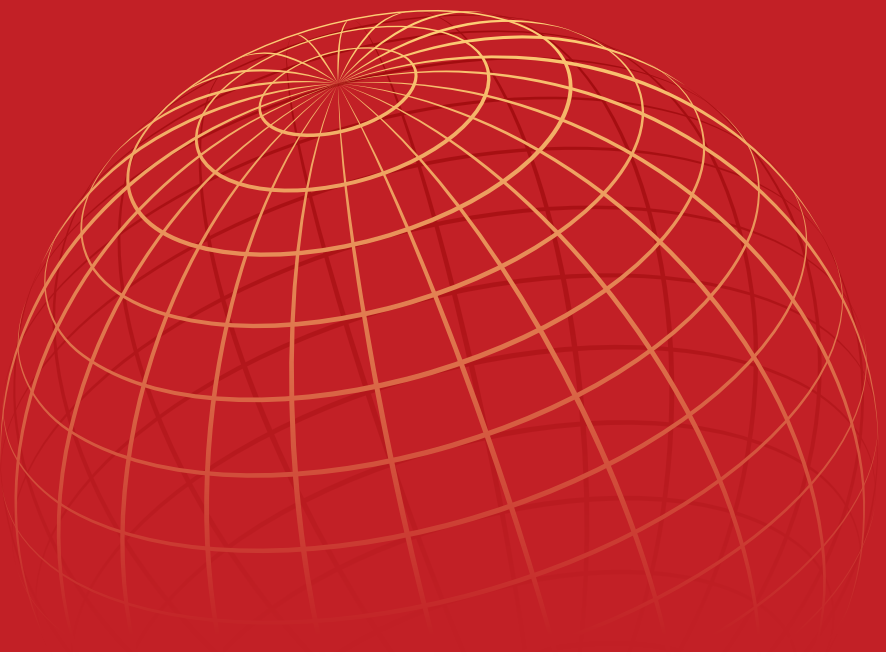


CHAPTER 3

FADING PROMISE

How to Rekindle Productivity Growth

A broad-based slowdown in labor productivity growth has been underway since the global financial crisis. In emerging market and developing economies (EMDEs), the slowdown has reflected weakness in investment and moderating efficiency gains as well as dwindling resource reallocation between sectors. The pace of improvements in key drivers of labor productivity—including education, urbanization, and institutions—has slowed or stagnated since the global financial crisis and is expected to remain subdued. To rekindle productivity growth, a comprehensive approach is necessary: facilitating investment in physical, intangible, and human capital; encouraging reallocation of resources towards more productive sectors; fostering firm capabilities to reinvigorate technology adoption and innovation; and promoting a growth-friendly macroeconomic and institutional environment. Specific policy priorities will depend on individual country circumstances.

Introduction

Productivity growth is the primary source of lasting income growth, which in turn is the main driver of poverty reduction. Most cross-country differences in income per capita have been attributed to differences in productivity (Figure 3.1).[1] Whereas the one-quarter of emerging market and developing economies (EMDEs) with the fastest productivity growth have reduced their extreme poverty rates by an average of more than 1 percentage point per year since 1981, poverty rates rose in EMDEs with productivity growth in the lowest quartile.

The broad-based slowdown in labor productivity growth over the past decade has raised concerns about progress in achieving development goals. In EMDEs, the slowdown puts at risk hard-won gains in productivity catch-up to advanced economies prior to the 2007-09 global financial crisis. Labor productivity gaps with advanced economies remain substantial, with workers in the average EMDE producing less than one-fifth of the output of those in advanced economies. Against this backdrop, this chapter presents a comprehensive examination of the evolution of productivity, the correlates of productivity improvements, and policy options to rekindle productivity growth. Specifically, the chapter addresses the following questions:

- How has productivity growth evolved over the last four decades?
- How has the pace of productivity convergence changed?
- What are the underlying factors associated with productivity growth?
- What policy options are available to boost productivity growth?

Contribution and framework. The chapter makes several contributions to the literature and policy debate on labor productivity. The framework of the analysis in this chapter is as follows:

- *EMDE focus.* Thus far, the literature has focused on trends in subsets of countries such as advanced economies, OECD countries or specific regions.[2] The chapter is the first to provide both an overarching global and in-depth EMDE view of productivity trends alongside detailed regional analysis. To achieve this, it utilizes a comprehensive dataset of multiple measures of productivity growth for up to 29 advanced economies and 74 EMDEs during 1981-2018.
- *Multiple approaches.* The chapter synthesizes findings from empirical exercises using macroeconomic, sectoral, and firm-level data on productivity. Previous studies have typically analyzed productivity using data for only one of these three dimensions.[3] This

Note: This chapter was prepared by Alistair Dieppe and Gene Kindberg-Hanlon, with contributions from Atsushi Kawamoto, Sinem Kilic Celik, Hideaki Matsuoka, Yoki Okawa, and Cedric Okou. Research assistance was provided by Khamal Clayton, Aygul Evdokimova, Awais Khuhro, Xinyue Wang, and Heqing Zhao.

[1] See for details Caselli (2005) and Hall and Jones (1999).

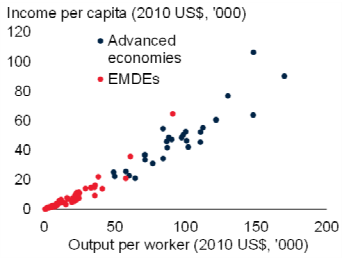
[2] For details, see Fernald (2012), Adler et al. (2017), OECD (2015), ADB (2017), Dabla-Norris et al. (2015), Cusolito and Maloney (2018), World Bank (2018a).

[3] For macroeconomic analysis, see Adler et al. (2017) and Kim and Loayza (2019). For sectoral analysis, see McMillan, Rodrik, and Verduzco-Gallo (2014); and McMillan, Rodrik, and Sepulveda (2017). For firm-level analysis, see Cirera and Maloney (2017); Cusolito and Maloney (2018); and Fuglie et al. (2019).

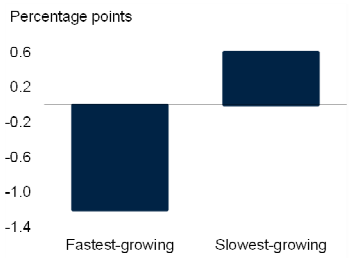
FIGURE 3.1 Labor productivity, per capita income and poverty reduction

Cross-country differences in labor productivity explain most of the variation in income per capita. 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.

A. Labor productivity and per capita income



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



Source: PovcalNet; World Bank.
Note: Sample includes 29 advanced economies and 74 EMDEs.
A. Income per capita and output per worker measured in US dollars at 2010 prices and exchange rates.
B. 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).
Click here to download data and charts.

chapter combines these approaches and includes a thorough review of the literature in each area.

- *Comprehensive assessment of correlates of productivity growth.* The chapter reviews a large body of literature on the correlates of productivity growth. It undertakes an empirical exercise that expands upon previous work, whose data typically use either a shorter sample or a narrower set of correlates.[4] The chapter also quantifies the damage that financial crises inflict on productivity growth.[5]

Main findings. The following findings emerge from the chapter.

- *Broad-based post-crisis decline in labor productivity growth.* Global labor productivity growth slowed from its pre-crisis peak of 2.7 percent in 2007 to a trough of 1.5 percent in 2016 and since then has remained low, at 1.9 percent in 2018. The post-crisis slowdown has been broad-based, affecting nearly 70 percent of advanced economies and EMDEs and over 80 percent of the global extreme poor and has affected all EMDE regions (Figure 3.2). In advanced economies, the slowdown continues a trend that has been underway since the late 1990s. In EMDEs, which have a history of recurring multi-year productivity growth surges and setbacks, the productivity growth slowdown from peak (6.6 percent in 2007) to trough (3.2 percent in 2015) has been the steepest, longest, and broadest yet. Commodity-exporting EMDEs—which account for almost two-thirds of EMDEs—have been the worst affected.[6]

- *Large labor productivity gaps, slow convergence in EMDEs.* Average output per worker in EMDEs is less than one-fifth of that in the average advanced economy, and just 2 percent in LICs. Although EMDE productivity convergence improved ahead of the global financial crisis, it is now progressing at rates that would require over a century to halve the current productivity gap with the average advanced economy. However, the pace of convergence differs across regions: more than half of EMDEs in East Asia and Pacific (EAP) are on course to halve their productivity gap in less than 40 years, while fewer than 20 percent of economies in the Middle East and North Africa (MNA), Latin America and the Caribbean (LAC), and Sub-Saharan Africa (SSA) will likely achieve the same reduction over this timeframe.

- *Accounting for the slowdown.* Slower capital deepening has accounted for the lion's share of the post-crisis (2013-18) slowdown in productivity growth in advanced economies from pre-crisis averages (2003-08). In EMDEs, subdued investment and slowing total factor productivity (TFP) growth have

[4] Durlauf, Kourtellos, and Tan (2008); Kim and Loayza (2019); Adler et al. (2017).

[5] This complements earlier work documenting damage from financial crises to the level of potential output (Cerra and Saxena 2008) and to potential growth (Furceri and Mourougane 2012a).

[6] In commodity-exporting EMDEs, productivity growth slowed by 4.1 percentage points between 2007 and 2015 to around 0, compared with 3.5 percentage points in commodity-importing EMDEs.

accounted, in approximately equal measure, for the post-crisis productivity growth slowdown. About one-half of the slowdown in EMDEs reflects fading gains from the reallocation of resources towards more productive sectors. Reallocation previously drove more than one-third of pre-crisis productivity growth in EMDEs, and three-quarters in LICs.

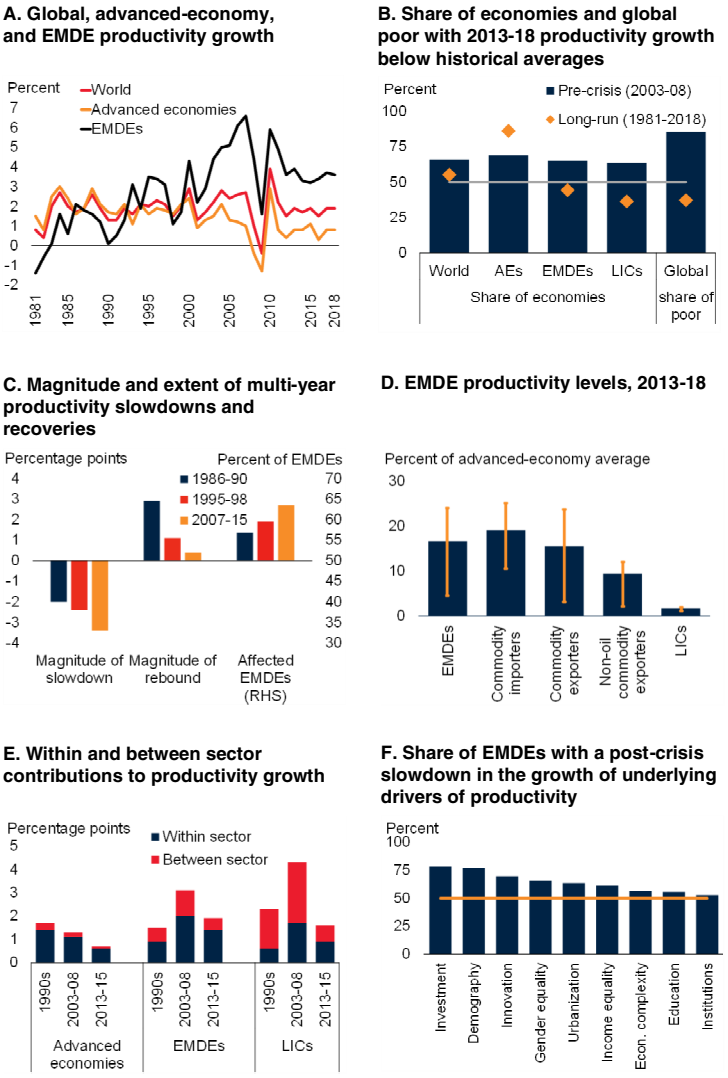
- *Challenging prospects for labor productivity growth.* Since the global financial crisis, improvements in many key correlates of productivity growth in EMDEs have slowed or gone into reverse. Working-age population growth has slowed, educational attainment has stabilized, and the pace of expansion into more diverse and complex forms of production has lost momentum as the growth of global value chains stalled. At the firm level, EMDE firms that are large and export-oriented are closest to the productivity frontier, suggesting that continued global trade weakness and slower global production integration could be particularly damaging to productivity growth in EMDEs. In addition, the global financial crisis dented productivity growth and momentum has yet to be rebuilt.

- *Policy priorities.* The broad-based nature of the labor productivity growth slowdown can be addressed with a comprehensive set of policies. Policies can lift labor productivity economy-wide by stimulating private and public investment, and improving human capital; fostering firm productivity, including by upgrading workforce skills; exposing firms to trade and foreign investment; facilitating the reallocation of resources towards more productive and a more diversified set of sectors; and creating a generally growth-friendly macroeconomic and institutional environment.

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 employed rather than the number of hours worked as the

FIGURE 3.2 Global productivity developments

A broad-based slowdown in productivity growth has been underway, affecting the majority of advanced economies and EMDEs. In EMDEs, productivity growth slowed from its most recent peak of 6.6 percent in 2007 to 3.2 percent in 2015, the steepest, longest, and broadest slowdown in 40 years. Productivity levels in EMDEs are less than 20 percent of the advanced-economy average, and just 2 percent in LICs. The productivity slowdown has coincided with lower gains from sectoral reallocation and a slowdown in improvements in many drivers of productivity growth.



Source: World Bank (full sources in subsequent figures).

Note: Productivity is defined as output per worker. Unless otherwise indicated, data are from a sample of 29 advanced economies (AEs) and 74 emerging market and developing economies (EMDEs). Aggregates are GDP-weighted at constant 2010 prices and exchange rates.

B. Percent of economies, or share of global extreme poor (population living on less than $1.90 per day), with productivity growth in 2013-18 below pre-crisis (2003-08) or long-term (1981-2018) average productivity growth. Grey line indicates 50 percent.

C. "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 (end) of the episode to three years later. "Affected EMDEs" is the share of EMDEs that experienced a slowdown.

D. Blue bars show unweighted average output per worker during 2013-18 relative to the advanced-economy average. Whiskers indicate interquartile range relative to the advanced-economy average.

E. Sample includes 80 economies, including 46 EMDEs (of which 8 are LICs), using data for 1995-2015. Growth "within sector" shows the contribution to aggregate productivity growth of each sector holding employment shares fixed. The 'between sector' effect shows the contribution arising from changes in sectoral employment shares.

F. Post-crisis slowdown defined as the share of economies where improvements in each underlying driver of productivity during 2008-2017 was less than zero or the pace of improvement during the pre-crisis period 1998-2007. Variables definitions in Chart 3.9.A.

Click here to download data and charts.

measure of labor input.[7] A second measure, total factor productivity (TFP), is also featured in the chapter. TFP measures the efficiency with which factor inputs are combined and is often used to proxy technological progress (Annex 3.2).

Evolution of labor productivity growth

Since 2007, a broad-based slowdown in labor productivity growth has been underway that has reached the majority of advanced economies and EMDEs. For EMDEs, this has partly reversed a pre-crisis productivity growth surge, although productivity growth remains above the very weak rates of the 1980s and 1990s. Some low-income countries have escaped the productivity growth slowdown but productivity growth has regressed in some fragile and conflict-afflicted low-income countries.

Global productivity. From its peak in 2007, global productivity growth has slowed by 0.8 percentage point, to 1.9 percent in 2018. The post-crisis (2013-18) average of 1.8 percent was 0.5 percentage point below the pre-crisis (2003-08) average and slightly below the long-term (1981-2018) average (Figure 3.3). This post-crisis slowdown from pre-crisis averages was broad-based, affecting two-thirds of economies, both advanced economies and EMDEs. Those economies with slower post-crisis productivity growth than during the pre-crisis period account for over 80 percent of global GDP and the extreme poor.

Advanced economies. The post-crisis slowdown 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 negative 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 Europe.[8] 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 0.4 percentage points below its pre-crisis average. This slowdown relative to long-run averages affected nearly 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 3.2 percent in 2015 and, since then, has inched up to 3.6 percent in 2018. The post-crisis slowdown from pre-crisis averages affected nearly 70 percent of EMDEs and, in around half of EMDEs, productivity growth has now 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-crisis productivity growth follows on the heels of a major productivity surge during 2003-08 when EMDE productivity growth more than doubled from 1990s averages, in part reflecting a strong cyclical rebound from the 1997-98 Asian financial crisis.

Since 1980, EMDE productivity growth has gone through three multi-year surges and setbacks in productivity growth. Previous multi-year slowdowns—in 1986-1990 and 1995-1998—preceded global recessions (1991) or global slowdowns and EMDE crises (1998). However, the slowdown since 2007 has been the most prolonged, steepest and broadest-based yet.[9] In

[7] Number of people engaged includes employees and self-employed. Alternative measures might better capture labor input but have insufficient coverage for EMDEs (Annex 3.1). In countries with large informal sectors, both employment and output may be subject to sizable measurement error (World Bank 2019a, Annex 3.1).

[8] For a summary of the effects of the ICT slowdown on U.S. productivity in the 2000s, see Duval, Hong, and Timmer (2017), Jorgenson, Ho, and Stiroh (2008), and Fernald (2012). 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).

[9] The 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 around 50 percent steeper than the slowdowns in the late 1980s and the late 1990s. It has reached 64 percent of EMDEs, slightly more than the slowdown in the 1990s (59 percent) and 1980s (57 percent).

contrast to previous episodes, the current productivity slowdown has yet to be marked by a strong rebound.

EMDE productivity growth remains slightly above its average in the 1980s and 1990s, which was well below the pre-crisis surge in productivity growth. In commodity importers, average productivity growth in 2013-18 has remained more than twice its 1980s average and one-third above its 1990s average. However, in commodity-exporting EMDEs, the post-crisis commodity price plunge has returned productivity growth to just 0.6 percent, rates which are weak but still above the growth rates of the 1980s.

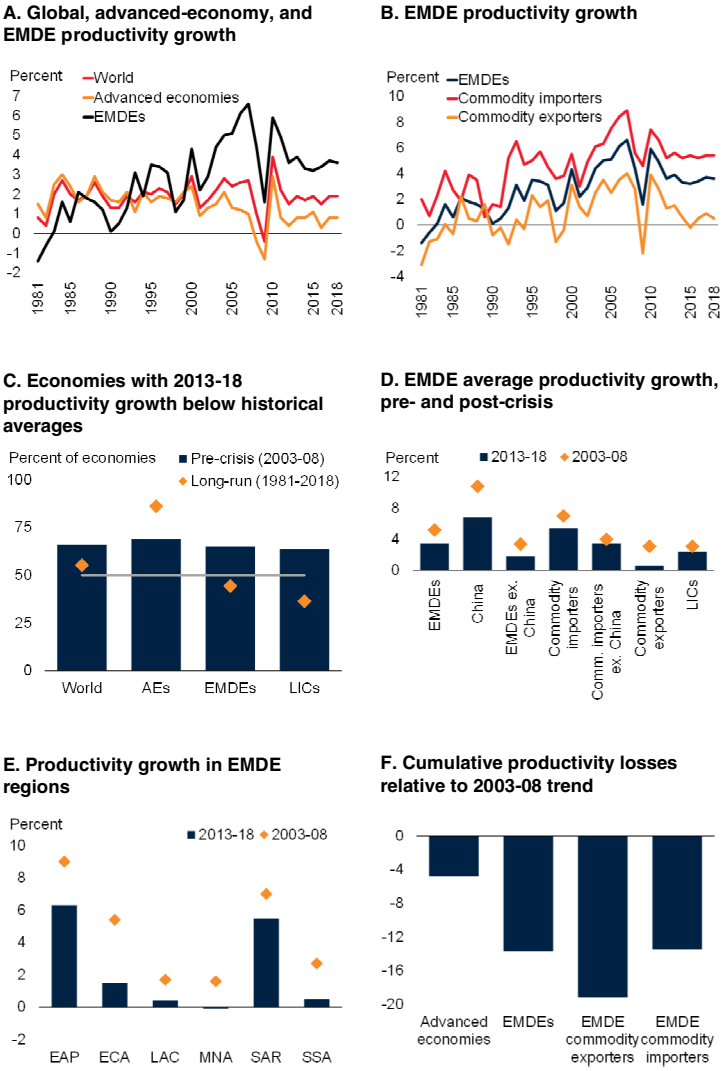
LICs. On average, LIC productivity growth has fallen only modestly to 2.4 percent during 2013-18, substantially above the negative rates of the 1980s and early 1990s. However, productivity growth has again slowed sharply or turned negative in some fragile and conflict-afflicted states (Burundi, Mozambique).

Regions. Productivity growth decelerated in all EMDE regions during 2013-18 from their pre-crisis (2003-08) averages (Box 3.1). This slowdown occurred amid heightened debt levels which increase the probability of financial crises and crowd out productive investments. The most pronounced slowdown (by 3.8 percentage points to 1.5 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 has also fallen steeply in Latin America and the Caribbean (LAC), the Middle East and North Africa (MNA), and Sub-Saharan Africa (SSA), to near zero. Productivity growth declined substantially in East Asia and Pacific (EAP) and more modestly in South Asia (SAR) from pre-crisis levels, but it continued to be robust, remaining above 5 percent in both regions.

Missed opportunities. 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-crisis trend. Output per worker in advanced economies would be 5 percent higher today had productivity growth continued at its

FIGURE 3.3 Evolution of global productivity growth

In EMDEs, productivity growth has declined from pre-crisis levels, although it remains strong relative to longer-run averages in half of EMDEs. At 0.6 percent, EMDE commodity exporters have had the weakest average productivity growth since 2013. Productivity growth in EMDE commodity importers and LICs has been more resilient.



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

Note: Productivity is defined as output per worker. Data are from a balanced sample between 1981-2018 and includes 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. GDP-weighted (at constant 2010 prices and exchange rates) aggregates.

A.B. GDP weighted averages (at 2010 prices and exchange rates).

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.

E. GDP-weighted productivity growth for 8 EMDEs in East Asia and the Pacific (EAP), 10 EMDEs in Eastern Europe and Central Asia (ECA), 18 EMDES in Latin America and the Caribbean (LAC), 10 EMDEs in Middle East and North Africa (MNA), 2 EMDEs in South Asia (SAR), and 26 EMDEs in Sub-Saharan Africa (SSA).

F. Percent fall in productivity level by 2018 relative to a counterfactual scenario where productivity continued to grow at its 2003-08 average growth rate from 2009 onwards.

Click here to download data and charts.

BOX 3.1 EMDE regional labor productivity trends and bottlenecks

The post-crisis slowdown in productivity growth was particularly severe in East Asia and Pacific, Europe and Central Asia, and Sub-Saharan Africa amid slowing investment growth, financial market disruptions, and a post-crisis commodity price slide. Meanwhile, productivity growth in Latin America and the Caribbean and the Middle East and North Africa—the slowest even before the global financial crisis—has fallen to near-zero as investment collapsed amid political uncertainty, episodes of financial stress in major economies, and falling commodity prices. As a result, the pace of catch-up to advanced-economy productivity levels has slowed in most regions since the global financial crisis and, in some regions, productivity is even falling further behind. In almost all regions, productivity gains from the reallocation of labor from low-productivity to higher-productivity sectors have slowed sharply. To boost productivity, policies are needed to address key obstacles to productivity growth. Some of these obstacles are shared across EMDE regions, including resource-reliant economies, widespread informality, shortcomings in education, and weak governance, and some are region-specific bottlenecks.

Introduction

Although common across all EMDE regions, the post-crisis productivity growth slowdown has differed markedly in severity. Generally, it was more pronounced in more open EMDE regions that are closely integrated into advanced-economy supply chains. Meanwhile, in regions with a large number of commodity exporters, productivity growth has fallen close to zero. As a result, to varying degrees, the catch-up to advanced-economy productivity levels has slowed since the global financial crisis and, in some regions, productivity is even falling further behind. Policy priorities to reignite productivity growth differ across regions.

This box draws out differences in regional productivity trends and policy priorities (summarizing Boxes 2.1-2.6).[1] Specifically, it addresses the following questions:

- How has the evolution of productivity varied across regions?
- What factors were associated with stronger productivity growth?

