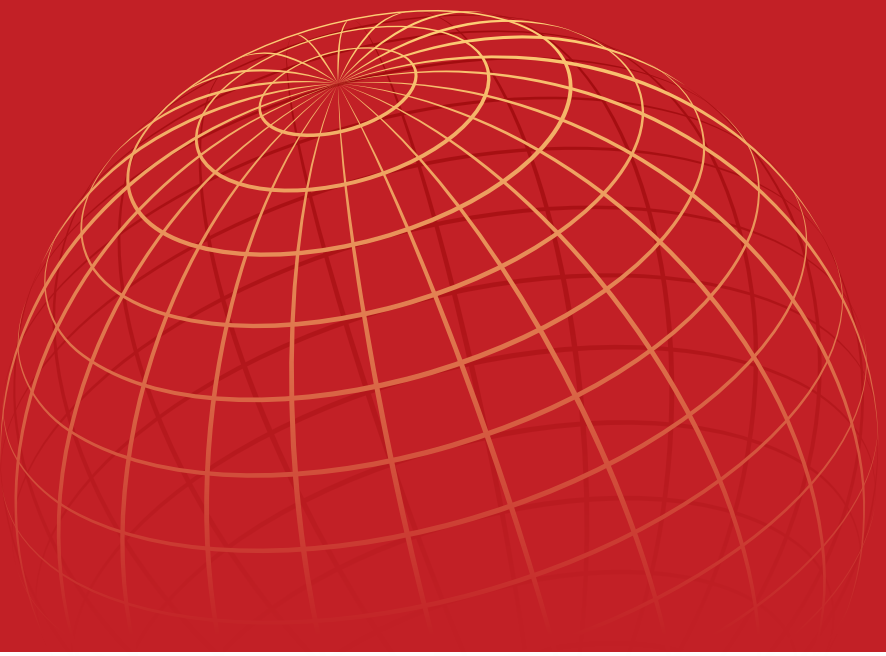


CHAPTER 3

BUILDING SOLID FOUNDATIONS:

How to Promote Potential Growth

Despite a recent acceleration of global economic activity, potential output growth is flagging. At 2.5 percent in 2013-17, post-crisis potential growth is 0.5 percentage point below its longer-term average and 0.9 percentage point below its average a decade ago, with an even steeper decline in emerging market and developing economies. This slowdown mainly reflects weaker capital accumulation, but is also evidence of slowing productivity growth and demographic trends that dampen labor supply growth. These forces will continue and, unless countered, will depress global potential growth further by 0.2 percentage point over the next decade. A menu of policy options could help reverse this trend, including comprehensive policy initiatives to lift physical and human capital, encourage labor force participation, and improve institutions.

Introduction

Although the global economy has regained some strength since mid-2016, potential output growth—the rate at which an economy would grow when labor and capital are fully employed—has continued to decline (Figure 3.1). Post-crisis (2013-17), global potential growth fell short of its long-term average and was well below its pre-crisis average. This weakness was broad-based, affecting both advanced economies, where it was evident even before the financial crisis, and emerging market and developing economies (EMDEs), where there was a short-lived pre-crisis up-tick. The decline raises concerns about the durability of the cyclical recovery described in Chapter 1.

Since the growth rate of per capita potential output is the overriding long-run force for sustained reductions in poverty, this trend is also cause for concern about the world community's ability to meet broader development goals.[1] In some regions, especially commodity-exporting ones such as Eastern Europe and Central Asia, and the Middle East and North Africa, the post-crisis slowdown in potential growth could set back per capita income convergence by more than a decade.

Against this backdrop, this chapter addresses the following questions:

- How has potential growth evolved since the turn of the century?
- What have been the drivers of potential growth?
- What are the prospects for potential growth?
- What policy options are available to lift potential growth?

To help answer these questions, the chapter examines the evolution of potential growth in a large sample of countries, with a strong regional focus. Since potential output is not directly observable, economists estimate it from long time series of actual output, employment, capital stocks, and productivity. The chapter constructs a comprehensive database of potential output growth series using a variety of techniques.[2]

Other studies have documented a potential growth slowdown in advanced economies and Asian economies, while the focus in this chapter is on the broader EMDE universe (IMF 2015; Dabla-Norris et al. 2015; Asian Development Bank 2016; and OECD 2014). There are many ways to estimate potential output. For clarity, and in keeping with a longer-term focus, this chapter uses the production function approach.[3] Second, the

Note: This chapter was prepared by Sinem Kilic Celik, M. Ayhan Kose, Franziska Ohnsorge, and Yirbehogre Modeste Some. Research assistance was provided by Xinghao Gong and Jinxin Wu.

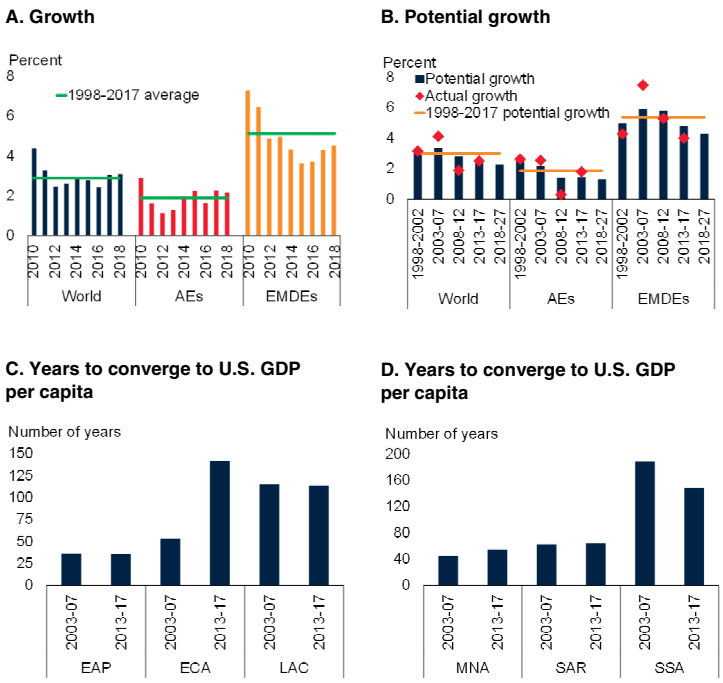
[1] Research suggests that two-thirds of cross-country differences in growth of the poorest households' income are accounted for by differences in average income growth (Dollar, Kraay, and Kleineberg 2013; Barro 2000). Mechanisms by which overall growth helps reduce inequality are varied, but include its impact in raising the demand for agricultural output which helps poor land holders, as well as rising urbanization and higher wages (Yankow 2006; Gould 2007; Ravallian and Datt 2002).

[2] Most of the existing literature on potential growth involves estimating the role of output gaps in driving inflation or domestic monetary policy in the context of individual countries (in about half of 67 publications for individual EMDEs surveyed by the authors).

[3] Other measures of potential growth incorporate short-term supply shocks that dissipate over time (Box 3.1). In this chapter, an exploration of the transition from short-term supply to long-term potential output is confined to the impact of steep output contractions to long-term potential output (Box 3.4).

FIGURE 3.1 Global growth

A cyclical upswing has been underway in the global economy since mid-2016. Global growth is estimated to have strengthened to 3.0 percent in 2017 from a post-crisis low of 2.4 percent in 2016, within reach of long-term average global growth. However, underneath the cyclical upturn, potential growth is slowing, which could set back income convergence by several decades in some regions.



Sources: Penn World Tables, World Bank.
A. Full sample of countries as in Chapter 1.
B. Based on production function approach, GDP-weighted averages for a sample of 30 advanced economies and 50 EMDEs.
C.D. GDP-weighted average of years to converge to U.S. per capita GDP in 2017. The years to converge to U.S. GDP per capita for each country are calculated as the years to close the difference between GDP per capita in 2017 from U.S. GDP per capita in 2017 assuming average potential growth in the period specified. EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
Click here to download data and charts.

chapter examines trends in the structural drivers of potential growth, including total factor productivity (TFP) growth, labor supply growth, and investment in human and physical capital. It documents how steep output contractions, although typically brief, cast a long shadow on potential growth, in part through an erosion of job skills and discouraged investment. Third, the chapter explores policy options to lift potential growth. These include measures to improve education, reforms to health care and labor markets, and steps to improve governance and business climates. In contrast to earlier studies, the discussion of policy options to lift potential growth is directly derived from the empirical exercise.[4]

The chapter's principal conclusions are as follows:

- The global financial crisis has ushered in a period of persistently weak potential growth. During 2013-17, global potential growth (2.5 percent a year) fell 0.5 percentage point below its longer-term (1998-2017) average, and even further below its average a decade ago (2003-07). EMDE potential growth slowed to 4.8 percent a year, 0.6 percentage point below its longer-term average. This weakness in potential growth has been broad-based, affecting almost half of EMDEs and 87 percent of advanced economies in the sample, together representing 69 percent of global GDP.

- A host of factors have contributed to this post-crisis shortfall in potential growth below longer-term averages. Half of the deceleration reflects weaker-than-average rates of capital accumulation. Just over one-quarter of the slowdown is due to weaker total factor productivity (TFP) growth while just under one-quarter of the moderation is attributable to demographic trends.

- The global financial crisis and subsequent recession weakened productivity-enhancing capital accumulation, and deprived workers of opportunities to gain experience and skills, creating a vicious cycle of subdued growth. Conversely, in the past, cyclical upswings often generated momentum that fed into sustained increases in potential growth.

- The slowdown in potential growth may extend into the next decade. Trends in its fundamental drivers suggest that global potential growth may slow further by 0.2 percentage point on average over 2018-27, while EMDE potential growth could ease by

[4] Other studies have investigated the link between actual growth or productivity growth and structural reforms, focusing on the near-term benefits (Prati, Onorato, and Papageorgiou 2013), productivity effects (Dabla-Norris, Ho, and Kyobe 2015; Adler et al. 2017) or a sample consisting of mostly advanced economies (Banerji et al. 2017; IMF 2015 and 2016b).

BOX 3.1 What is potential growth?

Potential growth is the rate of increase of potential output, the level of output an economy would sustain at full capacity utilization and full employment. Since it is not directly observable, the measurement of potential growth relies on a range of assumptions about its relationship to observable variables. Historical data on the growth of actual output growth, and of the factors of production—the labor force, physical capital, and human capital—provide the main indicators. Numerous methods of assessing potential output are available. The key results pertaining to potential growth in this chapter are robust to the choice of method.

Potential growth is the rate of increase of potential output, defined as the level of output an economy would sustain at full capacity utilization and full employment. Although the concept is of fundamental importance to short- and long-run macroeconomic analyses, it is not directly measurable. Estimates of potential growth may, however, be inferred from the behavior of observable variables. An approach which links potential output to the underlying factor inputs of labor, capital and technology—known as the production function approach—is appropriate for the assessment of long-term growth, the main focus of this chapter.

However, the background analysis is based on a wide range of methodologies. The headline results are robust to the choice of methodology. To set the stage, this box discusses some major conceptual issues. In particular, it addresses the following issues:

- What is potential growth?
- How is potential growth measured?
- Are the results robust to the choice of measure?

What is potential output growth?

Potential output is the level of output an economy would produce at full capacity utilization and full employment. Different estimates of potential output growth capture different time-horizons: "short-term" versus "long-term" (Basu and Fernald 2009).

Short-term potential output growth is the growth of potential output that can be achieved without putting pressure on production capacity and inflation when factors of production cannot immediately relocate in response to shocks (Okun 1962). It can be buffeted by temporary disruptions and boosts to supply that dissipate over the longer-term. For example, a shift in the composition of demand may render part of the existing capital stock obsolete, effectively reducing potential output; over time, firms would adjust to the new requirements, returning potential output toward its previous path. The short-term measure is particularly useful for monetary policy, since supply constraints or adverse demand shocks, even if they are not permanent, reduce the effective slack in the economy, and therefore influence the policy interest rate at a given decision point.

