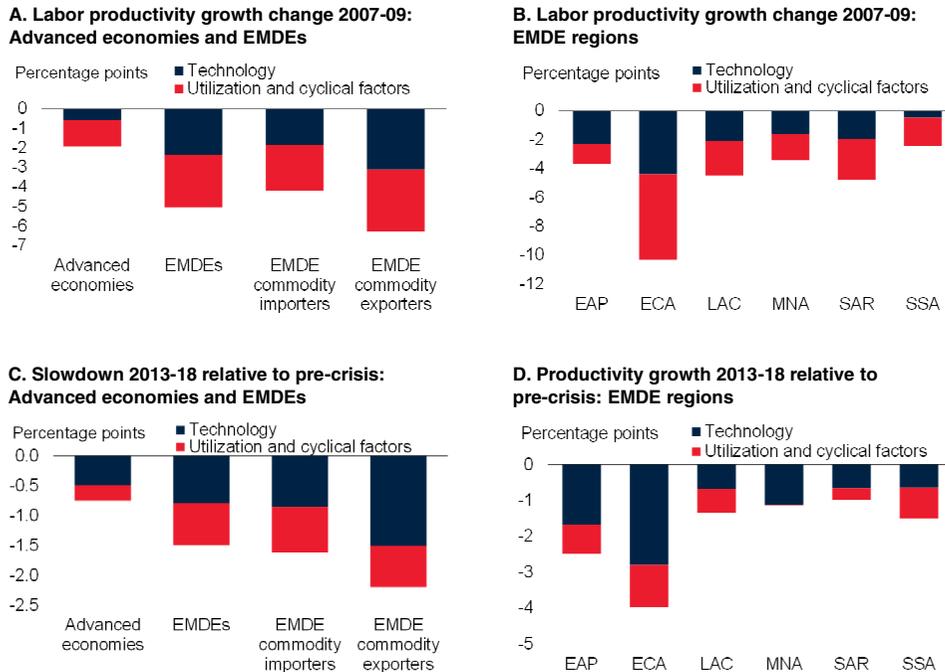
¹¹Adler et al. (2017), Basu, Fernald, and Kimball (2006), Comin et al. (2019), Duval et al. (2017), and Levchenko and Pandalai-Nayar (2018) have implemented these for advanced economies other than the US, but not for EMDEs. A second difficulty with this approach is the possibility of a wide range of structural relationships between different inputs to production, preventing the application of this methodology on a broad-basis. For example, labor markets may be inflexible around the number of hours worked, such that it is a poor proxy for utilization.

¹²Importantly, this identification does not impose the condition that no other shocks can have permanent impacts on productivity, as is the case with long-run identifications. A similar methodology has been used to assess shocks that drive business cycle movements in a range of macroeconomic variables, which allows the identification of demand-drivers of the macroeconomy (Angeletos, Collard, and Dellas 2018).

¹³See also Chen and Wemy (2015), Fisher (2006), and Francis and Ramey (2005).

FIGURE 1.5 Role of cyclical factors the GFC productivity slowdown

Cyclical factors such as changing factor utilization explain one-half or more of the labor productivity slowdown during the GFC, and a proportion of the post-crisis slowdown (around one-third). A measure of labor productivity which removes the effects of changing utilization of factor inputs (and other less persistent demand-side drivers of productivity), “technology,” has declined significantly since the global financial crisis but by different magnitudes across EMDE regions, suggesting different degrees of scarring from the crisis.



Source: World Bank.

Note: The “technology” contribution to labor productivity growth consists of the contribution of the Spectral SVAR-identified technology shock in addition to the contribution from the constant and initial condition in the VAR, which can also be considered long-term processes. Utilization and cyclical factor contributions are defined as the residual of the contribution of “technology” and labor productivity growth. See Annex 1 for further details. Sample of 32 advanced economies and 96 EMDEs, including 65 commodity exporters and 31 commodity importers.

A.B. Contributions to labor productivity slowdown during 2007-09.

C.D. Pre-crisis period defined as 2003-07 for advanced economies, and 2003-08 for EMDEs.

