CHAPTER 2

What Explains Productivity Growth

Long-term productivity growth is driven by innovation, investment in physical capital, and enhanced human capital. This requires a growth-friendly environment, with supportive institutions and macroeconomic stability. The effects of some drivers on productivity growth have changed over time. Innovation, cross-border technology transfer, and expertise in producing complex and sophisticated exports have increased in importance, along with demographic factors. Despite remarkable improvements over the past 60 years in schooling and health outcomes, gaps between EMDEs and advanced economies remain. Some gaps have even widened, in areas such as tertiary education, financial development, and patents per capita. Furthermore, improvements in key drivers of productivity growth—including education, urbanization, and institutions—have slowed since the global financial crisis and are expected to remain subdued in the years ahead, not least in the aftermath of the COVID-19 pandemic. To rekindle productivity growth, a comprehensive approach is needed to stimulate investment in physical and human capital, and promote a growth-friendly macroeconomic and institutional environment.

Introduction

Long-term labor productivity growth rates have varied enormously across EMDEs. In 1960, labor productivity—output per worker—in China was $423 in 2010 U.S. dollars, slightly lower than Burkina Faso's $427. By 2018, productivity in China had increased to $13,919, eight times higher than Burkina Faso's $1,641. There are many differences between the two countries: for example, in 1960 the share of the population with primary school education was 26 percent in China compared to 0.7 percent in Burkina Faso. China has also invested substantially more: gross investment in China averaged 37 percent of GDP over 1960-2018, about double that of Burkina Faso.

This chapter explores the drivers of long-term productivity growth and how their roles have varied over time, with a focus on the recent slowdown. Many factors have influenced productivity growth over the past 60 years.[1] In the long term, labor productivity growth relies on innovation, physical capital investment, and investment in human capital. These proximate drivers are shaped by the environment in which firms operate: market structures, infrastructure, the institutional framework, and the quality of governance.

Key drivers of productivity growth—such as investment in human capital through primary and secondary education—have seen major improvements over the last 60 years

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Note: This chapter was prepared by Alistair Dieppe, Atsushi Kawamoto, Yoki Okawa, Cedric Okou, and Jonathan Temple. Research assistance was provided by Yi Li.

[1] See Bruns and Ioannidis (2020); Durlauf (2009); Durlauf, Johnson, and Temple (2005); Kataryniuk and Martínez-Martín (2019); Kim and Loayza (2019); and Rockey and Temple (2016).

in EMDEs. They have even improved more than in advanced economies and contributed to strong productivity growth prior to the global financial crisis (GFC). Nonetheless, in many cases, wide gaps between EMDEs and advanced economies remain. At the same time, reflecting the structural changes that economies have undergone over the last 60 years, the roles of various drivers have changed, with some increasing in importance, and others decreasing.

The recent evolution of these drivers help to explain why global productivity growth has weakened since the GFC. Some changes can be linked directly to the crisis, such as increased uncertainty and slower investment growth. The COVID-19 pandemic will be a further blow to growth prospects around the world, disrupting trade and FDI, causing investments to be postponed or canceled, and weakening government finances. Other changes reflect separate, long-term trends. For example, the pace of improvements in some drivers of productivity in EMDEs have naturally slowed as the distance to the best-practice frontier has diminished.

The COVID-19 pandemic threatens to weigh on longer-run trends that could impede productivity growth in EMDEs. Over the past decade, the prospects for further trade integration have diminished, and the expansion of global value chains has lost momentum. Sharp declines in global trade and investment, amid the pandemic, could accelerate these trends. For many countries, they will mean subdued activity, instability, and new pressures on governments.

In the latter decades of the 20th century, many countries benefited from a rising share of the working-age population. This is now leading to aging populations and at least a partial reversal of the earlier "demographic dividend." In other areas, past improvements will be difficult to replicate. Further progress in health and education can contribute to growth, but it will be hard to match the major gains of the last 60 years. Meanwhile, investments could be further damaged by the lasting impacts of COVID-19. On a more positive note, new technologies could yet reinvigorate productivity growth, and some of the improvements in drivers already achieved should continue to support growth over the next few decades.

Against this backdrop, the chapter examines four questions:

- What have been the main factors associated with long-term productivity growth?
- How much have the main factors individually contributed to long-term productivity growth?
- What are the factors behind recent trends in productivity?
- What policy options are available to boost productivity?

Contributions

The chapter makes several contributions to the literature and policy debates:

- The chapter reviews past research on the correlates of productivity growth, motivating the selection of drivers for investigation. It explores the channels through which various drivers operate, while recognizing that they should not be considered in isolation. As some previous research acknowledges, drivers can interact in ways that strengthen or weaken their effects. The chapter also reviews the literature on sources of growth in total factor productivity (TFP) at the firm level.

- The chapter presents new empirical findings that go beyond previous work, partly by examining a range of potential drivers over a longer time period, using a Bayesian approach to combine information from many different models. The analysis allows the importance of drivers to change over time, while the choice of priors recognizes that several candidate variables may represent the same underlying driver.

- The chapter presents new stylized facts on developments in key productivity drivers: whether drivers in EMDEs have been converging with those in advanced economies over the long run, their paths since the GFC, and the prospects for improvement. The chapter presents the likely implications of COVID-19 for productivity drivers and discusses policy options to raise productivity growth.

Main findings

The following findings emerge:

- *Key long-run drivers.* Historically, labor productivity growth has been driven by innovation, better education, and investment in physical capital. Innovation and investment by the private sector require a growth-friendly environment, with supportive institutions and policies, including policies that promote macroeconomic stability and the rule of law. Productivity growth also seems to benefit from expertise in producing relatively complex and sophisticated exports, which is associated with international technology diffusion. This finding complements past research on familiarity with complex production, and supports the argument that "what you export matters" (Hausmann, Hwang, and Rodrik 2007).

- *Changing contribution to productivity growth of drivers.* The effects of different drivers on productivity growth have changed over time. Innovation and experience with economic complexity, related to participation in global value chains and cross-border technology transfer, seem to have increased in importance. So have demographic factors, notably changes in population age structures. In contrast, the importance of urbanization, related to the sectoral shift from agriculture to manufacturing and services, has weakened. These findings complement those of Bruns and Ioannidis (2020), as well as recent evidence on the changing effects of economic complexity, urbanization and innovation.

- *Widening or persistent gaps in many drivers.* Many productivity drivers in EMDEs fall short of advanced-economy conditions, despite remarkable improvements over the last 60 years in key human capital indicators such as the provision of primary education and infant mortality rates. The chapter documents these gaps in a

systematic way. For some productivity drivers, including ones that are essential to innovative economies—tertiary education, financial development, patents per capita—the gaps have widened. Improvements in other drivers, such as institutions and economic complexity, have stalled. Over the past decade, many drivers of productivity growth have faltered, including those which had previously supported strong productivity growth. Working-age population growth has slowed, along with growth in average educational attainment. As the expansion of global value chains has lost momentum, so has the movement toward more diverse and complex forms of production.

- *Challenging prospects with the impact of COVID-19 on drivers*. The COVID-19 pandemic has made the near-term outlook for productivity growth even more challenging. Weaker investment and trade, erosion of human capital, slower labor reallocation, heavier public and private debt burden, and widening inequality could push down the productivity growth. Yet, the pandemic may also create productivity-enhancing opportunities such as lasting organizational and technological changes for business and education, reshaping global value chains toward higher diversification, and changing social norms.

- *Policy priorities.* The recent slowdown in productivity growth has multiple sources, and action on a range of fronts will be needed. Governments seeking to raise productivity growth can increase public investment and stimulate private investment; improve human capital; foster firm productivity, partly through on-the-job training and upgraded management capabilities; increase the exposure of firms to international trade and foreign investment; enable the reallocation of resources towards more productive sectors; and seek to diversify production. The benefits of many productivity-friendly policies could be enhanced by improving the macroeconomic and institutional environment.

Long-run drivers

This section reviews the literature and presents new stylized facts. It considers theory and evidence on the links between productivity drivers and growth, and draws attention to differences across income groups and regions, and over time.

Sustained economic growth ultimately requires technological progress and higher TFP, since growth cannot rely indefinitely on expanding the quantity of inputs (Easterly and Levine 2001; Solow 1956). Drawing on growth theory and economic history, the empirical literature has identified many potential drivers of labor productivity growth.[2] For the purpose of this chapter, these can be classified into three broad categories:[3]

- Proximate sources: innovation, physical capital, and the quality of the labor force;

[2] See Acemoglu and Dell (2010); Barro (1996); Barro and Sala-i-Martin (2004); Isaksson (2007); Kim and Loayza (2019); and Pritchett (2000) for discussions of various drivers.

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

- The supporting environment: institutions, infrastructure, policies, and social conditions;
- Improvements in firm-level factors: innovation capabilities, input quality, and regulations acting at the firm or market level.

Proximate sources of growth

Innovation and technology transfer. In the long run, growth relies on innovation. Firms innovate by introducing new products and better ways to produce existing goods and services. As a result, overall productivity is likely to rise (Hall, Mairesse, and Mohnen 2010).

The role of research and development (R&D) activity in EMDEs differs compared to countries already at the technological frontier. New patents, one measure of R&D outcomes, tend to be more closely associated with productivity growth in countries with highly-educated and skilled workers. But even when human capital is less developed, improvements in productivity can be achieved, albeit slowly (Chen and Dahlman 2004; Furman and Hayes 2004; World Bank 2018a). Gradual improvements in production processes and product quality have been reported across all income levels (Goñi and Maloney 2017). In addition, R&D activity can enhance the absorptive capacities of firms and their ability to assimilate new technology (Cohen and Levinthal 1989, 1990).

EMDEs can benefit from the diffusion of technologies across national borders. Buera and Oberfield (2020) use a calibrated model to show that trade-induced technology diffusion can greatly increase the gains from trade. This can help to explain past instances of sustained growth, in which countries such as China and Republic of Korea have rapidly integrated with the world economy. In other cases, though, the diffusion of technology may be slow (Chapter 1).

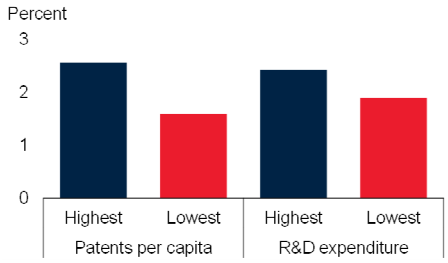
EMDEs invest much less than advanced economies in formal R&D (Figure 2.1; Acemoglu and Zilibotti 2001; Goñi and Maloney 2017). The gap between EMDEs and advanced economies narrowed after 2000, mainly due to more innovation-related activity in China. For EMDEs excluding China, patent applications per capita and R&D spending as a share of GDP barely increased between 2000 and 2017. The number of patent applications per capita remains relatively low, and lags advanced economies in Latin America and the Caribbean (LAC), South Asia (SAR), and Sub-Saharan Africa (SSA).

Physical capital. Since Solow (1956), standard growth models have linked the height of the long-run growth path to the rate of investment. In many East Asian economies, rapid output growth has been closely linked to high investment. In the empirical literature, there is a robust cross-section association between the investment rate and labor productivity, which may even have strengthened over time (Beaudry, Collard, and Green 2005). Research based on the non-parametric estimation of global production frontiers, tracking their movement over time, also finds a major role for capital accumulation in productivity growth (Kumar and Russell 2002).

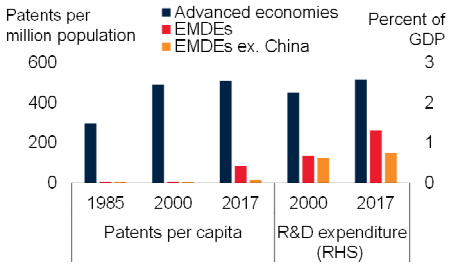
FIGURE 2.1 Innovation

Economies characterized by formal innovation activities—such as higher patents per capita and R&D expenditure—tend to grow faster after controlling for the initial productivity level. Measures of innovation are lower in EMDEs than in advanced economies—new patents per capita were six times larger in advanced economies than EMDEs in 2017. Although the gap between advanced economies and EMDEs has been narrowing since 2000, the convergence in patents per capita and R&D expenditure is largely driven by China.

A. Productivity growth by innovation activity



B. Innovation activities



Source: United Nations Educational, Scientific and Cultural Organization; World Bank.
Note: EMDEs = emerging market and developing economies.
A. Average annualized labor productivity growth grouped by the initial level of each indicator. "Highest" / "Lowest" group contains countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail. "Patents per capita" is the number of new patent applications per capita. The samples includes 32 advanced economies and 74 EMDEs for patents per capita from 1995-2018, and 31 advanced economies and 49 EMDEs for R&D expenditures from 2000-18.
B. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates. The samples include 23 advanced economies and 37 EMDEs for patents per capita, and 26 advanced economies and 40 EMDEs for R&D expenditures.
Click here to download data and charts.

Most private-sector firms rely on services provided by infrastructure. Investment in infrastructure can complement new technologies, and raise productivity and well-being.[4] Infrastructure needs in EMDEs remain high and relate to transport, water and sanitation, power, and telecommunications. Achieving infrastructure-related Sustainable Development Goals (SDGs) in low-income and middle-income countries will require average yearly investment of 2 to 8 percent of GDP during 2015-30 (Rozenberg and Fay 2019; Vorisek and Yu 2020). The contribution of capital accumulation to output growth has been higher for EMDEs than advanced economies (Chapter 1).

The quality of labor. The productivity of an economy depends partly on the quality of its labor force, which can be improved in several ways. Other things equal, a better-educated and healthier labor force will contribute more to economic activity. Education can enhance not only skills, but also the ability to adopt new technologies. In the long term, education may have wider positive effects, on the nature of civil society and the effectiveness of governments.