Long-term potential output is a function of the available capital stock, labor input and current technology (Solow 1962). As such, long-term potential output growth captures movements in the slow-moving fundamental drivers of output assuming allocation of all factors of production to their most productive uses, regardless of temporary supply shocks. Long-term potential output sets the underlying trend of short-term potential output as well as actual output.

How is potential growth measured?

Estimates of short-term output may be computed using filtering techniques, including univariate and multivariate filters, while estimates of long-term potential output rest on structural models or long-term growth expectations.

Filtering techniques. *Univariate filters* involve estimates of trend output using only GDP series. *Multivariate* filters take into account the relationship between GDP and other variables (such as inflation or unemployment rates) to help distinguish short-run deviations of output from trends. The database underpinning this chapter employs the Hodrick-Prescott filter, the Baxter-King filter, the Christiano-Fitzgerald filter, the Butterworth filter, an unobserved components model, a multivariate filter that utilizes financial variables and commodity prices, a Phillips curve relationship, and an Okun law (Annex 3.2).

Production function approach. This approach represents potential output as a (Cobb-Douglas) production function of the amount of full-employment capital and labor, as well as technology and efficiency of factor allocation that drive total factor productivity (TFP). Potential TFP growth is estimated as the predicted value of a parsimonious panel regression of five-year averages of trend TFP growth on lagged per capita income relative to

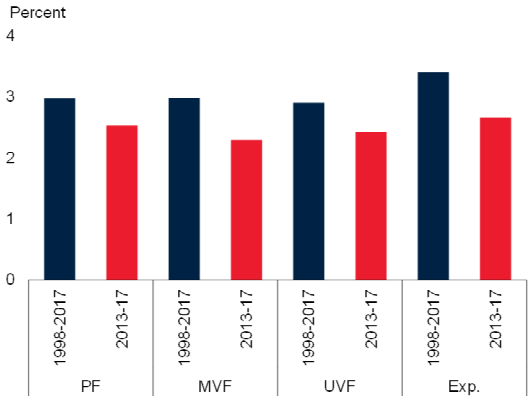
Note: This box was prepared by Sinem Kilic Celik, M. Ayhan Kose, Franziska Ohnsorge, and Yirbehogre Modeste Some.

BOX 3.1 What is potential growth? *(continued)*

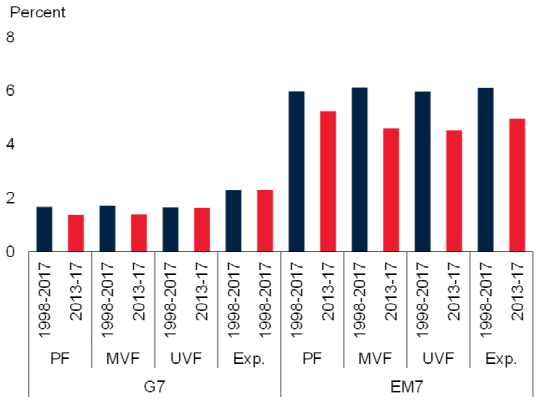
FIGURE 3.1.1 Potential growth estimates

Estimates vary, according to the method of calculation, but suggest that, in 2013-17, global potential output growth fell by about 0.5 percentage point below its longer-term average. This decline is reflected in all measures of potential growth and across country groups.

A. Global potential growth estimates



B. G7 and EM7 potential growth estimates



Source: World Bank.
Notes: "PF" stands for potential growth estimates using the production function approach, "MVF" for those derived using the multivariate filter, UVF for those derived using the Hodrick-Prescott filter, and "Exp." for those based on 5-year-ahead *World Economic Outlook* forecasts. Bars reflect the estimates based on different potential growth measures.
A. To ensure comparability between the measures, the samples are held constant to include 13 advanced economies and 15 EMDEs.
B. EM7: Brazil, China, India, Indonesia, Mexico, Russia, and Turkey; G7: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.
Click here to download data and charts.

advanced economies (to proxy for convergence-related productivity catchup), education, demographics, and trend investment.[1] Potential labor supply is estimated as the population-weighted aggregate of predicted values of age- and gender-specific labor force participation rates from regressions on policy outcomes and cohort characteristics, business cycles, and country effects.[2] The potential capital stock is assumed to match the actual capital stock.

Expectations. The approaches above are supplemented with long-term growth expectations, such as five-year-ahead growth forecasts from *Consensus Economics* or the IMF's *World Economic Outlook*. These growth expectations reflect both model estimates and forecasters' judgment. Judgment can be especially useful during periods of major structural changes, which model-based estimates may not be well-equipped to capture.

Each approach has advantages and disadvantages.

- *Filtering techniques.* Even in data-poor environments, univariate filters are straightforward to implement while multivariate filters utilize additional information that can ensure that the measure of potential output is better aligned with economic theory. However, all statistical filters suffer from well-known "end-point" problems—their measured trends tend to overemphasize actual data at the beginning and end of the sample—and tend to correlate closely with actual data.[3] Measures of potential growth based on filtering techniques correlate strongly with actual output growth and with each other.

- *Production function approach.* The production function approach has the advantage of correlating less with actual growth and producing estimates that help explain the movement of potential output in terms of its inputs. The distinct nature of potential growth measured by the production function approach is also reflected in its weak correlation with potential growth based on filtering techniques. The production function approach relies on proxies for potential productivity and labor supply growth and

[1] This approach is similar to Abiad, Leigh, and Mody (2007); Bijsterbosch and Kolasa (2010); and Turner et al. (2016).

[2] This approach combines those by Fallick and Pingle (2007) and Goldin (1995).

[3] However, real-time estimates of actual and potential output respond differently to shocks (Coibion, Gorodnichenko, and Ulate 2017).

BOX 3.1 What is potential growth? *(concluded)*

capital structural accumulation that are liable to measurement error.

- *Expectations.* Long-term growth expectations can in principle incorporate judgment and, thus, capture factors that cannot be modelled. As a result, like the production function based-estimates, long-term growth expectations are only weakly correlated with filter-based estimates of potential growth. However, in practice, expectations tend to be highly sticky and, at times, in ways that are challenging to interpret.

Are the results robust to the choice of measure?

This chapter draws on a comprehensive database that estimates potential growth using all approaches. For each approach, the largest possible sample is used, up to 181 countries for 1980-2017 (extending to 2027 for the production function approach). For presentational clarity, the chapter presents only results using a production function approach, which is available for 30 advanced economies and 50 emerging market and developing economies for 1998-2027 (Annex 3.1, Table 3.1.1).[4] It assumes that output can be modelled as a (Cobb-Douglas) production function of total factor productivity (TFP), labor supply and capital.[5]

- Estimated potential TFP growth is the fitted value from a parsimonious panel regression of trend TFP growth on relative per capita income as a proxy for convergence potential, education, demographics, and trend investment.

- Estimated potential labor supply is the population-weighted aggregate of fitted values of age- and gender -specific labor force participation rates from regressions on policy outcomes and cohort characteristics, business cycles, and country effects.

- The potential capital stock is assumed to match the actual capital stock.

The key results pertaining to potential growth presented in this chapter are broadly robust to the choice of potential growth measures: the broad-based post-crisis slowdown in potential growth (Figure 3.1.1), the decline in potential growth through investment slumps (Box 3.3) and deep recessions (Box 3.4), and the increase in potential growth following multi-year growth upswings.

[4] The 50 EMDEs include 4 economies in East Asia and the Pacific, 9 economies in Europe and Central Asia, 15 economies in Latin America and the Caribbean, 7 economies in the Middle East and North Africa, 2 economies in South Asia and 13 economies in Sub-Saharan Africa (Annex 3.1). Data for half of EMDEs (especially in Europe and Central Asia and Sub-Saharan Africa) is missing before 1997. Hence, to ensure broad country coverage, the sample period is restricted to 1998-2027.

[5] Human capital is not separately accounted for in the production function approach but affects TFP growth and labor supply growth.

0.5 percentage point. The projected slowdown from 2013-17 would affect EMDEs and advanced economies that account for 73 percent of global GDP.

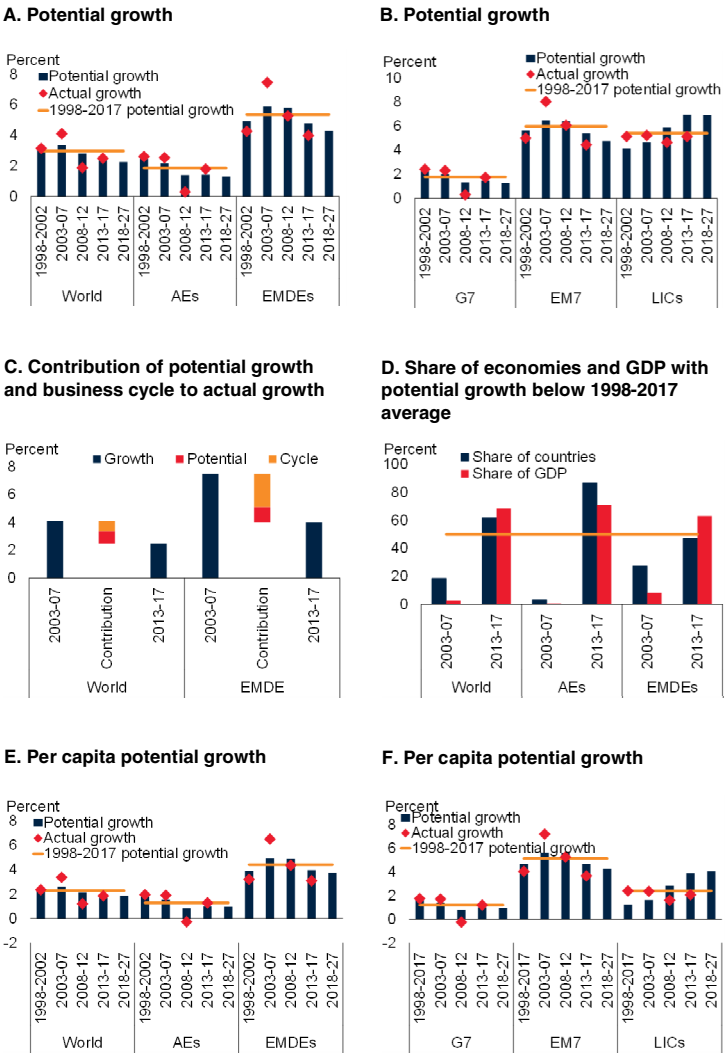
- Policies could help reverse these trends and boost global growth. Among EMDEs, in particular, education, health, and labor market reforms could significantly increase potential growth. Broader reform packages to improve institutional quality and business climates would also pay important dividends.

- Policy improvements are particularly critical at the current juncture. Over the last half-century, the world economy has been disrupted by a financial crisis of varying breadth and severity in every decade. If this pattern were to be repeated and another crisis occurred in the next ten years, it would generate lasting damage to potential output that would require a sustained policy push to reverse.

The current cyclical upswing poses a risk of complacency. To sustain higher potential growth, countries need to reform labor and product markets, strengthen human and physical capital and build conducive environments for business and households to invest. The onus is particularly on the largest emerging markets and advanced economies, whose growth momentum generates spillovers for other EMDEs.

FIGURE 3.2 Evolution of potential growth

During 2013-17, global potential growth declined to 2.5 percent, below the longer-term average and average rates a decade ago. In advanced economies, potential growth declined below its longer-term average, to about 1.4 percent. It slowed more sharply, to 4.8 percent, in EMDEs. The potential growth slowdown affected most EMDE regions and accounted for about one-third of the actual global growth slowdown.



Sources: Penn World Tables, World Bank.
Notes: Based on potential growth derived using production function approach.
A. B. C. E. F. GDP-weighted average.
A. C. E. Sample includes 30 advanced and 50 emerging market and developing economies.
B. F. G7 includes Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. EM7 includes Brazil, China, India, Indonesia, Mexico, Russia, and Turkey. LICs includes 6 countries.
C. Blue bars denote average actual global growth during 2003-07 and 2013-17. Red bars denote the contribution of global potential growth to the change in actual growth between the two five-year periods; orange bars denote contribution of the cyclical component of global growth to change in actual global growth between the two five-year periods.
D. Number of economies and their share of global GDP among 30 advanced economies and 50 EMDEs with potential growth in each period below its longer-term average (1998-2017). Horizontal line indicates 50 percent.
Click here to download data and charts.