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Role of cyclical factors in productivity synchronization

The broad-based decline in productivity growth since the GFC in both advanced economies and EMDEs in all regions suggests the presence of common factors or spillovers. A large literature has already documented the comovement of output across economies.¹⁴ The strong correlation between output growth and labor productivity

¹⁴See, for example, Francis, Owyang, and Savascin (2017), Francis, Owyang, and Soques (2019), Kose, Otrok, and Whiteman (2003).

growth (70 percent on average) raises the possibility of common determinants of productivity developments across economies. The cross-country synchronization of labor productivity growth, and the extent to which it is driven by demand or supply-side factors, has so far been under-explored. The literature that does exist has focused on advanced economy synchronization and has found some co-movement in cyclical drivers of productivity but little in longer-term developments, such as the pace of technological change. This contrasts with expectations of increasingly rapid diffusion of new production technologies and techniques through trade and the development of global value chains, foreign direct investment (FDI), and other global financial flows along with the increased presence of multinational corporations and the internet.

Evidence on cross-country productivity co-movement. Evidence on the co-movement of productivity across countries has so far focused on the synchronization of TFP, and not yet explored the degree to which labor productivity is synchronized across countries. In advanced economies, while unadjusted measures of TFP are correlated, utilization-adjusted TFP, a similar measure to the SVAR-identified technology, is found to be uncorrelated across countries (Huo, Levchenko, and Pandalai-Nayar 2019; Imbs 1999). Finally, in a factor modeling framework, TFP growth is shown to be one of the most important correlates of common developments in GDP growth (Abate and Serven 2019; Crucini, Kose, and Otrok 2011). These studies have therefore concluded that changes in productivity are a key correlate of cross-country business cycle synchronization.

Evidence of spillovers. Structural VARs point to the presence of cointegration between TFP in the United States and other economies but with slow and limited spillovers (Mandelman et al. 2011; Miyamoto and Nguyen 2017). In a broader dataset, utilization-adjusted U.S. TFP has been found to have spillover effects on TFP growth in other advanced economies but only at very gradual rates (Adler et al. 2017). An alternative and growing strand of the literature has highlighted the role of slow technological diffusion between leading and lagging firms across advanced economies (Andrews, Criscuolo, and Gal 2015; Cirera and Maloney 2017; OECD 2015). Long lags in the adoption and intensity of use of new technologies have been found to explain a material proportion of cross-country income divergence (Comin and Hobijn 2010; Comin and Mestieri 2018). Both approaches, based on firm and country-level data, emphasize that structural improvements in productivity can diffuse across borders primarily over long time-lags, implying that structural measures of productivity synchronization are low.

Methodology. Cross-country correlations provide an insight into the extent to which different measures of productivity are synchronized. This approach is applied to labor productivity growth, TFP growth, as well as the SVAR-identified technology measure. Average correlations provide a summary statistic of synchronization within groups of economies (IMF 2013).¹⁵

¹⁵ An alternative approach to assessing the synchronization of different measures of productivity would be to estimate the contribution of common factors to productivity variation. However, common factors may explain a large proportion of the variance of productivity, while at the same time having opposite effects on different economies (productivity growth can rise in one country and fall in another). Correlation analysis is a better tool to assess the extent to which common directional variation is prevalent across economies.

Results: cyclical contribution to labor productivity synchronization. The average 10-year rolling correlation between all bilateral pairs of economies for each measure of productivity growth suggests that global synchronization of productivity was very low before the onset of the global financial crisis (Figure 1.6). During the GFC and its immediate aftermath, correlations rose for all measures of productivity growth. Correlations between those measures with sizable demand-driven cyclical components (labor productivity and TFP growth) were considerably higher than those for the SVAR-identified technology shocks, which exclude these components. This result is consistent with previous findings for advanced economies (Huo, Levchenko, and Pandalai-Nayar 2019; Imbs 1999). Using a shorter rolling sample window, the correlations of labor productivity and TFP have also returned close to zero shortly after the GFC, adding further evidence that the decline was a largely cyclical phenomenon (Figure 1.7).

Slow pace of technology diffusion. Based on these correlations, productivity synchronization in both advanced economies and EMDEs appears to be a largely cyclical phenomenon. Advanced economies featured higher cross-country correlations of labor productivity and TFP than EMDEs over this period. Since 2005, LIC productivity growth has been largely unsynchronized even during the GFC, plausibly reflecting limited trade integration and the effects of idiosyncratic shocks. Low average correlations of the SVAR-identified technology measure do not rule out transfers of productivity-enhancing technology across countries over the long-term. However, low synchronization of structural measures of productivity growth support findings of very low average rates of productivity convergence for most EMDEs with advanced economies, suggesting slow or non-existent levels of technology adoption (Chapter 5).