For the purposes of this box, productivity is defined as labor productivity—that is, real GDP per worker (at 2010 prices and exchange rates).

Evolution of productivity

Post-crisis labor productivity growth slowdown. An exceptional pre-crisis surge in productivity growth was broad-based across regions, with productivity in more than 50 percent of economies in each region except The Middle East and North Africa (MENA) growing faster than the advanced economy average (Rodrik 2011; Roy, Kessler and Subramanian 2016; Figure 3.1.1). Since the global financial crisis (2013-18), however, productivity growth has slowed from pre-crisis (2003-08) rates in all EMDE regions.

The slowdown was particularly steep in East Asia and the Pacific (EAP), especially in China, as well as in Europe and Central Asia (ECA) and Sub-Saharan Africa (SSA). In these regions, investment growth has declined sharply from pre-crisis levels amid a policy-guided public investment slowdown in China (EAP), financial system disruptions associated with the Euro Area crisis (ECA), and the commodity price collapse of 2014-16 (ECA, SSA). However, in all three regions, there were important exceptions to the sharp slowdown. In EAP, the slowdown was concentrated in China while productivity growth continued to be robust in other major EAP economies, especially some ASEAN economies (the Philippines and Vietnam), as FDI and investment growth remained robust (Box 2.1). In ECA, the slowdown was muted in agricultural economies in Central Asia that shifted their economic ties towards China and in Central European economies that continued to integrate into Western European supply chains and benefited from investment financed by European Union structural funds. In SSA, productivity growth accelerated in agricultural commodity exporters.

The slowdown was mildest in South Asia (SAR), in part because the region is the least open EMDE region to global trade and finance, continued to urbanize rapidly, and, as a predominantly commodity-importing region, benefited from the commodity price slide. In MENA, the slowdown was mild since limited links to global financial markets insulated commodity-importing economies from global financial stress.

Post-crisis productivity growth across regions. Productivity growth in Latin America and the Caribbean

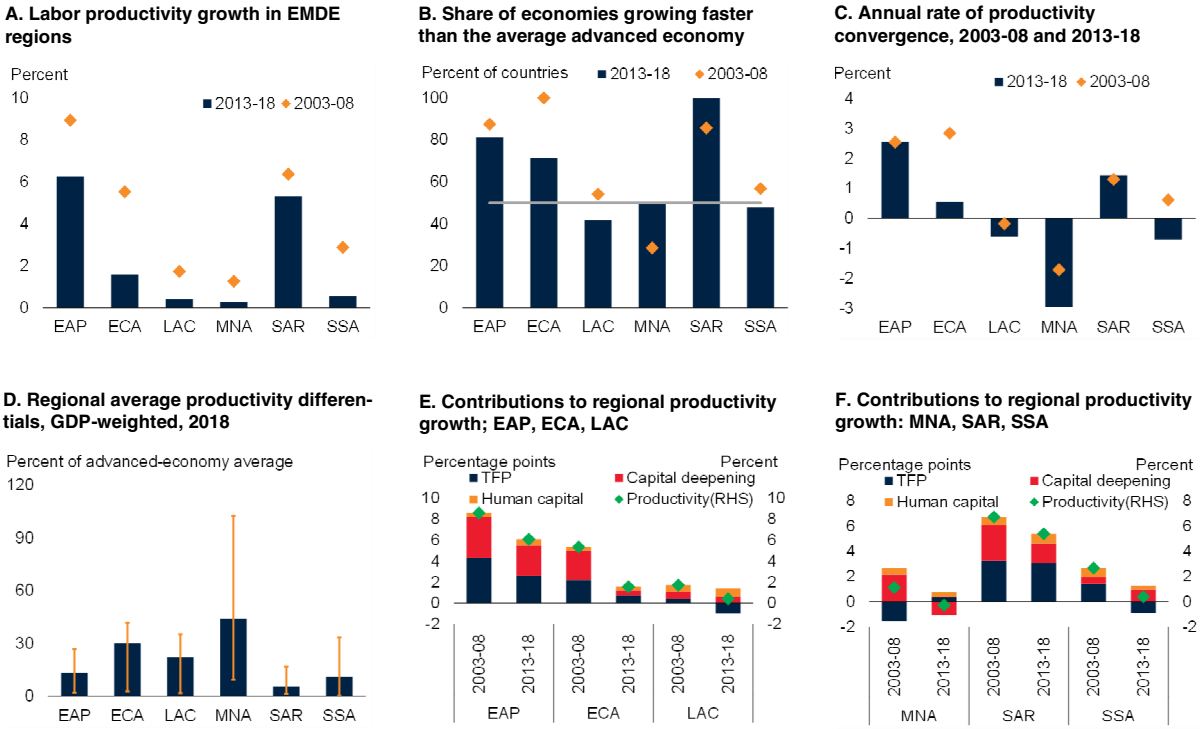
Note: This box was prepared by Gene Kindberg-Hanlon with research assistance from Shijie Shi.

[1] To be as representative of each region as possible, this box uses a broader sample than the main text in Chapter 3, resulting in a shorter time horizon under consideration. This box and the regional boxes cover a sample containing 127 EMDE economies, compared to 74 in the main text.

BOX 3.1 EMDE regional labor productivity trends and bottlenecks (*continued*)

FIGURE 3.1.1 Evolution of regional labor productivity

The post-crisis slowdown in labor productivity growth was particularly severe in EAP, ECA and SSA as these regions struggled with slowing investment growth, financial market disruptions, and weaker commodity prices. In EAP and ECA, the slowdown in productivity growth has reflected both a slower pace of capital deepening and weaker TFP growth. In MENA and SAR, TFP has continued growing or stabilized after earlier contractions (MENA).



Source: International Monetary Fund; Penn World Table; The Conference Board; World Bank, World Development Indicators.

A.B.C.D. Productivity refers to output per worker at 2010 prices and exchange rates. Sample includes 35 advanced economies (AE) and 16 EMDEs in East Asia and the Pacific (EAP), 21 EMDEs in Eastern Europe and Central Asia (ECA), 25 EMDES in Latin America and the Caribbean (LAC), 14 EMDEs in Middle East and North Africa (MNA), 7 EMDEs in South Asia (SAR), and 44 EMDEs in Sub-Saharan Africa (SSA).

A. GDP-weighted average labor productivity growth.

B. Share of economies with faster productivity growth than the advanced-economy average in each period.

C. Rate of convergence calculated as the difference in productivity growth rates with the average advanced economy divided by the log difference in productivity levels with the average advanced economy. Regional rate of convergence is the GDP-weighted average of EMDE members of each region.

D. Whiskers show the range within the region as a percent of the advanced economy average while bars show the GDP-weighted average level of productivity relative to advanced economies. Productivity reflects output per worker measured in US dollars at 2010 prices and exchange rates.

E.F Aggregates calculated using GDP weights at 2010 prices and exchange rates. The sample includes 92 emerging market and developing economies (EMDEs), including 8 East Asia and Pacific, 21 Europe and Central Asia, 19 Latin America and the Caribbean, 12 Middle East and North Africa, 2 South Asia, and 30 Sub-Saharan Africa economies.

Click here to download data and charts.

(LAC), MNA, and SSA—even before the crisis, the slowest—has fallen to near zero as investment collapsed amid political uncertainty, episodes of financial stress in major economies, and falling commodity prices (Box 2.3). As a result, productivity growth in the majority of EMDEs in LAC, MNA, and SSA now lags that in advanced economies and, on average in these regions, productivity levels are diverging from those in advanced economies. In contrast, productivity growth continues above 5 percent in EAP and SAR, where investment growth is still higher than in other EMDE regions (EAP, SAR) or the shift towards more productive sectors has accelerated (SAR). In these two regions, productivity continues to converge towards advanced-economy levels at approximately the pre-crisis pace.

Regional dispersion of productivity. On average, productivity in EMDEs was just 19 percent of the

BOX 3.1 EMDE regional labor productivity trends and bottlenecks (*continued*)

advanced-economy average in 2018.[2] Among EMDE regions, average labor productivity is highest in the MNA (45 percent of the advanced-economy average), LAC and ECA (about 22-30 percent, respectively) and lowest in SAR (6 percent) and SSA (11 percent). However, these regional averages disguise wide dispersion within some regions, especially MNA, ECA, and SSA. In some Gulf Cooperation Council (GCC) countries in MNA, for example, productivity is near advanced-economy averages whereas in heavily agricultural economies, such as the Arab Republic of Egypt and Morocco, it amounted to 10 percent of the advanced-economy average (Box 2.4). Similarly, close trade integration with Western Europe and, increasingly, China and major reforms since the collapse of the Soviet Union have helped raise average productivity levels in ECA to the second-highest among EMDE regions (30 percent). However, there is wide heterogeneity, with Poland producing around 38 percent of the advanced economy average worker, while some agricultural economies in Central Asia produce just 3 percent (Box 2.2). In SSA, LICs produce about 2 percent of the advanced economy average whereas oil exporters such as Gabon produce 33 percent (Box 2.6). In contrast, closely integrated EAP has a narrower range of productivity levels (2-25 percent of the advanced-economy average).

Capital deepening versus total factor productivity growth. Productivity growth can be decomposed into the use of factor inputs (human or physical capital) or the effectiveness of their use (total factor productivity, or TFP, Figure 3.1.1). In EAP and ECA, the post-crisis slowdown in productivity growth has reflected both a slower pace of capital deepening and weaker TFP growth, albeit to varying degrees. Two-fifths of the slowdown in EAP reflected slowing capital deepening, the remainder slowing TFP growth. In EAP, a policy-guided move towards more sustainable growth in China and trade weakness weighed on investment and capital deepening. In ECA, most (two-thirds) of the productivity growth slowdown reflected a collapse in investment growth as conflict erupted in parts of the region, sanctions were imposed on the Russian Federation, political and economic shocks unfolded in Turkey, financial systems transformed after the Euro Area debt crisis, and the commodity price collapse hit commodity exporters (Arteta and Kasyanenko 2019).

[2] In this section, GDP-weighted averages of productivity are used to compare productivity levels across economies—in the main text, simple averages are used.

In MNA and SAR, in contrast, TFP continued growing at the pre-crisis pace (SAR) or stabilized after earlier contractions (MNA), even as capital deepening slowed sharply (SAR) or reversed (MNA). In MNA, the oil price collapse of 2014-16 weighed heavily on investment in oil exporters and political tensions discouraged investment in commodity importers. However, macroeconomic and structural reform efforts helped stem pre-crisis contractions in TFP. In SAR, persistent post-crisis investment weakness—in part due to disruptive policy changes and tapering growth of FDI inflows—was offset by productivity-enhancing sectoral reallocation, as labor moved out of agriculture into more productive sectors amid rapid urbanization (Box 2.5).

Conversely, in SSA and LAC, TFP contracted. In major LAC economies, continued post-crisis credit extension or intensifying economic distortions (such as trade restrictions and price controls) allowed unproductive firms to survive to a greater extent than pre-crisis. In SSA, the contraction in TFP was partly offset by accelerating capital deepening as a number of countries invested heavily in public infrastructure, typically financed by debt.

Regional sources of productivity growth and bottlenecks

A wide range of factors have weighed on productivity growth since the global financial crisis, but their relative role has differed across regions. In all regions other than SAR, productivity gains from the reallocation away from low-productivity (usually agriculture) sectors to higher-productivity sectors have slowed (Enache, Ghani, and O'Connell 2016). In addition, the pre-crisis pace of improvements in various aspects of the supporting environment for productivity growth has slowed. Productivity levels in all regions remain less than half of those in advanced economies, providing significant scope for faster productivity growth. However, significant bottlenecks to productivity convergence remain, many of which differ across regions.

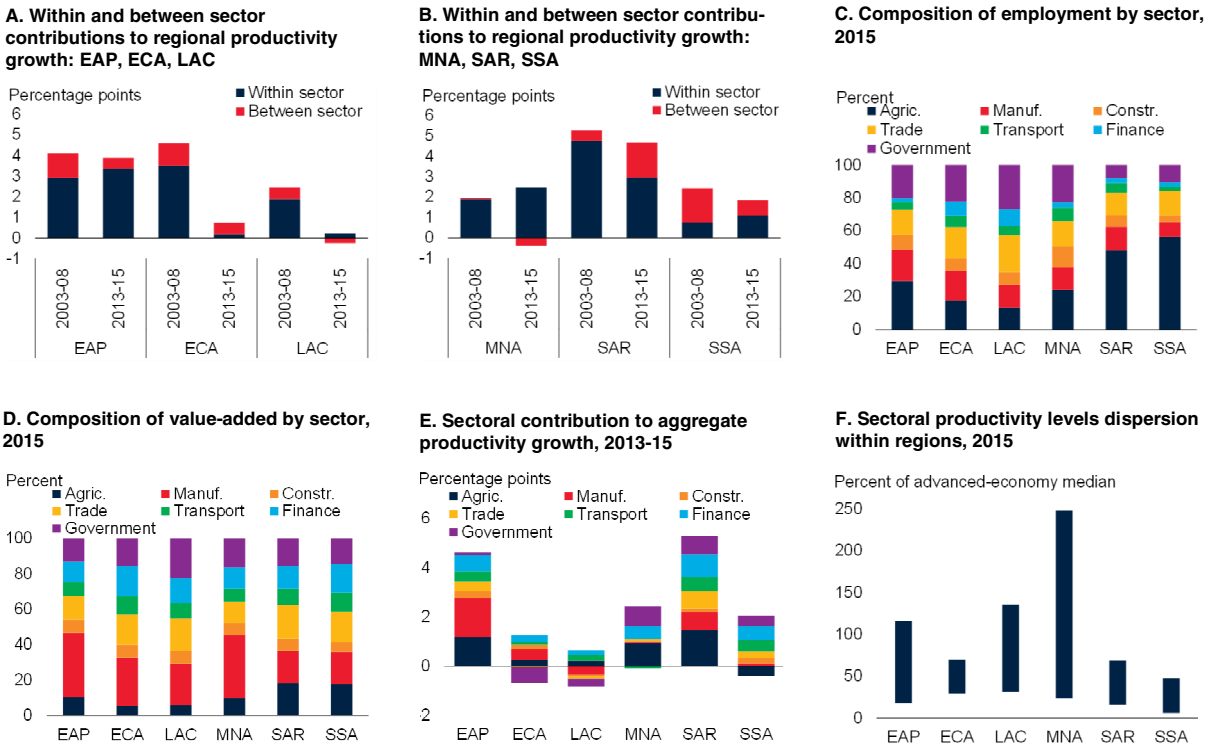
Sectoral reallocation

Declining gains from sectoral reallocation. In all regions except MNA, switching employment from low-productivity sectors to sectors with above-average productivity levels supported productivity growth during 2003-08, especially in EAP, ECA, and SSA (Figure 3.1.2). In SSA, it accounted for more than half of growth in the median economy during 2003-2008 (Diao, McMillan, and Rodrik 2017).

BOX 3.1 EMDE regional productivity trends and bottlenecks (*continued*)

FIGURE 3.1.2 Sectoral contributions to regional productivity growth

Since the global financial crisis productivity gains from sectoral reallocation have faded across all regions (with the exception of SAR). In SAR and SSA, around half of employment is in the agricultural sector, which only accounts for around 20 percent of output, reflecting low productivity in this sector. The wide dispersion of sectoral productivity levels within regions demonstrates the importance of introducing measures to reduce misallocation and boost productivity in the weakest sectors.



Source: APO productivity database; Expanded African Sector Database; Groningen Growth Development Center Database; Haver Analytics; ILOSTAT; OECD STAN; United Nations; World KLEMS.

Note: Sample includes 46 EMDEs, of which 8 are LICs and 9 East Asia and Pacific, 6 Europe and Central Asia, 6 Latin America and the Caribbean, 3 Middle East and North Africa, 3 South Asia, and 19 Sub - Saharan African economies.

A.B. Median contribution for each region. Growth within sector shows the contribution of initial real value added-weighted productivity growth rate of each sector and 'between sector' effect shows the contribution arising from changes in sectoral employment shares.

E. Median contribution to productivity growth.

F. Range of (regional averages of) sector-specific productivity levels relative to advanced-economy average productivity for the same sector in 2015, valued at 2011 purchasing power adjusted exchange rates. The range for MNA excludes sectoral productivity for mining which exceeds 1000 percent of the advanced-economy average.

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Since the global financial crisis, however, productivity gains from sectoral reallocation have faded across all regions (with the exception of SAR). In commodity-reliant regions such as LAC, MNA, and SSA, this in part reflected lower absorption of labor by services and construction sectors as real income losses in resource sectors spilled over into weaker demand. In EAP, it reflected slowing labor reallocation as overcapacity was gradually being unwound. In ECA, high-productivity manufacturing, financial, and mining sectors suffered during the Euro Area debt crisis and the post-crisis commodity price collapse. Meanwhile, in SAR, the move of labor out of low-productivity agriculture into more productive sectors accelerated as rapid urbanization continued and strong consumption growth fueled employment in higher-productivity trade services.

Looking ahead, further sectoral reallocation continues to have a high potential to lift productivity growth in SSA and SAR, where low-productivity agriculture accounts for around 50 percent of employment and 20 percent of output. Substantial gaps in productivity between sectors

BOX 3.1 EMDE regional productivity trends and bottlenecks (*continued*)

remain, offering the potential for further aggregate productivity gains from resource reallocation between sectors.

Bottlenecks to productivity growth

Several bottlenecks to higher productivity are shared, to varying degrees, by multiple EMDE regions. These include commodity-reliance, widespread informality, poor education, and weak governance. Other bottlenecks are mostly region-specific.

Reliance on commodity exports. In LAC, MNA, and SSA, commodities account for over 20 percent of exports on average. In ECA, they account for 30 percent of exports, largely due to Russia, where around 60 percent of exports are (mostly energy) commodities. Economies that are highly reliant on a narrow range of commodity exports can also suffer from misallocation and procyclical trends for productivity growth (Frankel 2010). Conversely, producing across a broad range of sectors can insulate economies from external shocks, and can facilitate knowledge transfer to strengthen productivity (Kraay, Soloaga, and Tybout 2002; Schor 2004). In EAP, for example, high pre-crisis productivity growth was spurred by rapid integration into global supply chains and attraction of FDI which enabled a substantial increase in the range and sophistication of production in the region (Wei and Liu 2006).

Weak governance and institutions. In most EMDE regions, governance and business climates are less business-friendly than in advanced economies. The largest distances to the frontier (the most business-friendly climates) are in SSA, SAR, and LAC, but also in pockets of ECA (Central Asia and Eastern Europe) and MNA (North Africa). In all regions, a large majority of EMDEs fall below the global average for tackling corruption. Poor institutions have been associated with weak firm productivity and inefficient government investment in productivity-augmenting infrastructure (Cirera, Fattal-Jaef, and Maemir 2019). In EAP, poor corporate governance in some sectors contributes to resource misallocation and weighs on productivity.

Informality. Informality is pervasive in EMDEs, although there are large differences in the productivity of informal sectors across regions. Informal firms are less productive than those in the formal sector and, by competing on more favorable terms, can deter investment and erode the productivity of formal firms (Amin, Ohnsorge, and Okou 2019). In all regions except MNA, the informal sector accounts for 25-40 percent of official GDP (22 percent of GDP in MNA); however, reflecting heterogeneity in productivity levels, informal employment (measured as self-employment) varies widely from 22 percent (MENA) to 62 percent (SSA) of total employment (World Bank 2019a).

Limited human capital. Higher-skilled and better-educated labor forces tend to adopt new technologies, including new ICT and manufacturing technologies, more readily and more effectively (World Bank 2019c). In EAP and ECA, expected years of schooling for children are now within one year of advanced economies on average, but SAR and SSA lag more than 3 years behind the advanced-economy average (Figure 3.1.3). Even where years of schooling are on par with advanced economies, education can be ineffective where learning outcomes are poor (World Bank 2018a). In learning-adjusted terms, which controls for the quality of education in addition to years of attainment, SAR and SSA lag substantially (six or more learning-adjusted years) behind advanced economies.

Region-specific factors. In each region, some challenges to improving or sustaining productivity growth are notable:

- In **EAP**, the region faces challenges in sustaining productivity growth as rapid trade integration, which spurred productivity growth in the 2000s, fades. With maturing supply chains and weak global trade, the priority has shifted towards improving the allocation and efficiency of investment, including in a wider range of sectors (World Bank and DRCSC 2019).

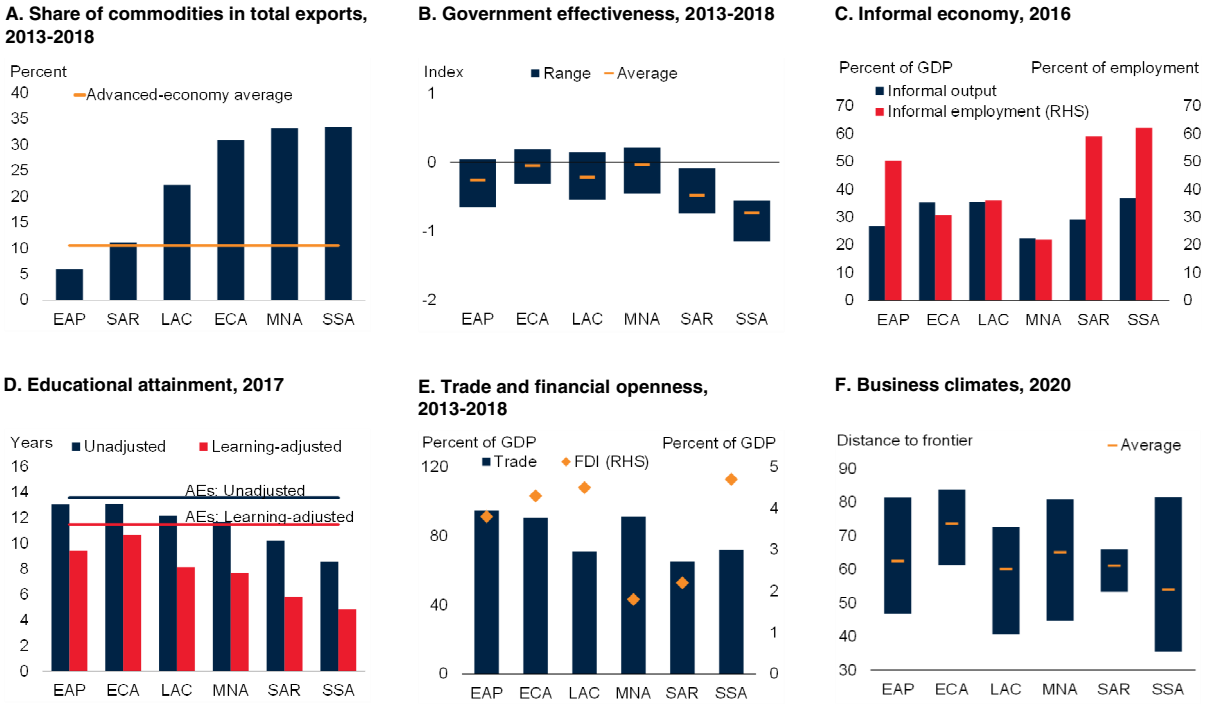
- In **ECA**, reform momentum has stalled in many economies since the global financial crisis. This follows on the heels of a period of rapid progress in the 1990s and 2000s in the transition to market-based economies and, in Central Europe, in the accession to the European Union (Georgiev, Nagy-Mohacsi, and Plekhanov 2018). Restrictive product market and services regulations now hinder competition and deter foreign investment.

- In **MNA**, the government accounts for a large share of employment relative to other regions. About one-fifth of the workforce is employed in the public sector. This is in part driven by a sizable wage premium for public-sector workers and a bias in the education system toward training for public sector employment. The non-GCC private sector is anemic, with lower firm turnover than in other EMDE regions.

BOX 3.1 EMDE regional productivity trends and bottlenecks (*continued*)

FIGURE 3.1.3 Potential bottlenecks to productivity growth

Several bottlenecks to higher productivity are shared, to varying degrees, by EMDE regions. These include undiversified economies, weak governance, widespread informality, poor learning outcomes, and low trade and financial openness.