- *Education.* Workers who are more educated, better trained, and more highly skilled are better placed to contribute to technological advances, and to help absorb new

[4] See, for example, Aschauer (1989); Calderón, Moral-Benito, and Servén (2015); Martins (2019); Melo, Graham, and Brage-Ardao (2013); and Pereira and Andraz (2013).

technologies, including ones from abroad (Benhabib and Spiegel 2003; Im and Rosenblatt 2015; Romer 1990). For EMDEs, investment in education is likely to shift patterns of comparative advantage towards more complex and higher-value products.[5] It should encourage shifts in resources, towards sectors that draw more intensively on education and skills (Chapter 7).

Since the 1960s, there has been a substantial increase in average years of schooling in EMDEs, from 3.5 to 8.6 years.[6] Primary education is now almost universal. Gaps between EMDEs and advanced economies in the provision of secondary education have steadily narrowed, but the overall gap with advanced economies remains at four years, reflecting a divergence in tertiary education (Figure 2.2). Over the last 60 years, tertiary education has expanded faster in advanced economies than in EMDEs.

- *Health.* Better health raises labor productivity. Healthy workers tend to be more efficient, faster learners, and more committed to improving their skills (Benhabib and Spiegel 2003; Knowles and Owen 1995; World Bank 2018b). Good health complements education, reinforcing the supply of high-quality labor (Bloom, Canning, and Sevilla 2004; Knowles and Owen 1995). Evidence is mixed on the size of these effects, however. Acemoglu, Johnson, and Robinson (2003) and Acemoglu and Johnson (2007) find against large effects of health improvements on growth, but this has been contested.[7]

  Over the last 60 years, infant mortality rates in EMDEs have converged on those in advanced economies, while mortality rates for older ages have diverged for some EMDE regions (Figure 2.3). The infant mortality rate in EMDEs in 2018 was one-tenth that of 1960. Across all regions, the infant mortality gap between EMDEs and advanced economies has narrowed. In contrast, life expectancy at age 50 has risen faster in advanced economies. These differences are likely to reflect variation in non-communicable disease rates (UNDP 2019).

Demographic factors. One demographic factor affecting labor productivity is the age composition of the labor force. New technologies may be adopted faster in economies with younger labor forces: compared to more experienced workers, their expertise is less tied to older technologies. Evidence suggests that economies with higher young or working-age population shares adapt more readily to new technologies, skills, and organizational structures (Liu and Westelius 2017; Maestas, Mullen, and Powell 2016).

Working-age population shares in EMDEs increased between 1969 and their peak in 2015 (Figure 2.3). In advanced economies, the share peaked in 1990 and fell by three percentage points between 2008 and 2018. This decline reflects aging workforces, which have been associated with lower productivity growth.[8]

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[5] A measure of product complexity will be discussed in the latter part of this section.

[6] Quality of education also matters. See, for example, World Bank (2018c).

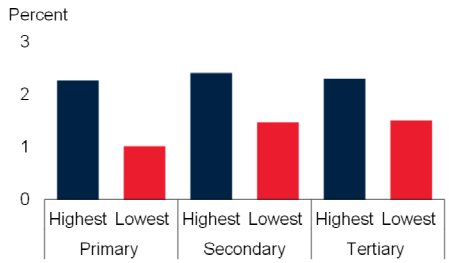
[7] See the discussion of Acemoglu and Johnson (2014) and Bloom, Canning, and Fink (2014).

[8] See Aiyar, Ebeke, and Shao (2016); Aksoy et al. (2019); Feyrer (2008); Jones (2010); Liu and Westelius (2017); and Maestas, Mullen, and Powell (2016).

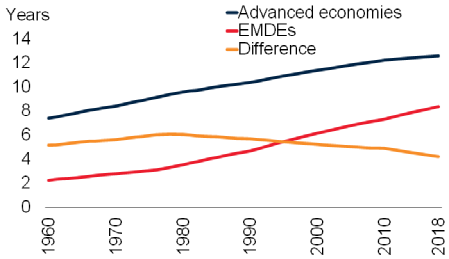
FIGURE 2.2 Education

Productivity in economies with a higher level of education grew about one percentage point faster than economies with lower education levels, after controlling for initial productivity levels. The average years of schooling for EMDEs more than doubled over the last 50 years. Despite catchup in primary and secondary education, the difference in education levels between advanced economies and EMDEs is only slowly narrowing as gaps widen in tertiary education.

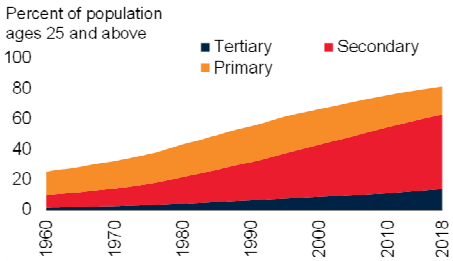
A. Productivity growth by education level, 1960-2018



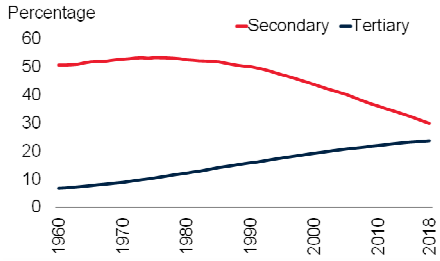
B. Years of schooling



C. Share of education in EMDEs



D. Differences in education shares between advanced economies and EMDEs



Source: Wittgenstein Center for Demography and Global Human Capital; World Bank.
Note: EMDEs = emerging market and developing economies.
A. Average annualized productivity growth from 1960 to 2018, grouped by the level of education as a share of the adult population in 1960. "Highest" / "Lowest" group contain countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail. The samples include 26 advanced economies and 51 EMDEs.
B.-D. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates.
B. Total years of schooling. "Difference" shows the gap in years of schooling between advanced economies and EMDEs. The samples include 26 advanced economies and 75 EMDEs.
C.D. Share of the population age 25 or above with specified education levels. The samples include 26 advanced economies and 82 EMDEs.
Click here to download data and charts.

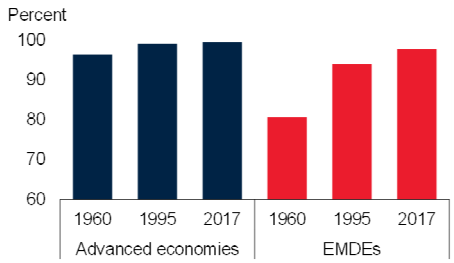
The supporting environment

Institutions. North (1991) defined institutions as "the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights)." Institutions include the rule of law, the legal system, and regulatory barriers to the creation and operation of firms. Political institutions include the system of government. Institutional considerations are often invoked to explain why total factor productivity and labor productivity vary across countries, including differences between EMDEs and advanced economies.

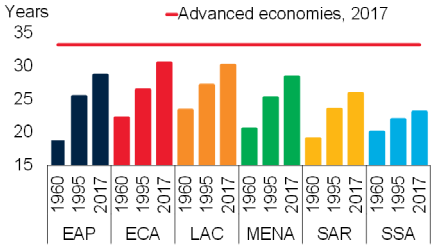
FIGURE 2.3 Health and demography

The survival rate at age five was significantly lower in EMDEs than in advanced economies in 1960, but has been converging to advanced-economy levels since then. For life expectancy at age 50, which is related to the control of non-communicable diseases, advanced economies made more progress than EMDEs, which has widened the gap in 2017 compared to 1960. Furthermore, the improvement is slowest in Sub-Saharan Africa (SSA), whose initial level was low, suggesting divergence within EMDEs. Productivity growth is positively associated with the working-age population share, which has increased over the last 50 years in EMDEs, as fertility rates have declined. However, the working-age population share peaked in 1990 for advanced economies and in 2015 for EMDEs.

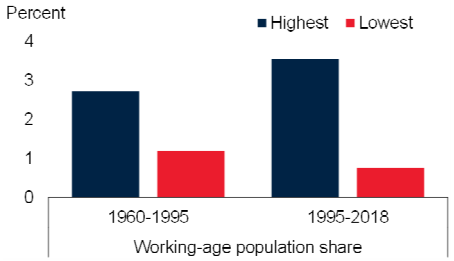
A. Age five survival rate



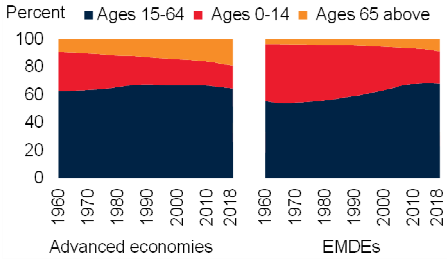
B. Life expectancy at age 50



C. Productivity growth by working-age population share



D. Age structure



Source: United Nations; World Bank.
Note: EMDEs = emerging market and developing economies, EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
A-B. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates. The samples include 26 advanced economies and 85 EMDEs.
C. Average annualized labor productivity growth grouped by the initial level of working-age population share. "Highest" / "Lowest" group contain countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail. The samples include 26 advanced economies and 52 EMDEs from 1960 to 1995 and 32 advanced economies and 127 EMDEs from 1995 to 2018.
D. Share of the population for each age group. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates. The samples include 26 advanced economies and 85 EMDEs.
Click here to download data and charts.

Economists often regard the rule of law as an especially important determinant of productivity (Acemoglu, Johnson, and Robinson 2001; Acemoglu and Johnson 2005; Barro 1996; Bazzi and Clemens 2013). The rule of law can mitigate violence, secure property rights, preserve institutional checks and constraints on government, and limit state capture and corruption. The control of corruption may be one of the most important channels (Haggard and Tiede 2011; Kaufmann, Kraay, and Mastruzzi 2007).

Productivity growth is positively associated with institutional quality, proxied by a rule of law index, after controlling for the initial level of productivity (Figure 2.4). Productivity growth in economies with relatively good institutions also tends to be more stable than where institutions are weaker. In EMDEs, this measure of institutional quality remains significantly lower than in advanced economies, across all regions, with little improvement over the last 20 years.

Transitions to democracy seem to have positive effects on productivity growth in subsequent years, as in the findings of Papaioannou and Siourounis (2008). A more recent study found that democratic transitions could raise productivity by about 20 percent over the subsequent 25 years (Acemoglu et al. 2019). However, some other work finds no effect of democracy on growth (Ruiz Pozuelo, Slipowitz, and Vuletin 2016).

Macroeconomic stability. This chapter uses two proxies for macroeconomic stability: low inflation and a low black-market exchange rate premium. Macroeconomic instability can form a binding constraint, which limits the benefits of other drivers. Uncertainty in the macroeconomic environment can deter investment and cause capital outflows (Gramacy, Malone, and Ter Horst 2014). There is also evidence that, in stable macroeconomic environments, the effect of investment on output is stronger, conditional convergence is faster, and measures of institutional quality have more explanatory power as determinants of productivity growth (Sirimaneetham and Temple 2009).

The aftermath of the COVID-19 pandemic is likely to place government finances under new pressure, risking instability for many EMDEs. Even for countries with ample buffers, financial instability can be contagious. Monetary and fiscal policy frameworks still lag behind best practices in many EMDEs (Kose and Ohnsorge 2019). Nevertheless, trends in inflation have been favorable in recent decades. In advanced economies, inflation rates have trended downwards since the early 1980s. For some EMDEs, inflation spiked in the 1990s, when financial and currency crises were relatively common. Inflation in the Europe and Central Asia region was especially high in the mid-1990s, as transition economies adjusted. But inflation in EMDEs has moderated since then. The median annual inflation rate in EMDEs has recently been about 3 percent, down from 12 percent in the 1990s (Figure 2.4).

Income inequality. Most empirical studies that link growth to income inequality find that inequality has an adverse effect.[9] The literature has considered several mechanisms: higher fertility, lower provision of schooling, and greater political and social instability, including pressures for redistribution (Perotti 1996).

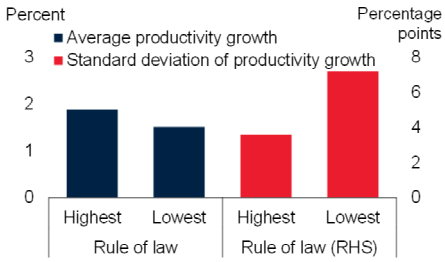
Some work has questioned the relative importance of these mechanisms and the overall effect of inequality (Alvaredo et al. 2018; Herzer and Vollmer 2012). A few studies report no relationship (Panizza 2002) or even a positive relationship (Forbes 2000; Frank 2009). The effect may vary with the level of development (Barro 2000) and

[9] A non-exhaustive list includes Alesina and Rodrik (1994), Berg et al. (2018), Clarke (1995), Deininger and Squire (1998), Herzer and Vollmer (2012), Perotti (1996), and Persson and Tabellini (1994).

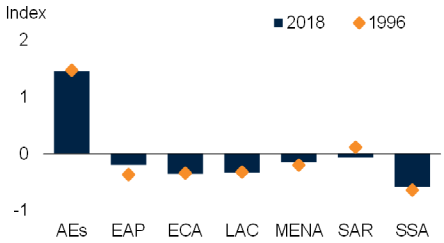
FIGURE 2.4 Institutional quality and price stability

Productivity growth is positively related to institutional quality, proxied by the rule of law index, after controlling for the initial level of productivity. Productivity growth in economies with good institutions tend to be more stable than economies with low institutional quality. In EMDEs, however, this measure of institutional quality remains significantly lower than in advanced economies across all regions, with little improvement over the last 20 years. Inflation rates have been trending down in advanced economies, and have moderated in EMDEs following a spike in the 1990s. The number of financial crisis episodes rose during the commodity price collapse in 2011-16.