Sizable cyclical productivity spillovers. The high degree of cyclical comovement of TFP and labor productivity growth during the GFC suggests a sizeable labor productivity and TFP growth slowdown could occur during the COVID-19 recession. Some of these factors are likely to have scarring effects through a reduction in investment and endogenous technology adoption. However, a more complex set of headwinds and country-specific characteristics have influenced the extent of the longer-term post-GFC slowdown in advanced economies and EMDEs, which have varied widely across regions and economies, limiting their synchronization.

Conclusion

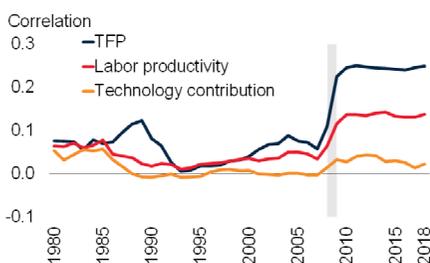
The weakness in productivity growth during and after the GFC is estimated to stem from both a common cyclical demand shock, as well as a wide range of structural headwinds. To prevent lasting negative effects from an additional synchronized negative shock due to COVID-19, EMDEs will require a range of policy actions.

Weakening investment. The post-crisis period has been characterized by pronounced investment weakness reflecting adverse terms-of-trade shocks for commodity exporters, slowing foreign direct investment inflows for commodity importers, spillovers from advanced-economy growth weakness, heightened policy uncertainty, and private debt

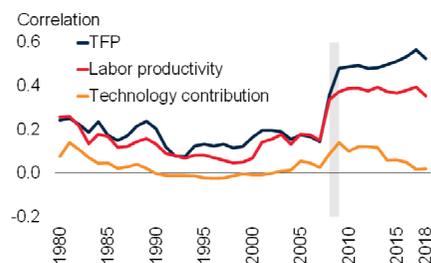
FIGURE 1.6 Synchronization of productivity measures: 10-year rolling correlations

Globally, TFP and labor productivity have shown a material pickup in synchronization since the global financial crisis. However, a large proportion of this synchronization reflects non-technology spillovers from factors such as demand developments—SVAR-identified technology developments, which exclude business-cycle factors, have remained uncorrelated. A similar pattern emerges in the synchronization within advanced economies, and EMDEs, which show a lower average level of cross-country correlation for all measures. In contrast, the synchronization of all productivity measures has remained subdued in LICs since the early 2000s.

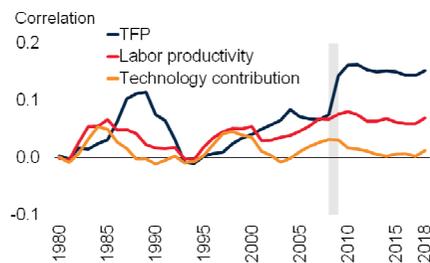
A. Average correlation: World



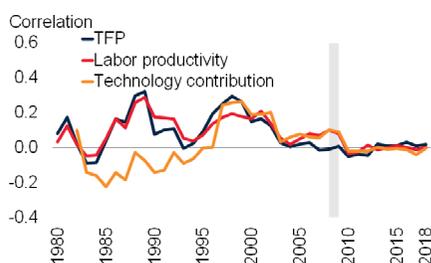
B. Average correlation: Advanced economies



C. Average correlation: EMDEs



D. Average correlation: LICs



Source: World Bank.

Note: EMDEs = emerging market and developing economies, LICs = low income countries.

A-D. 10-year rolling correlations. Simple average across all bilateral pairs of economies for each measure of productivity. The "technology" measure is the contribution of "technology" drivers to productivity growth. This measure removes cyclical components that are present in labor productivity and TFP growth. Sample includes 24 advanced economies and 74 EMDEs, including 6 LICs, with data available for all measures since at least 1981.