Source: United Nations; World Bank, Doing Business, Human Capital Project, World Development Indicators, Worldwide Governance Indicators.
A. Exports of metals, agricultural and energy products in percent of total exports. GDP-weighted average for each region. Average during 2013-2018.
B. WGI index defined as capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formation and implementation, and the credibility of the government's commitment to such policies. Bars show interquartile range.
C. Average informal output (DGE-based estimates, percent of official GDP) and employment estimate (self-employment, percent of total employment) in each region. Based on World Bank (2019a).
D. Expected years of schooling and learning-adjusted years of schooling from the World Bank's Human Capital Project. Learning-adjusted years of schooling uses harmonized cross-country test scores to adjust the average years of schooling.
E. Unweighted average of trade (exports plus imports) in percent of GDP and net foreign direct investment inflows in percent of GDP.
F. Unweighted average distance to frontier measure of the ease of doing business score from the 2020 Doing Business Indicators. A higher value indicates a business climate that is closer to best practices. Bars show range.
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- In **LAC**, productivity could be boosted by policies to improve innovation and competition. Greater trade integration and more welcoming environments for FDI could lift productivity growth through knowledge and technology transfers.
- In **SAR**, productivity has been held back by below-average international trade integration and FDI, which limits technology and knowledge spillovers, and restricted access to finance from a banking system that is heavily state-dominated.
- In **SSA**, low productivity reflects the presence of large agricultural sectors, including widespread subsistence agriculture. A policy priority is therefore to lift productivity in the agricultural sector. In addition, SSA economies tend to be involved in supply chains only at early stages of production, producing primary products, and have few exporting firms.

average pace ahead of the crisis (2003-2008). Losses relative to the exceptionally high rate of productivity growth in EMDEs ahead of the crisis are closer to 14 percent, and higher still at 19 percent for EMDE commodity exporters.

Labor productivity convergence

EMDE productivity levels are less than one-fifth of the advanced-economy average, falling to just 2 percent in LICs. In some large EMDEs, such as China and India, productivity is growing substantially faster than in advanced economies, resulting in productivity catch-up. However, average EMDE productivity growth is just half a percentage point faster than in advanced economies, requiring more than a century to halve productivity gaps.

Faster productivity growth occurs in countries with lower initial productivity levels when controlling for factors such as the level of human capital and institutional quality (Durlauf, Johnson, and Temple 2005; Johnson and Papageorgiou 2018). At 3.6 percent in 2018, productivity growth in EMDEs remained more than four times as high as in the average advanced economy (0.8 percent). However, this aggregate growth rate is dominated by China and India, the largest EMDEs by output and population, where productivity growth is above five percent. Many EMDEs are growing at a substantially slower pace than China and India: *on average*, EMDE productivity is growing by just 0.5 percentage point faster than in advanced economies.

Productivity gaps. Despite some narrowing of the productivity gap in 60 percent of EMDEs since the 1990s, output per worker in EMDEs remains less than one-fifth that of the average advanced economy (Figure 3.4).[10] This productivity differential accounts for a considerable proportion of global income inequality since global per capita income differences (reflecting mainly productivity differences) drive two-thirds of global inequality (World Bank 2018c).

- *Commodity importers and exporters.* Relative productivity levels are slightly higher in commodity-importing EMDEs on average (19 percent of advanced-economy productivity) than in commodity-exporting EMDEs (17 percent) and, lower in non-oil exporters (10 percent) than in oil exporters (28 percent) (Chapter 2 boxes).

- *LICs.* In LICs, productivity is just 2 percent of the advanced-economy average, having made negligible progress in narrowing this gap since the 1990s (World Bank 2019b).

- *Regions.* Productivity is lowest on average in SSA and SAR (8 and 7 percent of the advanced-economy average respectively). Within SSA, which hosts most LICs and mostly non-oil commodity exporters, productivity is even lower in many economies, falling to just 2 percent of the advanced economy average in the bottom quartile of the region (Box 3.1). It is highest in MNA (36 percent of the advanced-economy average), which hosts several high-income oil exporters, and ECA (19 percent of the advanced-economy average), parts of which are closely integrated with EU supply chains and EU labor markets. Throughout the 2000s, pre- as well as post-crisis, the gap with advanced economies has closed fastest in EAP and SAR but continued to widen in parts of LAC, MNA, and SSA.

Pace of productivity convergence. Productivity convergence between low and high-productivity economies became broad-based in the late 1990s, with little evidence for convergence prior to this (Patel, Sandefur, and Subramanian 2018; Figure 3.4).[11] While the presence of convergence during the 2000s is reassuring, its pace is disappointing. At current productivity growth rates, productivity gaps to advanced-economy average productivity

[10] This productivity gap is measured using output per worker in 2010 U.S. dollars at market exchange rates. When measured at Purchasing Power Parity (PPP) adjusted U.S. dollars, the gap to advanced economies is smaller, with EMDE productivity around one-third of the advanced economy average (World Bank 2018a).

[11] The speed of productivity convergence can be formally assessed using a "β convergence" test, where productivity growth is regressed on the initial level of productivity (Barro 1991; Barro and Sala-i-Martin 1992).

are narrowing by 0.3 percent per year on average—requiring more than a century just to close half of the gap. But the pace of convergence differs across regions. At current rates of productivity growth, less than 20 percent of economies in LAC, MNA or SSA—but at least 50 percent of those in EAP and SAR—are on course to halve their productivity gap over the next 40 years.

Sources of post-crisis slowdown in labor productivity growth

Aggregate labor productivity growth can be decomposed into its sources: into factor inputs and the efficiency of their use, or into sectors. These decompositions suggest that the post-crisis productivity growth slowdown in EMDEs, in approximately equal measure, reflected weak investment and a slowdown in total factor productivity growth, as well as fading gains from factor reallocation towards more productive sectors.

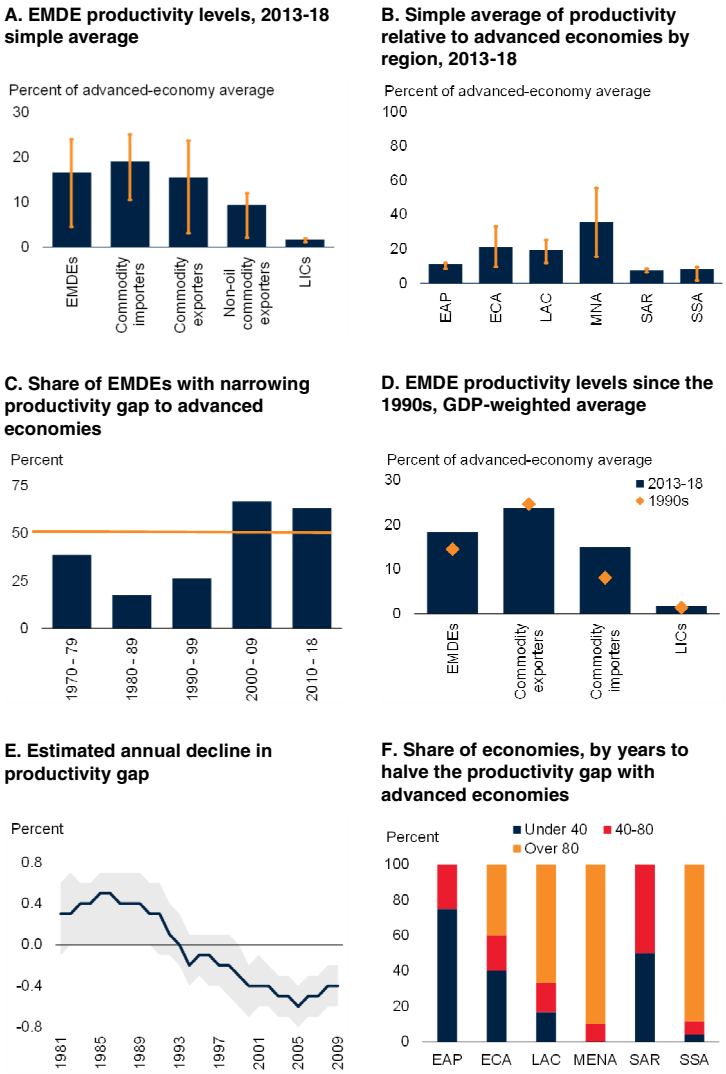
Decomposition into factor inputs

Approach. In the first step, productivity growth is decomposed into contributions from individual factor inputs (capital and human capital) and the effectiveness of their use (total factor productivity, or TFP, growth), assuming a Cobb-Douglas production function (Annex 3.2). Capital deepening directly increases labor productivity, while human capital improvements (e.g. education and training) enhances the quality of labor input and therefore the resulting 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.[12] TFP growth can also be affected by non-technology

[12] The 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. Weaker rates of investment reduce TFP growth by reducing the incorporation of new technologies into the production process (Adler et al. 2017; Hulten 1992). Conversely, slower technological change reduces the expected return on capital and, hence, the incentives to invest.

FIGURE 3.4 Distribution of productivity levels and convergence progress

On average, productivity in EMDEs is less than one-fifth of the advanced-economy average, and in LICs it is just 2 percent. EMDE productivity gaps with the advanced-economy average widened during the 1970s-1990s but narrowed from 2000 onwards. However, the implied pace of convergence is low—even at the peak of EMDE growth, the productivity gap would have taken over a century to halve.



Source: Penn World Table; The Conference Board; World Bank, World Development Indicators.
Note: Productivity defined as output per worker in U.S. dollars (at 2010 prices and exchange rates). Based on 29 advanced economies and 74 EMDEs, which include 22 commodity-importing EMDEs and 52 commodity-exporting EMDEs.
A. Blue bars indicate unweighted average output per worker during 2013-18 relative to the advanced-economy average. Whiskers indicate interquartile range relative to the advanced-economy average.
B. Unweighted average productivity during 2013-18 relative to average advanced economy by region (2013-18). Includes 29 advanced economies and 74 EMDEs = 8 EMDEs in East Asia and the Pacific (EAP), 10 EMDEs in Eastern Europe and Central Asia (ECA), 18 EMDES in Latin America and the Caribbean (LAC), 10 EMDEs in Middle East and North Africa (MNA), 2 EMDEs in South Asia (SAR), and 26 EMDEs in Sub-Saharan Africa (SSA).
C. Share of EMDEs with faster productivity growth than the advanced-economy average.
D. GDP-weighted (at 2010 prices and exchange rates) averages.
E. Line shows the implied annual rate of decline of the productivity gap based on a regression of labor productivity growth on initial productivity. Shaded area indicates 90 percent confidence intervals. Estimation performed over 10-year rolling windows in the specification
$\log\Delta y_t = c + \beta y_{t-10} + \varepsilon_t$ where y is output per worker. Coefficient converted to the average annual decline in the productivity gap following Sala-i-Martin (1992).
F. The proportion of EMDEs in each region that will close half of the productivity gap with the average advanced economy in each bracket of years based on average growth during 2013-18 relative to average advanced economy growth and the outstanding productivity gap over the same period.
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factors, such as changing levels of capital and labor utilization—therefore estimates may over or understate the true change in the influence of technology on productivity. Efforts to control for utilization have found that while some of the pre-crisis surge in productivity in EMDEs was a demand-driven phenomenon of increased utilization, a large proportion of the subsequent slowdown was structural, reflecting factors other than fading demand after the global financial crisis (Dieppe, Kiliç Çelik, and Kindberg-Hanlon, Forthcoming).

Factors inputs versus the effectiveness of their use. Globally, the post-crisis (2013-18) slowdown in labor productivity growth from pre-crisis (2003-08) 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). In advanced economies, the slowdown in TFP growth was a minor source of the post-crisis decline in labor productivity growth, due to a structural slowdown prior to the crisis.[13] 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 post-crisis slowdown in productivity growth from pre-crisis averages in advanced economies (Figure 3.5). 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.[14] Investment contracted by an average of 6 percent per year between 2008-09. While the investment share of GDP has recovered close to pre-crisis levels, 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 pre-crisis period (2003-08) relative to the 1980s and 1990s and has now recovered modestly.[15]

- *EMDEs.* The post-crisis slowdown in EMDE productivity growth from pre-crisis averages 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 pre-crisis. This was compounded by contracting TFP growth, which had accounted for most of the remainder of pre-crisis productivity growth. Investment stalled or contracted in commodity exporters during the commodity prices collapse of 2011-16 (Aslam et al. 2016; World Bank 2017). TFP growth has also been weak historically, contributing little to catch-up growth (De Gregorio 2018). In *commodity-importers*, especially China, capital deepening accounted for much of the productivity gains over the past four decades. This momentum has slowed since the global financial crisis reflecting diminishing growth prospects, heightened uncertainty, and weak FDI inflows. In the early 2000s, TFP was boosted by earlier reforms that allowed greater FDI inflows in the 1990s and 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 (Bosworth and Collins 2008; He and Zhang 2010; Tuan, Ng, and Zhao 2009).

- *LICs.* In LICs, heavy public infrastructure investment and business climate improvements have supported post-crisis output and productivity growth (World Bank 2019c). This followed on the heels of a decade of heavy investment into mines and oil fields

[13] This finding is in line with previous studies of the United States and other advanced economies (Adler et al. 2017; Fernald et al. 2017).

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

[15] Much of the recent discussion of advanced economy TFP growth has focused on the slowdown in the United States, where TFP has weakened further since the crisis following a surge from the mid-1990 to 2000s (Fernald et al. 2017; Cowen 2011; Gordon 2018). In contrast, average TFP growth was low in the pre-crisis period in major European economies such as Germany and France (0.1-0.4), and even negative in Italy and Spain, such that the post-crisis TFP slowdown is much less pronounced for advanced economies in aggregate.

amid surging pre-crisis commodity prices. As a result, continued post-crisis 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 from high levels of debt in the 1980s and 1990s also contributing to frequently negative TFP growth (Claessens et al. 1997; IMF 2014).

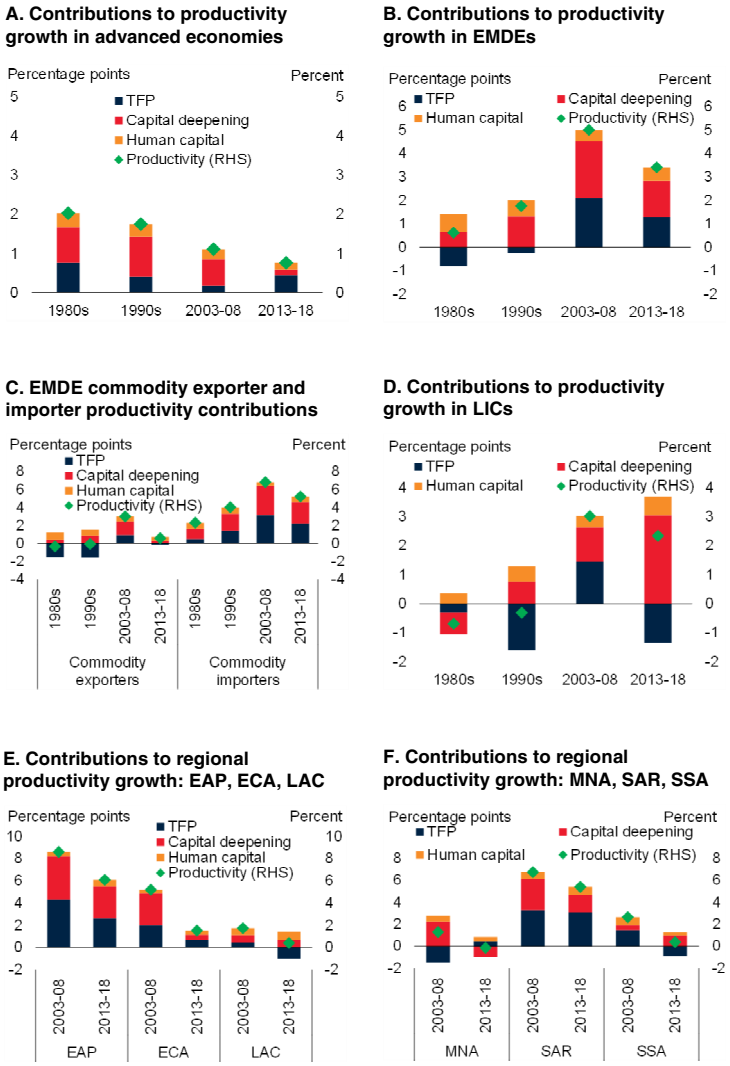
- *EMDE regions.* Capital accumulation accounted for virtually all of the post-crisis slowdown in productivity growth in MNA, where oil-exporting EMDEs suffered stalled or contracting investment amid the oil price collapse of 2014-16 (Stocker et al. 2018). It also accounted for most of the slowdown in 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 is underway and slower capital accumulation accounted for about two-fifths of the slowdown in post-crisis productivity growth. In SSA, which hosts most LICs, and in LAC, the slowdown was entirely driven by declining TFP growth. In contrast to other EMDE regions, TFP growth strengthened in MNA, from negative pre-crisis rates amid heavy resource investment, and in SAR, which was little-affected by the disruptions of the global financial crisis.

Decomposition into sectors

Approach. Higher aggregate productivity growth in EMDEs in the pre-crisis 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-crisis 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 80 economies, including 38 EMDEs, of which 7

FIGURE 3.5 Decomposition of productivity growth

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 accumulation. 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.



Source: Barro and Lee (2015); International Monetary Fund; Penn World Tables; The Conference Board; United Nations; Wittgenstein Centre for Demography and Global Human Capital; World Bank, World Development Indicators.

Note: Productivity defined as output per worker. Aggregate growth rates calculated using constant 2010 US dollar weights. 52 commodity exporters, 22 EMDE commodity importers, 8 East Asia and Pacific, 10 Europe and Central Asia, 18 Latin America and the Caribbean, 10 Middle East and North Africa, 2 South Asia, and 26 Sub - Saharan Africa economies. GDP weights. The sample includes 29 advanced economies, and 74 emerging market and developing economies including 11 low-income countries.

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are LICs, for nine sectors during 1995-2015 (Box 3.2).

Wide differentials in sectoral productivity. Labor productivity varies widely across sectors, being lowest by far in agriculture and highest in mining, financial and business services, and utilities. In EMDEs, labor productivity in mining and financial and business services, which are often foreign-owned, is thirty to forty times the level of productivity in the agriculture sector, which is often characterized by smallholder farms (Figure 3.6; Lowder, Skoet, and Raney 2016). In advanced economies, this differential is considerably narrower (three times). As a result, agricultural productivity in EMDEs lags far behind that in advanced economies—in the average EMDE, agricultural productivity is less than one-fifth that in the average advanced-economy. In contrast, services sectors such as transport or financial and business services are small in EMDEs, accounting for 22 percent of value-added in total, but feature productivity that is two-fifths to one-half of advanced-economy productivity on average.

Fading gains from factor reallocation in EMDEs. In EMDEs, about one-half of the post-crisis (2013-15) slowdown in productivity growth from pre-crisis (2003-08) averages reflected fading gains from resource reallocation towards more productive sectors. In the 1990s and pre-crisis, such resource reallocation had accounted for more than one-third 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 over half of productivity growth during 2003-2008, amid a large fall in the share of agricultural employment.

Post-crisis, the contribution of reallocation to productivity growth fell to less than one-quarter on average in EMDEs. To some degree as countries reach middle-to high income, sectoral reallocation tends to become a less important driver of productivity growth (de Nicola, Kehayova, and Nguyen 2018; Mason and Shetty 2019). In addition, technology and knowledge spillovers between sectors may also be diminishing (Foerster et al. 2019). However, productivity gaps between sectors in EMDEs remain sizeable. In contrast to other regions, productivity gains from reallocation continue to be sizable in SAR, accounting for one-half of post-crisis productivity growth, as agricultural employment moves into industrial sectors.

Challenges for within-sector productivity growth. Within-sector productivity gains also decelerated post-crisis, in EMDEs as well as advanced economies. The post-crisis slowdown may reflect the challenges faced by the most productive firms (large, export-oriented ones) amid post-crisis trade and investment weakness (Box 3.3). In many EMDEs, an additional challenge may arise from the sheer size of the informal sector (World Bank 2019a). The labor productivity of informal firms is, on average, only one-quarter of the productivity of formal firms. Informal firms are less able than formal firms to reap the productivity gains from economies of scale (size), accumulated experience (age), agglomeration benefits (location), and best managerial practices (Fajnzylber, Maloney, and Montes-Rojas 2011). Moreover, aggressive competition from informal firms can erode the productivity of exposed formal firms by about 24 percent relative to those formal firms that do not face informal competition (Loayza 2016; World Bank 2019a). A more conducive business climate, and economic development more broadly, can alleviate some of the corrosive productivity effects of informal competition on formal firms.

Fading gains from reallocation away from agriculture in LICs. In LICs, agriculture accounts for 31 percent of GDP, 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 (Box 3.2). Since then, however, this engine of LIC productivity growth appears to have stalled. In part, this is due to a collapse in global industrial commodity prices, which have discouraged further growth in employment in the mining and extraction sector,

BOX 3.2 Sectoral sources of productivity growth

Labor reallocation towards higher-productivity sectors has historically accounted for about one-third of aggregate productivity growth in EMDEs. This mechanism has, however, weakened since the global financial crisis. Fading productivity gains from labor reallocation have accounted for about one-half of the post-crisis productivity slowdown in EMDEs. In commodity-exporting EMDE regions, deindustrialization contributed to the slowdown.

Introduction

Factor reallocation towards higher-productivity sectors has long been recognized as one of the most powerful drivers of aggregate productivity growth (Baumol 1967).[1] It has been identified as an important driver of productivity growth in economies as diverse as Sub-Saharan Africa, China and Vietnam (Cusolito and Maloney 2018; de Vries, de Vries and Timmer 2015; Fuglie et al. 2019). Especially in East Asia, the move out of agriculture into higher-productivity industry and services has been credited with rapid productivity growth (Helble, Long, and Le 2019).

In part as a result of several decades of sectoral reallocation away from agriculture, agriculture now accounts for only 10 percent of EMDE value-added—one-quarter less than two decades earlier and less than one-third the share of industrial production (Figure 3.2.1). LICs are an exception where agriculture still accounts for one-third of value-added, more than industry, and accounts for over 60 of employment.

Meanwhile, services sectors have grown rapidly over the past two decades. They now account for about one-half of value-added in EMDEs as well as LICs, compared with three-quarters of value-added in advanced economies. Services sectors have also been the main source of post-crisis productivity growth, accounting for almost two-thirds of productivity growth in the average EMDE (compared with one-fifth accounted for by industry) and more than three-quarters in the average LIC.

Services describe a highly heterogeneous set of activities. Whereas industry mostly consists of manufacturing (64 percent in the average EMDE), services include in almost equal measure trade services, transport services, financial and business services, and government and personal services. These service subsectors vary widely in their skill- and capital-intensity as well as their productivity.

Against this backdrop, this box examines the sources of the post-crisis slowdown in productivity growth from a sectoral angle. Specifically, it addresses the following questions.

- What are the main features of sectoral productivity?
- What was the role of sectoral reallocation in the post-crisis productivity growth slowdown?

Much of the earlier literature on sectoral productivity has focused on three sectors (agriculture, manufacturing, and services) with only a limited number of cross-country studies including more sectors.[2] There is evidence that the findings of reallocation are sensitive to the level of aggregation (de Vries et al. 2012; Üngör 2017). To explore these issues, this box draws on a comprehensive dataset for 80 countries and 9 sectors over 1995-2015.

Features of sectoral productivity

Wide productivity differentials across sectors. Productivity differs widely across sectors, offering large potential for productivity gains by factor reallocation across sectors (Figure 3.2.3). In the average EMDE, productivity in the most productive sector—mining, which accounts for 4 percent of value-added—is twelve times that in the least productive sector—agriculture, which accounts for 10 percent of value-added.[3] In the average LIC, the range is even larger: productivity in the most productive sector—financial and business services, accounting for 13 percent of value-added—is twenty-two times that in the least productive sector—agriculture, which accounts for almost one-third of value-added

Note: This box was prepared by Alistair Dieppe and Hideaki Matsuoka.

[1] Throughout this box, productivity refers to labor productivity, defined as value added per employed worker.