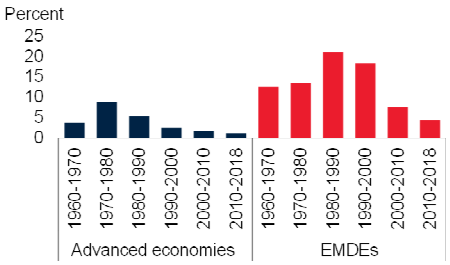
A. Productivity growth and rule of law, 1996-2018



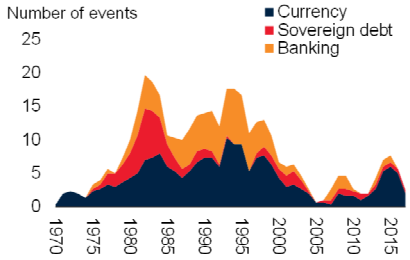
B. Rule of law



C. Inflation



D. Financial crisis



Source: International Monetary Fund, International Financial Statistics; Laeven and Valencia (2018); World Bank, World Governance Indicators.

Note: AEs = advanced economies, EMDEs = emerging market and developing economies, EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.

A. Average productivity growth from 1996-2018. Countries are grouped by average values during the period. "Highest" shows the average productivity growth of countries in the fourth quartile, while "Lowest" shows the average productivity growth of countries in the first quartile. The effect of initial productivity has been partialled out. Standard deviations are calculated across time for each country. Calculated standard deviations are aggregated using simple averages.

B. Aggregates of index are calculated using GDP weights at 2010 prices and market exchange rates.

C. Average annual CPI inflation rate during each period. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates.

D. The number of financial crises defined in Chapter 3 for EMDEs by type. Three-year moving averages.

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depend on precisely where inequality arises within the income distribution (Voitchovsky 2005). It has also been argued that changes in inequality, rather than its level, could affect growth (Banerjee and Duflo 2003). A more recent study finds that lower inequality (after taxes and transfers) is associated with faster and more durable growth, while redistribution does not have an adverse effect on growth unless it is extreme (Berg et al. 2018).

Recent trends in inequality have varied across EMDE regions. Between 1995 and 2015, the income share of the poorest 10 percent of the population declined in EAP and ECA, remained virtually unchanged in MENA, SSA, and SAR, and increased in LAC (Figure 2.5).

Gender equality. Disparities between women and men—in access to education, health care, and earning opportunities—can lower overall productivity and national income. Improved earning opportunities for women can increase human capital and physical capital investment, through higher income and higher returns to the human capital of women (Galor and Weil 1996; Klasen and Santos Silva 2018). Improved female access to education and earning opportunities will also tend to lower fertility, and fewer children per family can mean that each child receives better education and health care. Improved female education can contribute to the health of civil society and social participation. It can also broaden perspectives in decision-making, contributing to better outcomes (Gallen 2018; Loko and Diouf 2014; Schober and Winter-Ebmer 2011). In Italy, teams with a higher proportion of women have been found to be more innovative (Díaz-García, González-Moreno, and Sáez-Martínez 2013).

The productivity of women in farming can be constrained by unequal access to finance and weaker property rights protection. Female farmers have been found to be less productive than men in several countries, including Burkina Faso, Ghana, Ethiopia, Paraguay, and Zimbabwe (Croppenstedt, Goldstein, and Rosas 2013). The gender difference disappears after controlling for access to farmer education and factor inputs, such as fertilizer usage. This suggests routes through which female farmers could become more productive.

The average gender gap in tertiary schooling remains larger in EMDEs than in advanced economies, but narrowed significantly between 1960 and 2020 (Figure 2.5). The range of gender gaps also narrowed significantly in this period across advanced economies, which have achieved near-universal gender equality in tertiary education. However, gender gaps in some EMDEs remain substantial. There are 20 EMDEs where average years of tertiary education are more than 50 percent higher for men than women, while the gap is less than 10 percent in all advanced economies.

Trade. Most of the evidence on trade indicates that relatively open economies are more productive (Alcala and Ciccone 2004; De Loecker 2013; Frankel and Romer 1999; Hall and Jones 1999).[10] Trade liberalizations in the 1980s and 1990s were often followed by significant productivity gains (Irwin 2019). In addition to gains through exploiting comparative advantage, participation in global markets can enable knowledge diffusion and technology transfer. Imports of sophisticated machinery can directly improve labor productivity at the firm, sector, and country level.[11]

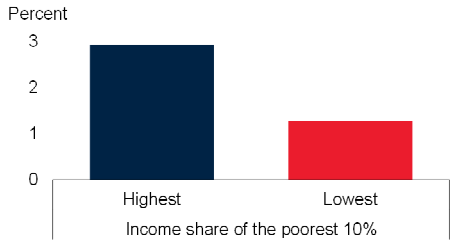
[10] A few studies find only a weak relationship between trade and productivity, or trade and growth (Bosworth and Collins 2003; Rodríguez and Rodrik 2000; Rodrik, Subramanian, and Trebbi 2004).

[11] See Casacuberta, Fachola, and Gandelman (2004); Fernandes (2007); Mayer (2001); and Xu and Wang (1999).

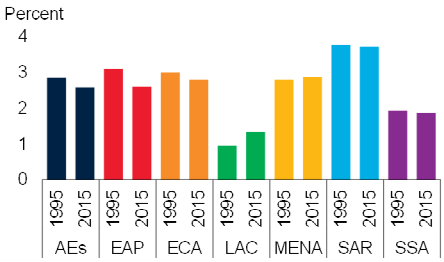
FIGURE 2.5 Income and gender equality

Productivity growth is positively associated with income equality, after controlling for initial productivity levels. The evolution of income equality varies across EMDE regions, with notable declines in East Asia and Pacific and Europe and Central Asia, but almost unchanged for Middle East and North Africa, Sub-Saharan Africa, and South Asia, and has increased in Latin America and the Caribbean. Productivity growth is correlated with gender equality in education in the 1995-2018 period. The gender gap in schooling is larger in EMDEs than in advanced economies but has narrowed significantly on average, albeit with wide variation for EMDEs.

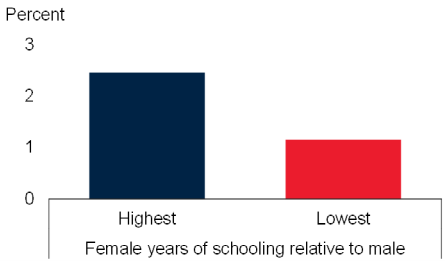
A. Productivity growth by income equality, 1995-2018



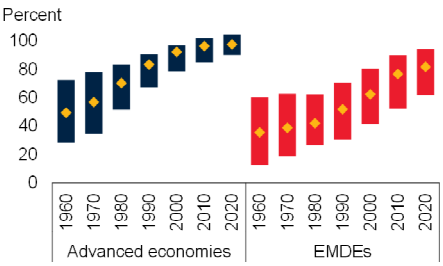
B. Poorest 10 percent income share



C. Productivity growth by gender equality, 1995-2018



D. Interquartile range for female ratio for tertiary education



Source: United Nations; Wittgenstein Center for Demography and Global Human Capital; World Bank.

Note: AEs = advanced economies, EMDEs = emerging market and developing economies, EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.

A.C "Highest" / "Lowest" group contain countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail.

A. Average annualized labor productivity growth grouped by the share of the bottom 10 percent in income distribution. The samples include 30 advanced economies and 109 EMDEs from 1995 to 2018.

B. Data are the median income share of the poorest 10 percent for each country group. Data are inter/extrapolated as necessary when data are unavailable. The samples include 10 advanced economies and 64 EMDEs.

C. Average annualized labor productivity growth grouped by the initial level of the ratio of the female years of schooling to male years of schooling. The samples include 32 advanced economies and 123 EMDEs from 1995-2018.

D. Ratio of female share of population with tertiary education to male share of population with tertiary education, as a percentage. 100 indicates perfect equality and less than 100 indicates gender bias towards men. Bars show the interquartile range. Diamonds show the median. The samples include 26 advanced economies and 77 EMDEs.

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Exporting firms are often relatively productive, but evidence on the role of exports is complicated by self-selection: other things equal, productive firms are more likely to be competitive and choose to export (Clerides, Lach, and Tybout 1998; Dercon et al. 2004; Graner and Isaksson 2009). Some evidence from Kenya and Korea accounts for self-selection, and finds that exporting does increase productivity (Aw, Chung, and Roberts 2000; Graner and Isaksson 2009). "Learning-by-exporting" effects may depend on the development levels of importers or exporters, with learning gains that are larger when the exporter and importer are at similar development levels, or when the importer has high human capital (Aw, Chung, and Roberts 2000; Blalock and Gertler 2004; Graner and Isaksson 2009; Keller 2004).

EMDE participation in global value chains declined after the global financial crisis, partly reflecting the shift to domestic production within China (Figure 2.6). This may reduce cross-border transfers of technology. In the longer term, supply chains could be restructured in ways that increase their diversity and improve resilience (World Bank 2020b).

Economic complexity. Complexity reflects diversification and production capabilities, and may be linked with higher productivity or greater scope for future growth (Diao, McMillan, and Rodrik 2019; Jarreau and Poncet 2012). Producing more complex goods may also promote technological diffusion and convergence (Goodfriend and McDermott 1998).

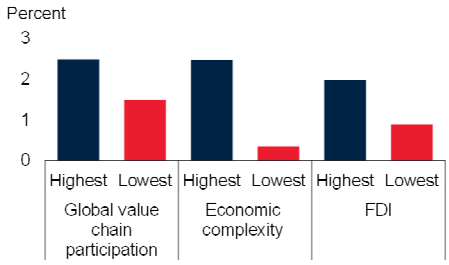
Hidalgo and Hausmann (2009) introduced an economic complexity index as a holistic measure of the productive capabilities of a country. The index reflects the diversity, sophistication, and relative knowledge manifested in a country's exports; it is constructed by comparing a country's sectoral export shares with the respective shares of the corresponding sectors in world trade. Measured complexity will be higher when a country exports more complex goods, such as ceramic-metal composites and compound semiconductors, produced by relatively few economies (Hausmann et al. 2014). EMDEs generally remain behind advanced economies in the complexity of their exports, but with significant regional variation. Complexity in the EAP region is now close to advanced-economy levels, but other regions remain significantly behind. Complexity in the SSA region fell further behind advanced economies between 1970 and 2017 (Figure 2.6).

Foreign direct investment. Inflows of foreign direct investment (FDI) can promote convergence in productivity, through improved organizational structures and management practices, as well as advanced technology (Griffith, Redding, and Simpson 2004; Keller and Yeaple 2009). As a source of capital, FDI should raise labor productivity and wages, especially for host countries with a high development level and high-quality institutions (Isaksson 2007; Kose, Prasad, and Terrones 2009). The positive relationship between FDI and labor productivity may, however, be weaker for EMDEs (Keller and Yeaple 2009). In some countries, the cost of subsidies used to attract FDI may exceed the productivity benefits (Görg and Greenaway 2004; Haskel, Pereira, and Slaughter 2007). Inward FDI to EMDEs stalled after the global financial crisis (Figure 2.6) and is likely to be under new pressure after the COVID-19 pandemic.

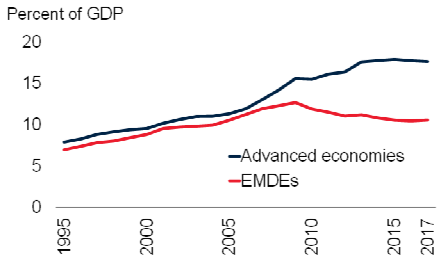
FIGURE 2.6 Trade and FDI

Productivity growth is positively correlated with measures related to external openness, such as global value chain participation, complexity of export goods, and share of FDI as percentage of GDP, after controlling for the initial productivity level. Global value chain participation declined in EMDEs after the global financial crisis, partly reflecting the shift to domestic production in China. Economic complexity, which measures the relative sophistication of the domestic manufacturing sector, reached the advanced-economy level in East Asia and Pacific, while other regions remained significantly below the advanced-economy level. In particular, relative economic complexity declined in Sub-Saharan Africa from 1970 to 2017. Inward FDI to EMDEs stalled after the financial crisis.

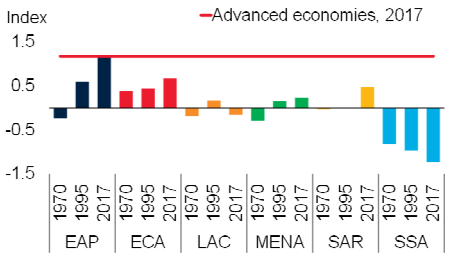
A. Productivity growth by trade-related measures



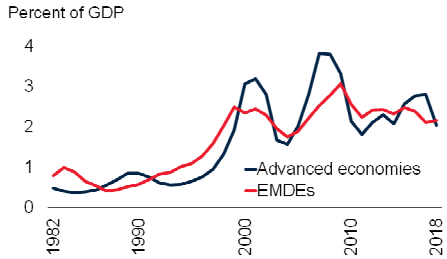
B. Global value chain participation



C. Economic complexity



D. Inward FDI share of GDP



Source: United Nations Conference on Trade and Development; World Bank, World Development Indicators; World Trade Organization.

Note: EMDEs = emerging market and developing economies, EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.

A. Average annualized labor productivity growth grouped by the initial level of drivers. "Highest" / "Lowest" group contain countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail. The samples include 32 advanced economies and 113 EMDEs from 1995 to 2018 for global value chain participation as a share of GDP, 23 advanced economies and 59 EMDEs from 1970 to 2018 for economic complexity, and 25 advanced economies and 101 EMDEs from 1995 to 2018 for FDI.

B. The total amount of intermediate goods in imports and exports, as a percentage of GDP. Three-year moving averages. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates.