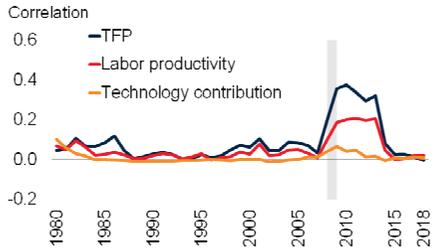
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burdens (World Bank 2017). The legacy of weak investment since the GFC and diminishing long-term outlook for investment growth raises concerns about future productivity growth (World Bank 2019b). Moreover, subdued investment growth, especially in R&D-dependent sectors, can hinder technological progress and TFP growth through weaker capital embodied technological change (Adler et al. 2017). A range of policies to encourage public sector investment and foster private sector investment can spur labor productivity growth (Chapter 4). Major financial crises, pandemics, and commodity price shocks have been found to have lasting negative

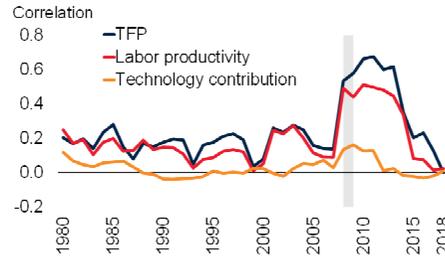
FIGURE 1.7 Synchronization of productivity measures: 5-year rolling correlations

A smaller rolling window for correlations is more volatile, but shows that the increase in correlations of measures of productivity containing cyclical components faded shortly after the global financial crisis.

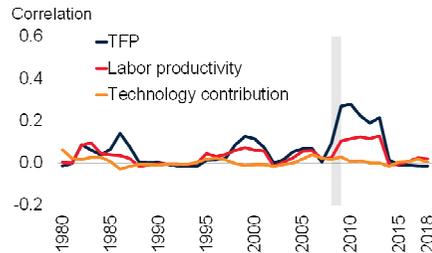
A. Average correlation: World



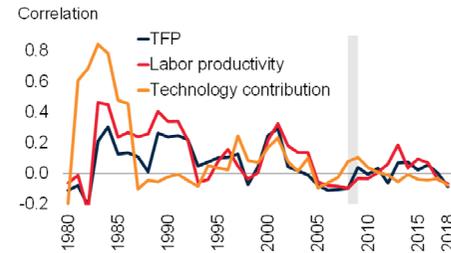
B. Average correlation: Advanced economies



C. Average correlation: EMDEs



D. Average correlation: LICs



Source: World Bank.

Note: EMDEs = emerging market and developing economies, LICs = low income countries.

A-D. 5-year rolling correlations. Simple average across all bilateral pairs of economies for each measure of productivity. The "technology" measure is the contribution of "technology" drivers to productivity growth. This measure removes cyclical components that are present in labor productivity and TFP growth. Sample includes 24 advanced economies and 74 EMDEs, including 6 LICs, with data available for all measures since at least 1981.

[Click here to download data and charts.](#)

consequences for labor productivity, particularly through the capital deepening channel, highlighting the importance of countercyclical policy to counteract the effects of the COVID-19 driven global recession (Chapters 2 and 5).

Slower sectoral transformation. Sectoral reallocation from agriculture to manufacturing has historically been an important driver of growth particularly for EMDEs. However, this transformation has slowed since the GFC. The rising complexity and automation of the manufacturing sector and sectoral distortions have made it increasingly difficult for employment to switch to high productivity sectors. Nonetheless, there remain opportunities for EMDEs to raise productivity in agriculture, which remains the most important sector for many countries, and to shift activity towards high-productivity service sectors (Chapter 7).

Slower growth at the technology frontier. There has been a broad-based slowdown in both labor productivity and TFP growth in advanced economies since the 1990s, with limited signs of an impending upturn. However, there are mixed views on the prospects of groundbreaking technological progress that could return growth to historical norms and spill over to EMDEs. On the one hand, the impact on productivity growth of modern innovations seems to be reduced compared to those of 20th century (Fernald 2015; Gordon 2016). On the other, recently introduced new digital technologies and those on the horizon such as artificial intelligence and innovations in IT sectors may begin to feed through to measured productivity (Cusolito and Maloney 2018). Some of these innovations may require time to be widely adopted into production processes, resulting in an acceleration of productivity growth only after a long lag (Brynjolfsson, Rock, and Syverson 2018). This process may be accelerated as some innovations have been utilized and adopted more intensively due to social distancing measures to restrain COVID-19.