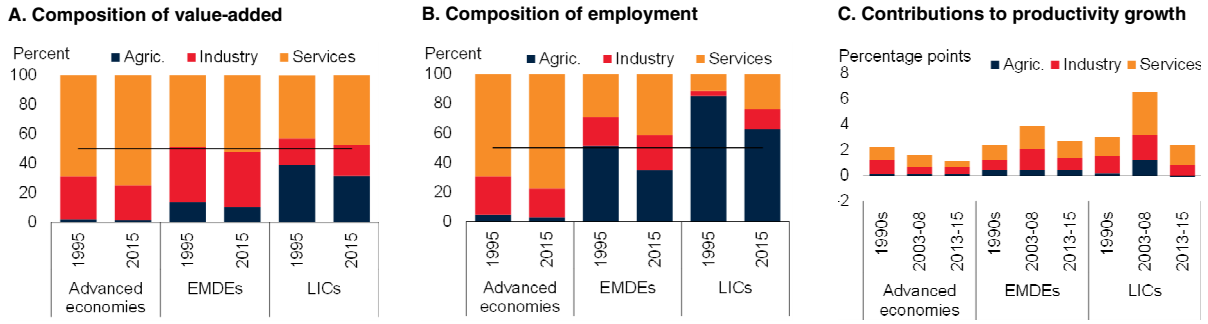
[2] Diao, McMillan, and Rodrik (2017) and McMillan, Rodrik, and Verduzco-Gallo (2014) employ 38 and 39 countries; Martins (2019) use 7 sectors and 169 countries, and International Monetary Fund (2018) use 10 sectors and 62 countries. Further disaggregation using micro panel data (such as by Hicks et al. 2017) would help to ensure differences in marginal product are accounted for.

[3] The high productivity extractive sectors offer few opportunities for sectoral reallocation and are intrinsically limited by the size of the resource, and market power. It should be noted that refining and processing of extractives can sometimes be classified as manufacturing in resource rich countries.

BOX 3.2 Sectoral sources of productivity growth (*continued*)

FIGURE 3.2.1 Agriculture, industry and services

In part as a result of a several decades of sectoral reallocation away from agriculture, agriculture now accounts for only 10 percent of EMDE value-added—one-quarter less than two decades earlier and less than one-third the share of industrial production. LICs are an exception; agriculture still accounts for one-third of value-added in these economies, more than industry. Meanwhile, services sectors—which include a highly heterogeneous set of activities—have grown rapidly over the past two decades, accounting for about half of post-crisis productivity growth.



Source: APO productivity database, Expanded African Sector Database, Groningen Growth Development Center Database, Haver Analytics, ILOSTAT, OECD STAN, United Nations, World KLEMS.
Note: Based on sample of 80 countries.
A.B. Share of agricultural, industry and services in value added. Industry includes mining, manufacturing, utilities, and construction. Services include trade services, transport services, financial and business services, government and personal services. Black horizontal line indicates 50 percent.
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(Figure 3.2.2).[4] Since the 1990s, the productivity dispersion within the manufacturing and service sectors, has narrowed. Similar differentials, between the most productive sector (financial and business services) and the least productive sector (agriculture), in advanced economies are considerably narrower.

Wide sectoral productivity differentials across countries. Productivity in all sectors is lower in EMDEs than in advanced economies, and lower again in LICs. The gap between EMDE and advanced-economy productivity is particularly wide (almost 80 percent) in agriculture, which tends to be characterized by smallholder ownership and family farms in EMDEs (Lowder, Skoet, and Raney 2016). This reflects in part slow technology adoption in the agriculture sector in some of the poorest EMDEs. In mining, which tends to be dominated globally by a few large companies, the productivity gap is considerably narrower (just over 20 percent).

Sectoral productivity growth. Productivity growth in the various subsectors of services varied widely, from negative (pre-crisis) or near zero (post-crisis) in mining to the highest sectoral growth rates (4.8 percent) in transport services in EMDEs in 2003-08 (Duernecker, Herrendorf, and Valentinyi 2017).[5] The post-crisis (2013-15) slowdown in manufacturing productivity growth was the largest among all nine sectors, nearly 2 percentage points below the pre-crisis average (2003-08).

In advanced economies, the post-crisis productivity growth slowdown was broad-based across almost all sectors (except construction). More than one-half of the post-crisis (2013-15) slowdown in productivity growth from pre-crisis rates (2003-08) in the average EMDE originated in the manufacturing sector. The slowdown in agricultural productivity growth had only a limited aggregate effect in EMDEs due to its relatively small share in the economy. In contrast, EMDE productivity growth picked up after

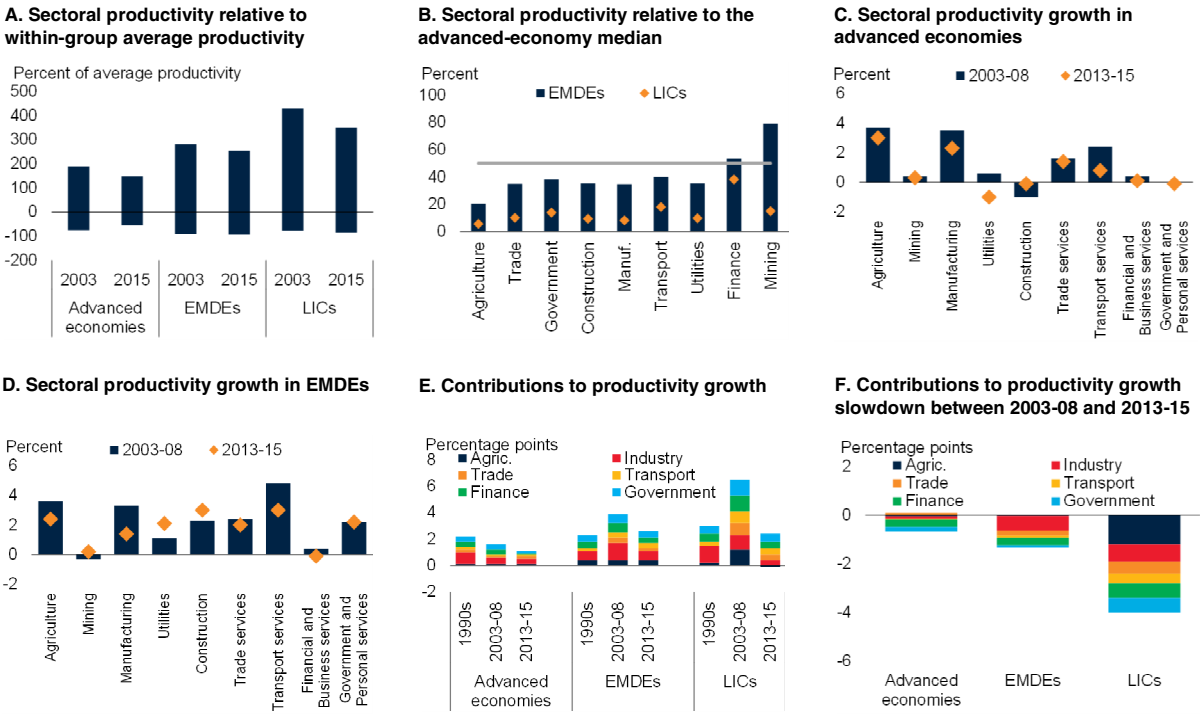
[4] As agricultural workers often do not work full time in agriculture, the sectoral gap is diminished if productivity is measured per hours instead of per worker (McCullough 2017). However, even after accounting for hours and human capital per worker, a large sectoral gap remains for many of countries (Gollin, Lagakos, and Waugh 2014).

[5] Two waves of service sector growth have been identified in the literature: a first wave in countries with relatively lower income levels and a second wave in countries with higher income levels. The first wave appears to be made up primarily of traditional (personal) services, the second wave of modern (financial, communication, computer, technical, legal, advertising and business) services that are receptive to the application of information technologies and tradable across borders (Eichengreen and Gupta 2013). Moreover, there is evidence of the second wave also occurring in lower income countries after 1990 which are democracies, and have high trade and financial openness.

BOX 3.2 Sectoral sources of productivity growth (*continued*)

FIGURE 3.2.2 Sectoral labor productivity

Productivity differs widely across sectors and subsectors, especially in EMDEs and even more so in LICs. Productivity in all sectors is lower in EMDEs than in advanced economies, and lower again in LICs. The gap to advanced-economy productivity is particularly wide in agriculture, and narrow in mining. Industry was the main source of pre-crisis productivity growth; its slowdown accounted for more than half the post-crisis slowdown in aggregate productivity in EMDEs.



Source: APO productivity database, Expanded African Sector Database, Groningen Growth Development Center Database, Haver Analytics, ILOSTAT, OECD STAN, United Nations, World KLEMS.
Note: Based on samples of 80 countries. Median of the county-specific productivity level, or growth rate.
A. Bar charts range from the minimum to the maximum sector productivity gap.
B. Sectoral productivities compared at PPP exchange rates.
E.F. "Industry" includes mining, manufacturing, utilities, and construction; "Finance" includes business services; "Government" includes personal services.
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the global financial crisis in construction, utilities and mining.

Role of sectoral reallocation

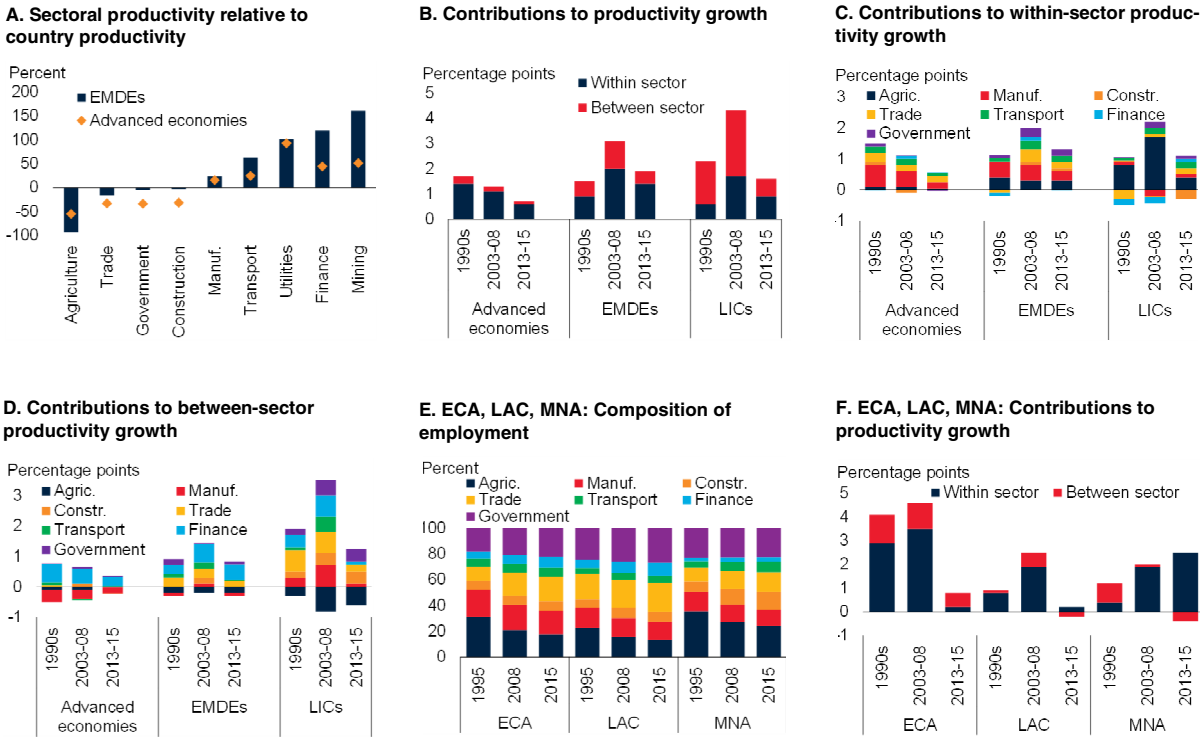
Framework. The productivity differentials between sectors offer the potential for productivity gains from labor reallocation towards higher-productivity sectors, in addition to within-sector productivity gains (Figure 3.2.3).[6] This is captured in a shift-share analysis that decompose aggregate labor productivity into within-sector and between-sector components (Wong 2006, Padilla-Pérez and Villarreal 2017). *Within-sector productivity growth* captures changes in aggregate labor productivity growth due to productivity improvements within sectors. This may reflect improvements in human capital, investments in physical capital, or the reallocation of resources from the least to the most productive firms within each sector. *Between-sector productivity growth* is driven by the change in employment share and the productivity differential. It reflects both the reallocation of resources to sectors with higher productivity *levels* (static sectoral effect), and the reallocation of employment towards sectors with higher productivity *growth* (dynamic

[6] However, Fuglie et al. (2019) point out that different factor shares in value added would result in a gap of average labor productivity even if the factor allocation is efficient. A gap in average productivity is not sufficient evidence of misallocation because labor productivity can be equalized at the margin.

BOX 3.2 Sectoral sources of productivity growth (*continued*)

FIGURE 3.2.3 Between- and within-sector sources to productivity growth

While productivity growth in advanced economies has predominantly originated within sectors, between-sector gains have accounted for a sizable portion of EMDE productivity growth, and its post-crisis slowdown. In EMDEs, the between-sector productivity gains have involved shifts out of agriculture into higher-productivity sectors that have differed over time.



Source: APO productivity database, Expanded African Sector Database, Groningen Growth Development Center Database, Haver Analytics, ILOSTAT, OECD STAN, United Nations, World KLEMS.

B-D. 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 county-specific contributions. Based on samples of 80 countries. "Manuf." includes mining and utilities; "Finance" includes business services; "Government" includes personal services.

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sectoral effect). Underlying drivers of such between-sector productivity growth include changes in household's preferences and changes in relative sectoral productivity, in part as a result of diverging evolutions of labor quality (Lagakos and Waugh 2013).[7]

Decomposition of aggregate productivity growth. While productivity growth in advanced-economies has predominantly originated within sectors, between-sector gains have accounted for one-third of EMDE productivity growth since the 1990s. In part as a result of narrowing cross-sector productivity differentials and, in some regions, labor movements into lower-productivity sectors, fading sectoral reallocation has accounted for about one-half of the post-crisis slowdown in EMDE productivity growth. The between-sector EMDE productivity gains have involved shifts out of agriculture into higher-productivity sectors that have differed over time.

[7] Improvements in agricultural productivity can significantly reduce agriculture's share of employment, contributing to between-sector productivity growth (Gollin, Parente, and Rogerson 2007). The role of agriculture in structural change depends on economic integration within the domestic economy and with global markets (Barrett et al. 2017).

BOX 3.2 Sectoral sources of productivity growth (*continued*)

- *Advanced economies.* Productivity growth in advanced economies, where sectoral productivity differentials tend to be narrower than in EMDEs, has been almost entirely driven by within-sector productivity growth since the 1990s. Within-sector productivity growth has dwindled to 0.6 percent during 2013-15—less than half its 1990s average (Figure 3.2.3). The predominant structural change has been the reallocation of resources from manufacturing to the financial and business services sector, two sectors with comparable levels of productivity.

- *EMDEs.* In contrast, between-sector productivity gains in EMDEs boosted productivity growth pre-crisis (2003-08) by 1.1 percentage points. Post-crisis, this contribution fell to 0.5 percentage points, accounting for about one-half of the slowdown in EMDE productivity growth. Between-sector productivity gains have mainly reflected a move out of agriculture and manufacturing into services. In LICs, between-sector gains accounted for almost half of post-crisis productivity growth, down from almost three-quarters of pre-crisis productivity growth.[8] Whereas pre-crisis between-sector productivity gains in LICs mainly reflected a shift out of agriculture into manufacturing, their main post-crisis source was a shift out of agriculture into services such as trade services and finance and business services that have benefited from information and computing technologies (Eichengreen and Gupta 2013).

Leapfrogging. Over the two decades until the global financial crisis, one-third of the EMDE employment that left agriculture moved into industrial sectors (predominantly manufacturing and construction) and another one-third into trade services. The share of agricultural employment in EMDEs declined by 9.4 percentage points between 1995 and 2008 while the shares of industry and trade services rose by 2.5 and 3.0 percentage points, respectively. Although trade services and construction typically have below-average productivity and manufacturing productivity is near the EMDE average, the employment shift out of extremely low-productivity agriculture generate aggregate productivity gains. In LICs, a somewhat larger portion (almost half) of the 10 percentage point decline in the share of agricultural employment was absorbed by trade services and only just over one-third by industry. The phenomenon of employment shifting out of agriculture into services has been dubbed "leapfrogging" in the context of concerns about premature deindustrialization (Rodrik 2016). Looking ahead, productivity gains arising from low-skilled labor shifting out of agriculture into manufacturing or services may diminish if robotization and artificial intelligence discourage this movement.

Deindustrialization. In three regions—Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), the Middle East and North Africa (MNA)—the manufacturing sector's (as well as agriculture's) share of employment has shrunk since the crisis, continuing a pre-crisis trend.[9] Employment has largely shifted into construction (MNA), finance (ECA, LAC) and trade services (ECA, MNA). Since some of these sectors, especially construction and trade services, have lower productivity than manufacturing, this has resulted in a sharply lower contribution (ECA) or even negative contribution (LAC, MNA) of between-sector sources of productivity growth (Rodrik 2016). In LAC, for example, trade liberalization in the 1990s led to cheaper manufacturing imports and a contraction in employment in the uncompetitive manufacturing sector. Much of this labor was absorbed in construction and trade services that were buoyed by pre-crisis commodity boom (Gollin, Jedwab, and Vollrath 2015).

Conclusion

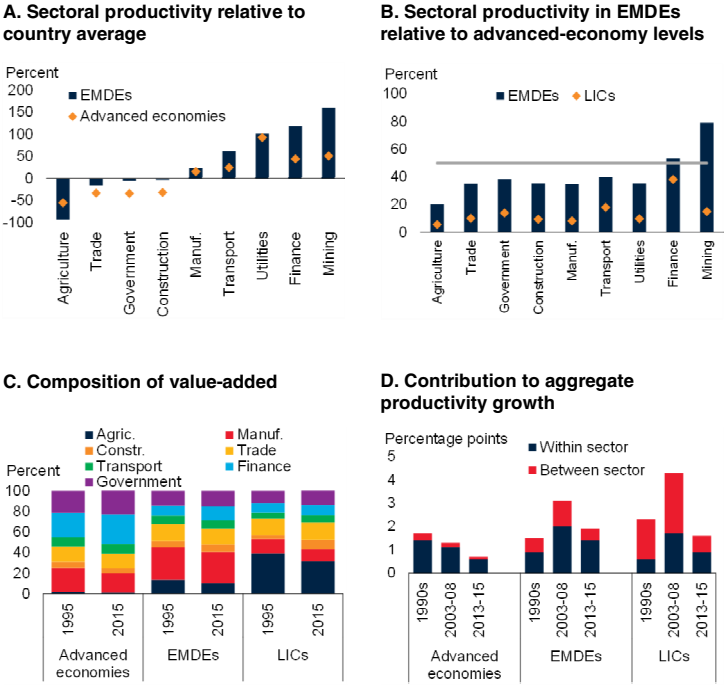
Large sectoral productivity differentials in EMDEs and LICs offer the potential of additional productivity gains when labor moves towards higher-productivity sectors. Such between-sector productivity gains have contributed importantly to productivity growth in EMDEs and LICs since the 1990s. However, since the global financial crisis, these gains appear to have faded.

[8] This is consistent with Diao, McMillan, and Rodrik (2017) and, for Sub-Saharan Africa, McMillan, Rodrik, and Verduzco-Gallo (2014).

[9] To some degree this could reflect an outsourcing of parts of the manufacturing sector to the service sector.

FIGURE 3.6 Sectoral productivity developments

Productivity varies widely across sectors, with agricultural productivity in EMDEs lagging both advanced economies and other sectors in EMDEs. Fading gains from resource reallocation towards more productive sectors have accounted for about half of the post-crisis slowdown in productivity growth. Within-sector productivity growth has also slowed.



Source: APO productivity database, Expanded African Sector Database, Groningen Growth Development Center Database, Haver Analytics, ILOSTAT, OECD STAN, United Nations, World KLEMS.
Note: Sample includes 80 economies (including 46 EMDEs, of which 8 are LICs). "Manuf." includes mining and utilities; "Finance" includes business services; "Government" includes personal services.
A. Deviation of sectoral productivity level from country-specific average productivity.
B. Grey horizontal line indicates 50 percent.
C. Share of total value added.
D. Growth "within sector" shows the contribution to aggregate productivity growth of each sector holding employment shares fixed. The 'between sector' effect shows the contribution arising from changes in sectoral employment shares. Median of the country-specific contributions.
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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.

Long-run drivers of productivity growth

During the pre-crisis productivity surge in EMDEs, growth was highest in those economies with more favorable institutional environments, more developed product and factor markets, and higher or higher-quality factor inputs. Subsequently, improvements in many of these and some other correlates of productivity growth have slowed or gone into reverse. These include investment weakness; a slower pace of urbanization; maturing gains from macroeconomic stability and global integration; and diminishing improvements or stagnation in educational attainment, gender equality, and governance.

A large number of variables have been proposed as possible drivers of productivity (Annex 3.3).[16] These drivers can be grouped into three categories: the quality and quantity of factors of production and the effectiveness of their use, such as capital, education, and innovation; the supporting economic environment, such as institutions and social conditions; and the degree of market development, such as trade integration and financial market development. This section presents the correlations of productivity growth with initial conditions for these drivers and, in a second step, discusses the evolution of these drivers.

Correlation between productivity growth and its drivers

Methodology. The contributions of potential drivers of productivity growth are estimated in a cross-section regression to identify the main initial country features associated with subsequently higher long-term productivity growth (1960-2018 and 1995-2018) for 59 countries, including 38 EMDEs. Key correlates of productivity growth are selected from a pool of 29 variables by Bayesian techniques to systematically exclude variables that have poor explanatory power for productivity growth and overlapping variables which reflect the same underlying driver (Annex 3.3).

Key initial conditions for higher productivity growth. Productivity in economies with favorable starting conditions in the 1960s grew significantly faster than other economies annually. A better educated workforce (proxied by years of schooling) and stronger institutions (proxied by improvements in the rule of law), greater

[16] See Durlauf, Johnson, and Temple (2005) and Kim and Loayza (2019).

BOX 3.3 Patterns of total factor productivity: A firm perspective

There is substantial variation in firm-level total factor productivity (TFP) across industries and across regions. Weak firm productivity in emerging market and developing economies (EMDEs) partly reflects the divergence between a few highly productive firms and a large number of firms that operate far from the productivity frontier. The difference between frontier and laggard firms is, on average, larger in EMDEs than in advanced economies. Among EMDE firms, large firms tend to be more productive than small firms. Firms in technology-intensive industries, mainly located in East Asia and Pacific (EAP), Europe and Central Asia (ECA), and South Asia (SAR), tend to be more productive than firms in more traditional sectors. Measures to promote exports and improve business climates can help close the observed TFP gap.

Introduction

Firm-level productivity in emerging markets and developing economies (EMDEs) has been low relative to advanced economies, and growth has lost momentum over the past decade. This has diminished prospects among many EMDEs to catch up with the advanced economies (Andrews, Criscuolo, and Gal 2016; Cusolito and Maloney 2018).

Numerous factors have been identified as underlying the low firm-level productivity observed in EMDEs: weak institutions and pervasive informality, slow technology innovation and adoption, subdued investment and poor quality infrastructure, low human capital and poor firm management practices, protectionist trade policies and weak economic integration (Cusolito and Maloney 2018; World Bank 2019d, 2019e).[1] Moreover, outdated technologies, lagging innovation, misallocation of labor to inefficient sectors, and market rigidities weigh on productivity and contribute to dispersion in total factor productivity (TFP) across countries (Araujo, Vostroknutova, and Wacker 2017; Bahar 2018; Syverson 2011). In some EMDEs, low participation in global value chains, or lack of openness to foreign direct investment and migration, has resulted in missed opportunities for a productivity boost through the transfer of innovative processes and managerial capabilities (Goldberg et al. 2010; World Bank 2019d).

This box undertakes a cross-sectional study to analyze firm-level TFP patterns, and maps these to firm characteristics in EMDEs to address the following questions:

- How does firm-level TFP vary across EMDE sectors and regions?
- What firm characteristics account for the dispersion in TFP?