C. The economic complexity index (ECI+) of Albeaik et al. (2017) , extended with an economic complexity index using the methodology of Hidalgo and Hausmann (2009). Aggregates are calculated using GDP weights at 2010 prices and market exchange rates. The samples include 23 advanced economies and 68 EMDEs.

D. Three-year moving averages of total inward FDI flow as a share of nominal GDP.

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Urbanization. Agglomeration, through urbanization and higher population density, tends to raise productivity (Combes and Gobillon 2015; Duranton and Puga 2004). Agglomeration benefits include knowledge spillovers, deeper markets for workers and local services, and better matching between the skills of workers and the needs of firms. 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 partnerships, and start new businesses (Abel, Dey, and Gabe 2014). Urban populations are steadily increasing in EMDEs, and in aggregate, first exceeded the rural population in 2017 (Figure 2.7). Nevertheless, the difference between the shares of urban populations in advanced economies and EMDEs has remained almost unchanged over the last 60 years.

Finance. Financial depth is often linked with higher labor productivity (Buera, Kaboski, and Shin 2011) and faster productivity growth.[12] For countries with a given level of initial productivity, greater financial depth is associated with faster subsequent productivity growth (Figure 2.7). Well-developed financial markets can improve the efficiency of capital allocation and enable firms to make productivity-enhancing investments (Fisman and Love 2003; Levine 1997). They may also allow firms to diversify investment risk and increase liquidity, and stimulate entrepreneurship (Beck, Levine, and Loayza 2000a, 2000b; Demirgüç-Kunt and Levine 1996).

There is generally a wide gap between EMDEs and advanced economies in financial development, reflecting the fact that many EMDEs lack developed capital markets, and financial products are not easy to access for much of their populations (Sahay et al. 2015). This can be seen in an index based on financial depth and the quality of institutions related to financial markets. Measured by the index, progress from 1995 to 2017 was slower in LAC, MENA, and SSA than in advanced economies, but faster in EAP, ECA, and SAR. SSA remains behind in financial depth and had the slowest rate of improvement between 1995 and 2017. But financial sector reform is not without risks, since mismanaged deregulation can lead to unsustainable lending booms and banking crises. For this reason, poorer countries may benefit less from financial sector reforms (Prati, Onorato, and Papageorgiou 2013).

Firm productivity

In most markets, highly productive firms are likely to have an edge. They will tend to innovate more and grow faster, and are more likely to survive than less productive competitors (Goñi and Maloney 2017). There are both internal and external factors that help to shape firm productivity:

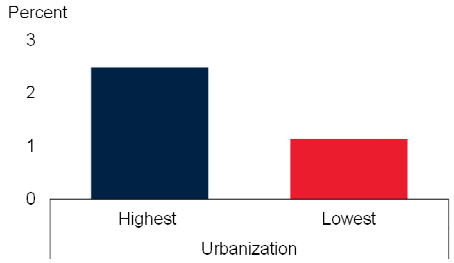
Internal drivers. The internal drivers include productivity-enhancing organizational features and practices that shape firms' capabilities.

[12] See, for example, Aghion, Howitt, and Mayer-Foulkes (2005) and King and Levine (1993).

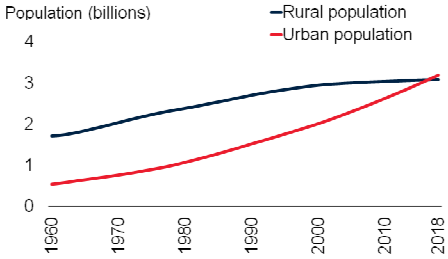
FIGURE 2.7 Urbanization and financial development

The urban population is steadily increasing in EMDEs, exceeding the rural population by 2017. Higher productivity growth is associated with a large urban population share. Financial development varied across EMDE regions, and progress has been slowest in Sub-Saharan Africa. Long-term productivity growth is correlated with financial development, after controlling for initial productivity levels.

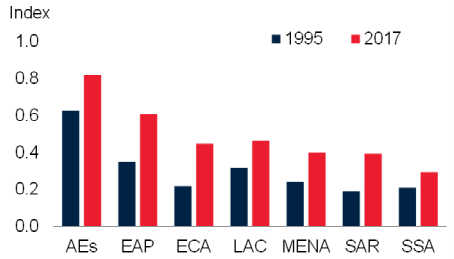
A. Productivity growth by urban population share, 1960-2018



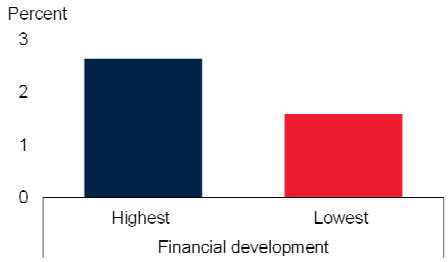
B. Rural and urban population



C. Financial development, by region



D. Productivity growth and financial development, 1995-2018



Source: International Monetary Fund; World Bank, World Development Indicators.
Note: AEs = advanced economies, EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
A. Average annualized productivity growth from 1960 to 2018, grouped by the level of urban population share in 1960. "Highest"/"Lowest" group contain countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail. The samples include 26 advanced economies and 52 EMDEs.
B. Total rural and urban population in EMDEs from 1960-2018. The sample includes 159 EMDEs.
C. Aggregates are calculated using GDP weights at 2010 prices and market exchange rates. The financial development index is a relative ranking of countries on the depth, access, and efficiency of their financial markets from the International Monetary Fund. The samples include 32 advanced economies and 124 EMDEs.
D. Average annualized productivity growth from 1995 to 2018, grouped by the level of financial development in 1995. "Highest"/"Lowest" group contain countries whose indicator is in top/bottom 25 percent. The effect of initial productivity has been partialled out. See Annex 2.1 for detail. The samples include 32 advanced economies and 124 EMDEs.
Click here to download data and charts.

- *Technological progress.* A firm's total factor productivity hinges on its ability to create, acquire and use advanced technology. Technological innovation, driven partly by R&D and complemented by physical capital and workers' skills, will boost labor productivity and output (Cohen and Levinthal 1990). New production techniques allow firms to improve product quality and expand the range of marketed products (Bernard, Redding, and Schott 2010). An increase in patenting and the variety of products can also strengthen firm productivity (Balasubramanian and Sivadasan 2011).

- *Input quality.* Higher-quality labor and capital can raise a firm's labor productivity measured as output per worker or per worker hour. Better educated, well-trained, and experienced workers tend to be more productive (Fox and Smeets 2011). New capital goods enable faster productivity growth, through embodied technical progress (Sakellaris and Wilson 2004).

- *Management.* Good management can improve the efficiency of production. The best managerial practices include setting clear targets, monitoring progress, and rewarding performance (Bloom and Van Reenen 2010; Lazear 2000). Incentives for team production, cross-training, work experience, and frequent employee-manager communication can also raise firm productivity (Bandiera, Barankay, and Rasul 2011).

External drivers. Outside forces influence productivity within and between firms. These external factors can allow each firm to improve its efficiency (the "within" effect) and stimulate more efficient firms to grow faster than others (the "between" effect).

- *Regulatory and operating environments.* Institutions and regulations influence firm productivity partly through incentives to invest in human and physical capital, and to acquire technology (Bartelsman and Doms 2000; Kouamé and Tapsoba 2018). Firm productivity tends to be lower in poorly-regulated markets: weaker enforcement of competition laws can allow a large inefficient firm to drive productive competitors out of the market by abusing its market power; higher barriers of entry can prevent creative destruction (Goldberg et al. 2010). Private firms may be reluctant to undertake costly R&D when competitors, especially those in the informal sector, can infringe intellectual property rights (Amin and Islam 2015; Amin, Ohnsorge, and Okou 2019). The enforcement of property rights, and public-private partnerships to create technology extension centers in sectoral clusters, can increase firm participation in global value chains and raise productivity (Cirera and Maloney 2017). Improvements in the business environment and conducive regulatory practices—fair competition, increased business freedom—support growth of TFP and labor productivity.

- *Spillovers and input markets.* The presence of highly productive firms can have spillover effects and raise the productivity of other firms. These spillovers occur as knowledge and innovation are transferred through trade, FDI and agglomeration channels (Aitken and Harrison 1999; Combes and Gobillon 2015). Flexible and integrated capital and labor markets can promote the reallocation of inputs toward the most productive firms (Bartelsman, Haltiwanger, and Scarpetta 2013).

Box 2.1 reviews the literature on firm-level TFP in more detail.

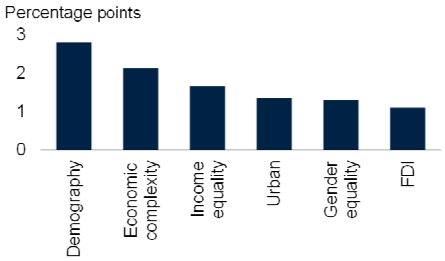
Summary of stylized facts

In summary, there are positive associations between several drivers and labor productivity growth, after controlling for the initial productivity level (Figure 2.8). Growth of labor productivity has been faster in countries that began with a larger

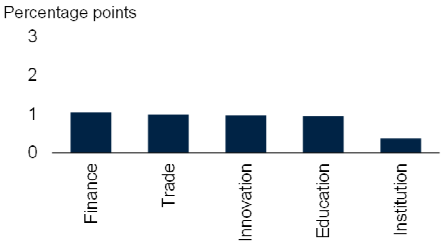
FIGURE 2.8 Productivity growth performance and key initial conditions

Growth was faster for countries that began with a higher working-age population share, higher economic complexity, lower income inequality, higher patents per capita, deeper financial markets, higher education, larger FDI per GDP, greater gender equality in education, higher global value chain participation, larger share of urban population, and better institutions. Gaps in average levels of drivers between advanced economies and EMDEs are widening in tertiary education, life expectancy at age 50, financial development index, and GVC participation. Gaps remain almost constant for economic complexity, urban population share, patents per capita, and rule of law.

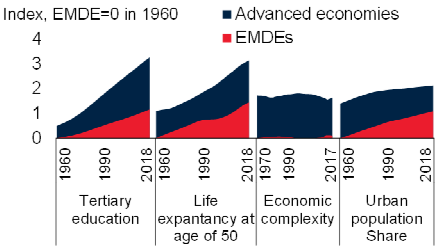
A. Improvement in productivity growth with favorable initial conditions



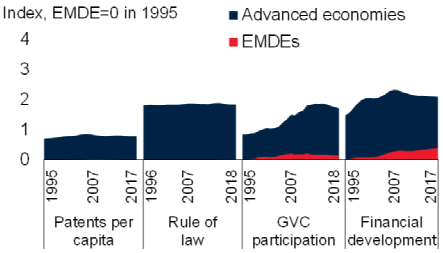
B. Improvement in productivity growth with favorable initial conditions (cont.)



C. Average level of drivers over time



D. Average level of drivers over time (cont.)



Source: World Bank.

A.B. The difference in productivity growth between the highest 25 percent and lowest 25 percent of the distribution of initial levels of key correlates of productivity growth. Variables corresponding to each concept and sample years are: Demography = working-age population share (1995-2018); Economic complexity = Economic Complexity Index of Hidalgo and Hausmann (2009) and Albeaik et al. (2017) (1970-2018); Income equality = income share of poorest 10% (1995-2018); Innovation = patents per capita (1995-2018); Finance = financial development index (1995-2018); Education = share of population with secondary education and above (1960-2018); FDI = inward FDI as a percent of GDP (1995-2018); Gender equality = the ratio of the female years of schooling to male (1995-2018); Trade = global value chain participation (total amount of intermediate goods in imports and exports, as a percentage of GDP) (1995-2018); Urban = urban population share (1960-2018); Institution = rule of law index (1996-2018). See Figures 2.1-2.7 for detail.

C.D. Simple average of drivers over time, by income level. Variables are normalized so that average value for the EMDEs in the starting year is zero and standard deviation in the starting year is one. Economic complexity is a five-year moving average, and patents per capita, rule of law, GVC participation, and financial development are three-year moving averages.

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working-age population share, greater economic complexity, lower income inequality, higher patents per capita, deeper financial markets, higher educational attainment, higher FDI relative to GDP, lower gender inequality, greater global value chain participation, a higher urban population share, and better institutions. These associations are only indicative, and should not be seen as causal effects.

TABLE 2.1 Recent developments in productivity drivers

	Driver	Are EMDEs approaching advanced economies?
Proximate sources	Innovation	Partially. Divergence in innovation measures excluding China.
	Capital	Partially. Higher investment ratio in EMDEs; divergence in financial development indicators.
	Education	Partially. Convergence in secondary education and divergence in tertiary education.
	Health	Partially. Convergence in infant mortality and divergence in old age life expectancy.
	Demography*	No. Working-age population share in EMDEs has started to decline.
Supporting environment	Institutions	Partially. Significant improvements in rule-based fiscal and monetary policy, but limited improvement in institutional measures.
	Macroeconomic stability	Yes. Milder inflation and fewer financial crises compared to 1980-90s.
	Gender inequality	Partially. Gender gaps are narrowing except in some regions.
	Income inequality*	No clear uniform trend in the last 25 years.
Market development	Trade/Complexity	Stalled. Divergence of GVC participation. No convergence in economic complexity, with a few exceptions.
	FDI*	Stalled. No increase in FDI.
	Urban	No. Continued large gap in urbanization rate.
Sample period is the longest available: typically, 1960-2018, but significantly shorter for some drivers.		

* These drivers are not necessarily lower in EMDEs than in advanced economies. The answers in the row are about absolute improvements, rather than improvements relative to advanced economies.