This chapter draws on a comprehensive database that estimates potential growth using all standard approaches for up to 181 countries for 1980-2017 (extending to 2027 for 80 countries). For clarity, the remainder of the chapter presents only results using a production function approach for 30 advanced economies and 50 emerging market and developing economies for 1998-2027 that together account for 91 percent of global GDP (Annex 3.1; Box 3.1).[5] The key results pertaining to potential growth presented here—such as the broad-based slowdown in potential growth, the long-term effect of deep recessions or investment busts on potential growth, and the virtuous circle triggered by sustained cyclical upswings—are broadly robust to the choice of potential growth measures (Annexes 3.2-3.5; Box 3.1).

Evolution of potential growth: What happened?

Slowdown in global potential growth. Global potential growth fell to 2.5 percent a year during 2013-17. This is below its longer-term (1998-2017) average of 3 percent a year and even further below its average a decade earlier (2003-07; Figure 3.2). The potential growth weakness was broad-based and robust to the specific choice of potential growth measures. During 2013-17, potential growth was below its longer-term average in 87 percent of advanced economies and in almost half of EMDEs. Economies with potential growth below its longer-term average accounted for 69 percent of global GDP. Per capita estimates also show a trend deceleration. These estimates suggest that there was a persistent slowdown in global potential growth beneath the temporary cyclical shocks that appear to have been the main reasons for the post-crisis slowdown in actual growth from elevated pre-crisis levels.

[5] The 50 EMDEs include 4 economies in East Asia and the Pacific, 9 economies in Europe and Central Asia, 15 economies in Latin America and the Caribbean, 7 economies in the Middle East and North Africa, 2 economies in South Asia and 13 economies in Sub-Saharan Africa (Annex 3.1). Data for more than one-third of them (and about half of the sample's EMDEs in Europe and Central Asia and Sub-Saharan Africa) is missing before 1997 and no data for EMDEs is available before 1991. Hence, to ensure broad country coverage, the sample period is restricted to 1998-2027.

Broadening slowdown. In advanced economies, the potential growth slowdown set in before the global financial crisis whereas EMDEs enjoyed a short-lived pre-crisis surge in potential growth that subsequently faded.

- *Advanced economies.* After a sharp decline during 2008-12—the period of the global financial crisis, the Euro Area crisis, and pronounced investment weakness—potential growth stabilized in 2013-17 as investment growth recovered.[6] However, at 1.4 percent a year over 2013-17, potential growth in advanced economies remains about 0.5 percentage points below its longer-term average.

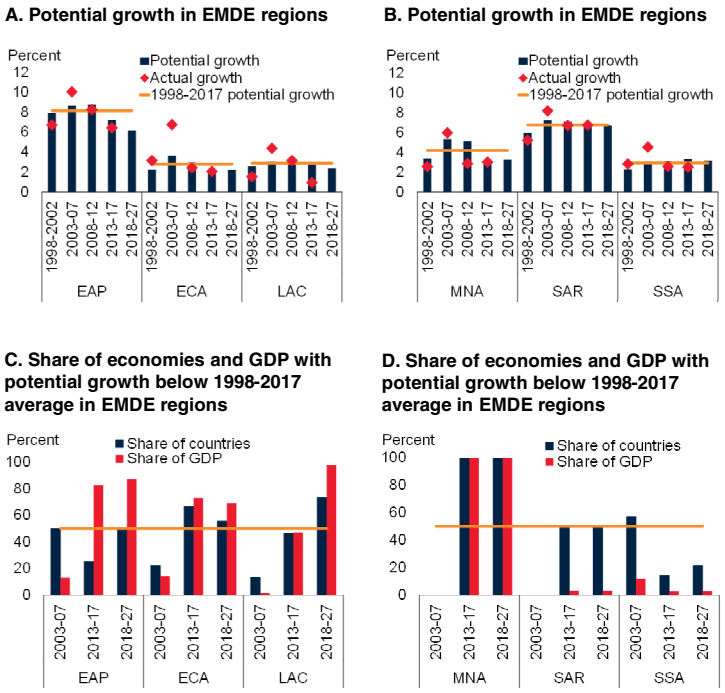
- *EMDEs.* In the initial wake of the global financial crisis, a surge in public investment underpinned EMDE potential growth, offsetting softening productivity and labor supply growth. As EMDE policy stimulus was unwound, and as investment growth plummeted in commodity-exporting EMDEs following the oil price slide in mid-2014, EMDE potential growth slowed sharply to 4.8 percent a year in 2013-17, 0.6 percentage point below its longer-term average.[7]

Regional patterns. Potential growth has fallen furthest in EMDE regions that had benefited from rapid per capita income convergence or that hosted many commodity-exporting EMDEs (Figure 3.3).

- *MNA.* The shortfall of potential growth during 2013-17 from its longer-term (1998-2017) average was one of the sharpest in the Middle East and North Africa (MNA, 1.2 percentage point) where investment growth plunged amid the oil price drop of mid-2014, a period of violent conflict and policy uncertainty in parts of the region.

FIGURE 3.3 Regional potential growth

Potential growth has slowed from its longer-term average in all EMDE regions other than South Asia and Sub-Saharan Africa. Among the causes are weakening fundamentals and disruptions to growth prospects, such as sharp and persistent commodity price declines (for commodity exporters), crises in major trading partners such as the Euro Area (for the ECA region), and spillovers from growth slowdowns in major economies (such as from China).



Sources: Penn World Tables, World Bank.
Notes: EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
A. B. GDP-weighted averages using potential growth estimate based on production function approach.
C. D. Number of economies and their share of GDP in the region among 50 EMDEs with potential growth in each period below its longer-term average (1998-2017). Horizontal line indicates 50 percent.
Click here to download data and charts.

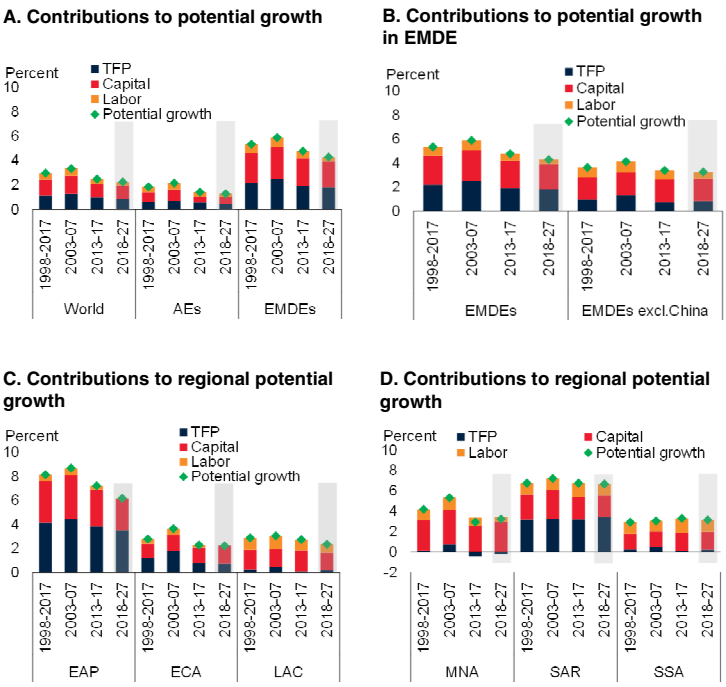
- *ECA, LAC.* During 2013-17, potential growth also fell 0.5 and 0.2 percentage points, respectively, below its longer-term average in Europe and Central Asia (ECA) and Latin America and the Caribbean (LAC). The ECA region's past two decades of rapid integration into European production networks has gradually diminished its potential for further catchup productivity growth. The region also hosts several energy exporters which suffered deep recessions or slowdowns following the mid-2014 decline in oil prices. Weak productivity growth and less favorable

[6] As in the broader set of advanced economies, potential growth in G7 economies—Canada, France, Germany, Italy, Japan, United Kingdom, and United States—was, at 1.5 percent on average in 2013-17, 0.3 percentage points below its longer-term average.

[7] The potential growth slowdown from pre-crisis rates was also evident in EM7 economies—Brazil, China, India, Indonesia, Mexico, Russia, and Turkey. On average during 2013-17, EM7 potential growth slowed to 5.4 percent. Almost three-quarters of this decline in EM7 potential growth between 2003-07 and 2013-17 reflected slowing potential growth in China.

FIGURE 3.4 Drivers of potential growth

The post-crisis slowdown in global potential growth below its longer-term average rates has mainly reflected slowing capital accumulation, labor supply growth, and TFP growth. In ECA and LAC, the decline predominantly reflected weak TFP growth. In EAP and MNA, slowing TFP growth was compounded by weak investment. In SAR and SSA, favorable demographic trends offset investment weakness (SAR) and weak productivity growth (SSA).



Sources: Penn World Tables, World Bank.
Notes: GDP-weighted averages of production function-based potential growth estimates (as defined in Annex 3.1). TFP growth stands for total factor productivity growth.
A.B. Sample includes 30 advanced economies and 50 EMDEs.
C.D. Regional samples include largest available sample for each region to ensure broad-based coverage. EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
Click here to download data and charts.

demographics reduced potential growth in LAC.[8]

- *EAP*. In 2013-17, potential growth in China fell 1.3 percentage points below its longer-term average as policy efforts succeeded in rebalancing growth away from investment towards more sustainable growth engines, combined with slowing productivity and working-age population growth. Elsewhere in EAP, potential growth rose 0.7 percentage point on robust capital accumulation and strengthening TFP growth.

- *SAR, SSA*. During 2013-17, favorable demographics have helped lift potential growth in South Asia (SAR) and Sub-Saharan Africa (SSA). In SAR, rates were offset by investment weakness such that potential growth in 2013-17 broadly matched its longer-term average. In SSA, potential output accelerated by 0.4 percentage point during 2013-17 compared to its longer-term average. This demographic dividend was complemented by rapid capital accumulation over the past two decades as resource discoveries were developed into operating mines and oil fields and governments undertook large-scale public infrastructure investments. The commodity price slide after 2011 has raised concerns about the sustainability of such potential growth.

Drivers of the slowdown in potential growth

Contribution of different drivers. Of the 0.5-percentage-point shortfall in post-crisis (2013-17) global potential growth below its longer-term (1998-2017) average, about one-half can be attributed to weaker capital accumulation (0.2 percentage point) and the remainder to weaker TFP growth and slower labor supply growth (0.1 percentage point, respectively; Figure 3.4). Weak global capital accumulation mainly reflected investment weakness in advanced economies, in the wake of financial crises in the United States and Europe, and a policy-driven rebalancing away from investment in China. Unfavorable demographics and slowing TFP growth were features of both advanced economies and EMDEs (Figure 3.4).

Total factor productivity growth

Channels of transmission. By allowing output to expand with a given amount of factor inputs, TFP growth has historically been the critical driver of sustained growth in per capita output and

[8] In contrast to production function-based potential growth measures, potential growth estimates based on filtering techniques have slowed sharply in LAC and SSA. The predominantly host commodity exporters, where actual growth decelerated steeply in the commodity price slide from 2011.

prosperity (Romer 1986; Lucas 1988; Grossman and Helpman 1991). TFP growth can rise with the adoption of new technologies, adaptation of existing technologies, introduction of more efficient processes, or changes in management practices (EBRD 2014). Differences in TFP account for about two-thirds of the variation in per capita income across the world (Jones 2016). Higher productivity lifts firms' marginal product and reduces their marginal cost, which allows firms to increase their demand for factors of production. Technological advances reduce the price of capital equipment, encouraging further capital accumulation which, in turn, embodies further improvements in productivity (Greenwood, Hercowitz, and Krusell 1997; Sakeflaris 2004; Box 3.2).