TFP variation across sectors and regions

Productivity varies across firms, within sectors, and across regions (Goñi and Maloney 2017). By focusing on TFP, differences due to capital deepening or other factor inputs can be abstracted from. This allows to identify where TFP dispersion and gaps are the largest, and where steps are needed to improve productivity. Firm-level TFP data are obtained from surveys conducted by the World Bank from 2007 to 2017 (Cusolito et al. 2018). The database of survey results contains TFP for 15,181 manufacturing firms in 108 EMDEs, including 20 low-income countries (LICs). A cross-sectional analysis of the firm-level TFP database is undertaken, which complements longitudinal studies that use micro-level panel data, but with a smaller country coverage.[2] Two measures of TFP are constructed: output and value-added revenue TFP measures. The latter is obtained by subtracting the value of intermediate inputs (materials, electricity, etc.) from output before computing TFP. TFP measurement challenges are discussed in Annex 3.5.

TFP across sectors. Differences in firm-level TFP across sectors have been frequently emphasized in the literature.[3] On average, firms in technology-intensive industries have higher TFP than those in other sectors (Figure 3.3.1.A). Technology-intensive industries, denoted by TINT, include computing and electrical machinery, precision equipment, electronics, information, and communication sectors (as in Fernald 2015). One explanation for this observation is that firms operating in a technology-intensive industry rely more on research and development (R&D) and network linkages than physical assets, and as

Note: This box was prepared by Cedric Okou.

[1] Many studies focus on labor productivity, which depends on both TFP and capital per worker–also known as capital deepening.

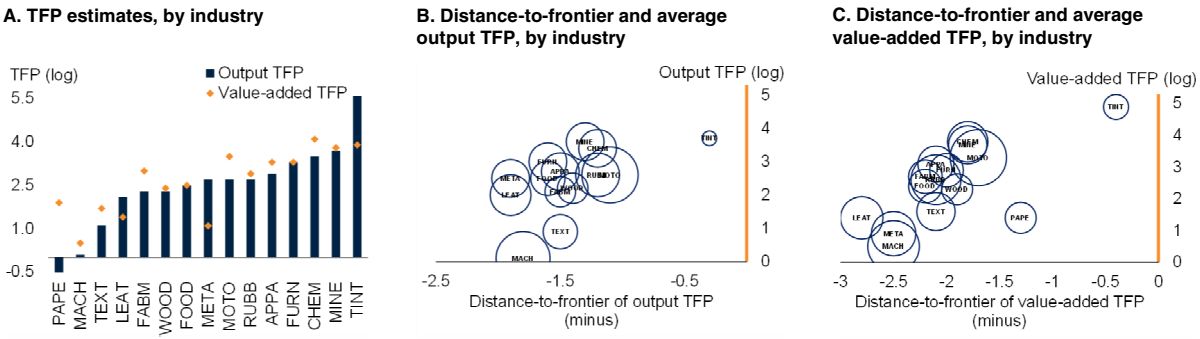
[2] This analysis does not explore the time series dimension because World Bank's firm output and input data used to construct TFP estimates were collected at different time in different countries. For example, these firm surveys were conducted in 2007 in South Africa and in 2017 in Ecuador. Moreover, the number of surveyed firms in many countries is small, which does not allow to conduct robust within and cross-country comparisons.

[3] See for example, Bartelsman and Doms (2000) and Levchenko and Zhang (2016).

BOX 3.3 Patterns of total factor productivity: A firm perspective (*continued*)

FIGURE 3.3.1 Firm TFP and distance-to-frontier in EMDEs by industry

Firms in technology-intensive industry (TINT) have higher average TFP. These technology-intensive firms are also more tightly clustered around their industry-specific frontier than firms in other sectors.



Source: World Bank Enterprise Surveys, World Bank.

Note: Firm-level TFP is computed using a Cobb-Douglas production function for each industry, assuming that elasticities of output with respect to inputs are the same across countries in a given income group. The distance-to-frontier of TFP is computed within each industry, excluding the top 2.5 percent of firms. For each sector, the location shows the average and the size of the marker (circle) is proportional to one standard deviation of distance to frontier of TFP. Averages and standard deviations are computed using survey weights. Sample includes 15,181 firms in 108 EMDEs, including 20 LICs, for the period 2007-17. Firms operate in 15 industries: APPA = apparel, CHEM = chemicals, FABM = fabricated metals, FOOD = food, FURN = furniture, LEAT = leather, MACH = non-electrical machinery, META = metals, MINE = non-metallic minerals, MOTO = motor vehicles, PAPE = paper, RUBB = rubber, TEXT = textiles, TINT=technology-intensive, WOOD = wood. The technology-intensive industry (TINT) includes firms in computing and electrical machinery, precision equipment, electronics, information, and communication sectors.

A. In the manufacture of paper (PAPE) industry, the value-added TFP is positive and much higher than the corresponding (negative) output TFP due to a relatively high elasticity of output with respect to intermediate inputs.

B. C. Distance-to-frontier of firm-level TFP (minus) and TFP (log), by industry. The right-hand-side y-axis represent the frontier.

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such can reap the benefits of technology to boost productivity (Chevalier, Lecat, and Oulton 2012).

Distance to TFP frontier across sectors. TFP dispersion may signal rigidities in the generation, transfer and acquisition of technology across firms in a sector. To assess within-sector productivity dispersion, a firm's distance to an industry-specific TFP frontier is computed.[4] Firms in basic manufacturing industries, such as non-electrical machinery (MACH), textiles (TEXT), leather (LEAT), and basic metals (META), are not only on average less productive than firms in other sectors, but also relatively far from their industry-specific frontiers (Figure 3.3.1.B and 3.3.1.C). By contrast, firms in technology-intensive industries (TINT) are more tightly clustered around their industry-specific frontiers and are more productive.[5]

TFP across regions. Across regions, firms in East Asia and Pacific (EAP) are, on average, more productive than those in other regions (Figure 3.3.2.A). EAP also has the highest proportion of large size firms and firms exporting more than half of their sales (Figure 3.3.2.C and Figure 3.3.2.D). Most firms in technology-intensive industries are located in EAP, Europe and Central Asia (ECA), and South Asia (SAR) (Figure 3.3.2.B; regional boxes in Chapter 2). Perceptions of corruption and licensing as obstacles for firm operation seem to correlate negatively with total factor productivity (Figure 3.3.2.E-F).

Robustness of TFP dispersion. Substantial TFP dispersion may signal misallocation of factor inputs or rigidities in the generation, transfer, and acquisition of technology across firms (Hsieh and Klenow 2009). However, commonly used dispersion metrics can also reflect mismeasurements, quality differences, adjustment costs, markups, and investment risks, among other factors. Recent evidence shows that half of the dispersion is unrelated to misallocation, and driven rather by markups and technology wedges (Cusolito and Maloney 2018). Thus, dispersion results should be interpreted with caution. Nonetheless, the variation in distance to frontier in technology-intensive industries is less than one-fifth of that in basic manufacturing industries (leather, metals, machinery), suggesting that firms in technology-intensive industries are much closer to their sector-specific frontier.

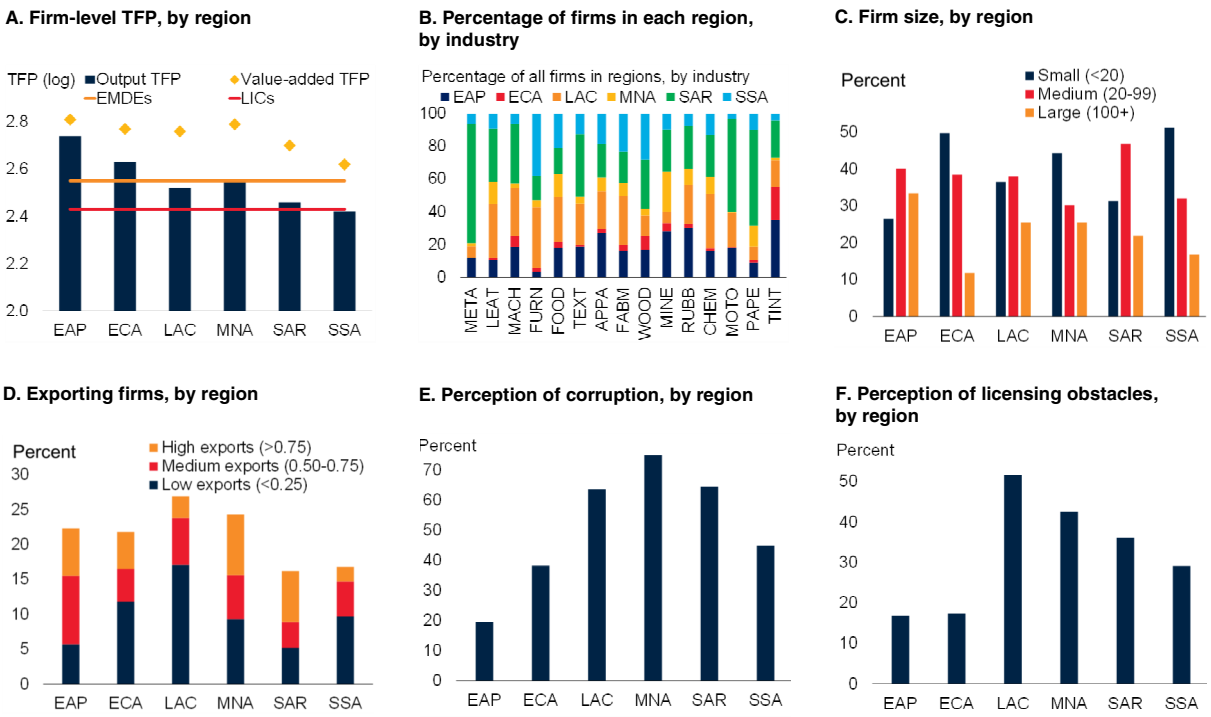
[4] For a given firm i, the distance to an industry-specific TFP frontier (97.5th quantile) is computed as $DTF_i = TFP_{0.975} - TFP_{i\leq 0.975}$. The top 2.5 percent firm-level TFP values are dropped to minimize the impact of extreme values. Results are robust to alternative 1 and 5 percent cutoffs of top firm TFP values.

[5] This finding is broadly in line with the evidence in Hallward-Driemeier and Nayyar (2017).

BOX 3.3 Patterns of total factor productivity: A firm perspective (*continued*)

FIGURE 3.3.2 Firm TFP by regions

Firms in EAP are more productive than those located in other EMDE regions. EAP also has the highest share of large-size firms and those exporting more than half of their sales. Most firms in technology-intensive industry (TINT) are located in EAP, ECA, and SAR. Perceptions of corruption and licensing as obstacles for firm operation correlate negatively with total factor productivity (TFP).



Source: World Bank Enterprise Surveys, World Bank.

Note: Firm-level TFP is computed using a Cobb-Douglas production function for each industry, assuming elasticities of output with respect to inputs are the same across countries in a given income group. Unweighted regional averages are computed. Sample includes 15,181 firms in 108 EMDEs, including 20 LICs, for the period 2007-17. EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.

A. Solid lines are averages of output TFP (log) for EMDEs (orange) and LICs (red). EMDEs = emerging markets and developing economies, LICs = low-income countries.

B. Bars show in each industry the percentage of firms in each region, by industry. Firms operate in 15 industries: APPA = apparel, CHEM = chemicals, FABM = fabricated metals, FOOD = food, FURN = furniture, LEAT = leather, MACH = non-electrical machinery, META = metals, MINE = non-metallic minerals, MOTO = motor vehicles, PAPE = paper, RUBB = rubber, TEXT = textiles, TINT = technology-intensive, WOOD = wood. The technology-intensive industry (TINT) includes firms in computing and electrical machinery, precision equipment, electronics, information, and communication sectors.

C. Firm size in terms of number of employees.

D. Share of exporting firms. High, medium, and low exports firms export more than 75 percent, between 50 and 75, and up to 25 percent of their sales, respectively.

E. Share of firms that perceive corruption as an obstacle for their operations.

F. Share of firms that perceive licensing and permits as an obstacle for their operations.

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Firm characteristics associated with higher TFP growth

Heterogeneous characteristics related to entering, incumbent, and exiting firms can explain the observed patterns of TFP dispersion (Bartelsman and Doms 2000). A large and expanding literature points to three broad categories of correlates of sectoral TFP dispersion in EMDEs: within-firm upgrading and spillovers, regulatory environment, and managerial ability.

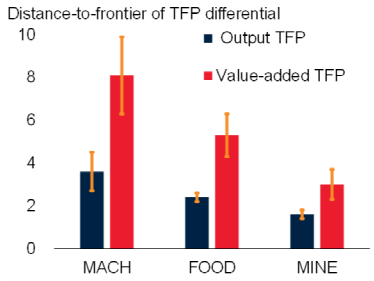
Within-firm upgrading and technology spillovers. Controlling for both size and exports, firms in the technology-intensive industry are on average much closer to the TFP frontier than firms in traditional industries such as non-electric machinery, food, and non-metallic

BOX 3.3 Patterns of total factor productivity: A firm perspective (*continued*)

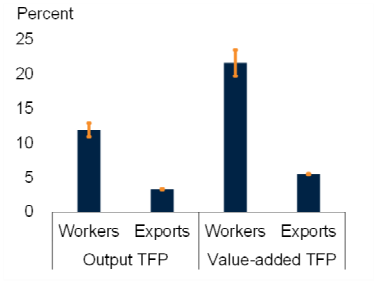
FIGURE 3.3.3 Distance-to-frontier of TFP, firm characteristics, and regulations

The average firm in the technology-intensive industry (TINT) is significantly closer to the frontier than the average firm in non-electric machinery (MACH), food (FOOD), and non-metallic minerals (MINE) industries, after controlling for firms' size and exports. As firms grow by number of employees and increase their ratios of exports to total sales, they move closer to the TFP frontier. A conducive business environment can enhance firm-level TFP. Improvements in business freedom and control of corruption are correlated with a reduction in the distance-to-frontier of TFP.

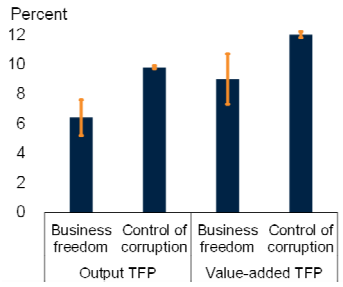
A. Distance to TFP frontier differential between traditional industries and the technology-intensive industry



B. Distance to TFP frontier differential between firms in lowest and highest quartile of firm size and exports



C. Distance to TFP frontier differential between firms in lowest and highest quartile of business environment



Source: World Bank Enterprise Surveys, World Bank.

Note: Firm-level TFP is computed using a Cobb-Douglas production function for each industry, assuming that elasticities of output with respect to inputs are the same across countries in a given income group. The distance-to-frontier (DTF) of TFP is computed within each sector, excluding the top 2.5 percent of firms. Sample includes 15,181 firms in 108 EMDEs, including 20 LICs, for the period 2007-17.

A. Distance-to-frontier of TFP differential between traditional industries, such as manufacturing of non-electric machinery (MACH), food (FOOD), and non-metallic minerals (MINE), and the technology-intensive (TINT) industry, controlling for firm characteristics (firm size and exports). Based on OLS regressions of the DTF of TFP (dependent variable) on industry dummies, controlling for firm characteristics and using the technology-intensive industry (TINT) as the base category as per Annex 3.5.

B. Distance to TFP frontier differential between the median firm in the lowest quartile and highest quartile of firms in terms of firm size (number of workers) and exports (share of exports in total sales). Based on OLS regressions of the DTF of TFP (dependent variable) on industry dummies, controlling for firm characteristics and using the technology-intensive industry (TINT) as the base category (Annex 3.5). A positive DTF differential implies that firms in the lowest quartile in terms of size and exports are far from the frontier relative to firms in the highest quartile. The lowest quartile of exports is zero, as more than half of firms have no exports.

C. Distance to TFP frontier differential between the median firm in the lowest quartile and highest quartile of firms in terms of business freedom and control of corruption index, controlling for firm characteristics. Based on OLS regressions of the DTF of TFP (dependent variable) on industry dummies and business environment quality, controlling for firm characteristics and using a technology-intensive industry (TINT) as the base category as per equation 3. A positive DTF differential implies that firms in the lowest quartile in terms of business freedom and control of corruption are far from the frontier relative to firms in the highest quartile.

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minerals industries (Figure 3.3.3.A). Knowledge, experience, R&D, and information technology can raise TFP through improvements in product quality and production process upgrading within firms.[6] Firms with a large number of employees are significantly closer to the TFP frontier, as larger firms can invest more in R&D and bring together a richer set of ideas. On average, the productivity of a firm in the highest quartile of size is about 12 and 22 percent closer to output and value-added TFP frontiers relative to a firm in the lowest quartile of size (Figure 3.3.3.B). Moreover, technology in frontier firms can have positive spillovers for productivity in other firms through agglomeration linkages and cross-border flows of goods, capital and people. Firms can reap agglomeration benefits by emulating the best production practices and organization structures of "nearby" highly productive firms (Dercon et al. 2004; Syverson 2011). Knowledge is also transferred through contacts with other firms, courtesy of trade, foreign direct investment and migration (De Loecker 2007). Firms with a high share of exports are significantly closer to the TFP frontier. A firm in the top quartile of exports, measured as a share of exports in total sales, is about 4 and 6 percent closer to output and value-added TFP frontiers relative to a firm in the lowest quartile of exports (Figure 3.3.3.B). Enabling effective innovation policies appears critical to boosting innovation gains (Cirera and Maloney 2017).

Regulatory environment. Institutions reflect political and legal forces that shape social and economic environments. Regulations and policies affect firms' productivity through incentives to acquire human capital, physical capital, and technology (Bartelsman and Doms 2000). Firm productivity tends to drop in poorly-regulated markets,

[6] See Brynjolfsson and Hitt (1995) and Goldberg et al. (2010).

BOX 3.3 Patterns of total factor productivity: A firm perspective (*continued*)

due to adverse incentives and the lack of creative destruction (Goldberg et al. 2010). In contrast, improvements in the business environment are associated with lower distance to TFP frontier, even after controlling for firm characteristics. Conducive regulatory practices—reflected in highest quartile values of business freedom index—may entail up to 9 percent reduction in the distance-to-frontier of TFP relative firms in the lowest quartile. Similarly, high quality governance—proxied by the top quartile estimates of control of corruption index—is associated with up to 12 percent drop in the distance to TFP frontier relative to firms in the bottom quartile (Figure 3.3.3.C).

Managerial ability. TFP also reflects how efficiently productive factors—labor, capital, and intermediate inputs—are assembled. Through their talents or the quality of their practices, managers coordinate the integration of factor inputs in the production process. Management and organizational styles may vary across firms due to competition, location, ownership, and trade ties. Intervention-led improvements in management practices can raise productivity by more than 10 percent (Van Reenen 2011). A policy shift that is more focused on enhancing firm managerial capabilities can, therefore, strengthen production synergies and bolster TFP gains (Cusolito and Maloney 2018).

Conclusion

The dispersion of firm-level TFP within and across industries in emerging markets and developing economies (EMDEs) is associated with various firm characteristics. TFP dispersion correlates negatively with firm size, partly because large firms can invest more in R&D to innovate. Exports also facilitate the transfer and adoption of new technologies, and therefore, can help close the gap between laggards and frontier firms. Moreover, a conducive business climate characterized by a greater freedom in entrepreneurship and less corruption can support TFP improvements. Undertaking policies to support R&D and innovation, promote exports, combat corruption, increase the ease of doing business, and enhance firm managerial capabilities, appears critical to boosting productivity.

innovation (proxied by higher per capita patents), stronger investment (as a share of GDP), higher levels of urbanization (proxied by population density), price stability, and a diverse and sophisticated economic structure (proxied by the economic complexity index of Hidalgo and Hausmann 2009), are all significantly associated with higher productivity growth (Figure 3.7).[17]

Differences between EMDEs and advanced economies. The estimated impact of improved levels of each driver of productivity growth depends on the stage of development and therefore differs between EMDEs and advanced economies. The extent of urbanization has a larger impact on productivity growth in EMDEs than in advanced economies, reflecting higher returns to the reallocation of workers away from rural agricultural production to higher productivity manufacturing and service sectors (Box 3.2). The level of education and investment also produces larger impacts on productivity in EMDEs in the long-run estimation, highlighting their importance at lower levels of productivity. Since 1995, the relationship between labor productivity and the economic complexity of tradable goods has strengthened in EMDEs.

Evolution of the drivers of productivity

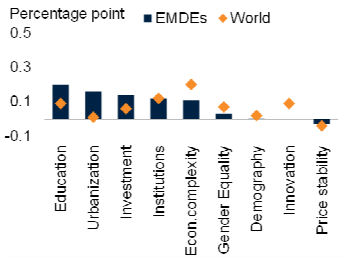
Pre-crisis improvements. There were substantial gains in many of the underlying drivers of productivity growth in the pre-crisis period, growing faster in EMDEs than advanced economies (Figure 3.8). The selected drivers can be aggregated to an index based on the size of their estimated impacts on productivity—demographics, economic complexity, the number of patents filed, and price stability are all considered to be key determinants of productivity growth over this period by the econometric model. Cumulatively over 1995-2008, productivity in the one-quarter of EMDEs with the most

[17] These are largely consistent with existing studies which tend to have shorter time spans and smaller cross-sections (Durlauf, Kourtellos, and Tan 2008; Kim and Loayza 2019).

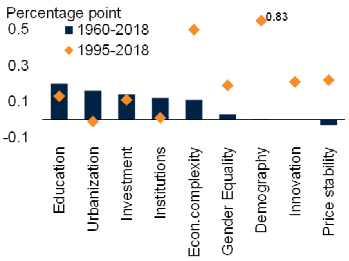
FIGURE 3.7 Impact of drivers on productivity growth

Productivity in economies with favorable initial conditions grew by up to 0.8 percentage point per year faster than other economies. The scale of these effects varies over time and between EMDEs and advanced economies. In 1960, the importance of innovation and economic complexity was lower in EMDEs. Demography and economic complexity have become increasingly important determinants of EMDE productivity growth in recent decades.

A. Effects of initial level of drivers on productivity growth, 1960-2018



B. Effects of initial level of drivers for EMDEs on productivity growth, 1960-2018 vs. 1995-2018



Source: World Bank.
A. B. Estimated marginal contribution to annual long-term productivity growth if the driver improves from the 25th to the 75th percentiles. Sample includes 59 economies, 36 of which are EMDEs. Groups which are not significant in both 1960-2018 and 1995-2018 (Finance, Income equality, and health) are excluded from the chart. Variables corresponding to each concept are: Institutions = ICRG rule of law index, Geography=share of non-tropical area, Innovation=patents per capita, Investment=investment to GDP ratio, Income equality=(-1)*Gini coefficient, Urbanization=urban population (% total), Econ. complexity = Economic Complexity Index of Hidalgo and Hausmann (2009), Education=years of schooling, Demography=share of working-age population, Gender equality= female average years of education minus male average years. See Annex 3.3 for details.
B. Marginal contribution of demography for 1995-2018 is 0.83.
Click here to download data and charts.

favorable initial conditions grew by nearly 15 percent more than productivity in those with the least favorable initial conditions. Among LICs, the differential between the two groups was even larger (53 percent). LICs were better able to benefit from catch-up growth in the presence of favorable initial conditions.

Post-crisis slowdown in improvements. The pace of growth of the drivers most strongly associated with productivity growth has slowed in EMDEs since 2008, consistent with the slowdown in productivity growth over this period (Figure 3.9).

Investment growth in EMDEs slowed, reflecting weak activity and spillovers from advanced economies, weaker growth of commodity demand, and political uncertainty. In addition, earlier favorable demographic trends in many EMDEs have waned as the population ages. From 2018 to 2030 the working-age share of the population is expected to decline by 3 percentage points in advanced economies and 2.5 percentage points in EMDEs. For educational attainment, growth has been three times higher than in advanced economies. Nonetheless, as countries catch up (as measured by average years of schooling), the potential for further growth has slowed.[18]

Other factors that had helped spur EMDE productivity growth also have deteriorated since the crisis. For example, the trend toward broadening production to a more diverse range of products at more upstream stages of the value chain slowed partly because the expansion of global value chains stagnated after 2008 (World Bank 2019d). In addition, improvements in inequality and measures of institutional quality have also stagnated or declined in many countries. Finally, gains in price stability, which had significantly improved operating environments for firms in the 1990s, slowed (Ha, Kose, and Ohnsorge 2019).

Prospects for productivity growth

The post-crisis weakness in several fundamental drivers of productivity growth is expected to persist or deepen. The weak outlook for the drivers can be improved though a concerted reform effort.

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 burdens (World Bank 2017). The legacy of weak investment since the crisis 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).