Between 1960 and 2018, most drivers in EMDEs improved. However, the gaps between EMDEs and advanced economies have widened for some drivers, including ones that are essential to innovative economies—tertiary education, financial development, patents per capita—and in EMDEs improvements in others, such as institutions and economic complexity, have stalled (Table 2.1).

Analyzing the effects of drivers

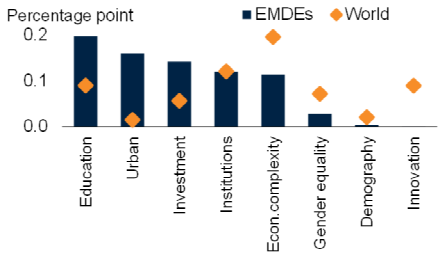
Thus far, the analysis has considered individual drivers in isolation. This section considers them together: it examines the partial correlations between productivity growth and various drivers, and how they have changed over time.

Methods. To study the role of drivers in productivity growth, cross-country regressions are used. These regressions are useful for uncovering associations between initial conditions and later growth. The sample comprises 60 countries, including 38 EMDEs, observed from 1960 to 2018. The time span is longer than in many previous studies, and should ensure that the results are not confounded by short-run or cyclical effects. The use of initial values of the drivers, rather than averages or changes during the sample period, helps to address potential concerns over reverse causality. Nevertheless,

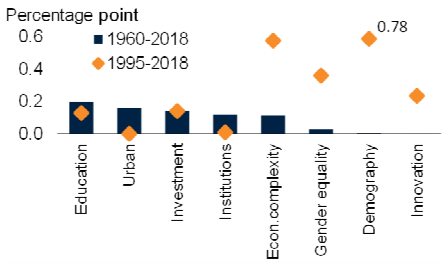
FIGURE 2.9 Impact of drivers on productivity growth

Productivity in economies with favorable initial conditions grew faster than other economies, after controlling for interactions among drivers. The scale of these effects varies over time. 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. Productivity growth is 0.78 percentage points higher for an economy with 7.1 percentage points higher working age population share.

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



B. Effects of drivers on EMDE productivity growth, 1960-2018 vs. 1995-2018



Source: World Bank.
A.B. Estimated marginal contribution to annual long-term productivity growth if a driver improves from the 25 percentile to the 75 percentile. The samples include 59 economies, 38 of which are EMDEs. Groups that 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 = ratio of years of schooling of female to male. See Annex 2.2 for details.
B. Marginal contribution of demography for 1995-2018 is 0.78 percentage points.
Click here to download data and charts.

significant pitfalls remain, and it should be remembered that causality is hard to establish.[13]

In early growth studies, researchers often carried out inference as if the identity of the true model was known with certainty. This approach was heavily criticized, since many findings were sensitive to changes in model specification (Levine and Renelt 1992). Following the more recent literature, this chapter uses a Bayesian approach which combines information from a wide range of models, while favoring simple models with high explanatory power. This approach is used to identify key correlates of productivity growth from a pool of 29 candidate variables. It recognizes that some variables overlap and may reflect the same underlying driver, with implications for the appropriate structure of the priors. The details of the approach are discussed in Annex 2.2.

Key initial conditions. The results indicate that, other things equal, countries with favorable initial conditions subsequently experienced faster productivity growth (Figure 2.9). More specifically, higher productivity growth rates between 1960 and 2018 were

[13] A discussion of causality and other qualifications to the results is included in Annex 2.2.

BOX 2.1 Review of recent firm-level TFP literature

A large literature identifies various sources of firm TFP growth, which has slowed over the last decade. Enhancing firm capabilities, easing the efficient reallocation of input factors, and fostering the net entry of high-productivity firms are key to raising TFP growth.

Introduction

The literature on firm productivity is extensive (Bloom et al. 2010). This box reviews the literature on total factor productivity or TFP, a measure of efficiency in translating a combination of inputs into value added (Cusolito et al. 2018). It addresses the following questions:

- How has firm-level TFP varied over time and across countries?
- What factors drive firm TFP growth?

Firm TFP patterns

Research provides a range of empirical findings on firm TFP growth patterns (Dall'Olio et al. 2014; di Mauro et al. 2018).

Longitudinal evidence. The post-GFC slowdown in productivity reignited the debate on firm-level drivers of TFP growth. In the United States, TFP growth has slowed since the 2000s, reflecting a loss of momentum in job reallocation and entrepreneurship, exacerbated by adverse shocks from the crisis (Cardarelli and Lusinyan 2015; Decker et al. 2016). Japan has experienced a longer-term decline in TFP growth since the early 1990s, with headwinds from an aging population and a gradual reduction in the statutory work-week (Hayashi and Prescott 2002). In EMDEs, TFP growth has also slowed down, though by less than in the advanced economies (Cusolito and Maloney 2018; Papa, Rehill, and O'Connor 2018).

Cross-sectional evidence. Variation in aggregate TFP is often found to account for nearly half the variation in output per capita across economies (Bartelsman, Haltiwanger, and Scarpetta 2013). Studies of firm-level TFP in OECD member countries reveal dispersion between the frontier and lagging firms.[1] This is true as well within particular sectors and across firms in advanced economies and EMDEs (Bartelsman and Doms 2000). The typical "frontier firm" is more productive, more innovative, more capital intensive, with larger sales revenue,

Note: This box was prepared by Cedric Okou.

[1] At the firm level, revenue-based productivity measures use total sales as a proxy for output.

BOX 2.1 Review of recent firm-level TFP literature *(continued)*

and more likely to benefit from cross-border technology transfers via multinational networks (Andrews, Criscuolo, and Gal 2016).

In the U.S. manufacturing sector, the top 10 percent of firms ranked by TFP levels are twice as productive as the bottom 10 percent of firms, for given inputs (Syverson 2004, 2011). The TFP gap between the top 10 percent and the bottom 10 percent of firms is even more pronounced in emerging economies, with a ratio of more than 5 to 1 in China and India (Hsieh and Klenow 2009). The dispersion of firm-level TFP is typically skewed, with more firms below the average than above (Bernard, Redding, and Schott 2011). The dispersion can matter for policy, because interventions may affect firms differently, depending on where they are within the productivity distribution (Giovanni, Levchenko, and Mejean 2018).

Regional evidence. Market frictions, stringent regulations, and weak institutions lower productivity. This has been especially apparent in SSA (World Bank 2017). Harmonized and simplified regulation through integrated regional markets can remedy these challenges and help diffuse knowledge and accelerate technology adoption (Acemoglu and Autor 2011; Autor and Dorn 2013; Dutz, Almeida, and Packard 2018). Connectivity-led productivity improvements have been documented in ECA, EAP, and SAR through global value chains, foreign direct investment, communication, transport, and migration (Gould 2018; Lopez-Acevedo, Medvedev, and Palmade 2017; World Bank 2019c).

Bottlenecks. Unfair privileges insulate certain firms with deep political connections from competition and discourage other firms from innovating (Schiffbauer et al. 2015). Reforms that remove benefits for vested interest groups and promote fairer competition can raise TFP and labor productivity (Araujo, Vostroknutova, and Wacker 2017; EBRD et al. 2016). Informality is pervasive in many economies, especially in LAC and SSA, and is associated with low productivity (Amin, Ohnsorge, and Okou 2019). Addressing informality may lead to improvements in productivity. Moreover, technology adoption can be slower in economies with high agricultural employment and low levels of numeracy and literacy. Low-skill-biased technologies can be leveraged to upgrade skills and boost firm productivity (Dutz, Almeida, and Packard 2018; Fuglie et al. 2020; Nguimkeu and Okou 2019).

Measurement challenges. Conceptual and measurement issues complicate the analysis of firm-level TFP (Cusolito and Maloney 2018; Goldberg et al. 2010). Data limitations mean that standard microeconomic measures of productivity and distortions can be misleading. Good measures should account for the effects of markups, market power, adjustment costs, quality differences, and investment

BOX 2.1 Review of recent firm-level TFP literature *(continued)*

risk (Cusolito et al. 2018; Foster et al. 2008, 2017; Hsieh and Klenow 2009; Restuccia and Rogerson 2013; Syverson 2011).

Drivers of firm TFP growth

Rules and regulations shape the business environment and TFP dynamics within and between firms (Goldberg et al. 2010).

Within-firm TFP growth and internal capabilities. Firms can achieve "more from less" (McAfee 2019) by strengthening their internal capabilities. These include innovation and absorption capacities, workforce quality and managerial skills (Cusolito and Maloney 2018). The accumulation of knowledge, experience, and R&D can support innovation, upgrade product quality, improve production methods, and raise TFP.[2] Firm size plays a role: larger firms can benefit from a richer set of new ideas and expertise, and invest more in R&D (Isaksson 2007; World Bank 2019a). Skilled workers are better placed to create and adopt new technologies. Targeted educational programs can be used to develop cognitive skills through on-the-job training and tertiary education (Danquah, Moral-Benito, and Ouattara 2014; World Bank 2018c). Managers matter, because they coordinate the production process and influence its efficiency. Managerial and organizational styles vary across firms due to competition, location, ownership, and trade ties (Collard-Wexler and De Loecker 2015; Del Carpio and Taskin 2019). Interventions to improve management practices can raise productivity by more than 10 percent (Bloom and Van Reenen 2010; Van Reenen 2011).

Between-firm TFP growth, efficient allocation, and input quality. Economy-wide productivity depends partly on the market shares of productive firms compared to less productive firms, and their respective factor usage (Autor et al. 2020). Poor rules and regulations—weak legal systems, corruption, unfair competition—sometimes obstruct the reallocation of factors to more productive firms (Cirera, Fattal Jaef, and Gonne 2017; Dias, Marques, and Richmond 2020). Addressing market distortions, through fairer competition, greater product and labor market flexibility, and trade liberalization, can aid reallocation and raise aggregate TFP (Goñi and Maloney 2017; Maloney and Nayyar 2018).

TFP dispersion across firms can arise from differences in the quality of labor and capital (Isaksson 2007; Syverson 2011). Labor force quality, or human capital, may vary due to health, education, training, and experience (Acemoglu 1996;

[2] See Atkin, Khandelwal, and Osman (2017); Yahmed and Dougherty (2012); Brynjolfsson and Hitt (1995); Goldberg et al. (2010); Nelson (1981); Romer (1990); Syverson (2004); and Wolitzky (2018).

BOX 2.1 Review of recent firm-level TFP literature *(continued)*

Acemoglu and Dell 2010; Gamberoni, Giordano, and Lopez-Garcia 2016). Variation across firms in the distribution of capital vintages can help to explain disparities in capital-embodied technical progress (Nguyen, Taskin, and Yilmaz 2016; Restuccia and Rogerson 2013).

Net entry of high-productivity firms. Entry of high-productivity firms and exit of low-productivity ones should lead to aggregate TFP gains (Decker et al. 2016). In some developing countries, High-growth firms (HGFs) make up less than 20 percent of firms in manufacturing and services, yet account for 80 percent of output and job creation.[3] They generate spillovers for other businesses through gains in agglomeration, innovation, value chains, skill upgrading, and managerial experience.

In practice, it may be difficult to identify HGFs in their early stages, and predicting firm success has proved challenging (Grover Goswami, Medvedev, and Olafsen 2019). Rather than relying on guesswork to identify HGFs, policies should aim at removing entry and exit barriers (Cirera, Fattal Jaef, and Gonne 2017; Decker et al. 2016).

Conclusion

For individual firms, TFP can benefit from enhanced firm capabilities. Workforce quality and managerial skills complement technological innovations and absorption capacity. Across firms, aggregate TFP growth can benefit from flexible labor and product markets that enable the reallocation of inputs. When highly productive firms enter, they can increase their market share relative to less productive incumbents, thereby raising overall productivity.

[3] High-growth firms (HGFs) can be defined either in absolute terms, based on average annualized employment or revenue growth of more than, say, 20 percent over a three-year period, or in relative terms, as firms above, say, the 90th percentile in employment and sales growth.

associated with the following conditions in 1960: higher investment as a share of GDP, a better-educated workforce (proxied by average years of schooling), stronger institutions (proxied by the rule of law), greater innovation (proxied by a higher number of patents per capita), higher urbanization, and lower inflation. A positive association was also found between productivity growth and the initial value of the economic complexity index of Hidalgo and Hausmann (2009).

The effects of key initial conditions: differences between EMDEs and advanced economies. The estimated effects of the productivity drivers differ between EMDEs and

advanced economies. The effects of average years of schooling and the investment rate are higher for EMDEs than for advanced economies, indicating the relative importance of these proximate sources of growth for EMDEs. The extent of urbanization also has a larger impact on productivity growth in EMDEs than in advanced economies. This could reflect reallocation of workers from agriculture to manufacturing and service sectors, where productivity may be higher at the margin (Chapter 7).

Changing importance of drivers. The changing importance of productivity growth drivers can be highlighted by comparing results for 1960 to 2018 with results for 1995 to 2018, updating the initial conditions. In EMDEs, the role of economic complexity seems to have strengthened since the mid-1990s (Diao, McMillan, and Rodrik 2019; Hausmann and Hidalgo 2010; Jarreau and Poncet 2012). Experience in complex production can assist in knowledge diffusion and raise productivity growth (Kraay, Soloaga, and Tybout 2004; Schor 2004). In EMDEs, the role of complexity may reflect experience gained through participation in global value chains and the hosting of FDI, in addition to an increasingly important role in innovation. Knowledge transfer via foreign investment could lead to diversified and more sophisticated exports (World Bank 2020a).

Demographic forces—in the form of changes in the working-age share of populations—supported growth in the latter half of the 20th century in EMDEs and advanced economies. More recently, population aging has become a potential headwind for many economies, working against further productivity growth. In a related Bayesian study, using a rolling sample, Bruns and Ioannidis (2020) also find that the importance of demographic variables has increased over time, although their work emphasizes population growth and the fertility rate.