Evolution of potential TFP growth. Global potential TFP growth—the part of TFP growth that is stripped of its wide cyclical swings—slowed from about 1.3 percent a year a decade ago to about 1 percent a year during 2013-17, but with wide heterogeneity (Figure 3.5). In advanced economies, productivity growth showed signs of flattening well before the global financial crisis. For some advanced economies, the productivity growth slowdown during the early 2000s has been described as a return to productivity growth before the surge of information and communications technologies in the mid-1990s (Gordon 2013; Cette, Fernald, and Mojon 2016).

By contrast, TFP growth in EMDEs surged to 2.5 percent a year a decade ago (2003-07), reflecting productivity-enhancing investment, partly financed by capital inflows.[9] Reforms of policy frameworks after EMDE financial crises in the late 1990s and early 2000s and greater integration into global value chains provided a conducive environment for rapid productivity growth. However, since 2007, TFP growth in EMDEs has slowed to 1.9 percent a year in 2013-17.

Sources of the TFP growth slowdown. Some sources of the TFP growth slowdown are likely to be structural and persistent. TFP growth may have slowed as a wave of information and communications technologies matured (Box 3.2). Cross-country diffusion of technology may have slowed as global value chains stopped growing. Aging workforces may have slowed the adoption of new ideas. In commodity exporters, a downgrading of expectations for long-term profitability of resource projects would have reduced investment and, with it, embodied productivity gains. Finally, the large-scale factor reallocation, especially from agriculture to manufacturing, that has supported robust EMDE productivity growth over the past two decades appears to be slowing (Box 3.2).

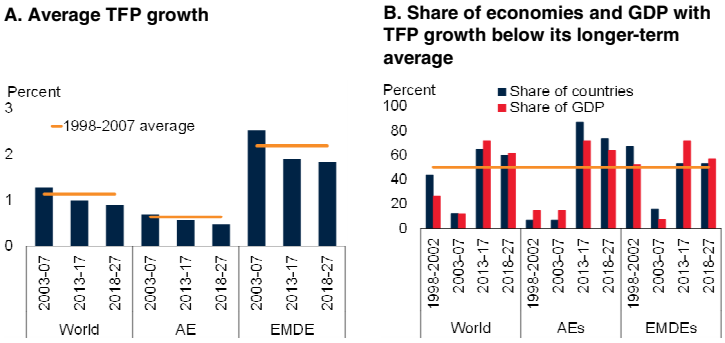
The role of human capital. Over the past three decades, TFP growth in EMDEs has been supported by growing human capital. Among a better-educated and healthier working-age population, both TFP growth and labor force participation rates tend to be higher. EMDEs have made rapid strides towards improving education and health outcomes over the past two decades.

- On average in EMDEs, secondary school completion rates have increased by 7 percentage points between 1998-2002 and 2013-17. At 27 percent, this is about two-thirds of the advanced-economy average.

[9] The regression results suggest that for many EMDEs, catchup productivity growth is a key driver of overall TFP growth (Annex 3.1).

FIGURE 3.5 Total factor productivity growth

Potential TFP growth has declined from average rates a decade ago and are now below longer-term averages in the majority of advanced economies, EMDEs, and EMDE regions.



Sources: Penn World Tables, World Bank.
Note: TFP growth stands for total factor productivity growth. This figure refers to potential TFP growth (Annex 3.1).
A. GDP-weighted average of total factor productivity growth. Includes 50 EMDEs and 30 advanced economies.
B. Number of economies among 30 advanced economies and 50 EMDEs in which potential total factor productivity growth is lower than its longer-term average (1998-2017).
Click here to download data and charts.

BOX 3.2 Understanding the recent productivity slowdown: Facts and explanations

Potential total factor productivity growth slowed, post-crisis, below its longer-term average and pre-crisis levels. The slowdown started well before the global financial crisis in advanced economies (AEs) and spread to EMDEs after the crisis. Weaker productivity growth has been attributed to slower investment growth, partly because of heightened uncertainty and crisis legacies, population aging, increased regulation, and maturing global value chains and information and communications technology.

Introduction

Global growth of total factor productivity (TFP), defined as the residual part of output growth not explained by factor accumulation, has slowed sharply over the past decade. Much of this reflected a steep cyclical slowdown, but global *potential* TFP growth—the focus of this box—also slowed in 2013-17 below its pre-crisis and longer-term average (Figure 3.2.1). Labor productivity growth, defined as output growth per worker, has shown a similar decline.

In advanced economies, TFP growth was flattening before the global financial crisis, as documented in the large literature reviewed below. By contrast, TFP growth in EMDEs surged to 2.5 percent a year during 2003-07, reflecting productivity-enhancing investment, partly financed by capital inflows, and ample room for convergence-driven productivity growth (Adler et al. 2017). Reforms of policy frameworks after EMDE financial crises in the late 1990s and early 2000s and greater integration into global value chains provided a conducive environment for rapid productivity growth. However, TFP growth in EMDEs slowed to 1.9 percent a year in 2013-17 amid investment weakness in the two-thirds of EMDEs that are commodity exporters, rapid per capita income convergence in commodity importers that narrowed the room for catchup productivity growth in some EMDEs, and a policy-driven rebalancing away from investment growth in China.

The recent slowdown in TFP growth was broad-based but steepest in commodity exporters (Figure 3.2.1). In EMDE regions where commodity exporters have struggled to adjust to low commodity prices (MNA, LAC, SSA) or which faced heightened political uncertainty that weighed heavily on investment, TFP growth slowed to near-zero during 2013-17. In contrast, TFP growth continued to be robust above 3 percent during 2013-17 in East Asia and Pacific (EAP) and Southeast Asia (SAR)—both regions hosting predominantly commodity-importing economies.

Considering the synchronous slowdown in productivity growth, this box addresses two questions:

- What are the linkages between productivity growth and potential output growth?
- What are the reasons behind the ongoing productivity slowdown?

Linkages between productivity and potential output growth

Differences in productivity growth account for about two-thirds of the variation in per capita income across the world (Jones 2016). Higher productivity lifts firms' marginal product and reduces their marginal cost, which allows firms to increase their demand for factors of production and, in turn, expand output. Technological advances can also reduce the quality-adjusted price of capital equipment, encouraging further capital accumulation which, in turn, embodies further improvements in productivity (Greenwood, Hercowitz, and Krusell 1997).

Weaker productivity growth reduces not only *actual* output growth, but also *potential* output growth. For example, the productivity slowdown in the United States, which pre-dates the global financial crisis, may reflect a return to productivity growth rates before the surge of information and communication technologies (ICT) in the 1990s and the early 2000s and may, therefore, be associated with a long-term reduction in potential output growth (Fernald 2015; CBO 2014).[1] Other factors, such as financial frictions that reduce investment in R&D and population aging, have contributed to the recent slowdown in TFP growth and may have dampened the potential of the economy to innovate in the future, i.e., they may have reduced potential TFP and output growth.

Explanations of productivity growth slowdown

The literature offers a number of explanations for slowing productivity growth. These include temporary factors—

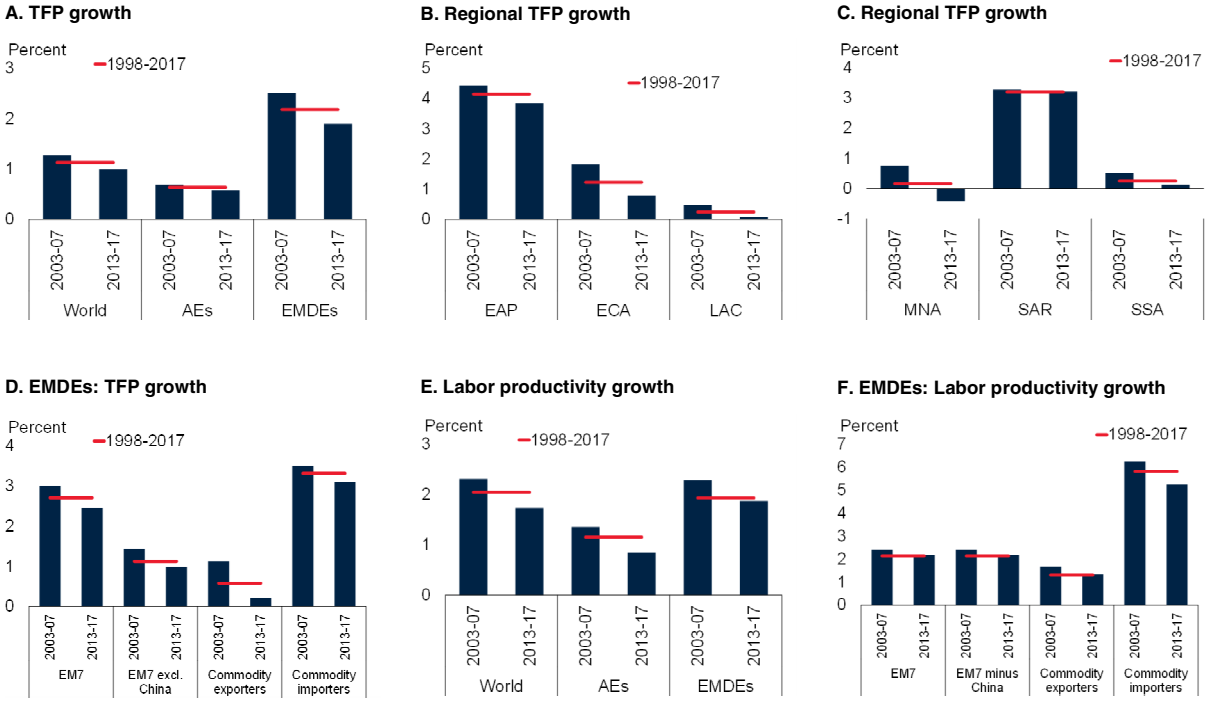
Note: This box was prepared by Ergys Islamaj, M. Ayhan Kose, and Franziska Ohnsorge.

[1] CBO (2014) has revised its estimates of potential GDP growth compared to 2007, taking into account a lower rate of productivity growth.

BOX 3.2 Understanding the recent productivity slowdown: Facts and explanations *(continued)*

FIGURE 3.2.1 Evolution of potential productivity growth

Potential productivity growth slowed in advanced economies and EMDEs during 2013-17 to rates below longer-term averages and average rates a decade ago.



Source: World Bank.
Notes: GDP-weighted averages of potential total factor productivity growth, defined as in Annex 3.1. 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; MNA = Middle East and North Africa; SAR = South Asia; SSA = Sub-Saharan Africa; EM7: Brazil, China, India, Indonesia, Mexico, Russia, and Turkey; G7: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.
A. D. Sample includes 30 advanced economies and 50 EMDEs.
E. F. GDP-weighted averages of potential labor productivity defined as potential GDP divided by potential employment.
Click here to download data and charts.

such as heightened policy uncertainty, crisis legacies that have eroded investment—as well as persistent factors, such as maturing global value chains, a switch in information and communications technologies to consumer applications (from productivity-enhancing hardware and software), and slowing human capital accumulation.[2] In the context of EMDEs, slowing productivity growth has also been attributed to slowing factor reallocation.

Uncertainty and investment slowdown. The decade 2008-17 was marked by heightened policy uncertainty, including following the global financial crisis and the Euro Area crisis. Uncertainty dampens investment, leading to lower productivity growth through less investment in R&D and through the loss of improved technologies embodied in new capital equipment (World Bank 2017a; Box 3.3). Uncertainty may also slow the reallocation of resources from less to more productive firms and from larger and older towards more innovative younger firms, as credit markets may be less willing to finance risky start-ups (Bloom 2009; Bloom 2014; Fort et al. 2013; Baker et al. 2016). In LAC, weak investment, especially in intangible assets, has contributed to low productivity growth (OECD 2016a).