[18] While the gap in average years of education with advanced economies has declined, substantial gaps in the quality of education remain (World Bank 2018b).

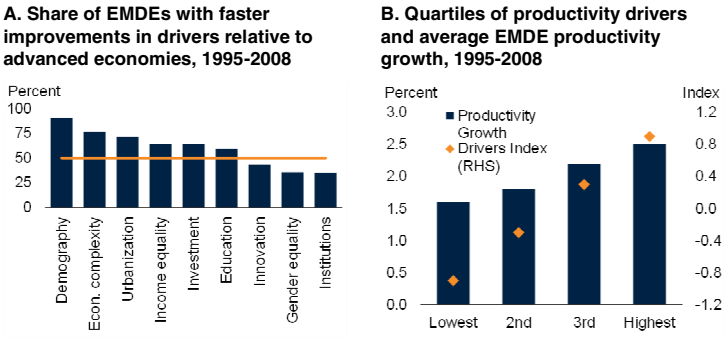
Slower growth at the technology frontier. There has been a broad-based slowdown in both labor productivity and TFP growth in advanced economies since the early 2000s with limited signs of an impending upturn. To the extent that this reflects slowing productivity growth in multinationals and the origins of foreign direct investment—two major channels for knowledge and technology spillovers to EMDEs—this is likely to weigh on EMDE productivity, too (Wooster and Diebel 2010). However, there are mixed views on the prospects of groundbreaking technological progress that could return growth to historical norms, and also spillovers to EMDEs. On the one hand, the impact on productivity growth of new innovations compared to 20th-century innovations seems to be reduced (Fernald 2015; Gordon 2016). On the other hand, 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).

Fewer opportunities for technology transfer. Substantial productivity gaps to the frontier are still present in EMDEs, providing opportunities for rapid productivity growth. However, routes to technology transfer are narrowing. The expansion of global value chains has come to a halt in the post-crisis period after rapid expansion in the pre-crisis period (World Bank 2019d). Rising implementation of protectionist measures risks further compounding the weakness in global value chains and trade. Moreover, firms in EMDEs may lack the necessary capabilities to adopt new technologies without sustained improvements in human capital such as enhancements in educational quality and management abilities despite the progress in education attainments (Cirera and Maloney 2017).

A more challenging environment for structural transformation. As highlighted in Box 3.2, the contribution to productivity growth from the manufacturing sector has been in decline and presents fewer opportunities for EMDE productivity growth. Secular trends, such as a declining employment share in the manufacturing sector in some economies and risks from automation will make manufacturing-led development increasingly challenging in the future (Hallward-Driemeier and Nayyar 2017; Sinha 2016). Furthermore, gains from faster productivity growth in the agricultural sector, freeing up workers to transition to other sectors, have declined.

FIGURE 3.8 Pre-crisis developments in productivity drivers and productivity growth

All drivers of productivity growth in EMDEs, except for innovation, gender equality and institutions, improved more than in advanced economies during the pre-crisis period, helping to narrow the productivity gap with advanced economies. There was a strong link between drivers and productivity growth—those economies with better initial conditions in the 1990s grew at faster rates subsequently. The benefits of improving drivers are larger for LICs.



Source: Barro and Lee (2015); International Monetary Fund; Observatory of Economic Complexity; United Nations; World Bank, World Development Indicators.

A. Share of EMDE countries whose improvement in drivers are larger than average changes for advanced economies. Variables corresponding to each concept are (sample in parentheses): Institutions (74) = WGI Rule of Law Index, Innovation (30) = patents per capita, Investment (72)= investment to GDP ratio, Income equality (72) = (-1)*Gini coefficient, Urbanization (74) = Urban population (% total), Econ complexity (56) defined as Economic Complexity Index of Hidalgo and Hausmann (2009), Education (69) = years of schooling, Demography (74) = share of working age population, Gender equality (28) = Ratio of female to male labor market participation.

B. Average level of productivity growth and "index of drivers" in each quartile over 1995-2008. "Index of drivers" created by weighting normalized levels of each potential driver in chart A by its estimated impact on productivity growth (Figure 3.7; Annex 3.3).

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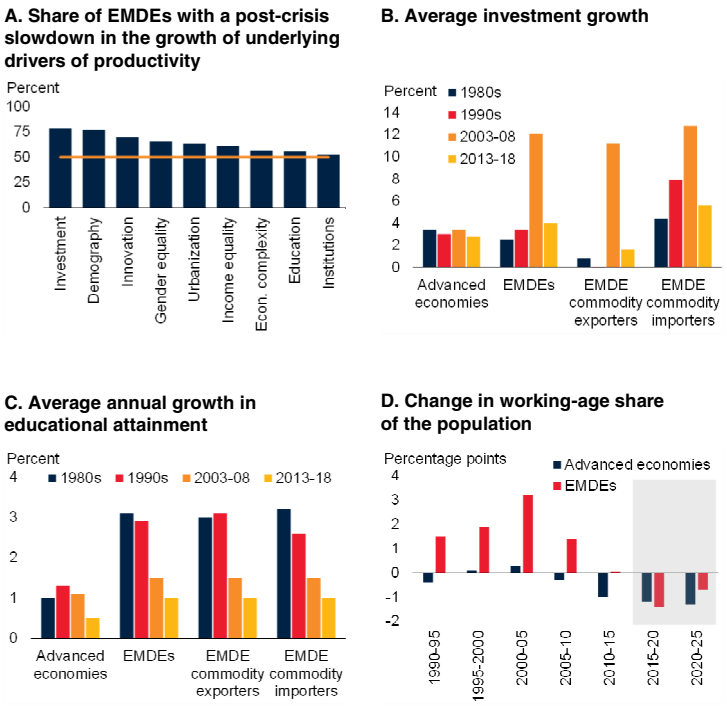
Rising debt risk in EMDEs. Amid record-high EMDE debt, a wide range of adverse shocks could precipitate a financial crisis in EMDEs, which could do severe damage to productivity (Box 3.4). Since 2010, total debt in EMDEs has risen markedly by 54 percentage points, to 168 percent of GDP in 2018, with private debt growing faster than public debt, reaching 120 percent of GDP in 2018 (Chapter 4). Low productivity growth and rising sovereign debt burdens may even reinforce one another (Posen and Zettelmeyer 2019).

Climate change. Over the longer-term, climate change will likely increase the challenges to improving productivity in the agricultural sector,

FIGURE 3.9 Post-crisis slowdown of the drivers of productivity growth

In EMDEs, improvements in a broad range of productivity drivers slowed after 2008. Investment growth slowed to one-third of its pre-crisis rate in EMDEs. Working-age population shares are expected to contract in the coming years. And the growth of educational attainment has also slowed as EMDEs reduce the gap with advanced economies.



Source: Barro and Lee (2015); International Monetary Fund; Observatory of Economic Complexity; Penn World Table; IMF World Economic Outlook; United Nations; World Bank, World Development Indicators; Wittgenstein Centre for Demography and Global Human Capital.

A Post-crisis slowdown defined as the share of economies where improvements in each underlying driver of productivity during 2008-2017 was less than zero or the pace of improvement during the pre-crisis period 1998-2007. Variables corresponding to each concept are (sample in parentheses): Investment (69)=investment to GDP ratio, Demography (74)=share of working-age population, Innovation (33)=patents per capita, Gender equality(32)= Share of female labor market participation rate to male, Urbanization (74)=Urban population (% total), Institutions (74)= WGI Rule of Law Index, Income equality (72)=(-1)*Gini coefficient, Education (72)=years of schooling, ECI (55) defined as Economic Complexity Index of Hidalgo and Hausmann (2009). Price stability excluded due to demand-side influences on inflation following the global financial crisis.

B. GDP-weighted average annual investment (gross fixed capital formation) growth.

C. GDP-weighted change (at 2010 prices and exchange rates) in average years of education.

D. Changes in the working-age share of the population (aged 15-64).

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with large falls in crop yields expected as global temperatures rise (Fuglie et al. 2019). Agriculture currently accounts for 30 percent of GDP in LICs, compared to just 9 percent in non-LIC EMDEs. In addition, EMDEs in several regions are heavily reliant on agriculture: around half of employment is in the agricultural sector in SAR and SSA.

Less favorable demographics. Younger populations and larger working-age population tend to adopt new technologies, skills, and organizational structures more readily (Maestas, Mullen, and Powell 2016). The working-age share of the population rose by 13 percentage points of the population during 1995-2008 in MENA, the fastest-growing region, and 8 percentage points in EAP, the second-fastest growing. In the coming years, EMDE populations are set to age. In EAP and ECA, the working-age share of the population is expected to decline by 3-4 percentage points of the population by 2030, while, in LAC, MENA, SAR, and SSA it will stagnate.

Policy implications

Concerns about prospects for productivity growth in EMDEs call for a renewed emphasis on structural policies that can unlock productivity gains, but undertaking the right structural policies is challenging. Drawing on the findings in this chapter, four strands of policy options emerge.

The results suggest that a four-pronged policy approach can lift productivity. First, policies can raise labor productivity economy-wide by stimulating private and public investment and improving human capital. Second, policies can foster firm productivity by exposing firms to trade and foreign investment and strengthening human capital, and upgrading workforce skills including that of firm managers. Third, policies can facilitate the reallocation of resources towards more productive sectors and a more diversified set of sectors. Finally, to be effective, these policies need to be set in the context of a growth-friendly macroeconomic and institutional environment (Cirera and Maloney 2017).

Within these four broad strands, specific priorities depend on country characteristics. For example, countries with large unmet investment needs may want to prioritize expanding fiscal resources to achieve more and better public investment. Countries with anemic private investment may want to prioritize business climate and institutional reforms, reduce support for state-owned enterprises, and broadening access to finance to allow private sector investment to flourish. Countries with predominantly low-skilled workers may want to improve health and education for workers and managers alike. Countries with lethargic innovation may want to

BOX 3.4 Debt, financial crises, and productivity

High debt levels increase the probability of financial crises and weigh heavily on productivity growth through a wide range of channels. During debt accumulation episodes associated with financial crises, cumulative productivity gains three years into the episode are 2 percentage points lower than in episodes without crises. Financial crises are accompanied by large and protracted declines in productivity: five years after the financial crisis, productivity is 6.5 percent lower than it would have been without a crisis.

Introduction

Productivity growth is vulnerable to a range of adverse shocks including those associated with financial crises, especially in the context of rapid debt accumulation (Chapter 4). Following the global financial crisis and subsequent global recession of 2007-09, a broad range of countries experienced a rapid accumulation of debt together with a significant slowdown of productivity growth. Debt accumulation raises both long-term and short-term risks to productivity growth. In the long-term, it can lead to misallocation of resources towards low productivity projects, worsen investment prospects, weigh on competitiveness, and curb technological transfers embodied in investment.[1] In the short-term, debt accumulation also increases the probability of financial crises that sharply raise borrowing cost, worsen balance sheets and depress productivity growth, which can last over an extended period.[2]

Against this backdrop, this box discusses the linkages between productivity and financial crises as well as rapid debt accumulation. Specifically, it addresses the following two questions:

- Through which channels does debt affect productivity?
- What is the empirical link between financial crises and productivity?

Channels of transmission

Elevated debt levels can affect productivity growth via several channels. These include misallocation of resources, policy uncertainty and debt overhangs that weigh on productivity-enhancing investment, and a higher probability of financial crises.

Misallocation of resources. If used to fund productive investments with high rates of return, debt can have positive effects on productivity and growth (Reinhart and Rogoff 2010; Poirson, Pattillo, and Ricci 2004). However, debt accumulation can impede productivity by encouraging a misallocation of resources towards projects that yield short-term returns at the expense of long-term returns or offer low risk at the expense of high returns (Poirson, Pattillo, and Ricci 2002; Checherita-Westphal and Rother 2012). These short-term projects can include those that rely heavily on returns from asset price appreciation on expectations of rapid future growth (Claessens and Kose 2017, 2018).

Debt overhangs. Rapid debt accumulation can lead to debt overhangs whose debt service crowds out productive investment.[3] At the firm level, a large outstanding debt stock can weigh on investment and, hence, the productivity growth that technology embedded in this investment can generate. At the government level, debt service on high debt may crowd out other productivity-enhancing spending, including for education, health or infrastructure.

Policy uncertainty. Especially high government debt increases uncertainty about growth prospects. For investors, large projected government debt service cost creates policy uncertainty because they may eventually compel governments to introduce distortionary taxation (including on future investment returns), curtail growth-enhancing spending, or delay reforms that may support innovation and productivity (IMF 2018). Such uncertainty lowers incentives to invest in productivity-enhancing technologies (Krugman 1988).

Higher probability of financial crises. Higher debt increases the probability of financial crises. These tend to be associated with severe short-run productivity losses and lasting productivity weaknesses. Financial crises include debt, banking, and currency crises.

- *Sovereign debt crises.* Higher government debt may encourage governments to shift towards lower-cost

Note: This box was prepared by Alistair Dieppe, Sinem Kilic Celik, and Cedric Okou.

[1] Blanchard and Wolfers (2000); Bulow and Rogoff (1989).

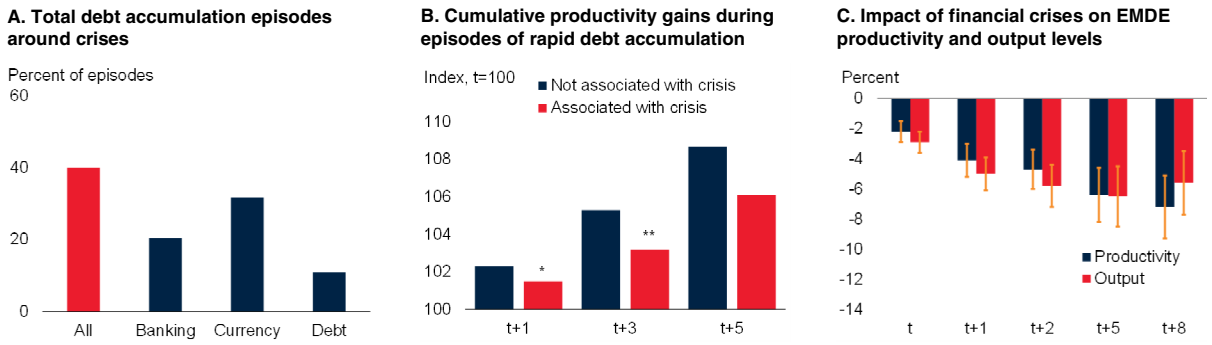
[2] See Aguiar and Gopinath (2006), Arteta and Hale (2008), Blanchard, Cerutti, and Summers (2015), Cerra and Saxena (2008, 2017), Furceri and Mourougane (2012a), Jordà, Schularick, and Taylor (2013), and Reinhart and Rogoff (2009, 2010).

[3] Debt overhang can occur in the presence of high levels of debt, as potential investors hold back new investments because they face heightened uncertainty about tax rates on future investment returns, given the government's large projected revenue needs to service the outstanding debt.

BOX 3.4 Debt, financial crises, and productivity (*continued*)

FIGURE 3.4.1 Productivity in debt accumulation episodes and financial crises

About 40 percent of all episodes of debt accumulation are associated with financial crises. During those episodes, productivity gains are significantly lower than during other episodes. Specifically, a financial (banking, currency and debt) crisis is accompanied on average by a 6.5 percent cumulative decline in the level of labor productivity after 5 years, and the negative effect is protracted, exceeding 7 percent at an 8 year-horizon.



Source: World Bank.
A. Share of total (government and private) debt accumulation episodes that were associated with financial (banking, currency, debt) crises.
B. * and ** indicates 10 and 5 percent significance level for the difference between productivity growth during the median total debt accumulation associated with crises and the median total debt accumulation episode not associated with crises.
C. Bars show the average loss in labor productivity and output levels in EMDEs, expressed in percent, at impact, 1, 2, … and 8 years after a financial crisis (Laeven and Valencia 2018). Financial crises include banking, currency and debt crises. Whiskers represent 90 percent confidence intervals. The estimation is based on local projection method (Jordà 2005), which includes control variables (country fixed effects, lagged shocks, forward bias correction terms, and lagged TFP growth) and bias correction (Teulings and Zubanov 2014) for forward values of the crisis dummy between time t and t+h-1.
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but higher-risk debt issuance such as at shorter maturities or in foreign currency (Kalemli-Özcan, Laeven, and Moreno 2018). This heightens the probability that financial market stress precipitates a sovereign debt crisis that sharply raises investor risk premia and borrowing cost.[4] These tend to coincide with severe economic disruption just as sovereign debt distress prevents governments from supporting activity with counter-cyclical fiscal policy (Reinhart and Rogoff 2010). This depresses public and private investment and restricts other productivity-enhancing public spending.

- *Banking and currency crises.* Other types of financial crises, including systemic banking crises and currency crises, can also do lasting damage to productivity (Cerra and Saxena 2017; Oulton and Sebastiá-Barriel 2017). The disruptions in financial intermediation during banking crises curb the funding of productivity-enhancing technologies and typically trigger recessions (De Ridder 2017). In the subsequent protracted weakness, elevated long-term unemployment erodes human capital.[5] Because of their shorter duration, currency crises are typically less harmful to productivity. However, combined banking and currency crises can be particularly damaging for economic activity and productivity.

Empirical link between financial crises and productivity

Productivity gains during rapid debt accumulation episodes. Long-term productivity gains during rapid debt accumulation episodes have been considerably lower when these debt accumulation episodes were associated with financial crises. As in Chapter 4, rapid debt accumulation episodes are defined as an expansion from trough to peak of total debt-to-GDP ratios by more than one standard deviation, with troughs and peaks identified using the Harding and Pagan (2002) algorithm. This yields 190 episodes, of which almost half were associated with financial crises—identified as in (Laeven and Valencia 2018) —at some point during the episode.

[4] Aguiar and Gopinath (2006); Arellano (2008); Sandri (2015).

[5] See Blanchard and Wolfers (2000) and Furceri and Mourougane (2012b).

BOX 3.4 Debt, financial crises, and productivity (*continued*)

In a debt accumulation episode accompanied by a crisis, median productivity three years into the episode was 3 percent higher than at the beginning of the episode. This is statistically significantly less than during a debt accumulation episode that was not associated with a crisis (5 percent). The difference may reflect the severe short-term damage to productivity driven by financial crises. Two years later (five years into the episode), productivity differences between the two types of episodes were no longer statistically significant.

Impact of financial crises on productivity. The productivity losses associated with financial crises are estimated in a local projections model of productivity levels in financial crises episodes. These episodes are identified as in (Laeven and Valencia 2018). There are 299 financial crisis episodes for which labor productivity estimates are available. 72 percent of these episodes occurred in 71 middle- or high-income EMDEs and 10 percent in 13 low-income countries.

Financial crises are accompanied by large and lasting productivity losses. Immediately after the onset of a debt crisis, labor productivity declines on average by about 2.2 percent and then falls by a cumulative 6.5 percent at the end of five years (Figure 3.4.1). The effect persists into the eighth year. This is consistent with earlier studies that document protracted effects of financial crises on productivity growth (Obstfeld 1996; Morris and Shin 1998; Barro 2001).[6]

Conclusion

Financial crises weigh heavily on productivity growth through a wide range of channels. During debt accumulation episodes associated with financial crises, cumulative productivity gains three years into the episode are 2 percentage points lower than in episodes without crises. Financial crises are accompanied by large and protracted productivity losses—following an initial drop of 2.2 percent, productivity falls by a cumulative 6.5 percent five years after the onset of the crisis. In this context, the rapid post-crisis build-up of debt in EMDEs increases vulnerability to financial crises and represents an important downside risk to productivity growth (Chapter 4).

[6] The damage to output and productivity does not differ statistically significantly over the first eight years following the crisis.

expose their private sectors to foreign knowledge and technologies through greater trade and foreign direct investment (Boxes 2.1-2.6).

Policy interactions can lead to unintended consequences. For instance, trade liberalization reforms can increase the exposure of private sector firms to foreign knowledge and frontier technologies, and boost productivity. However, trade liberalization can also be associated with greater informality in the short-run if labor markets are not flexible, thus counteracting policies that aim at facilitating the reallocation of resources towards more productive sectors (Bosch, Goni, and Maloney 2007; World Bank 2019a). Therefore, these potential interactions should be accounted for when designing a policy mix for a country.

Improving factors of production

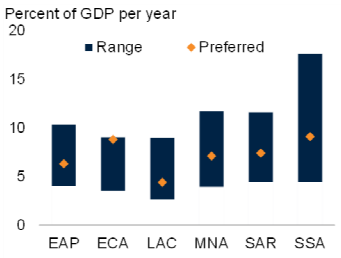
Meet infrastructure investment needs. In several regions (ECA, MNA, SAR), weaker rates of capital deepening accounted for most of the post-crisis slowdown in labor productivity growth. Elsewhere (SSA, SAR), sizable infrastructure deficits restrict firms' ability to improve productivity. Better physical capital and infrastructure—transport, power, telecommunications—can reinforce a country's competitiveness and boost its productivity (Calderón, Moral-Benito, and Servén 2015). A key challenge is to prioritize investments to reconcile large development needs with funding constraints and to improve public investment management. Low– and middle-income countries will need to spend between 4.5 to 8.2 percent of GDP on new infrastructure annually to 2030 in order to meet infrastructure-related Sustainable Development Goals (Rozenberg and Fay 2019).[19] Where fiscal space exists, governments should fund infrastructure spending in areas likely to generate high-returns. SSA is estimated to have the

[19] SDG targets for universal access to safely managed water, sanitation, and hygiene services, improved irrigation infrastructure to improve food supplies, universal access to electricity and improved transport infrastructure.

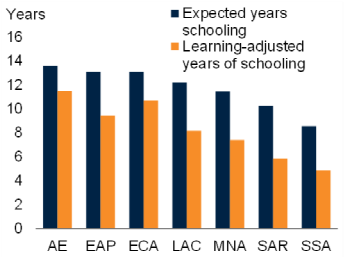
FIGURE 3.10 EMDE infrastructure and education gaps

Infrastructure needs to meet the Sustainable Development Goals are highest in SSA. While education gaps, measured as years of schooling, are closing in many regions, they remain large in SAR and SSA. The gaps to advanced economy levels are even larger after adjusting for educational quality.

A. Infrastructure gaps



B. Years of education and learning-adjusted years of education (2017)



Source: Rozenberg and Fay (2019); World Bank, Human Capital Project.

A. Investment and maintenance needs based on the Sustainable Development Goals as set out in Rozenberg and Fay (2019) including both new investment and maintenance of existing capital stock. Infrastructure investment includes investment in electricity, transport, water supply and sanitation, flood protection, and irrigation. Preferred is defined as the infrastructure "pathway [that] limits stranded assets, has a relatively high per capita consumption due to electric mobility, and invests mostly in renewable energy and storage."

B. GDP-weighted expected years schooling and learning-adjusted years of schooling from the World Bank's Human Capital Project. Leaning-adjusted years of schooling use harmonized cross-country test scores to adjust average years of schooling.

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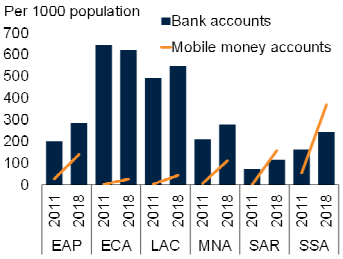
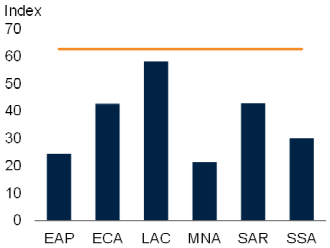
FIGURE 3.11 Developments in Fintech and Govtech

Economies with the largest "unbanked" populations have also seen the biggest increases in fintech innovations to payment systems and other financial services. The rise of fintech has been largest in SSA. These systems are critical to improving access to finance to make productivity-enhancing investments. EMDE government transparency still lags advanced economies. New ICT can facilitate the rapid dissemination of information within and outside of government to monitor performance and service shortfalls.

A. Access to banking services and mobile money accounts



B. Information openness: national government data availability



Source: GSM Association (GSMA), Open Knowledge Foundation, World Bank.

A. Mobile money accounts based on a sample of 16 EMDEs, excluding China, in East Asia and the Pacific (EAP), 7 EMDEs in Eastern Europe and Central Asia (ECA), 18 EMDES in Latin America and the Caribbean (LAC), 9 EMDEs in Middle East and North Africa (MNA), 7 EMDEs in South Asia (SAR), and 40 EMDEs in Sub-Saharan Africa (SSA).