Developments in drivers of productivity

This section examines how drivers have developed in the recent past, and relates these changes to the post-GFC slowdown in productivity growth. The prospects for some of the drivers are also assessed.

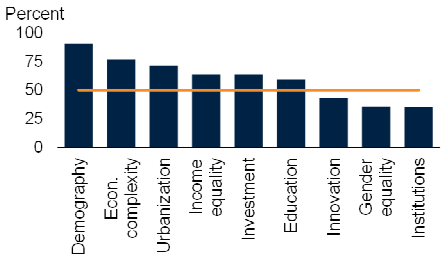
Recent developments

Pre-GFC improvements. Before the financial crisis, there had been major improvements in many drivers of productivity growth, and improvements in EMDEs were often larger than in advanced economies (Figure 2.10). Using the cross-country regression results, the drivers considered here can be aggregated into a single index, weighted by their relative estimated effects. The analysis suggests that demographics, economic complexity, the number of patents filed per capita, and low inflation were key determinants of productivity growth over this period. Between 1995 and 2008, the quarter of EMDEs with the most favorable initial conditions experienced productivity increases 23 percent larger, on average, than the quarter of EMDEs with the least favorable initial conditions. Among LICs, the differential between the two groups was even larger, at 52 percent.

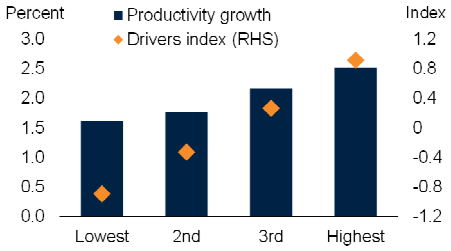
FIGURE 2.10 Pre-GFC developments in productivity drivers and productivity growth

Drivers of productivity growth in EMDEs, except for innovation, gender equality, and institutions, improved more than in advanced economies during the pre-GFC 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.

A. EMDEs with faster improvements relative to advanced economies, 1995-2008



B. Productivity drivers and average EMDE productivity growth 1995-2008



Source: Barro and Lee (2015); International Monetary Fund; Observatory of Economic Complexity; Penn World Table; World Bank.
A. Share of EMDE countries whose improvement in drivers are larger than average changes for advanced economies. Variables corresponding to each concept are: Institutions = WGI Governments Effectiveness; 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 = ratio of years of schooling of female to male. The samples include 30 advanced economies and 61 EMDEs.
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 2.9; Annex 2.2).
Click here to download data and charts.

Post-GFC slowdown in improvements. After the financial crisis, some of the drivers most strongly associated with productivity growth in EMDEs have seen slower improvement, or even reversals. This is consistent with the slowdown in productivity growth in this period (Figure 2.11). Investment growth in EMDEs faltered, reflecting weaker activity in advanced economies, subdued growth in demand for primary commodities, and political uncertainty. Demographic trends that had previously been favorable in many EMDEs waned, as populations aged. Other factors that spurred EMDE productivity growth before the crisis have also weakened. As the expansion of global value chains lost momentum after 2008, so did the trend toward broadening and diversifying production and the movement into upstream stages of the value chain (World Bank 2020a). Neither institutional quality nor income inequality has shown significant improvement. Before the crisis, gains in price stability improved operating environments for firms, but such gains have more recently slowed (Ha, Kose, and Ohnsorge 2019). On the other hand, EMDEs have seen faster growth than advanced economies in educational attainment, measured by average years of schooling.

Outlook

Even before the COVID-19 pandemic, several fundamental drivers of productivity growth had faltered in the wake of the 2008 global financial crisis (Figure 2.11). The pandemic will further undermine a number of drivers, perhaps especially in the short run, but with scope for longer-term effects also (Table 2.2). This section sketches how pre-existing trends and the pandemic will shape the outlook for productivity growth, while acknowledging that many effects remain uncertain.

Lasting impact of COVID-19. Many productivity drivers are expected to be negatively affected by the pandemic. Uncertainty about the duration of the pandemic, and the global economic landscape may discourage investment (Bloom 2014). Concerns about their long-term viability and resilience, may lead to a retreat from global value chains—which would choke off an important channel for international technology transmission—and discourage foreign investment that is often related to such production processes (World Bank 2019a). FDI could see a 30-40 percent fall in the short run (UNCTAD 2020). Steep income losses and disruptions to schooling, which have taken place in countries accounting for 90 percent of global GDP, could increase dropout rates and set back human capital accumulation for a generation of children (World Bank 2020b).

Pandemic-caused job losses could disproportionally affect the income and labor participation of low-skill workers and push 70-100 million into poverty (Chetty et al. 2020; Lakner et al. 2020; Mahler et al. 2020; Sumner, Hoy, and Ortiz-Juarez 2020). The pandemic-caused job-loss may affect poor women more than educated men, possibly widening income inequality.

A few consequences of the pandemic may be less negative. The experience of past crises suggests that some forms of human capital investment are more likely to be undertaken, which could partially offset the negative impact of school closures. History also suggests that some institutional reforms, including in the financial sector, may become more likely in the aftermath of a crisis. Supply chains could be restructured in ways that increase their diversity and improve resilience (World Bank 2020b). This could yet promote trade, FDI, and knowledge transfer for economies not well integrated in existing global value chains.

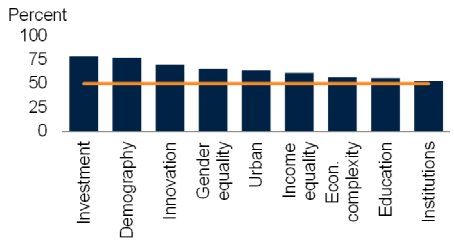
Weaker investment. Investment growth has been slower in the post-GFC period. This reflects adverse terms-of-trade shocks for primary commodity exporters, slowing foreign direct investment for commodity importers, heightened policy uncertainty, lower growth in the advanced economies, and private debt burdens (World Bank 2017). Uncertainty related to the pandemic seems likely to further reduce investment over the coming years (Chapter 3). As well as the direct effect on labor productivity growth, subdued investment may slow capital-embodied technical change, especially in R&D-dependent sectors (Adler et al. 2017; Hulten 1992).

Slower growth at the frontier. Since the early 2000s, there has been a broad-based slowdown in productivity growth in advanced economies, with few signs of an upturn

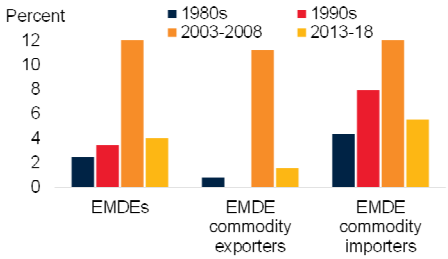
FIGURE 2.11 Post-GFC slowdown of the drivers of productivity growth

In EMDEs, improvements in a broad range of productivity drivers slowed after 2008. Investment growth slowed to one-third of its pre-GFC rate in EMDEs. Working-age population shares are expected to contract in coming years. The growth of educational attainment has also slowed.

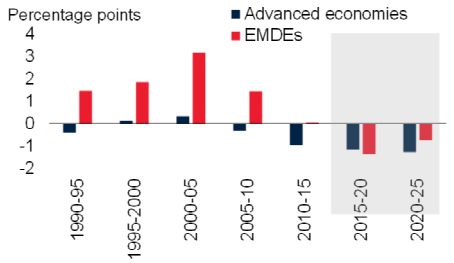
A. EMDEs with a slowdown in productivity drivers in the post-GFC period



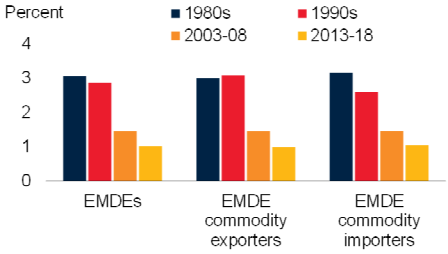
B. Average investment growth



C. Change in working-age population shares



D. Average growth in educational attainment



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

A. Share of economies where improvements in each driver of productivity during 2008-2018 are lower than those in the pre-GFC period 1998-2007. Variables corresponding to each concept are (sample in parentheses): Institutions (75) = WGI Government effectiveness Index; Innovation (27) = patents per capita; Investment (69) = investment to GDP ratio; Income equality (73) = (-1)*Gini coefficient; Urbanization (75) = Urban population share; ECI (56) = Economic complexity index of Hidalgo and Hausmann (2009); Education (52) = years of schooling; Gender equality = ratio of years of schooling of female to male; Demography (75) = share of working-age population.

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

C. Five-year average percentage point changes in the share of the working-age population (aged 15-64).

D. GDP-weighted average changes in years of education.

Click here to download data and charts.

even before the dislocation of the pandemic. These developments may limit the future role of FDI in transferring technologies to EMDEs (Görg and Strobl 2001; Wooster and Diebel 2010).

Views are divided on the growth prospects for advanced economies over the next few decades, and on whether productivity growth will return to historical norms, with spillovers for EMDEs. On the one hand, the innovations of recent decades seem to have benefited productivity growth less than those of the twentieth century (Cowen 2011; Fernald 2015; Gordon 2016). On the other hand, new digital technologies, such as artificial intelligence and other IT innovations, may soon feed through to productivity

TABLE 2.2 Possible impacts of COVID-19 on drivers of productivity growth

	Damaging	Offsetting
Innovation	A retreat from global value chains and foreign direct investment (FDI) could undermine technology transfer and research and development (R&D) spending (UNCTAD 2020). Subdued investment growth, especially in R&D-dependent sectors, could slow technological progress and total factor productivity growth, partly through weaker capital-embodied technological change (Adler et al. 2017). Labor reallocation to productive firms could slow during severe recession (Foster, Grim, and Haltiwanger 2016). Large scale government intervention to the economy could create "zombie firms" limiting the entrance and expansion of high productivity firms (di Mauro and Syverson 2020).	Low investment and accelerated capital depreciation due to an event such as COVID-19 pandemic could lead to faster adoption of new technologies in the near future (Caballero and Hammour 1994; Caballero 2008). Some sectors, such as health care and pharmaceutical industries, communications, and e-distribution, could experience a boost in R&D.
Investment	Past epidemics have been associated with lower investment, in part due to heightened uncertainty (Chapter 3). Given its global reach and the unprecedented containment measures, COVID-19 may erode investment more than prior epidemics.	In addition to higher public investment through fiscal support policies in response to the crisis, shifts in sector composition can spur new investment (chapter 7). Investments in pandemic-critical sectors, such as health care, medical supplies, pharmaceutical industries, communications and e-distribution, are likely to increase.
Education and human capital	There could be lasting setbacks to education and human capital accumulation, due to school closures and persistent unemployment (Protopsaltis and Baum 2019; World Bank 2020c).	Economic crisis lowers opportunity costs of learning, and human capital accumulation accelerated in some cases. (Dellas 2003; Heylen and Pozzi 2007). Improved utilization of online learning could expand access to education (Ichino and Winter-Ebmer 2004; Psacharopoulos et al.
Institutions	Economies could get more politically polarized and fractionalized following economic crises and slow structural reforms (Mian, Sufi, and Trebbi 2014).	Major crises could accelerate the pace of some structural reforms (Ostry, Prati, and Spilimbergo 2009).
Macroeconomic stability	The pandemic could exacerbate macroeconomic imbalances, especially fiscal and external vulnerabilities. Countries that entered the COVID-19 crisis with elevated debt levels and limited policy space could risk financial stress (World Bank 2020b).	The risk of a financial crisis may encourage reforms to strengthen macroeconomic policy frameworks, to return to fiscal sustainability and preserve price stability. Financial market reforms tend to happen more often during crises or in their wake (Ostry, Prati, and Spilimbergo 2009).
Income equality	Pandemic-caused job losses could disproportionally affect the income and labor participation of low-skill workers and push 70-100 million into poverty (Chetty et al. 2020; Lakner et al. 2020; Mahler et al. 2020; Sumner, Hoy, and Ortiz-Juarez 2020). Epidemics tend to hurt employment prospects for workers with basic education compared to those with higher education (Furceri et al. 2020). Higher inequality can negatively affect both social stability and human capital accumulation.	In some EMDE regions, such as SSA, inequality could decrease during recessions, perhaps reflecting a larger decline in income for relatively affluent households compared to low-income households (Camacho and Palmieri 2019).

TABLE 2.2 Possible impacts of COVID-19 on drivers of productivity growth *(continued)*

	Damaging	Offsetting
Gender	COVID-19 could increase caretaking burdens and unemployment for women and raise informality (World Bank 2020b). Differences across firms in implementing flexible work arrangements may lock workers into particular jobs and reduce labor mobility, particularly for women (James 2014).	Shifts toward flexible work arrangements, and changes in social norms as more men take primary responsibility for childcare, could promote gender equality (Alon et al. 2020).
Trade and FDI	Global trade is likely to see its worst contraction since World War II, at least in the short run (World Bank 2020b). FDI could see a 30-40 percent fall in the short run (UNCTAD 2020). Lower trade and FDI will narrow the path for achieving knowledge diffusion and technology transfer.	Supply chains could be restructured in ways that increase their diversity and improve resilience (World Bank 2020b). In countries with strong or credibly improving business climates and governance, this could be a new opportunity to attract FDI and participate in global value chains which could boost knowledge and technological transfer (World Bank 2019c).
Urbanization	Agglomeration in urban areas could be less and urbanization could be slower (Florida et al. 2020). Less agglomeration could limit knowledge exchange and the depth of markets in labor and services markets.	COVID-19 could spur improvements in urban design and functionality, based on incentivizing better access to core services, smarter cities, shorter commutes, and greener spaces. Home-based working for workers in middle-to-high income economies could boost performance (Bloom et al. 2010).