Crisis legacies. Deep recessions, especially those following financial crises, can lower TFP levels (Fatás 2000; Adler et

[2] Some authors question the very existence of a productivity growth slowdown, arguing that productivity is increasingly mismeasured (Brynjolfsson and McAfee 2011, 2014). However, thus far there has been limited evidence of rising mismeasurement during the last decade (Byrne, Fernald and Reinsdorf 2016; Syverson 2017). In addition, in the United States, the productivity growth slowdown has spread broadly across sectors, and, as a result, cannot be explained by a shift of economic activity towards poorly measured, low-productivity-growth sectors, such as services (Fernald et al. 2017).

BOX 3.2 Understanding the recent productivity slowdown: Facts and explanations *(continued)*

al. 2017; Reinhart and Rogoff 2014).[3] Financial frictions following severe recessions and crises may reduce investment in research and development, especially in firms with pre-existing balance-sheet vulnerabilities (Aghion et al. 2012; Duval, Hong and Timmer 2017). Hence, the global financial crisis and Euro Area crisis may have deepened a TFP growth slowdown already underway (Cette, Fernald, and Mojon 2016). An event study of 161 contractions in 93 advanced and emerging market and developing economies during 1981-2016 show that actual TFP growth typically fell sharply during contractions, and the subsequent rebounds were insufficient to lift TFP levels back to their pre-crisis paths (Figure 3.2.2).[4] In particular, the severe recessions in EMDE commodity exporters following the commodity price slide from 2011 may account for some of the recent slowdown in EMDE productivity growth. Yet, the timing of the productivity slowdown for advanced economies suggests that the main drivers are factors other than the global financial crisis or subsequent coping policies.

Trade slowdown. International trade growth slowed sharply following the global financial crisis (World Bank 2015a). Weaker trade growth slows incentives for firms to invest and eases competitive pressures. As a result, the pace of resource re-allocation within firms and within sectors toward more efficient firms and sector slows (Adler et al. 2017; Ahn and Duval 2017). In addition, the spread of vertical specialization, which had been a significant force for both earlier productivity gains and trade growth, slowed as global value chains have matured (Matoo, Neagu, and Ruta 2017). While the post-crisis slowdown in trade has dampened productivity growth in open economies, elevated tariff and non-tariff barriers have depressed trade openness, competition, access to global technologies, and, hence, productivity growth in MNA (Freund and Jaud 2015).

Slowing population growth and human capital accumulation. As population growth has slowed, the growth of the labor force has also declined. In advanced economies, the working-age share of the population has declined since the mid-1980s and, more recently, in EMDEs. An older labor force has, historically, been associated with slower learning of new skills and with slowing innovation and productivity growth (Maestas, Mullen, and Powell 2016). Population aging may have accounted for as much as 0.2–0.5 percentage point lower average productivity growth in advanced economies in the 2000s than the 1990s (Adler et al. 2017). In LAC, specifically, poor education and skills have been central to low productivity growth (OECD/ECLAC/CAF 2016).

Maturing ICT. Information and communication technologies (ICT) has boosted productivity in the ICT-producing and ICT-related industries since the mid-1990s and, as it became a general-purpose technology, in other industries (Fernald 2015; Fernald et al. 2017; Basu et al. 2004). Businesses throughout the economy became more efficient by reorganizing to take advantage of ICT. After an uptick in productivity in the U.S. and other advanced economies in the mid-90s and early 2000s, ICT technologies and their absorption appear to have been maturing (Fernald 2015).[5] Productivity growth in EMDEs tends to reflect advanced-country productivity trends with a lag, as technological innovations first introduced in countries at the technology frontier are eventually adopted by the rest (Comín et al. 2014; Gordon 2016). Costs of extracting ideas may have also increased over time, making it more likely that productivity growth will remain low in the future (Bloom at al. 2017). In addition, hi-tech innovation seems to have shifted this century from productivity-enhancing hardware and software, toward consumer applications (Gordon 2016).

Rising regulation and loss of dynamism. The stringency of labor and product markets regulations may be negatively correlated with productivity levels across countries (Fatás 2016; Cette, Fernald, and Mojon 2016; Nicoletti and Scarpetta 2005). Deregulation may boost productivity by accelerating the reallocation of resources, facilitating technology diffusion and adoption, and increasing incentives to innovate. In the U.S. ICT sector, deregulation may have also increased labor market flexibility and allocative efficiencies since the early 2000s (Decker et al. 2016, 2017). In contrast, zoning restrictions in U.S. cities heightened housing supply constraints and reduced the efficiency of labor allocation across the United States (Hsieh and Moretti 2015). In the United States, changes in the federal regulatory burden do not appear to

[3] In theory, the constraints imposed by credit crunches and recessions should force the least productivity firms out of business and lift aggregate productivity growth (Petrosky-Nadeau 2013).

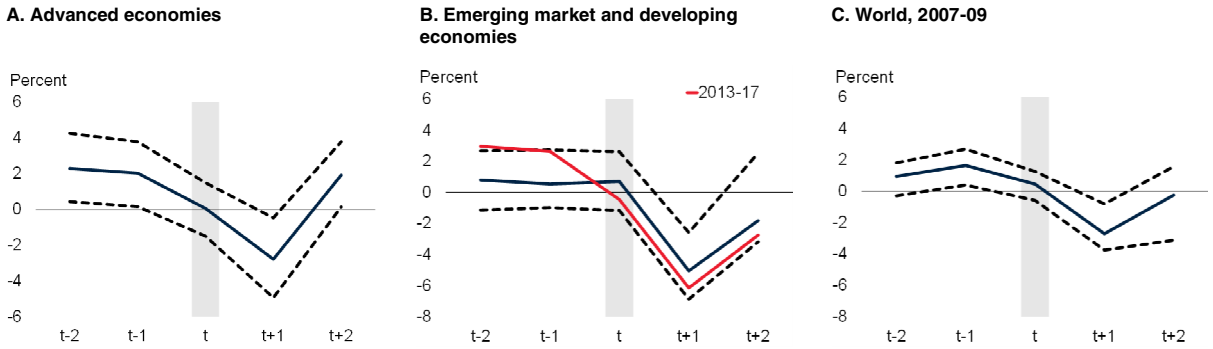
[4] Contractions are defined as the years of negative output growth from the year after the output peak to the output trough. Sample includes 161 events for 32 advanced economies and 61 emerging market and developing economies for the period 1981-2017. The methodology is described in detail in Annex 3.4.

[5] Adler et al. (2017) find that a shock to the U.S. TFP has had a gradual, increasing and significant spillover effect in the TFP of other advanced economies over the 1970-2010 period.

BOX 3.2 Understanding the recent productivity slowdown: Facts and explanations *(concluded)*

FIGURE 3.2.2 Productivity growth around contractions

Productivity growth has tended to slow by 4 percentage points during typical contraction episodes and to rebound quickly during subsequent expansions. The contraction episodes in commodity exporters following the commodity price slide after 2011 were associated with sharp declines in productivity growth.



Sources: Penn World Tables, World Bank.
Notes: Blue lines show unweighted averages around 161 contraction episodes in 32 advanced economies and 61 EMDEs. The methodology is described in detail in Annex 3.4. Dashed lines show 25th and 75th percentiles. Horizontal axis shows years.
A. B. t denotes the year of a business cycle peak preceding the contraction.
B. Red line shows unweighted average total factor productivity growth in countries that had recessions during 2013-2017 (Brazil, Burundi, Ecuador, Russia, Sierra Leone, Swaziland, Trinidad and Tobago, Ukraine, and República Bolivariana de Venezuela).
C. There are 52 countries identified as having a business cycle peak in 2008. t denotes 2008.
Click here to download data and charts.

explain variations in productivity growth, many small changes in the regulatory and institutional framework may have contributed to a decline in entrepreneurship dynamism and a decline in job and worker flows into the high-tech sector (Fernald et al. 2017; Haltiwanger 2015).

Slowing reallocation between firms and sectors. Reallocation of capital and workers toward more efficient firms and sectors has been an important driver of productivity growth over the past two decades both in AE and EMDEs (Restuccia and Rogerson 2017). In Europe, structural rigidities in labor and product markets may have hindered a favorable reallocation of resources. In China, the reallocation of labor from agriculture to manufacturing has been an important source of productivity growth (Cao and Birchenall 2013; Deininger et al. 2014). A reallocation of labor from low-productivity to high-productivity activities has been a major driver of productivity growth in Africa, Latin America and the Caribbean, and East Asia and the Pacific (Üngőr 2017; McMillan, Rodrik, and Verguzco-Gallo 2014). As the potential for reallocation is gradually exhausted, related productivity gains may be slowing.

Conclusion

Global productivity growth has slowed over the past two decades. Some of the underlying drivers of this slowdown may fade over time, such as policy uncertainty and crisis legacies. Others, however, are likely to persist: the decline in labor force growth and population aging; a levelling-off of productivity-enhancing innovations in information and communication technologies; and maturing global supply chains. Policies to address these persistent factors include better education for improved learning in aging populations and initiatives to stimulate investment in physical capital and research and development. Other measures, such as regulatory reform and trade liberalization, could raise productivity by reducing informality and increasing competition.

- Tertiary completion rates have risen by about one-half to 10 percent in 2013-17, but still about half of the advanced-economy average.

- Life expectancy has risen by 4 years to 71 years, about 10 years short of the advanced-economy average.

These substantial improvements in human capital mitigated other developments weighing on EMDE potential growth between 1998-2002 and 2013-17, and helped raise potential growth in regions where progress was particularly large. The largest improvements between 1998-2002 and 2013-17 were made in SSA, where secondary completion rates almost doubled (by 7 percentage points) to approach the advanced-economy average, and life expectancy rose by 7 years to almost 60 years. Life expectancy also rose considerably (4 years) in South Asia to 72 years.

Physical capital accumulation

Channels of transmission. Investment can lift potential output growth through direct and indirect channels (Box 3.3). Directly, investment is the source of capital accumulation, which raises labor productivity and potential output—provided investment is not channeled into excess capacity and wasted (Devarajan, Swaroop, and Zhou 1996; Presbitero 2016). Indirectly, investment can raise total factor productivity because technological improvements are often embodied in investment (Solow 1962).

Evolution of investment growth. Global investment growth halved between 2010 and 2016, with the investment weakness shifting from advanced economies to EMDEs over this period. Investment growth in advanced economies declined during the Euro Area crisis and, after a brief rebound, again after the oil price decline that disrupted energy sector investment in the United States. In EMDEs, investment growth slowed sharply following the global financial crisis, from double-digit rates in the immediate wake of the crisis to a post-crisis low of 3 percent in 2016. Despite signs of bottoming out in 2017, investment growth has been well below its pre-crisis average as well as its longer-term average in more than half of EMDEs in the sample (Figure 3.6). In EMDEs, both public and private investment were weak. Public investment accounted for about 31 percent of total investment in EMDEs and about 15 percent of advanced-economy investment during 2010-15 (World Bank 2017). After 2011, public investment growth remained anemic following the stimulus-related surge of 2008-09 and private investment growth slowed sharply after 2011.

Sources of investment weakness. Whereas investment weakness in advanced economies mainly reflected sluggish demand and output growth, in EMDEs a broader range of factors has been at play. In commodity importers, slowing FDI inflows and spillovers from soft activity in major advanced economies accounted for much of the slowdown in investment growth after 2011. In commodity exporters, a sharp deterioration in their terms of trade (particularly for energy exporters), slowing growth in China, and mounting private debt burdens accounted for much of the slowdown in investment growth. In several EMDEs, political and policy uncertainty was a key factor in investment contractions or slowdowns (Kose et al. 2017). Investment weakness may also reflect the declining price of capital goods or a growing role of poorly-measured intangible capital, such as design, research and developments, marketing and training (Corrado and Hulten 2010; Ollivaud, Guillemette, and Turner 2016).