Bank accounts, defined as depositors at commercial banks, based on a sample of 22 EMDEs, excluding China, in East Asia and the Pacific (EAP), 24 EMDEs in Eastern Europe and Central Asia (ECA), 32 EMDES in Latin America and the Caribbean (LAC), 19 EMDEs in Middle East and North Africa (MNA), 8 EMDEs in South Asia (SAR), and 48 EMDEs in Sub-Saharan Africa (SSA).

B. Global Open Data Index is a proxy for the availability of open national government data at large. GDP weighted average. 2016/7 data. It based on a sample of 27 Advanced economies, 14 EMDEs in Eastern Europe and Central Asia (ECA), 6 EMDEs in East Asia and the Pacific (EAP), 25 EMDES in Latin America and the Caribbean (LAC), 2 EMDEs in Middle East and North Africa (MNA), 6 EMDEs in South Asia (SAR), and 12 EMDEs in Sub-Saharan Africa (SSA).

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highest infrastructure deficit required to meet the SDGs (Figure 3.10). Poor infrastructure, such as power supply problems, have been found to lower manufacturing TFP in Bangladesh and reduce export diversification in lower-income EMDEs (Osakwe and Kilolo 2018). A range of infrastructure investments in the road and telecommunications networks in South Africa were found to have positive effects on manufacturing TFP (Bogetic and Fedderke 2009).

Remove private sector investment constraints. Removing business environment constraints, labor and product market inefficiencies, and improving corporate governance should be prioritized (World Bank 2019a). In addition, credit constraints can also hold back investment, with many EMDEs lacking developed capital markets and financial products for much of the population (Sahay et al. 2015). Weak access to finance is a key constraint to small and medium firms in SAR–especially for women-owned businesses—and holds back firm-level productivity gains in India (Box 2.5). Efforts are needed to encourage the use of fintech products in regions where access to traditional banking products and sources of finance is low, while addressing associated risks of these technologies, such as financial crime and cybersecurity risks (Figure 3.11; IMF and World Bank 2019). Investing an additional 4.5 percent of GDP annually in infrastructure in EMDEs would lift long-run productivity growth by 0.3 percentage point (Figure 3.12).

Raise human capital. Better-educated and healthier workers hold better-paying jobs, have more stable careers, and are more productive. Moreover, a better educated and healthier workforce is more capable of advanced technology adoption (Bils and Klenow 2000). Educational gaps with advanced economies are largest in SAR and SSA, where expected years of schooling is 3 and 5 years lower than in advanced economies, respectively. This gap increases to 6 and 7 years when adjusting for quality, suggesting that educational reforms should be a priority in these regions (Figure 3.10). In addition, tailored interventions at early ages are important. These can include measures to expand school attendance, provide student grants, support nutrition

programs for early childhood development, upgrade teachers' training, foster teacher accountability and incentivize performance, which can boost educational outcomes. Conditional cash transfer programs can have persistent effects on educational attainment and the quality of employment (Kugler and Rojas 2018). Transitioning to lower fertility rates can reduce dependency rates and free up resources to invest in education and health—Botswana and Ethiopia have experienced rapid declines in fertility rates in recent decades, alongside large falls in poverty rates (World Bank 2019f). By increasing educational attainment at the same rate as its fastest 10-year cumulative increase ending between 2000-2008, EMDEs could raise long-run productivity growth by about 0.1 percentage point (Figure 3.12).

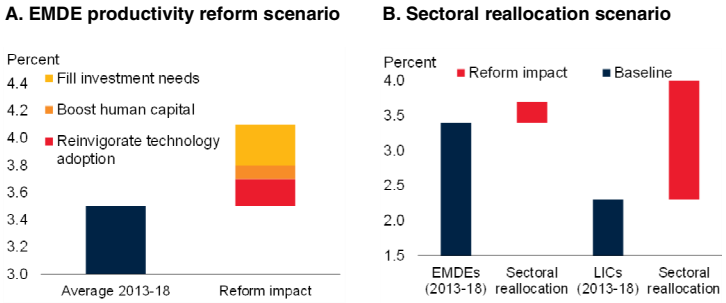
Another key component of human capital is health. Although life expectancy at birth in EMDEs has increased to 70 years on average as of 2017, this is still about 10 years below average advanced-economy levels (81 years). Improvements in access to clean water, the provision of adequate sanitation, health care, training, and performance-based payments to health service providers can yield substantial rewards on the well-being of the population and lift productivity (World Bank 2012, 2018b).

Boosting firm productivity

Foster firm capabilities. The structural slowdown in TFP growth in EMDEs suggests a need to reinvigorate technology adoption and innovation. Interventions to ease international and domestic knowledge diffusion and boost firm absorptive capacities will buttress innovative activities (De Visscher, Eberhardt, and Everaert 2018). On-the-job training and targeted educational reforms can update skills to complement current and newly introduced technologies, many of which require higher cognitive skills and tertiary education levels compared to previous technologies. Firm management capabilities have been shown to be key in generating high-quality R&D and technology adoption. In India, firms provided with training on management practices saw productivity rise by 17 percent—a key factor for improving management quality has been

FIGURE 3.12 Productivity growth: reform scenario

A reform package that combines filling investment needs, boosting human capital, and improving the adoption of new technologies could lift productivity by just over half of a percentage point over 10 years. Replicating the success of China and Vietnam in shifting out of agriculture towards manufacturing and trade services could provide a significant boost to productivity growth in low-income economies.



Source: World Bank
Note: GDP-weighted average. EMDEs = emerging markets and developing economies.
A. The reform scenario assumes: (1) Fill investment needs: the investment share of GDP increases by 4.5 percentage points as in the Rozenberg and Fay (2019) "preferred" infrastructure scenario. The increase is phased in over 10 years (2) Boost human capital: average years of education increases in each EMDE at its fastest cumulative 10-year pace ending during 2000-08; (3) Reinvigorate technology adoption: economic complexity (Hidalgo & Hausmann 2009) increases at the same pace as its fastest 10-year rate of increase ending during 2000-08.
B. The sectoral reallocation scenario assumes the sectoral reallocation reform replicates the successful transformation of China and Vietnam during 2003-2008. The share of employment in the agriculture sector falls by 15 percent and is reallocated to the manufacturing and trade services sectors over a 5 year period.
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participation in global value chains to boost knowledge diffusion on management practices (Bloom et. al. 2013; Cirera and Maloney 2017). However, private firms may be reluctant to undertake costly investments in R&D to open foreign markets if competitors can free-ride. Policies that ensure property rights and promote public-private partnerships to create technology extension centers in sectoral clusters can increase firm participation in global value chains, and lift productivity (Cirera and Maloney 2017).[20]

Firm-level analysis suggests that to benefit from technology spillovers EMDEs need to foster trade and financial integration (Box 3.3). Reducing trade restrictions, alongside increasing levels of human capital, increase export diversification and reduce reliance on commodity exports (Giri, Quayyum, and Yin 2019). Efforts to improve trade openness can include regional trade agreements, such as the African Continental Free

[20] Technology extension centers generate and transfer new foreign and domestic technologies, tailored to a country's specific needs, to local users.

Trade Area which includes economies in MENA and SSA. In India, reforms in the 1990s to boost foreign (and domestic) competition in the service sector also had large positive spillovers to manufacturing productivity (Arnold et al. 2016). Bangladeshi garment exporters increased productivity after gaining tariff-free access to EU markets in 2001, which also boosted productivity in domestically-focused firms (World Bank 2019d). In China, firms' participation in foreign supply chains and FDI complemented domestically-led research and development, spurring homegrown innovation (Hu, Jefferson, and Jinchang 2005). Enhancing technology adoption in EMDEs—returning economic complexity growth to its fastest pace during the EMDE growth and trade surge during 2000-2008—could increase productivity growth by 0.2 percentage point annually (Figure 3.12).

Address informality. The informal sector is associated with lower average productivity levels and accounts for around 70 percent of employment in EMDEs, with particularly high concentrations in SSA and SAR (World Bank 2019a). In Paraguay, informal firms have been found to be not only less productive than formal firms, but to have negative spillovers on formal firms' productivity (Vargas 2015). Reducing the scope for rent-seeking bureaucratic processes that obstruct formalization, improving the fairness of regulation, and enhancing the even-handedness of regulatory and tax enforcement have been associated with a more efficient reallocation of input factors from less productive informal activities to more productive formal ones (Amin and Islam 2015; Amin, Ohnsorge, and Okou 2019). Beyond formalization, pro-productivity and skill-upgrading interventions could be more focused on informal small-scale firms and unskilled workers (Nguimkeu and Okou 2019).

Encouraging sectoral reallocation

Support sectoral reallocation and diversification. Sectoral reallocation is an important engine of productivity growth (Box 3.2). The largest gains in productivity occur at low levels of income as workers shift away from the agricultural sector, with lower benefits in middle-income EMDEs. Furthermore, middle-income countries tend to be highly diversified across a broad range of both manufacturing and service sectors, although at high levels of development diversification tends to slow and there is a re-specialization (Imbs and Wacziarg 2003).

Sectoral diversification is of vital importance to economies with a high reliance on commodity extraction, who have usually experienced the lowest levels of productivity growth globally (Bahar and Santos 2018).[21] Commodity exporting economies in LAC, MENA, and SSA have had highly procyclical investment and low average TFP growth during the past three decades. The benefits of diversification include greater macroeconomic stability as well as higher average rates of productivity growth. Economies that have successfully reduced their reliance on oil exports, such as Malaysia, Mexico, and Indonesia, initially expanded to complementary industries, such as natural-resource processing and manufacturing, or expanded to labor-intensive manufacturing, before expanding to more complex manufacturing or services sectors. In addition, these economies established free trade zones, used tax incentives, and established industrial clusters to promote FDI (Cherif and Hasanov 2016).

Seek opportunities in services, boost lagging sectors. Many high value-added service sectors provide opportunities for rapid productivity catch-up growth (Box 3.2; Hallward-Driemeier and Nayyar 2017). High-productivity service sectors such as finance, ICT, accounting and legal services are likely to become increasingly tradable due to technological advances, but require an enhanced education, including at the tertiary level due to their skill-intensive nature. In LICs, notwithstanding rapid pre-crisis productivity gains, productivity levels in the agricultural sector remain less than 10 percent of the average advanced economy. SSA hosts the largest number of LICs and may stand to benefit most from reallocation away from agriculture. Yet, LICs in SSA have so

[21] EMDE commodity-exporters have historically experienced a "crowding-out" effect on other faster growth industries during periods of high commodity prices, which has hindered them from closing the productivity gap with advanced economies.

far shifted away from agriculture towards industrial sectors at a slower pace than LICs in Asia (Box 2.6).

Agricultural productivity can be improved through targeted measures to increase infrastructure in these regions, ensure secure land tenures, and promote access to finance. Productivity led growth in agriculture could free-up input factors. In Vietnam, successful reforms included strengthening of land property rights and relaxed restrictions on external and internal trade of agriculture goods. This could facilitate the reallocation of resources from agriculture to more productive sectors such as manufacturing and services, and boost overall productivity (Fuglie et al. 2019). If EMDEs replicated the successful 2003-08 sectoral reallocation of China and Vietnam from the agriculture sector to manufacturing and trade services, this would lift productivity growth by 0.3 percentage points. Given sizeable differences in sectoral productivity, LICs would particularly benefit, with a boost of over 1.5 percentage points (Figure 3.12).

Address market failures. Government efforts to promote specific sectors should first identify market failures that have prevented sectoral reallocation. In addition, the complexity and scale of interventions to foster new industries need to be balanced against government and institutional capacity to manage risks such as political capture by special interests (Maloney and Nayyar 2018). In addition, distortions that prevent the efficient allocation of resources to productive sectors and firms should be removed. Productivity in firms in India and China may be 30-60 percent lower due to misallocation of capital and labor across sectors which may be driven by market distortions (Hsieh and Klenow 2009). Where firm entry is costly—whether due to high levels of regulation or regulations that favor state-owned firms—regulations can be streamlined, access to finance expanded, implicit subsidies reduced, and corporate governance standard improved. In regions with high energy subsidies (LAC, MNA), lowering these subsidies can also reduce the misallocation of resources into low-productivity and inefficient energy-intensive sectors.

Creating a growth-friendly environment

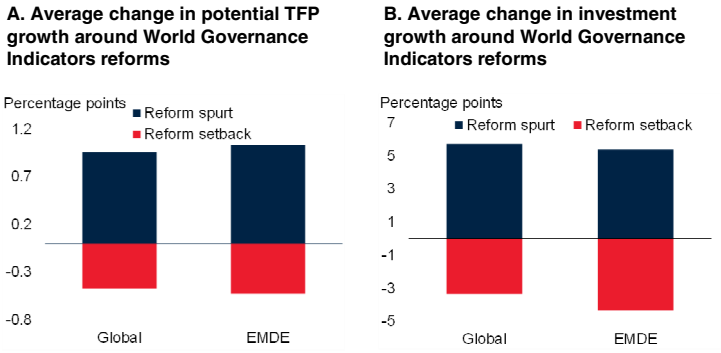
Strengthen institutions and government efficiency. Over the long term, institutional quality is one of the most important determinants of productivity growth (Figure 3.7). Productivity gains have been shown to stem from fair competition, even-handed contract enforcement, simplified and transparent legal processes, and contained political risk (Acemoglu et al. 2019). Governments can promote productivity growth by lowering transaction costs, increasing trust in institutions and facilitating long-term contracts (Leipziger and Thomas 1993). Major governance reform spurts are associated with faster TFP and investment growth (Figure 3.13).[22] Other measures to improve the business environment, such as product market and trade reforms or cutting red tape, may boost productivity by more in the presence of good governance (IMF 2019). New information and communications technologies ("Govtech") can provide one channel through which governments can facilitate the rapid dissemination of information within and outside of government to monitor performance and service shortfalls and improve transparency (Figure 3.11; World Bank 2018d).

Safeguard macroeconomic stability. As highlighted in Box 3.4, episodes of rapid debt accumulation and other triggers for financial crises have historically had scarring effects on productivity. Total EMDE debt has risen by 54 percentage points since 2010 and currently stands at 168 percent of GDP, exposing many EMDEs to the risk of financial instability (Chapter 4). Even excluding China, where corporate debt has soared post-crisis, total EMDE debt has risen to a near-record 107 percent of GDP in 2018. Private sector debt vulnerabilities can be contained with macroprudential policies and supervisory monitoring of risks. Where sovereign debt vulnerabilities exist, including those from contingent private-sector liabilities, establishing fiscal rules can increase confidence in the sustainability of debt, lengthening the maturity of

[22] These spurts are defined as those that improve at least one of four Worldwide Governance Indicators (government effectiveness, control of corruption, rule of law, and regulatory quality) by at least 2 standard deviations over two years.

FIGURE 3.13 Effect of governance reform spurts

Governance reform spurts have been associated with increased potential TFP and investment growth. Setbacks, where perceptions of the quality of governance decline sharply, are associated with slowing investment and TFP growth.



Source: World Bank.
Note: TFP growth refers to potential TFP growth, as estimated in World Bank 2018e
A.B. Simple averages of potential TFP (A) and investment (B) growth during reform spurts and setbacks (minus simple average potential TFP and investment growth outside such episodes) for all countries ("Global") or for EMDEs only ("EMDE") using World Governance Indicators. Based on an event study of 305 statistically significant reform events—defined as two-standard-error changes in one of four World Governance Indicators—for 136 EMDEs and 36 advanced economies. Data are from 1996-2018.
Click here to download data and charts.

existing debt can ease near-term financing hurdles, and improving the quality of spending towards high-return infrastructure investment can yield growth improvements.

Improve gender equality. Improvements in gender equality, in particular by narrowing differentials in education and labor force participation, can drive sustained improvements in productivity growth by enhancing the human capital available for production. Women currently comprise only about one-fifth of the labor force in MNA and one-quarter of the labor force in SAR. In SSA, where female employment rates are high, female entrepreneurs tend to have lower profits and access to capital. Gender inequality can be addressed by ensuring equal legal rights, targeted training programs, relieving capital and financing constraints for women, and addressing social norms that constrain women's economic opportunities. Policies to empower women and boost their productivity include building skills beyond those taught in traditional training programs, such as a greater focus on developing an entrepreneurial mindset—this approach has been found to lift sales and profits in Togo (World Bank 2019f). In the analysis of the underlying drivers of productivity, economies with the lowest gap between female and male educational attainment grew by an average of 0.2 percentage point faster each year than those with the highest differential when controlling for other characteristics of the economy (Figure 3.7).

ANNEX 3.1 Challenges of Productivity Measurement

There are two primary ways of measuring productivity: labor productivity and total factor productivity (TFP). The former is defined by the total output produced by a unit of labor, the latter measures the efficiency with which factor inputs are combined. TFP can also be interpreted as the technology embedded in the production process, but may also incorporate wider factors such as organizational characteristics. This annex reviews the different techniques and challenges of these different productivity measures and explains how they are tackled in this study.

Labor productivity. One of the common approaches is measuring labor productivity as output per worker by taking the number of employees as the unit of labor input. Its advantage is in its wide availability across countries. Its disadvantage rests in the failure to account for the quality and intensity of labor input.

- *Comprehensiveness.* Having high ratios of informality in EMDEs makes it challenging to appropriately measure productivity. While both output and employment might be mismeasured due to non-registration, many national statistics offices estimate the size of the informal sector and adjust their GDP estimates accordingly (SNA 1993, 2008; UNECE 2008; Charmes 2012). The difficulty in estimating the scale of informal output and lack of consistency in approach allows scope for productivity mismeasurement. 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, some self-employment does not involve the informal sector, while the scale of additional employment in the informal sector is also subject to uncertainty—therefore, difficulties in both the measurement of informal output and employment contribute to uncertainty around the productivity level, particularly in EMDE economies (Fajnzylber, Maloney, and Montes-Rojas 2011).[1]

- *Intensity of labor input.* The number of people involved in the production process does not take into account various work-arrangements that vary the intensity of labor input (Katz and Krueger 2016; Brandolini and Viviano 2018). The intensity of labor input is, for example, better captured by hours worked but these data are not available for many countries.

- *Quality of labor input.* The effectiveness of labor input may be affected by the level of education, training, and health of workers. These aspects of human capital can be addressed by estimating the years of schooling for education and the number of expected years of life for health. However, the quality of formal education and health, and the amount of on-the-job training is difficult to measure consistently in a panel setting.

Total factor productivity. One of the most commonly used measures of technological enhancement is total factor productivity growth. The standard growth accounting approach is one of the most common methodologies in the literature to estimate TFP. It is appealing due to its simple nature and its ease of interpretation. Being estimated as residual, it depends on the assumed functional form and any measurement error for factor inputs. In the context of the United States, this has triggered a debate about the extent to which TFP growth adequately reflects new technologies.

- *Functional form.* TFP is defined as "a shift in the production function", in contrast to biased technological change. Its calculation assumes the existence of a well-behaved and stable production function which also accurately describes the technology in use (Baqaee and Farhi 2018). One of the

[1] 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).

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 by market power in final goods (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 *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).

- *Factor utilization.* Since TFP is measured as a residual, it estimates not only technological change but also any mismeasurement of capital and labor input (Basu, Fernald, and Kimball 2006). The capital stock measures the total physical capital available for production without necessarily considering how much of the existing capital is actually used in the production process. Similarly, labor input, even if it is finely measured as total working hours, does not include labor effort. This may lead to an overly cyclical measure of productivity.

New technologies and output measurement. There have been concerns that quality improvements in information technology have not been accurately captured because price deflators for information and communications technology understate the true price declines in these assets (Hatzius et al. 2016). Mismeasurement of new IT technologies could, therefore, explain some of the slowdown in measured productivity growth. 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 United States productivity slowdown to measurement biases, particularly due to the increasing share of the services sector 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 slowdown can be explained by it alone (Cerra and Saxena 2017; Syverson 2016).

ANNEX 3.2 Data and Growth Accounting Approach

Data. The data on capital services and human capital are taken from the Penn World Table 9.1, while data on other macroeconomic aggregates such as GDP are primarily drawn from the World Bank's World Development Indicators (WDI) database, complemented by the ILO and Conference Board estimates of employment. This results in annual labor productivity, TFP and capital services data for 103 economies, of which 73 are EMDEs (including 11 low-income economies) and 29 are advanced economies, for 1981-2018. All aggregates are GDP-weighted averages at 2010 prices and exchange rates. These economies account for 96 percent of global GDP.

Growth accounting. Following Caselli (2005), productivity is decomposed into contributions from several factor inputs:

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

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 $k_t = log(\frac{K_t}{L_t})$ 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 [$(1 - \alpha)$ and α].

Capital services (K_t). 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).

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

Labor share estimates. The output-labor elasticity (α), proxied by the labor income share, is also derived from the PWT 9.1 database. It is estimated using the labor compensation to output ratio, including adjustments to take account of mixed-income and wages from self-employment. Labor shares are allowed to vary across countries in this chapter's decompositions. This analysis uses constant labor shares over time, defined as the long-term average of labor share data from PWT 9.1, although it varies across countries.

ANNEX 3.3 Drivers of productivity[1]

Productivity improvements are key for spurring sustained economic growth and social progress in the presence of limited quantity and quality of factor inputs—labor inputs, physical capital, and natural resources (Easterly and Levine 2001; Caselli 2005). Drawing from growth theories, the empirical literature has identified many potential drivers of productivity growth.[2] These can be classified into three broad categories: inputs of production, such as innovation, physical capital and labor;

- supporting environments, such as institutions, policies and social conditions; and
- market development, such as trade integration and financial deepening.

This annex reviews the theoretical and empirical literature that establishes linkages between each of the most commonly identified drivers and productivity growth and assesses differences across EMDE regions as well as over time.

Inputs of production

Innovation. Technical innovations create better ways to produce goods, deliver services, and improve within-sector productivity of firms. Despite large productivity gaps in EMDEs relative to advanced economies, most EMDEs invest much less in formal research and development (R&D) than advanced economies (Goñi and Maloney 2017). The number of patents per capita—one indicator of the pace of innovation—is particularly low in Latin America and the Caribbean (LAC), South Asia (SAR), and Sub-Saharan Africa (SSA; Annex Figure 3.3.1). Nonetheless, gradual improvements in process or product quality have been reported across all income levels (Goñi and Maloney 2017). New patents tend to be more productivity-enhancing in countries with ample supply of highly educated and skilled labor force, while gradual improvements in productivity can be achieved even with low human capital levels (World Bank 2018e).

Physical capital. Labor productivity can be boosted by capital accumulation, underpinned by investment and matched with adequate absorptive capacity (Eberhardt and Presbitero 2015). In particular, investments in infrastructure, including transport, water and sanitation, power, and telecommunications can complement technological progress and lift productivity.[3] Infrastructure needs in EMDEs remain large. Achieving infrastructure-related SDGs in low- and middle-income countries will require an average

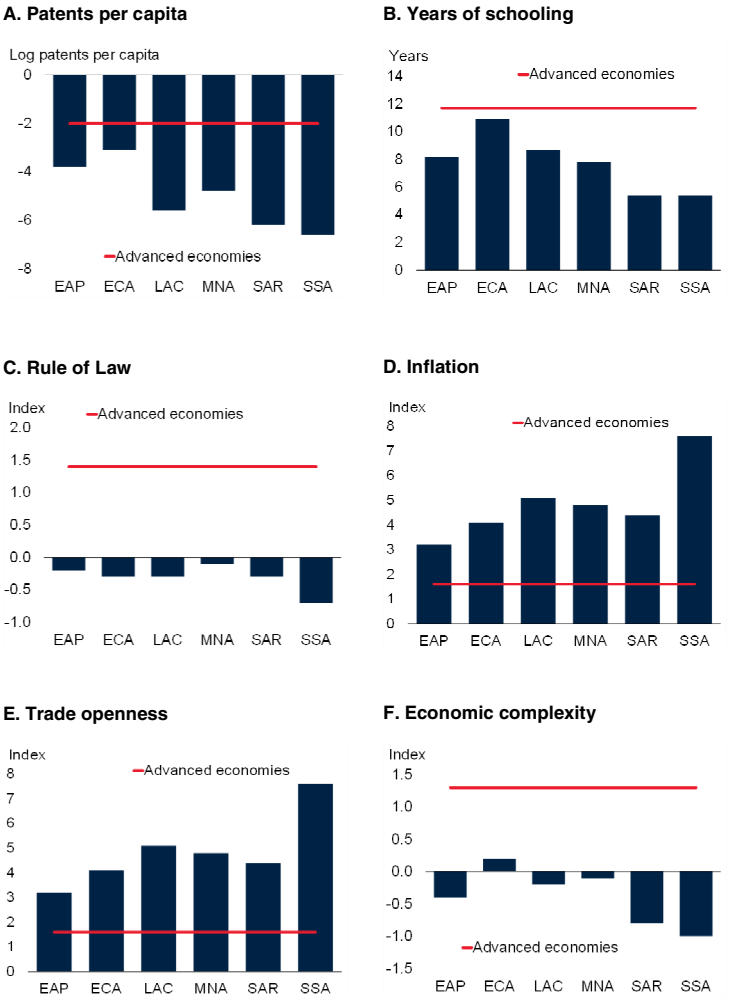
[1] This annex was prepared by Alistair Dieppe, Atsushi Kawamoto, Yoki Okawa, and Cedric Okou.