Note: The effects of the COVID-19 pandemic are highly uncertain, and many are not yet visible in official data at the time of writing. The possible implications described above have partly been inferred from research on past crises, such as World War II, the Great Depression, and the global financial crisis. Which effects prove most important in practice could differ significantly from those described in the table.

(Cusolito and Maloney 2018). As with earlier "general purpose technologies," major innovations often require organizational and operational changes that delay some of their benefits for productivity (Brynjolfsson, Rock, and Syverson Forthcoming.).

Fewer opportunities for technology transfer through trade and investment. At first glance, the fact that EMDEs remain behind the technology frontier seems to indicate scope for rapid growth. The paths to technology transfer may be narrowing, however. As noted earlier, the rapid expansion of global value chains before 2007 lost momentum with the global financial crisis (World Bank 2020b). It will be weakened further by the effect of the COVID-19 pandemic as well as recent moves towards protectionism. Low absorption capacity in some firms in EMDEs will continue to limit adoption of new technologies, without more progress in the quality of education and training, including management training (Cirera and Maloney 2017).

Limited progress in governance indicators. According to survey measures of perceptions of government effectiveness, the control of corruption, the rule of law, and political stability, there has been only limited progress since the 1990s (Figure 2.4). Across

EMDEs, the total number of people exposed to fragile and conflict-affected situations has doubled since 1990. There are few signs of renewed institutional progress in EMDEs. Although these developments may be seen as discouraging, they also indicate continuing potential for major productivity gains, if the right reforms are implemented.

Climate change and agriculture. Climate change is expected to continue to adversely affect productivity, partly because natural disasters have become more common (Chapter 3). The agriculture sector may be particularly affected, if higher temperatures decrease crop yields in some countries (Fuglie et al. 2020). Agriculture currently accounts for 32 percent of GDP in LICs, compared to just 9 percent in EMDEs excluding LICs. In 2018, agriculture accounted for half of all employment in SSA and 44 percent in SAR.

Less favorable demographics. The share of the working-age population rose by 13 percentage points between 1995 and 2008 in MENA, and by three percentage points in SSA. In the coming years, populations in these regions are set to age. From 2018 to 2030 the share of the working-age population is expected to decline by four percentage points in advanced economies and 2.5 percentage points in EMDEs (Figure 2.11). In EAP and ECA, the share of the working-age population is expected to decline by 3-4 percentage points by 2030, the reversal of a previous demographic dividend. In other regions—LAC, MENA, SAR, and SSA—the share is expected to be broadly stable.

Increased macroeconomic crisis risk. The COVID-19 pandemic could increase the vulnerability of many EMDEs to a macroeconomic crisis, perhaps linked to sovereign and private sector debt (World Bank 2020b Chapter 3). New pressures on the financial sector could also play a role. Previously, from the mid-1990s onwards, EMDEs had made progress in achieving low inflation and macroeconomic stability (Figure 2.4). In most cases, the scope for further improvement is limited (Ha, Kose, and Ohnsorge 2019). More EMDEs have adopted floating exchange rates and inflation targeting. Output volatility has declined in many countries (Ćorić 2014, 2019). It may be difficult to maintain that lower volatility given the pandemic, and more generally, productivity gains from greater stability may be even harder to achieve.

Policy priorities

The new analysis presented in this chapter, and its review of the literature, both suggest that a comprehensive policy approach is needed to raise productivity growth. Such an approach could have three main strands, recognizing that the productivity slowdown of the past decade has multiple sources.

First, governments should aim to stimulate private and public investment, and improve human capital. Second, policies should be designed to ensure a growth-friendly macroeconomic and institutional environment (Cirera and Maloney 2017). Third, governments should promote productivity growth at the firm level, by ensuring that enterprises are appropriately exposed to trade and foreign investment, and encouraging investment in human capital, including management as well as technical training.

Within these three strands, priorities will depend on the context. Countries with large unmet needs for infrastructure could seek to expand fiscal resources to finance more and better public investment. Countries with low private investment could implement institutional reform and other measures to improve the business climate; reduce support for state-owned enterprises; and improve access to finance, to enable private investment to flourish. Countries with skill shortages and many unskilled workers could seek to improve education and training. Countries where technological innovation is lacking may want to expose their private sectors to foreign knowledge and technologies, through greater openness to trade and foreign direct investment.

The design of policies for individual countries should consider the scope for them to interact, with unintended consequences. For instance, although liberalizing trade can increase the exposure of domestic firms to frontier technologies, increased competition with foreign firms can increase under-employment and the size of the informal sector, especially where labor markets are not flexible. This could counteract the reallocation of resources towards more productive sectors (Bosch, Goñi, and Maloney 2007; Goldberg and Pavcnik 2007; World Bank 2019a).

Improving the proximate sources of growth

Meet infrastructure investment needs. Among the forces explaining why growth has slowed, the weaker pace of capital deepening seems the largest contributor in several regions (ECA, MNA, SAR). Major investment needs remain. Better infrastructure—transport, power, telecommunications—can boost productivity (Aschauer 1989; Calderón, Moral-Benito, and Servén 2015; Martins 2019). In South Africa, a range of infrastructure investments in road and telecommunications networks were found to raise TFP (Bogetic and Fedderke 2009). Poor infrastructure, such as power supply problems, has constrained manufacturing TFP in Bangladesh (Fernandes 2008).

One practical challenge is to set priorities, since not all needs can be met. Where fiscal space allows, governments should fund projects especially likely to generate high social returns. It has been estimated that, to meet the infrastructure-related SDGs by 2030, EMDEs would need to spend between 2 to 8 percent of GDP on new infrastructure each year (Rozenberg and Fay 2019).[14] The region with the largest infrastructure deficit, relative to the SDGs, is SSA (Figure 2.12). In EMDEs, annual investment of 2.5 percent of GDP in new infrastructure could raise the growth rate by three-tenths of a percentage point (Rozenberg and Fay 2019).

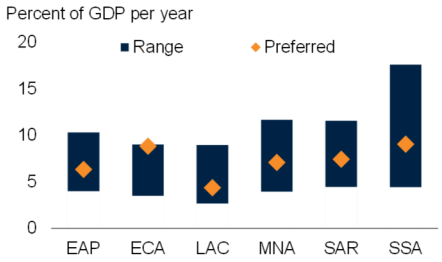
Remove private sector investment constraints. Productivity growth can be promoted by improving the business environment, corporate governance, and the functioning of labor and product markets (Richter 2006; World Bank 2019b). Financial depth is also relevant, since credit constraints can hold back private investment. Efforts are needed to

[14] This is based on 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.

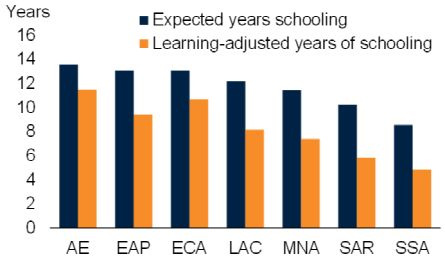
FIGURE 2.12 EMDE infrastructure and education gaps

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

A. Infrastructure gaps



B. Years of education and learning-adjusted years of education



Source: Rozenberg and Fay (2019); World Bank, Human Capital Project.
Note: EMDEs = emerging market and developing economies, EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MENA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
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 the 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. Learning-adjusted years of schooling use harmonized cross-country test scores to adjust average years of schooling.
Click here to download data and charts.

encourage the use of "fintech" products in regions where few adults have access to traditional banking products and sources of finance (Figure 2.13; IMF and World Bank 2019).

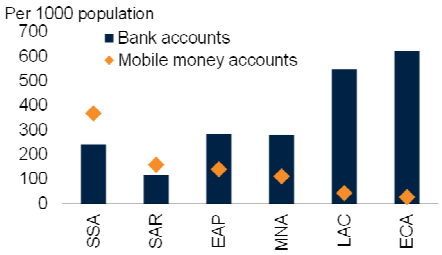
Invest in human capital. Educational gaps with advanced economies are largest in SAR and SSA. Compared to advanced economies, average years of schooling are three years lower in SAR, and five years lower in SSA. On adjusting for differences in the quality of education, these gaps increase to eight and nine years respectively (Figure 2.12). This suggests that public schooling reform should be a priority in these regions. Tailored interventions could be used to improve school attendance, provide student grants and prizes, support nutrition programs for early childhood development, upgrade teacher training, foster teacher accountability and incentivize performance. If EMDEs were to close half the gap in educational attainment between them and advanced economies, that could raise the annual growth rate by about 0.2 percentage points (Figure 2.14).

Better health also increases human capital. By 2017, average life expectancy at birth in EMDEs had risen to 70 years, from 50 years in 1960. This is striking progress, yet average EMDE life expectancy remains about ten years below the average for advanced economies (81 years). Continued improvements in access to clean water, adequate sanitation, and health care would improve well-being substantially as well as raise productivity. Such policies as improved training and performance-based payments for

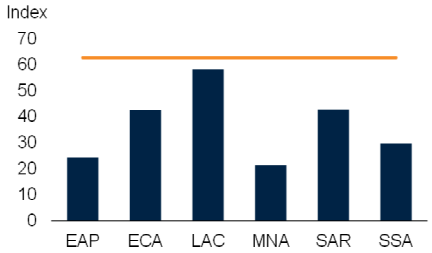
FIGURE 2.13 Developments in fintech and govtech

Economies with large "unbanked" populations have also seen the biggest increases in fintech innovations in payment systems and other financial services. 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 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 Pacific (EAP), 7 EMDEs in Europe and Central Asia (ECA), 18 EMDEs in Latin America and the Caribbean (LAC), 9 EMDEs in the 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 Pacific (EAP), 24 EMDEs in Europe and Central Asia (ECA), 32 EMDEs in Latin America and the Caribbean (LAC), 19 EMDEs in the 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 is based on a sample of 27 Advanced economies, 14 EMDEs in Europe and Central Asia (ECA), 6 EMDEs in East Asia and Pacific (EAP), 25 EMDEs in Latin America and the Caribbean (LAC), 2 EMDEs in the Middle East and North Africa (MNA), 6 EMDEs in South Asia (SAR), and 12 EMDEs in Sub-Saharan Africa (SSA).

Click here to download data and charts.

service providers could improve access to good-quality health care (World Bank 2012, 2018b).[15]

Creating a growth-friendly environment

Strengthen institutions and government effectiveness. Over the long term, institutional quality plays a crucial role in growth. Productivity gains can stem from policies that limit market power and promote fair competition; more even-handed contract enforcement; simplified and transparent legal systems; and governance reforms that lower political risk (Acemoglu et al. 2019; Rodrik 1999; Rodrik, Subramanian, and Trebbi 2004). Governments can also promote productivity growth by lowering transaction costs and increasing trust in institutions (Knack and Keefer 1997; World Bank 2019a).[16]

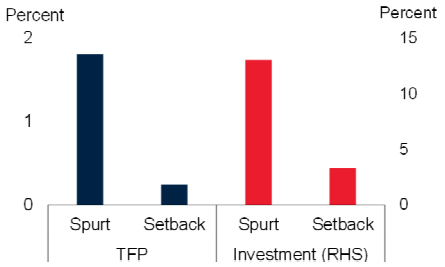
[15] Efforts to create a transparent and easily understandable metric of human capital might also help address the issue, especially considering the time needed for the benefits of human capital investment to materialize in the form of productivity growth (Kraay 2018; World Bank 2018a).

[16] In Rwanda, civil service reform between 1999-2009 improved the share of civil servants with a university degree from 6 percent to 79 percent and coincided with faster growth after 2000.

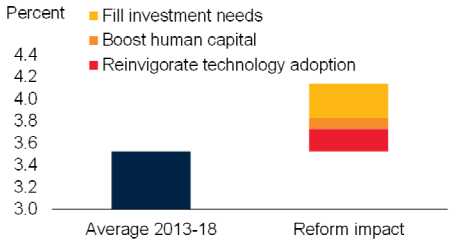
FIGURE 2.14 Effect of reforms

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. A reform package that combines filling investment needs, boosting human capital, and improving the adoption of new technologies could lift productivity growth by about one percentage point.

A. Effects of governance reform/setback



B. Simulated policy impact



Source: World Bank.

A. TFP growth refers to potential TFP growth, as estimated in Kose and Ohnsorge (2019). 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 reform events—defined as two-standard-error changes in one of four World Governance Indicators—for 150 EMDEs and 36 advanced economies. Data are from 1996-2017.

B. Annual average labor productivity growth in EMDEs and the long-run effect on labor productivity growth based on the reform scenario assuming: "fill investment needs": the investment share of GDP increases by 4.5 percentage points each year as in the Rozenberg and Fay (2019) preferred infrastructure scenario; "boost human capital": the education attainment gap between advanced economies and EMDES is reduced by half; "reinvigorate technology adoption": the economic complexity gap between advanced economies and EMDES is reduced by half.

Click here to download data and charts.

Simple comparisons suggest that better governance is associated with faster productivity growth (Figure 2.4).[17] In the years ahead, governments can use new information and communications technologies ("Govtech") to disseminate information more rapidly within and beyond government. This should enable better monitoring of performance and service shortfalls, and contribute to greater transparency (Figure 2.13; World Bank 2018a).

Promote gender equality. Improvements in gender equality could raise productivity and income per head (Figure 2.5). Other things equal, reducing gender differentials in education and labor force participation would enhance the human capital available for production and management, and increase the ratio of workers to population, thereby raising productivity and income. As noted earlier, in many countries, declining fertility means that the share of the working-age population will fall in the coming years. Aging

[17] These spurts are defined as those that raise at least one of four Worldwide Governance Indicators (government effectiveness, control of corruption, rule of law, and regulatory quality) by at least two standard deviations over two years, as in Didier et al. (2016). Setbacks are similarly defined.

populations may be one headwind restraining growth, but steps to improve female participation could partially offset this (World Bank 2018d).