Consequences of investment weakness. Cyclical factors, although transitory in themselves, can have long-lasting effects on potential output growth. More than half of EMDEs in the sample suffered at least one year of investment contraction during 2013-17. In some, investment contractions were triggered by the prolonged slump of commodity prices from their peak in early 2011. In others, it was accompanied by heightened domestic political or geopolitical tensions. Such episodes typically foreshadow weaker potential growth in the three years surrounding the trough of the investment contraction (Box 3.3).

Investment contractions are one reason for the long shadow cast by deep recessions over potential

BOX 3.3 Moving together? Investment and potential output

The recent slowdown in potential growth coincided with considerable investment weakness in emerging market and developing economies (EMDEs). After briefly reviewing the main linkages between investment and potential output, this box documents that investment busts (booms) are often associated with weaker (stronger) TFP and potential output growth.

Introduction

Since 2010, investment growth slowed sharply in emerging market and developing economies (EMDEs), from double-digit rates in the wake of the global financial crisis to a post-crisis low of 3 percent in 2016 (Figure 3.3.1). This slowdown has resulted from a range of headwinds facing EMDEs, including a sharp decline in commodity prices, slower FDI inflows, elevated policy uncertainty, and weaker growth expectations (Kose et al. 2017; Vashakmadze et al. 2017; World Bank 2017). Irrespective of its causes, weaker investment growth can dampen potential growth by reducing the speed of capital accumulation and the rate at which new technologies embedded in investment can increase productivity.

As global growth has firmed in recent quarters, investment growth in EMDEs has begun to bottom out: investment growth stabilized at 4.5 percent in 2017 and is expected to rise to 4.8 percent in 2018. It remains an open question to what extent the benefits of the ongoing investment pickup could offset the adverse effects on potential output growth of past protracted weakness in investment and productivity, and demographic shifts.

Against this background, this box addresses two questions.

- What are the basic linkages between investment and potential growth?
- How do TFP growth and potential output growth change during investment booms and busts?

Linkages: Theory and evidence

Investment growth can lift potential output growth through direct and indirect channels. Directly, capital accumulation raises potential output growth and labor productivity growth. Indirectly, investment can raise total factor productivity because of technological improvements embedded in investment in new equipment or research and development.[1]

A large literature has provided firm-level evidence in support of the linkages between investment and productivity growth (Syverson 2011).[2] Higher level of investment in research and development, and information and communications technology are associated with particularly large gains in firm productivity.[3] Jorgenson, Ho, and Stiroh (2007), for instance, find that investment in information technology played a dominant role in the U.S. productivity surge in the late 1990s and accounted for about one-third of productivity growth over 2000-2005. In addition to its direct impact on productivity, investment growth also tends to amplify the benefits of other sources of firm productivity, including staff education and experience, managerial skills, and firm structure (Bloom, Sadun, and Reenen 2012; Cirera and Maloney 2017).[4]

Macro-level evidence supports the linkages between investment growth and productivity growth. Investment in machinery and equipment has supported labor productivity growth in advanced economies and EMDEs (Herrerias and Orts 2012; De Long and Summers 1992a and 1992b). Research and development investment has been associated with higher productivity (IMF 2016). Growth of non-military public investment, especially infrastructure investment, has lifted total factor productivity growth (Aschauer 1989; Calderón, Moral-Benito, and Servén 2015; Ramirez 1998a, 1998b). Finally, aggregate investment growth appears to be associated with faster total factor productivity growth in OECD countries (Mourougane et al. 2016; Fournier 2016) and some EMDEs (Fedderke et al. 2005; Hendricks 2000). The slowdown in trend labor productivity growth between

Note: This box was prepared by M. Ayhan Kose, Franziska Ohnsorge, and Temel Taskin.

[1] Evidence for such investment-specific technological change has been presented in Greenwood, Hercowitz, and Krusell (1997 and 2000); Cummins and Violante (2002); Fischer (2006); Boileau (2002); He and Liu (2008); Levine and Warusawitharana (2014); Doraszelski and Jaumandreu (2013); and Hendricks (2000).

[2] For firm-level evidence, see Faggio et al. (2013); Boeing, Mueller, and Sandner (2015); Commander, Harrison, and Menezes-Filho (2011); and Aw, Roberts, and Xu (2008).

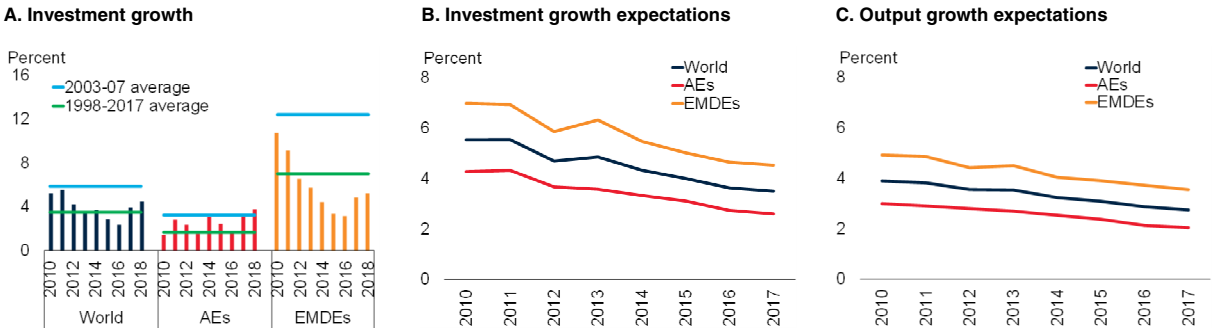
[3] Oliner, Sichel, and Stiroh (2007); Castellani et al. (2016); Raymond et al. (2015); and d'Artis and Siliverstovs (2016).

[4] Van Ark, O'Mahony, and Timmer 2008 document that investment in information and communication technology accounted for about one-third of the contribution of labor productivity to output growth in the European Union and the United States during 1995-2004. De Long and Summers 1992b estimate a 0.2- and 0.4-percentage-point increase in labor productivity growth in response to a 1-percentage-point increase in the investment-to-GDP ratio in a large sample of advanced and emerging market economies. Fournier 2016 finds that a 1-percentage-point increase in the share of public investment in primary government spending is associated with a 5 percent increase in long-term output in OECD countries.

BOX 3.3 Moving together? Investment and potential output *(continued)*

FIGURE 3.3.1 Potential output growth and investment growth

Investment growth in EMDEs has halved since 2010. Since capital accumulation makes a major contribution to potential output growth both directly, and indirectly via TFP, the slowdown has negative implications for future growth prospects.



Sources: Consensus Economics, Haver Analytics, Penn World Tables, World Bank.
Note: GDP-weighted averages.
A. Investment-weighted averages. Sample includes 37 advanced economies and 145 EMDEs.
B. Based on data for 24 advanced economies and 21 EMDEs. Five-year-ahead *Consensus* investment growth forecasts. Latest data is from July 2017.
C. Based on data for 24 advanced economies and 21 EMDEs. Five-year-ahead *Consensus* output growth forecasts. Latest data is from July 2017.
Click here to download data and charts.

2007 and 2015 has been entirely attributed to weakness in capital accumulation in OECD countries (Ollivaud, Guillemette, and Turner 2016). Conversely, investment busts may be accompanied by firm closures that reduce average productivity (Campbell 1998).

TFP and potential output during investment booms and busts

Data. Annual aggregate investment data is available from several sources, including the IMF, Eurostat, OECD, and World Bank. The impact of investment booms on TFP growth and on potential output growth is illustrated with an event study. Potential growth is estimated using the production function approach, but the results are robust to using other measures.

Definitions. An investment boom (bust) is defined as an episode during which investment growth is at least one standard deviation higher (lower) than its sample average for at least two consecutive years. The sample covers 94 episodes of investment booms and 32 episodes of investment busts in 40 EMDEs during 1980-2016. About one-half of busts but few booms occurred after the global financial crisis. A typical investment boom and bust episode lasts about 2.7 and 2.3 years, respectively.

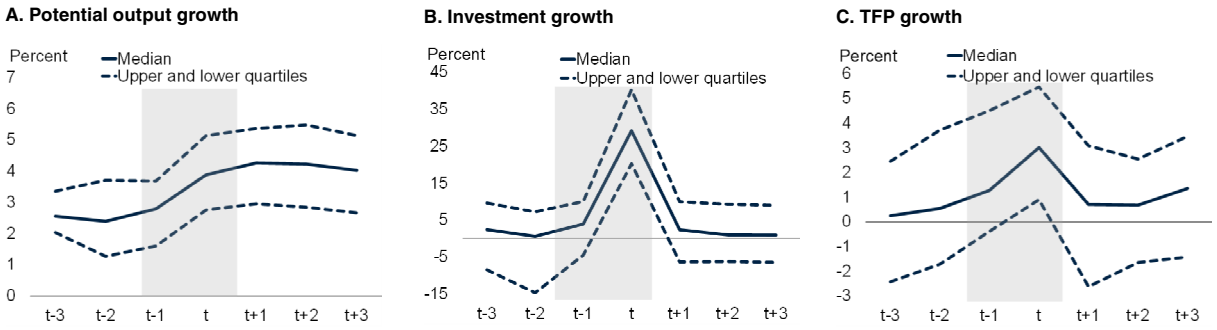
Methodology. The evolution of TFP growth and potential output growth 3 years before and after the boom and bust episodes are examined. The results derive from simple averages of the evolution of both variables and from a panel regression of potential growth on dummy variables for these events, controlling for country and year fixed effects. The two approaches serve somewhat different purposes. Simple averages illustrate the evolution of TFP and output growth during events while the regression approach allows a test of differences between event and non-event years.

Results. The event study suggests that the median investment boom in the sample is associated with a 2.8 percentage point a year increase in TFP growth and a 1.1 percentage point a year increase in potential output growth during the three years leading up to the peak of the investment boom (Figure 3.3.2). As the investment boom subsides, TFP and output growth rates gradually slow. Investment busts are associated with slowdowns in TFP growth of 4.9 percentage points a year and in potential growth of 1.0 percentage point a year during the three years leading up to the trough of the investment bust (Figure 3.3.3). Potential output growth and, especially, TFP growth usually rebound following a trough in investment growth. These events coincide with slower actual output growth. The panel regression confirms that the differences in TFP growth and potential growth during booms and busts from non-event years are statistically significant (Annex 3.3). While these results represent correlations, they are consistent with the results in the literature discussed above.

BOX 3.3 Moving together? Investment and potential output *(concluded)*

FIGURE 3.3.2 Growth around investment booms in EMDEs

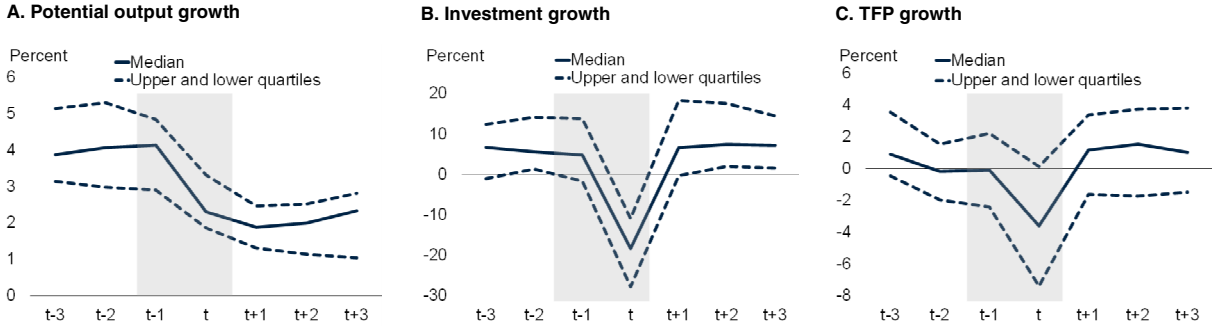
Investment booms have typically been associated with increases in potential output growth, followed by gradual slowdowns. Surges in TFP growth during investment booms have tended to be quickly reversed.