[2] As some concepts overlap there could be alternative classifications which focus on other concepts such as competition, geography, and social fragmentation.

[3] See, for example, Aschauer (1989); Servén (2015); and Martins (2019).

ANNEX FIGURE 3.3.1 Productivity drivers in 2017, by region

All EMDE regions fall short of advanced-economy conditions in important productivity drivers, including innovation, human capital, institutions, macroeconomic stability, and trade openness. There is considerable variation across regions: SSA and LAC tend to rank low in many of these dimensions whereas EAP and ECA tend to rank highly.



Source: Observatory of Economic Complexity; United Nations; World Bank, Worldwide Governance Indicators.
Note: Data for 2017. Unweighted averages. Trade openness is the sum of exports and imports in percent of GDP. Samples include 22-33 countries in advanced economies, 6-23 countries in EAP, 4-24 countries in ECA, 17-31 countries in LAC, 7-16 countries in MNA, 3-8 countries in SAR, and 10-48 countries in SSA,
Click here to download data and charts.

yearly investment of 4 to 8 percent of GDP during 2015-30 (Rozenberg and Fay 2019; Vorisek and Yu, forthcoming).

Labor. The productivity of labor can be improved in several ways. A better-educated or healthier work-force can adjust more easily to productivity-enhancing changes.

- *Education.* As a labor force becomes better trained and more highly skilled, it has a greater propensity to contribute to technological advancements and to benefit from positive innovation. Countries with better-educated working-age populations tend to have higher productivity (Barro and Lee 2015). This could reflect workforces in EMDEs moving jobs from sectors requiring limited skills, such as agriculture, to sectors requiring greater skill levels, such as manufacturing and services (Box 3.2). Despite significant catch-up over the past five decades, the gap in average years of schooling between EMDEs (8.6 years) and advanced economies (12.3 years) remains sizeable. There is a substantial dispersion among EMDE regions. For instance, Europe and Central Asia (ECA) has the highest years of schooling among EMDEs, just one year short of the advanced-economy average. By contrast, SSA and SAR has low years of schooling, less than half of the advanced-economy average (Annex Figure 3.3.1).
- *Health.* Healthy workers can work more efficiently and learn faster; they are also more committed to improving their skills and are better equipped to innovate (World Bank 2018e). Better health complements education in reinforcing the supply of good-quality labor, in turn raising human capital, attracting investment, and improving productivity.
- *Demographic trends.* Workforce aging is often negatively associated with productivity growth (Aiyar, Ebeke and Shao 2016; Aksoy et al. 2019).[4] New technologies can disrupt the value of existing human capital, as senior and unskilled workers may need retraining. The strength of this mechanism may depend on the economic structure of the country, as productivity benefits more from experience in some occupations and from innovation in others. This effect is particularly pronounced in advanced economies, where the working-age share of the population shrank

[4] The Solow model suggests a decline of the working age population could increase the capital per worker and positively affect labor productivity.

by 3 percentage points between 2008 to 2018. In the decades ahead, EMDEs are projected to follow the same path. Between 2018 and 2030, the working-age population share is expected to decline by 3 percentage points for advanced economies and 2.5 percentage points for EMDEs. In East Asia and Pacific (EAP) and ECA, the working-age population share has already begun to decline, whereas SSA continues to benefit from rising working-age population shares. Realizing the potential of a youthful population requires investing in education and accelerating job creation.

Supporting environment

Institutions. Institutions are the entities that shape human interactions within a society (North 1990). Institutions come in many forms—rule of law, barriers to firm creation and operation, and system of government, to name a few. Better quality institutions are associated with fairer competition and higher productivity (Easterly and Levine 2003; Levchenko 2007). Increased competition is found to support innovation and raise productivity through improvements in management and product quality (Van Reenen 2011). Acemoglu et al. (2019) find that the transition to democracy raises productivity by 20 percent in the subsequent 25 years, but the results vary across studies and some have not uncovered an effect (Ruiz Pozuelo, Slipowitz, and Vuletin 2016). Productivity improvements depend on a country's distance to the technology frontier (Prati, Onorato, and Papageorgiou 2013). There remains a large gap between the quality of institutions, proxied by the government effectiveness index, between all EMDE regions and advanced economies, and the gap has remained almost unchanged over the past twenty years (Annex Figure 3.3.1).

Price stability. Price stability in part reflects the absence of major distortions and uncertainty in the macroeconomic environment (Rodrik, Subramanian, and Trebbi 2004b). Price instability, which can be reflected by high inflation or a large difference between the black market and official exchange rates, may hinder investment, lead to sizeable capital outflows, and are negatively correlate with productivity and economic growth (Gramacy, Malone, and Horst 2014). Price stability in EMDEs, proxied by inflation, has substantially improved over time, and currently stands at about 4 percent (except in SSA), down from 18 percent in 1990 (Annex Figure 3.3.1). Nevertheless, in many EMDEs, monetary and fiscal policy frameworks still lag behind best practices (Koh and Yu 2019).

Income equality. Income inequality has been explored as a potential underlying driver of low productivity growth. However, the literature is agnostic about the impact of inequality on productivity and economic growth (Herzer and Vollmer 2012; Alvaredo et al. 2018). The elusive empirical link may be due to the u-shaped relationship between income equality and the stage of development: the adverse effects of income inequality tends to be high for low-income and high-income countries, but not high in middle-income countries (Banerjee and Duflo 2003). Income inequality has fallen in some EMDE regions, such as LAC. Yet, it remains much higher in EMDEs than in advanced economies. As of 2017, inequality measured by the Gini index, was 41 for EMDEs, compared to 33 for advanced economies.[5]

Gender equality. Large gaps between women and men in measures of education, health, and access to economic opportunities can lower productivity. Better income-earning opportunities for women can increase human and physical capital investment through higher household income and higher returns for building women's human capital (Klasen and Santos Silva 2018). It may also lower fertility and, hence, help provide each child with better education and health care. An increasing share of women in the labor force, with fair pay and equal job opportunity, can also be beneficial for productivity growth, as it brings a richer collection of perspectives to the decision-making and production process (Gallen 2018). By contrast, the exclusion of all women from managerial positions can reduce income per capita by 12 percent (Cuberes and Teignier 2012, 2014). The gap between EMDEs and advanced

[5] The Gini index is a measure of the distribution of income across income percentiles, presented on a scale of 0 to 100, where 100 is the most unequal.

economies for the latter of these indicators has declined during the last five decades.

Market development

Trade. Trade can significantly improve productivity growth (World Bank 2019d) although some studies find only a weak relationship between trade and productivity (Rodrik, Subramanian, and Trebbi 2004). Imports of machinery or high-technology goods can directly improve productivity at the firm, sector, and country level. Lower tariffs can increase imports, facilitate knowledge transfers, and strengthen firm-level productivity (Kraay, Soloaga, and Tybout 2002). Exporting firms tend to have higher productivity than non-exporting ones. The high productivity of exporting firms can be explained by self-selection in some cases (Clerides, Lach, and Tybout 1998). However, evidence from Kenya and the Republic of Korea suggests that exports can increase productivity after controlling for self-selection (Graner and Isaksson 2009). Learning-by-exporting effects on productivity depend on the income level of importers or exporters. The learning effect is large when the exporter and importer have similar productivity levels or importer's human capital is high (Graner and Isaksson 2009; Keller 2004; Blalock and Gertler 2004; Aw, Chung, and Roberts 1998). ECA and EAP are the EMDE regions that are most open to trade whereas SAR is the least open (Annex Figure 3.3.1).

Foreign direct investment. Investment from abroad can bring advanced technology, improved organizational structure, and good management practices from frontier technology economies, boosting productivity in host economies where it is lagging (Griffith, Redding, and Simpson 2003). Cross-border capital flows have a positive effect on productivity, especially those with a high level of development and high-quality institutions. However, this positive relationship is weaker for EMDEs (Keller and Yeaple 2009). In developing countries, the cost of subsidies offered to firms to attract foreign investments can exceed the positive effect of FDI on productivity (Haskel, Pereira, and Slaughter 2007).

Economic complexity. Economic complexity is measured as a composite indicator that compares each country's sectoral export shares with the sector's share in world trade. The economic complexity is higher if the country exports more "complex" goods such as X-ray appliances, which can be exported from only a few other economies (Hausmann et al. 2014). Greater export complexity has been associated with higher labor productivity through its association with the diversification and sophistication of a country's economic structure (Hausmann and Hidalgo 2010). EMDEs largely lag behind advanced economies in terms of economic complexity (Annex Figure A3.3.1)

Urbanization. Urbanization can facilitate agglomeration benefits such as knowledge spillovers, and improved skills matching within the labor force. Densely populated areas bring people and firms closer together, making it easier to share ideas, exchange information, invent new technologies, design new projects, engage in new partnerships, and start new businesses (Abel, Dey, and Gabe 2012). These agglomeration benefits can in turn lift productivity.

Finance. Well-developed financial markets can improve the efficiency of capital allocation, facilitate technology spillovers and help firms take advantage of productivity-enhancing investments (Fisman and Love 2003; Levine 1997). Financial development and integration are associated with productivity growth (Aghion, Howitt, and Mayer-Foulkes 2005). Financial markets allow firms to diversify investment risk, increase liquidity, and stimulate entrepreneurship and productivity.

Estimating impacts of drivers on productivity growth

Methodology. A cross-section analysis is undertaken where the dependent variable is the long-run growth of productivity during 1960-2018 and separately over 1995-2018. In addition to the initial level of log productivity (y_0), other regressors (X_0)—discussed in the literature and measured at the beginning of the period—are included:

$$y_{T,j} - y_{o,j} = \beta y_{o,j} + X_{o,j}\gamma + \varepsilon_j,$$

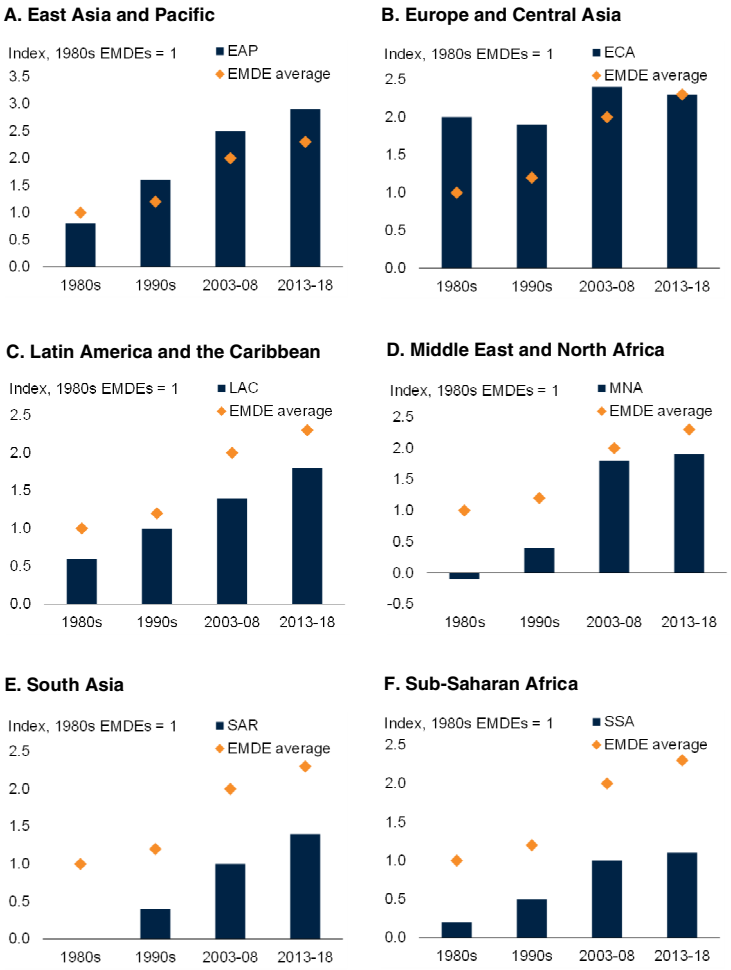
where ε_j is a disturbance term, and j denotes a

specific economy.[6] The set of coefficients γ capture how each covariate ($X_{0,j}$) drive productivity dynamics over the long-run. The wide range of potential drivers associated with productivity growth leads to a large range of potential model specifications (Fernández, Ley, and Steel 2001; Durlauf, Kourtellos, and Tan 2008, Durlauf, Johnson, and Temple 2005). In order to reduce the bias stemming from an ad-hoc selection and omission of variables, a Bayesian Model Averaging (BMA) approach is applied, which considers different subsets of potential variables and evaluates their inclusion probabilistically. Nonetheless, the estimation results can be unstable in the presence of strong collinearity, as many variables can essentially represent the same concepts (Ghosh and Ghattas 2015). Therefore, based on existing literature and growth theories, variables that represent common concepts are grouped together. The posterior distributions of the coefficients obtained from the BMA procedure are then aggregated to the group level.[7]

Impacts. The estimation is undertaken for 59 countries, including 36 EMDEs.[8] It shows that better educated workforce, stronger institutions, greater innovation, stronger investment, higher levels of urbanization, price stability and a diverse and sophisticated economic structure are all significantly associated with higher productivity growth (Figure 3.7). Furthermore, the estimated impact depends on the stage of development and has changed over the more recent period. The estimated coefficients can be interpreted as the hypothetical coefficient of each theoretical driver of productivity growth. Using these coefficients an aggregate index of drivers of productivity growth is formed. It shows it grew rapidly on average in EMDEs in the pre-crisis period supporting productivity growth (Annex Figure 3.3.2). However, since the global financial crisis, improvements in the drivers have begun to level off as the pace of improvement has slowed, particularly in several EMDE regions (EAP, ECA, LAC, and SAR) amid a productivity growth slowdown.

ANNEX FIGURE 3.3.2 Productivity changes in productivity drivers, by region

Productivity drivers—here captured in a composite index—have improved considerably in EMDEs since the 1980s. However, in several regions, including EAP, ECA, LAC and SAR, the pace of improvement appears to have stalled since the global financial crisis.



Source: World Bank

Note: For each country, index is a weighted average—weighted by the normalized coefficients shown in Figure 3.7—of the normalized value of each driver of productivity. Drivers include the ICRG rule of law index, patents per capita, share of non-tropical area, investment in percent of GDP, ratio of female average years of education to male average years, share of population in urban areas, Economic Complexity Index, years of schooling, and share of working-age population. Regional and EMDE indices are GDP-weighted averages. Samples include 7 economies in EAP, 8 economies in ECA, 18 economies in LAC, 6 economies in MNA, 4 economies in SAR, and 11 economies in SSA.

Click here to download data and charts.

[6] Most candidate variables can be viewed as outcomes of productivity, in addition to drivers of productivity, which constrains the interpretation of causal claims from the regressions. To counter the reverse causality issue, the variables used in the analysis are levels in 1960 (or 1995), based on the assumption that serial correlation in 1960 and average growth for the next 58 years is small.

[7] Parametric estimations cannot exclude the possibility of omitted variable bias. Panel estimation focusing on more recent periods can reduce this issue by the inclusion of country fixed effects and a wider range of potential variables, but usually rely on the constant country effects assumption and can suffer from serial correlation and other types of biases.

[8] Variables related to theories in the existing literature are chosen where data exists before 1970 for a large sample of economies. Observations which are not available in the particular year was substituted by the observations in the closest year available.

ANNEX TABLE 3.3.1 Variables included in the regressions and sources

Group	Variable	Source
Financial development	**Ratio of domestic credit to GDP**	**World Development Indicators (WDI)**
Investment	**Ratio of gross fixed capital formation to GDP**	**WDI**
Education	**Years of schooling**	**Barro & Lee, UN**
	Human capital	UNDP
	Years of tertiary schooling	Barro & Lee, UN
	Years of primary and secondary schooling	Barro & Lee, UN
Economic Complexity	**Economic Complexity Index plus**	**Economic observatory**
	(Exports + Imports)/GDP	WDI
Innovation	**Patents per capita**	**WDI**
	Patents per capita * years of tertiary schooling	WDI
Equality	**100 - Gini coefficient**	**UNU wider database**
Institutions	Political Rights Index	Freedom House
	Civil Rights Index	Freedom House
	Rule of Law Index	**International Country Risk Guide, PRS**
	Ratio of government consumption to GDP	WDI and various other sources
Urban	**Share of population in urban areas**	**WDI**
	Population density	WDI
Health	**Survival rate after 5 years per 1000 births = 1000-Infant mortality rate**	**WDI**
	Life expectancy at birth	WDI
Demography	**Share of population aged 15-64**	**WDI**
	Share of population aged below 15	WDI
Gender	**Ratio of years of schooling of female to male**	**Barro & Lee, UN**
	Ratio of years of primary schooling of female to male	Barro & Lee, UN
	Ratio of labor participation rate of female to male	WDI
Geography	Dummy for landlocked countries	WDI
	Share of land which is in tropical regions	**WDI**
	EMDE energy exporter dummy	World Bank
Stability	**(-1) * CPI Inflation Rate**	**WDI**
	Black market exchange rate relative to the official rate	WDI

Note: Sources and list of variables included in the Bayesian selection model. Variables selected with the highest probability of inclusion for each category are in bold.

ANNEX 3.4 Data and methodology for sectoral productivity

Data. The database consists of sectoral and aggregate labor productivity statistics for 80 countries, and nine sectors covering the period up to 2015. Compared with the literature using nine-sector data, it employs a large and diverse sample of countries. The database combine data from the OECD STAN database, World KLEMS (EU, LAC and Russia), the Groningen Growth Development Center (GGDC) database (de Vries, de Vries and Timmer 2015), and the Expanded Africa Sector Database (EASD, Mensah and Szirmai 2018) for value added data and employment. The APO Productivity Database, UN data, ILOSTAT and National sources are used for supplementary purposes. Following McMillan, Rodrik, and Verduzco-Gallo (2014), local currency value added is converted to U.S. dollars using 2011 PPP exchange rate obtained from Penn World Table for the international comparison of productivity levels.[1]

[1] Van Biesebroeck (2009) builds an expenditure-based sector-specific PPP in OECD countries, using detailed price data.

Shift-share analysis. Following (Wong 2006) and (Padilla-Pérez and Villarreal 2017), this chapter employs a shift-share-analysis which decomposes aggregate labor productivity into the growth within a sector and shifts between sectors:

$$\frac{\Delta y}{y} = \underbrace{\sum_{j=1}^{k} \frac{Y_j}{Y}\left(\frac{\Delta y_j}{y_j}\right)}_{\text{Intra-Sectoral Effect}} + \underbrace{\underbrace{\sum_{j=1}^{k} \frac{y_j}{y}\left(\frac{\Delta y_j}{y_j}\right)\Delta s_j}_{\text{Static Sectoral Effect}} + \underbrace{\sum_{j=1}^{k}\left(\frac{y_j}{y}\right)\frac{\Delta y_j}{y_j}\Delta s_j}_{\text{Dynamic Sectoral Effect Shift}}}_{\text{Structural Change Effect}}$$

where y is aggregate labor productivity, y_j is labor productivity of sector j, Y_j is initial value added of sector j, s_j is employment share of sector j. Structural changes are driven by the change in employment share. They are further decomposed into those which are due to the reallocation of sources to sectors which higher productivity levels (static sectoral effect), and those due to reallocation toward sectors with higher productivity growth (dynamic sectoral effect).

ANNEX TABLE 3.4.1 Sectoral classifications

Sector name	Description
1. Agriculture	Agriculture, forestry and fishing
2. Mining	Mining and quarrying
3. Manufacturing	Manufacturing
4. Utilities	Electricity, gas, steam and air conditioning supply
5. Construction	Construction
6. Trade services	Wholesale and retail trade; repair of motor vehicles and motorcycles; Accommodation and food service activities
7. Transport services	Transportation and storage; Information and communication
8. Financial and Business services	Financial and insurance activities; Real estate activities; Professional, scientific and technical activities; Administrative and support service activities
9. Government and Personal services	Public administration and defence; compulsory social security; Education; Human helath and social work activities; Arts, entertainment and recreation; Other service activities; Activities of households as employers; undifferentiated goods-and services-producing activities of households for own use; Activities of extraterritorial organizations and bodies.

ANNEX 3.5 Methodology for Box 3.3

Measurement challenges. Revenue-based TFP (TFPR) measures conflate physical productivity and price effects (Foster et al. 2008; Andrews, Criscuolo, and Gal 2016). These price effects can substantially distort TFPR estimates in non-competitive markets or when output prices and inputs choice are correlated. For instance, a high-productivity firm with market power can lower output prices to increase its market share. In this case, TPFR estimates can be low even though the firm is highly productive. Producer prices, if available, can be used to deflate firm-level sales and obtain physical TFP (TFPQ) estimates (Cusolito and Maloney 2018; Van Beveren 2012). Moreover, specifying a single production function for a firm using multiple production technologies is restrictive and can bias TFP estimates (Bernard, Redding, and Schott 2010; Goldberg et al. 2010). Disaggregated product-level data, if available, can be used to construct product-level TFP and help account for the richness in production mix.

Methodology. The fitted specification is

$$DTF_i^g = \theta_0 + \sum_g \rho_g I\,(g \in G\backslash\{\text{ref}\}) + \sum_j \gamma_j X_{ij} + v_i$$

where DTF_i^g is the distance-to-frontier of TFP for firm i in industry g, θ_0 stands for the constant term, $ref = TINT$ is the reference industry, and coefficients ρ_g are interpreted relatively to the reference group. X_{ij} is firm i's jth characteristic such as GDP per capita (in 2009 U.S. dollars per worker), size (number of employees), exports (as a proportion of total sales), and business climate (control of corruption, business freedom). The error term is denoted by v_i.

ANNEX 3.6 Local projection methodology for Box 3.4

The computation of crises impacts follows the local projection (LP) method (Jordà 2005). The dependent variable is the cumulative change in output or productivity levels between horizons $t\text{-}1$ and $t\text{+}1$, measured as the natural logarithms ($y_{t,j}$). The baseline model is given by

$$y_{t+h,j} - y_{t-1,j} = \alpha_{(h),j} + \tau_{(h),t} + \beta_{(h)} E_{t,j} + \sum_{s=1}^{p} \gamma_{l(h)t,s} E_{t-s,j} + \sum_{s=1}^{h-1} \gamma_{f(h),s} E_{t+h-s,j} + \sum_{s=1}^{p} \delta_{(h),s} \Delta y_{t-s,j} + u_{(h)t,j}. \quad (1)$$

Where $h = 0,1,2,\ldots, 8$ is the horizon, $\alpha_{(h),j}$ and $\tau_{(h),t}$ are country j and time fixed effects, and $u_{(h)t,j}$ is an error term. The coefficient of interest $\beta_{(h)}$ captures the dynamic multiplier effect (impulse response) of the dependent variable with respect to the event dummy variable $E_{t,j}$. The number of lags for each variable is denoted by p and set to 1 for the estimation. The specification controls for (i) country and time specific trends, (ii) lagged event dates, (iii) future values of the event dummy between time t and $t\text{+}h\text{-}1$ to correct for possible forward bias (Teulings and Zubanov 2014), and (iv) past changes $\Delta y_{t\text{-}s,j}$. Additional controls for country-specific interactions and non-linear effects may also be included.

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