Cyclical drivers dominate synchronized labor productivity developments. Global recessions and slowdowns are generally accompanied by sharp declines in labor productivity and TFP growth. The demand-driven component of productivity growth was the dominant driver of the synchronized nature of the slowdown during the GFC, but the degree of synchronization faded shortly after the crisis. The longer-term degree of slowing productivity growth, and the changing pace of convergence, has varied widely across EMDE commodity exporters and importers, and EMDE regions. More generally, low average synchronization of labor productivity growth outside of cyclical downturns and recoveries suggests a weak and delayed degree of technology transfer and adoption across economies. EMDEs may foster trade integration, FDI, and economic flexibility so they can benefit to a greater extent from technology spillovers, which currently appear to be limited in many economies (Chapter 4).

Broad range of productivity growth trends across EMDE regions. Longer-term developments in productivity growth have been highly diverse across advanced economies, EMDEs, and EMDE regions. Commodity exporters have experienced substantially lower average rates of labor productivity growth over the past 40 years, and have proved less resilient in the aftermath of the GFC than more diversified economies. Many EMDEs have continued to foster positive climates for investment growth and technology adoption, albeit at a reduced pace relative to the pre-GFC period. The importance of a range of correlates for driving cross-country differentials in long-run productivity growth is further explored in Chapter 2 and Chapter 4. These hold important lessons that could limit permanent damage from the COVID-19 pandemic.

Future research. The dynamics in global productivity growth around the GFC—with an appreciable acceleration beforehand, followed by a sustained slump thereafter—merits further study. In particular, future research could dig more deeply into the extent that pre-GFC productivity growth in EMDEs was linked to favorable external conditions, as embodied in rising exports and high commodity prices, and the extent that it was the result of domestic reforms. In particular, positive developments can be shaped by a set of drivers, which are examined in the next chapter.

ANNEX 1.1 Cyclical and ‘technology’-driven labor productivity developments

This annex describes the structural vector autoregression used to separate supply (technology) and demand-side influences on labor productivity growth. The methodology used to identify supply-side “technology” drivers of labor productivity uses a Spectral identification. “Technology” shocks are identified as those that explain the majority of productivity fluctuations at frequencies longer than 10 years— this approach disregards fluctuations at higher (shorter) frequencies and is robust to contamination in economies where productivity is affected by many other factors such as demand shocks. This approach identifies long-lasting innovations to labor productivity, assuming that these highly persistent changes are likely to consist of structural supply-side factors. The methodology is further explored in Chapter 6.

Estimation

Each VAR is estimated using annual data and consists of the natural log-difference of labor productivity, the log-level of employment, the share of investment and separately consumption in GDP, the consumer price inflation rate, and where available, the short-term policy interest rate. Table A.1.1 provides summary statistics on the data length available in each income group.

TABLE A.1.1 Median sample periods

	Labor Prod.	TFP	Spectral
AEs	1962-2018	1951-2018	1973-2018
EMDEs	1972-2018	1971-2018	1981-2018
LICs	1981-2018	1981-2018	1981-2018

Shock decomposition

The decomposition for each region or income-grouping is based on individual estimations which are aggregated using GDP-weights on GDP at 2010 US dollar prices and exchange rates.

Historical decompositions of labor productivity growth, Y_t , can be written as a function of the structural shocks identified through the Spectral identification ϵ_t , initial condition X_0 (which accounts for the lack of data before the start of the sample), and the constant, C .

$$Y_t = \sum_{i=0}^{t-1} F^i \epsilon_{t-i} + A^t X_0 + \sum_{i=0}^{t-1} F^i C$$

In the decompositions shown in Figure 1.5, the identified technology shock, initial condition, and constants are included in the “technology” category, given that they reflect average rates of growth and persistent effects from initial conditions, such as long-run trends. The effects of all other shocks are included in the non-technology category.

The estimation used for the historical decomposition includes labor productivity in growth rates. This is because the effects of initial conditions can be substantial in I(1) or highly persistent processes such as labor productivity levels. In the estimation on growth rates, the change in the contribution of the initial condition over time are minimal given the stationary nature of productivity growth.

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