Source: World Bank.
Notes: An investment boom is defined as an episode during which investment growth is at least one standard deviation larger than its long-run (over the sample period) average level. t denotes the average of the investment boom. The event studies in this box are conducted using the boom and bust episodes of at least two consecutive years. Shaded area is the peak of the investment boom. Solid lines indicate median, dotted lines indicate interquartile range.
A. Potential growth defined by production function approach.
C. Actual TFP growth as defined in Annex 3.1.
Click here to download data and charts.

FIGURE 3.3.3 Growth around investment busts in EMDEs

Investment busts have tended to be accompanied by lower subsequent or contemporaneous potential output growth, followed by gradual recoveries. TFP growth has tended to slump during investment busts but to rebound quickly as investment growth recovered.



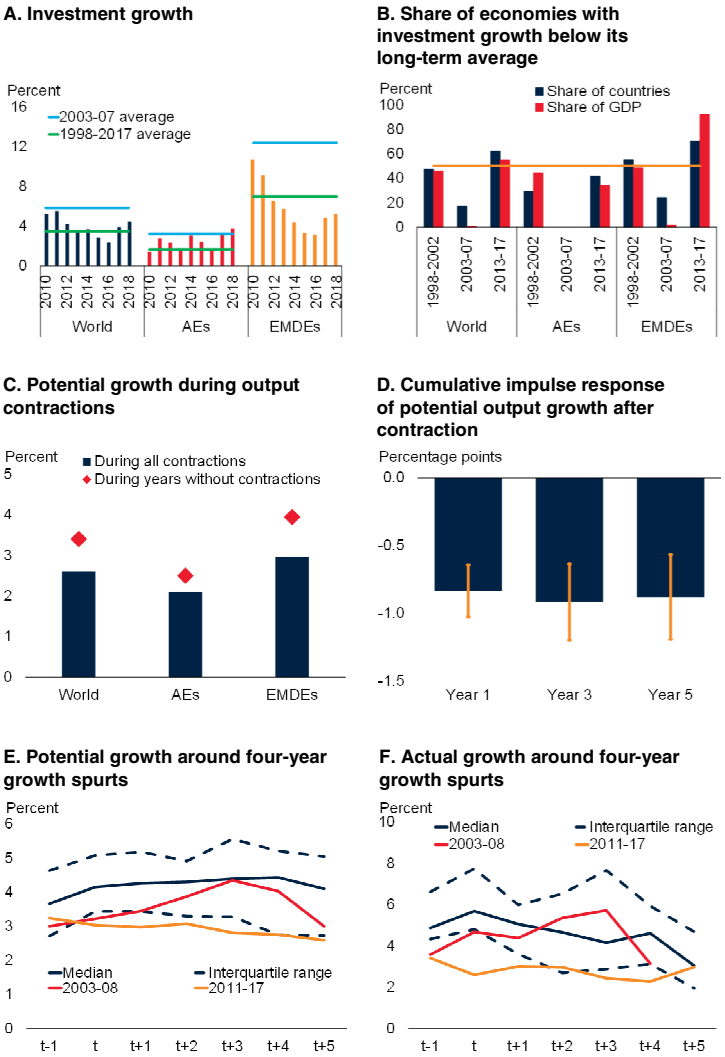
Source: World Bank.
Notes: An investment bust is defined as an episode during which aggregate investment is at least one standard deviation lower than its long-run average level. t denotes the average of the investment bust. The event studies in this box are conducted using the boom and bust episodes of at least two consecutive years. Shaded area is the trough of the investment bust. Solid lines indicate median, dotted lines indicate interquartile range.
A. Potential growth defined by production function approach.
C. Actual TFP growth as defined in Annex 3.1.
Click here to download data and charts.

Conclusion

Ample evidence supports the existence of multiple linkages between investment growth and potential output growth. By eroding productivity growth, investment busts have adverse indirect effects on potential growth, above and beyond the direct effects of slowing capital accumulation. The slowdown in investment growth in EMDEs since 2010, therefore, raises substantial longer-run concerns. The association between sharp swings in investment growth and changes in potential output growth suggests that proactive policy measures might usefully support investment, against the risk of investment busts, to avoid an erosion of potential growth.

FIGURE 3.6 Investment growth

Investment growth in EMDEs has slowed sharply since the global financial crisis from double-digit rates after the global financial crisis to a post-crisis low of—3 percent in 2016. Investment weakness during deep recessions, such as the global financial crisis, is one reason why output contractions are associated with about 1 percentage point lower potential growth for the next half-decade. Conversely, a cyclical upturn may generate its own momentum to lift potential growth. Following four-year growth spurts, potential growth rose around 1 percentage point above median potential growth in years outside such spurts.



Sources: Penn World Tables, World Bank.

A. Investment-weighted averages. For a sample of 37 advanced economies and 145 EMDEs.

B. Share of 139 countries in which investment growth is below the longer-term average (1998-2017).

C. D. Contractions are defined as the years of negative output growth from the year after the output peak to the output trough, as in Huidrom, Kose, and Ohnsorge (2016). Sample includes up to 32 advanced economies and 45 EMDEs during 1989-2016. The methodology is described in detail in Annex 3.4. Unweighted averages of potential growth during contractions compared with all other country-year pairs without such events (C). Impulse response for the full sample of up to 77 advanced and EMDE economies from local projections model, as described in Annex 3.4, over horizons of 1, 3, and 5 years (D). Dependent variable defined as cumulative slowdown in potential growth after a contraction event using baseline specification. Bar shows coefficient estimates, vertical lines shock +/- 1.64 standard deviations (10 percent confidence bands). Potential growth based on production function approach.

E. F. Median of potential growth using the production function approach (E) or actual growth (F) during 81 episodes (12 percent of country-year pairs) of growth upswings during 1988-2017 (9 in advanced economies, 72 in EMDEs). *t* = 0 is the fourth consecutive year in which growth has been positive and strengthened from year to year. "Median" indicates the median for *t* years in the five years around the upswing event. During non-event years, median actual growth was 3.2 percent and median potential growth was 2.9 percent. Sample includes 98 economies for 1988-2017.

Click here to download data and charts.

growth. In addition, deep recessions may lower labor productivity by extending unemployment spells that erode human capital. If accompanied by financial stress, recessions can reduce profitability or access to finance for productivity-enhancing R&D spending, technology absorption, and operations of innovative firms. Indeed, short-term output shocks often precede persistent potential growth slowdowns (Box 3.4). Output contractions have tended to leave a legacy of lower potential growth (by as much as 1 percentage point on average) four to five years after the onset of the contraction. The effects have tended to be initially stronger, but less persistent, for EMDEs.

Consequences of sustained cyclical recoveries. Conversely, the cyclical upswing currently underway may generate its own momentum that feeds into higher potential growth.[10] With improving growth, investors may become keener to invest. The embodied new technologies may, in turn, spark a burst of productivity growth. Rising employment may build workplace skills and, therefore, raise labor productivity. Over the past three decades, strong growth spurts—defined as years in which growth accelerated in four consecutive years—have been associated with about 1-percentage-point higher potential growth than in the median normal year.[11] Initially, this increase in potential growth was only one-third of the increase in actual growth, but was sustained even as the growth spurt dissipated (Figure 3.6). However, such growth spurts were rare: in the sample used here, they represent only 12 percent of all country-year pairs.

Labor supply

Channels of transmission. Growing working-age populations have been associated with "demographic dividends" to growth. Higher working-age shares of populations have been accompanied by higher capital accumulation and employment

[10] Past growth accelerations have been associated with better institutions, increased economic openness, and greater macroeconomic stability (Berg, Ostry, and Zettelmeyer 2013).

[11] Over the past three decades, there have been about 81 episodes (9 in advanced economies, 72 in EMDEs) in which actual growth accelerated every year for four consecutive years.

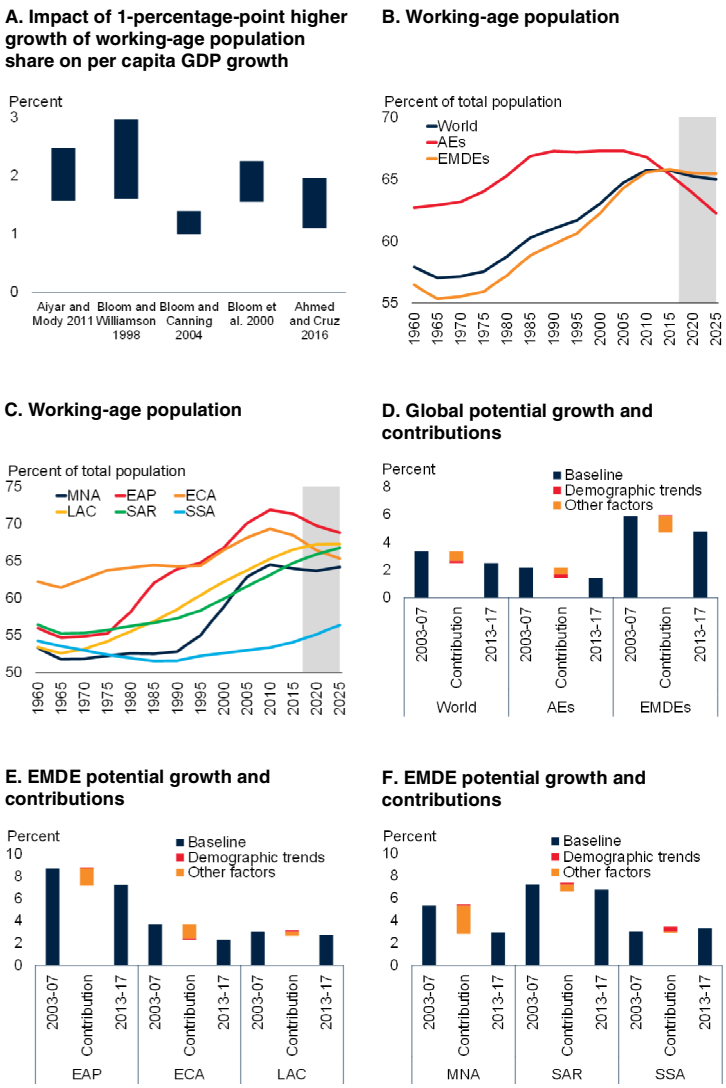
(Bloom and Canning 2004; IMF 2004; Figure 3.7).[12] Shifts towards an older age structure of the population affect potential output in several ways. Population aging may reduce the working-age population, which directly reduces potential labor supply. There are also less direct effects of population aging. For example, aging increases the share of the population with below-average labor force participation rates. Aging populations have been associated with slower labor productivity growth for various industries and occupations (Maestas, Mullen, and Powell 2016).

Another important driver of increased labor supply can be labor force participation among less represented groups, including women, young, and old workers. Rising female labor force participation rates have been attributed to better educational attainment (opening access to higher-earning jobs), lower fertility rates, a technology-driven shift toward non-manual skills, and cheaper home production (lowering the opportunity cost of working).[13]

Evolution of demographics. In the past five decades, growth was supported by rapidly growing working-age populations—until the mid-1980s in advanced economies and around 2010 in EMDEs (Figure 3.7). Since 2000, countries with rising working-age population shares accounted for half of global output growth and three-quarters of global GDP levels. With the retirement of the baby boom generation and lower fertility rates, demographic trends have turned less favorable to growth and will continue to do so over the next decade. In advanced economies, the working-age share of the population is set to decline, from 65.4

FIGURE 3.7 Demographics

Higher working-age population shares are associated with higher per capita output growth. Global demographic trends turned from tailwinds to growth into headwinds around 2010. Since 1998-2002, demographic trends shaved about 0.1 percentage point off global potential growth. In EMDEs, other factors were also important, and the impact varied by region.