Boosting productivity at the firm level

Foster capabilities of firms. Governments could promote international and domestic knowledge diffusion, and enhance the absorptive capacities of firms to support domestic innovation (Visscher, Eberhardt, and Everaert 2020). Firm-level analysis indicates that trade integration and economic flexibility can support economy-wide productivity growth (Box 2.1). Efforts to increase market integration include regional trade agreements such as the African Continental Free Trade Area, which includes economies in MENA and SSA. Countries that reduce trade restrictions and invest in schooling and training can diversify their exports, becoming less reliant on primary commodities (Giri, Quayyum, and Yin 2019). Bangladeshi textile exporters, after gaining tariff-free access to EU markets in 2001, saw increases in their productivity. There were also gains to productivity in domestically-focused firms, suggesting the presence of spillovers (World Bank 2020a). Enhanced technology adoption in EMDEs—say, closing half the gap with advanced economies in product complexity—could increase the annual growth rate by a tenth of a percentage point (Figure 2.14).

Management skills matter for high-quality R&D and innovation. In India, an intervention that provided firms with training on management practices saw productivity rise by 17 percent (Bloom et al. 2013). Participation in global value chains can improve management, partly through the diffusion of good practices. Moreover, the use of public-private partnerships to create technology extension centers in sectoral clusters can increase firm participation in global value chains and raise productivity (Cirera and Maloney 2017).[18] However, private firms may be reluctant to undertake costly R&D or develop market niches when competitors can free-ride on research or cost discovery (Hausmann and Rodrik 2003). This underscores the importance of enforcing patents and property rights, but these are only partial solutions.

Address informality. Informal sectors account for around 70 percent of employment in EMDEs, with especially high concentrations in SSA and SAR (World Bank 2019a). Informal enterprises are often small, inefficient and relatively unproductive (La Porta and Shleifer 2014). Reallocating capital and workers from relatively unproductive informal enterprises to formal firms could boost aggregate productivity (Amin and Islam 2015; Amin, Ohnsorge, and Okou 2019; Ulyssea 2018). This reallocation could be achieved by limiting rent-seeking bureaucracy, and improving the even-handedness of regulation and tax enforcement. Measures to raise productivity and skills could look beyond the formal sector, to address enterprises and unskilled workers and managers in the informal sector (Benhassine et al. 2018; Nguimkeu and Okou 2019).

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

Conclusion

Labor productivity growth has been driven by innovation, better education, and investment in physical capital. They are complemented by supportive institutions and policies, including measures that promote macroeconomic stability and enhance the rule of law. Productivity growth also benefits from expertise in producing relatively complex and sophisticated exports, linked to international technology diffusion. The effects of some of these drivers may have changed over time. Innovation and experience with economic complexity seem to have increased in importance. So have demographic factors, notably changes in population age structures.

Despite remarkable improvements over the last 60 years in key human capital indicators, such as the provision of primary education and infant mortality rates, many gaps between EMDEs and advanced economies remain. Moreover, since the GFC, many drivers of productivity growth have faltered, including those which had previously supported strong productivity growth. Some of these adverse trends are likely to be amplified and reinforced by the global effects of the COVID-19 pandemic.

The recent slowdown in productivity growth has multiple sources, and action on a range of fronts will be needed. Governments seeking to raise productivity growth can increase public investment and stimulate private investment; improve human capital; foster firm productivity, partly by promoting on-the-job training and upgrading management capabilities; increase the exposure of firms to international trade and foreign investment; enable the reallocation of resources towards more productive sectors; and seek to diversify production. The benefits of many productivity-friendly measures could often be enhanced by improving the macroeconomic and institutional environment.

Future research. Examining the effectiveness and the optimal design of policy measures attempting to boost labor productivity in different countries would be fruitful. In particular, analysis on the relative importance of specific aspects of the institutional environment that are conducive to productivity growth is needed. It is also critical to identify alternative sources of productivity growth capable of offsetting the fading impact of traditional drivers such as demographics, education, and GVCs. In light of the likely damage that COVID-19 is inflicting on long-term growth, implementing the appropriate structural reforms is critical, especially for EMDEs that are aiming to catch up with advanced economies. The next chapter focuses on the impact of unexpected adverse events and examines them in detail.

ANNEX 2.1 Partial correlations

Many drivers discussed in this chapter, such as patents per capita, are strongly correlated with the initial productivity level. The effect of initial productivity should be allowed for before analyzing the relationship between drivers and productivity growth. To remove the linear effect of the initial productivity level, consider the following equations:

$$dy_i = \beta_0 + \beta_1 y_{0,i} + e_{y,i} ,$$

$$x_i = \alpha_0 + \alpha_1 y_{0,i} + e_{x,i}$$

where dy_i is the long-term productivity growth rate of country i, $y_{0,i}$ is the initial log productivity level, x_i is the level of a driver, $e_{y,i}$, $e_{x,i}$ and are residuals. $e_{y,i}$ contains information about productivity growth after partialling out the (linear) effect of the initial productivity level. $e_{x,i}$ contains information about the driver after partialling out the effect of initial productivity.

In several of the charts, the average levels of $e_{y,i}$ for different subgroups of economies, grouped by the level of the $e_{x,i}$, are presented. Since $e_{y,i}$ is mean zero by construction, average dy_i are added to $e_{y,i}$ to recover the original average productivity growth.

ANNEX 2.2 Long-run regressions

For the growth regressions, the dependent variable is the log difference in labor productivity between the end and start year. Version 9.1 of the Penn World Table is used to construct labor productivity data. Data on drivers are mainly obtained from the World Development Indicators (Table A.2.2.1). Following Barro and Sala-i-Martin (2004), independent variables are taken from the start year or the year closest to the start year.

Bayesian Model Averaging. Model uncertainty is inherent in growth regressions because there are many potential drivers and hence many potential specifications (Brock and Durlauf 2001; Durlauf, Kourtellos, and Tan 2008; Fernández, Ley, and Steel 2001). As of 2005, more than 140 variables had been identified as growth determinants in the empirical literature (Durlauf, Johnson, and Temple 2005). Bayesian Model Averaging (BMA) can address model uncertainty formally, by recognizing that the identity of the true model is unknown and that it may be preferable to combine evidence from many different models. In the work for this chapter, a hyper-g prior is used for each coefficient, following Feldkircher and Zeugner (2012), which may achieve greater robustness than the priors used in the earlier literature. Priors on the inclusion probabilities are discussed below.

Grouping variables. Multiple variables can represent the same broad concepts; for example, both years of primary schooling and years of secondary schooling can proxy for educational attainment. Bayesian approaches should be designed to take this into account (Durlauf, Kourtellos, and Tan 2008; Ghosh and Ghattas 2015). In the analysis underlying this chapter, variables that represent common concepts are grouped together

following Durlauf, Kourtellos, and Tan (2008). As in their work, a group is deemed relevant if the posterior probability of including at least one variable from the group exceeds the prior inclusion probability. To account for the dependency within groups, the prior inclusion probability of each variable is defined as:

$$m_j^i = 1-(1-p_j)^{\frac{1}{K_j}}$$

where m_j^i, p_j, K_j are the prior inclusion probability of variable i in group j, the total probability of inclusion for group j, and the number of variables in group j, respectively. m_j^i is set so that the prior probability of including at least one variable out of the K_j variables in the group is equal to p_j. The quantity p_j is set to 0.5 for all j, so there is no specific prior knowledge on the probability of a group's inclusion. Posterior distributions of the coefficients of the variables obtained from BMA are aggregated to the group level. The marginal impact of a group is defined as follows:

$$\beta_j^G = \sum_{i \in Group\ j} \beta_i PIP_i \delta_{j,i}$$

where β_j^G is the marginal impact of the group j, β_i is a posterior mean of variable i given inclusion of the variable, PIP_i is a posterior inclusion probability of variable i, and $\delta_{j,i}$ is the factor loading of variable i in group j. A factor of group j is defined as the variable within a group whose coefficient posterior mean multiplied by the posterior inclusion probability is the highest. $\delta_{j,i}$ is the coefficient from the linear regression of variable i on the factor. β_j^G can be interpreted as the marginal impact of the factor, accounting for the correlations of the variables within groups. It can also be interpreted as the hypothetical posterior mean when including only one variable per group. In a linear regression, the factor-loading weighted sum of the coefficients is identical to the coefficient obtained by another regression which includes one variable per group.

Cross-section analysis. The empirical specification is based on the prediction of conditional convergence made by neoclassical growth models. In Mankiw, Romer, and Weil (1992), the conditional convergence dynamics are described by the following equation:

$$\ln(y_{t,j}) - \ln(y_{0,j}) = (1-e^{-\lambda t})\ln(y_j^*) - (1-e^{-\lambda t})\ln(y_{0,j})$$

where $y_{t,j}$ is output per worker for country j at time t, y_j^* is steady-state output per worker, and λ is the rate of convergence.

The steady-state output per worker depends on a linear combination of the various drivers X_j:

$$\ln(y_j^*) = X_j \beta + \varepsilon_j$$

Using $e^{-\lambda t} \approx 1-\lambda t$ for small λt, the conditional convergence equation becomes

$$\frac{\ln(y_{T,j}) - \ln(y_{0,j})}{T} = -\lambda \ln(y_{0,j}) + X_j \gamma + \tilde{\varepsilon}_j,$$

TABLE A.2.2.1 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**	**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 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: List and sources of candidate variables used in Bayesian Model Averaging. For each category, variables with the highest posterior probability of inclusion are shown in bold.

where $\gamma = \beta\lambda$ and $\tilde{\varepsilon}_j = \varepsilon_j \lambda$ .This is the equation used in the empirical work for this chapter. The dependent variable is annualized long-run productivity growth. 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.

The vector γ captures how the covariates ($X_{0,j}$) drive long-run productivity growth and/or the steady-state productivity level (the height of the growth path). The empirical

TABLE A.2.2.2 Estimates of PIPs and posterior means

	PIP	Posterior Mean	Group	Group Marginal Effects
Initial productivity	1.00	-0.01	initial productivity	-0.01
Domestic credit	0.33	0.07	finance	0.02
Investment ratio	0.47	0.09	investment	0.04
Years of schooling	0.38	0.38	education	0.07
Years of tertiary schooling	0.24	0.01		
Years of primary/secondary schooling	0.32	-0.26		
ECI+	0.61	0.32	complexity	0.20
Trade openness	0.21	-0.01	trade	0.00
Patents per capita	0.37	0.14	innovation	0.07
Patents per capita*years of tertiary schooling	0.25	-0.03		
R&D expenditure	0.35	0.08		
Gini *(-1)	0.33	0.05	equality	0.02
Government consumption share	0.25	0.02	institution	0.09
Political Rights	0.23	0.00		
Civil Rights	0.22	-0.01		
Rule of Law	0.52	0.17		
Urban population	0.60	-0.28	urban	0.01
Population density	0.37	0.06		
Infant survival rate	0.36	0.10	health	0.04
Working age population share	0.25	-0.07	demography	0.02
Population share less than 15	0.29	-0.11		
Female/male labor market participation rate relativeto male labor market participatin rate	0.23	-0.01	gender	0.05
Female years of schooling ratio	0.34	-0.01		
Female years of primary schooling ratio	0.35	0.16		
Water access	0.19	0.01	geography	0.18
Share of land in tropical region	0.69	0.26		
Oil exporter	0.21	0.01		
Inflation *(-1)	0.21	0.00	stability	-0.03
Black market premium *(-1)	0.92	-0.33		

literature often distinguishes between determinants suggested by the Solow model—the log of initial GDP per worker, the investment rate, and the population growth rate—and additional drivers such as education, demography, institutions, geography, innovation, and trade. The selection of these drivers is sometimes based on alternative growth theories, or augmented versions of the Solow model (Mankiw, Romer, and Weil 1992).

Robustness and caveats. The empirical analysis of growth and aggregate productivity raises major challenges. The growth literature has sought to address these, but the small

TABLE A.2.2.3 Estimated group marginal effects

	1960-2018		1995-2018	
	Full	EMDEs	Full	EMDEs
finance	0.022	0.112	-0.001	-0.006
investment	0.042	0.105	0.023	0.084
education	0.067	0.147	0.445	0.095
complexity	0.196	0.085	0.961	0.372
trade	-0.002	-0.002	0.015	0.000
innovation	0.067	0.000	-0.007	0.153
equality	0.016	0.010	-0.004	-0.010
institution	0.090	0.089	0.050	0.005
urban	0.011	0.119	-0.036	-0.006
health	0.036	0.000	-0.005	-0.139
demography	0.015	0.003	0.233	0.617
gender	0.053	0.021	-0.004	0.142
geography	0.179	0.049	0.087	0.032
stability	-0.030	-0.020	0.015	0.165

number of countries available for analysis is a major constraint. Discussions of various issues arising in the study of growth can be found in Brock and Durlauf (2001); Durlauf, Johnson, and Temple (2005); Durlauf, Kourtellos and Tan (2008); Kim and Loayza (2019); and Temple (1999).

Endogeneity. The Bayesian approach used in the chapter can help to overcome ad hoc variable selection and the arbitrary omission of variables. Issues of interpretation remain, since many candidate explanatory variables—innovation, democracy, rule of law, trade, education, health, investment, etc.—are best seen as equilibrium outcomes. Since growth and the explanatory variables are jointly determined, it is hard to draw conclusions about causal effects, and persuasive instrumental variables are hard to find. Some candidate variables may be best viewed as outcomes of growth, rather than (or as well as) drivers of growth. The analysis summarized in the chapter is based on the use of initial conditions, to limit this problem. Nevertheless, interpretation of the findings should be cautious.

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