Source: United Nations *World Population Prospects: The 2017 Revision.*
Note: EAP = East Asia and Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
A. The sample of each study differs from each other. Aiyar and Mody (2011): Indian states, 1961-2001; Bloom and Williamson (1998): 78 countries, 1965-90; Bloom and Canning (2004): Over 70 countries, 1965-95; Bloom et al. (2000): 70 countries, 1965-90; Amer and Cruz (2016): 160 countries, 1960-2010.
B.C. Population weighted averages. The working-age population is defined as people aged 15-64 years.
D. -F. GDP-weighted averages. Other factors include contribution from policy changes, cohort effects, changes in population growth, convergence-driven productivity growth, and investment. "Contribution" reflects percentage-point changes between the averages of 2003-07 and 2013-17. Methodology is described in detail in Annex 3.1.
Click here to download data and charts.

[12] The benefits from a rising working-age population have been particularly pronounced in Asia (Bloom et al. 2010; Bloom et al. 2007; Aiyar and Mody 2011). Demographic change over the period 1960-1995 for 86 countries has been estimated to have accounted for approximately 20 percent of per capita output growth, and more in Asia and Europe (Kelly and Schmidt 2005). Cruz and Ahmed (2016) estimated that a 1-percentage-point increase in the working-age population share was associated with a more-than-proportional increase in GDP per capita growth in 160 countries over 1960-2010. Other studies of the relationship between demographics and growth include Higgins and Williamson (1997); Eastwood and Lipton (2011); and Kelley and Schmidt (1995 and 2007).

[13] These factors have been explored in Mincer (1962); Goldin (1994); Hill (1983); Killingsworth and Heckman (1986); and Connelly (1992).

BOX 3.4 The long shadow of contractions over potential output

Contractions are associated with about 1 percentage point lower potential growth four to five years after their onset. The effect is initially stronger, but less persistent, for emerging market and developing economies.

The slow recovery from the global financial crisis and the sharp slowdown in commodity-exporting EMDEs caused by the recent slump in commodity prices have reignited the debate about the impact of deep recessions on potential output levels and growth. Global output contracted by 1.8 percent in 2009 and, in 2017, remained 4 percent below its pre-crisis trend. Most EMDEs avoided outright contractions in 2009—partly as a result of large stimulus. However, one-quarter of commodity-exporting EMDEs subsequently slid into recessions as commodity prices declined. In others, growth halved as a result of domestic political tensions or spillovers from policy uncertainty elsewhere. This post-crisis growth weakness has coincided with a decline in potential growth (Figure 3.4.1).

Severe short-term output shocks have been associated with highly persistent losses in output levels in both advanced economies and emerging market and developing economies (EMDEs). In advanced economies, output growth also tends to remain lower after recessions than pre-recession for a protracted period.[1] On average in a sample of 40 advanced economies and EMDEs, a recession was associated with 0.5 percentage point lower per capita potential growth in the two years following the pre-recession output peak, but half of this decline was reversed over the following two years (Haltmeier 2012).

Against this background, this box focuses on the impact of contractions on potential growth in a large sample of AEs and EMDEs. Specifically, it addresses the following questions:

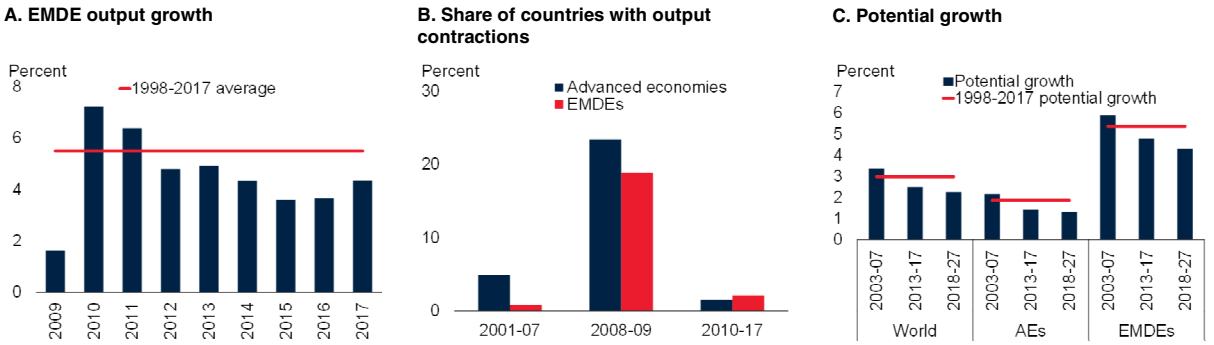
- How can contractions affect potential growth?
- What has been the impact of contractions on potential growth?

Linkages: Theory and evidence

A number of mechanisms may drive potential output losses as a result of crises or severe contractions. Theoretical models highlight the role of weak profitability for

FIGURE 3.4.1 Output

Global output remains 4 percent below its pre-crisis trend. While most EMDEs avoided outright contractions in 2009—partly as a result of large stimulus—several subsequently slid into recessions or sharp slowdowns. Since the global financial crisis, potential growth has also slowed, by all measures of potential growth.



Source: World Bank.
Note: GDP-weighted averages.
B. Includes 38 advanced economies and 150 EMDEs.
C. Potential growth estimates based on the production function approach.
Click here to download data and charts.

Note: This box was prepared by Sinem Kilic Celik and Franziska Ohnsorge.

[1] For research on the impact of contractions on growth, see Cerra and Saxena (2008); Candelon, Carare and Miao (2016); Queralto (2013); Blanchard, Cerutti and Summers (2015); Martin, Munyan, and Wilson (2015); Ball (2014); and Haltmeier (2012).

BOX 3.4 The long shadow of contractions over potential output *(continued)*

productivity-enhancing R&D spending (Fatás 2000), a liquidity demand shock that tightens availability of funds for technology absorption (Anzoategui et al. 2016), loss of access to bank lending for creative firms (Queralto 2013), a legacy of obsolete capacity (Nguyen and Qian 2014), self-fulfilling expectations of weak growth prospects (Caballero and Simsek 2017), human capital loss and reduced job search activity among the long-term unemployed (Lockwood 1991; Lindbeck 1995; and Blanchard and Summer 1987), and lower labor productivity after financial crises (Oulton and Sebastia-Barriel 2016). Damage to aggregate output during the global financial crisis in the United States has been attributed to a nonlinear effect of demand-side weaknesses (as captured by a threshold unemployment rate, Reifschneider, Wascher, and Wilcox 2015). Other studies also find that the adjustment of growth or output levels to the pre-recession trend is non-linear and depends on the persistence, depth and source of the recession and its coincidence with financial crises.[2]

Potential output during contractions

Data. The literature on the impact of recessions on potential growth has focused on univariate filter-based methodologies. Since they correlate strongly with actual growth, including during contractions, these filters tend to show a decline in potential growth during the depth of the recession and a subsequent rebound in synch with actual growth (Box 3.1). In contrast, potential growth based on the production function approach will only change in response to contractions if long-term fundamental drivers change substantially for an extended period of time. To capture this longer-term impact, this box focuses on the potential growth measure derived from the production function approach. That said, the results are robust to the use of other methodologies.

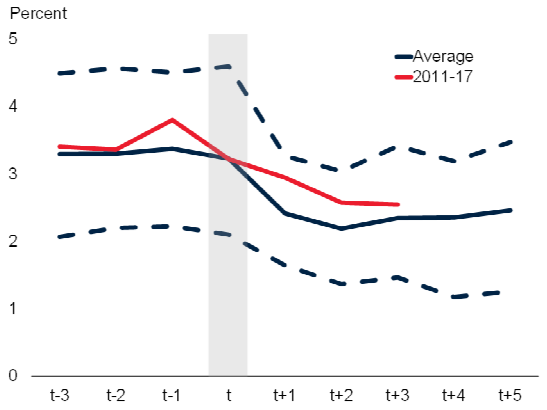
Definitions. Contractions are defined as years of negative output growth as in Huidrom, Kose, and Ohnsorge (2016). Depending on data availability for potential growth estimates, this definition yields up to 47 contraction events in 32 advanced economies and up to 77 contraction events in 49 EMDEs during 1990-2016 (Annex 3.4). Contractions, on average, lasted 1.4 years and were associated with growth of -4 percent, on average. In EMDEs, contractions were, on average, similarly short

[2] See Claessens, Kose, and Terrones (2009 and 2012); Furceri and Mourougane (2012); Haltmeier (2012); and Ball (2014).

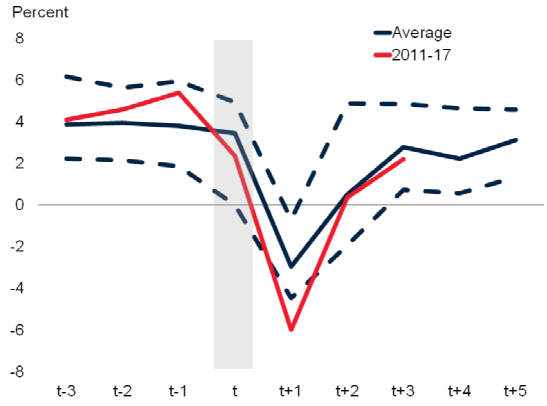
FIGURE 3.4.2 Potential growth around contractions

Contractions are associated with lower potential output growth.

A. Potential growth during contractions: Production function approach



B. Actual growth around contractions



Sources: Huidrom, Kose, and Ohnsorge (2016); World Bank; World Economic Outlook, International Monetary Fund.

Note: Contractions are defined as the years of negative output growth from the year after the output peak to the output trough, as in Huidrom, Kose, and Ohnsorge (2016). Sample includes 37 contraction events in advanced economies and 44 contraction events in EMDEs during 1989-2016. The methodology is described in detail in Annex 3.4. Dotted lines indicate interquartile range.

A. B. Unweighted averages of potential growth as estimated by the production function approach (A) or actual growth (B) during contractions. t denotes the peak preceding the contraction. 2011-17 is the unweighted average for countries with contraction episodes after a peak in 2014.

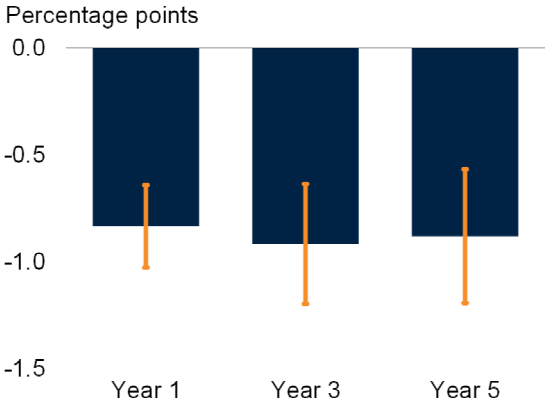
Click here to download data and charts.

BOX 3.4 The long shadow of contractions over potential output *(concluded)*

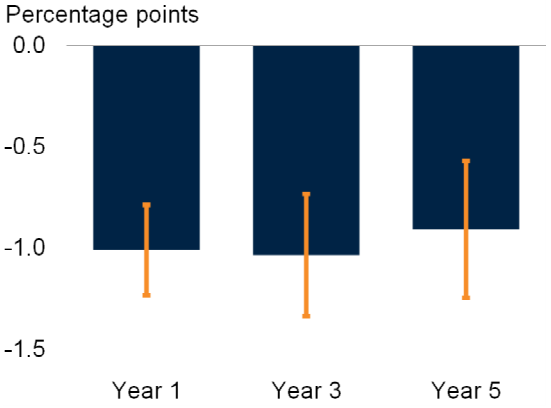
FIGURE 3.4.3 Potential growth after contractions

The fall in potential growth following contractions persists over the following half-decade, but with considerable uncertainty around the magnitude of the effect.

A. Cumulative impulse response of potential output growth after contraction



B. Cumulative impulse response of EMDE potential output growth after contraction



Sources: Huidrom, Kose, and Ohnsorge (2016); World Bank; World Economic Outlook, International Monetary Fund.

Notes: Contractions are defined as the years of negative output growth from the year after the output peak to the output trough, as in Huidrom, Kose, and Ohnsorge (2016). Sample includes yields 37 contraction events in advanced economies and 44 contraction events in EMDEs during 1989-2016. The methodology is described in detail in Annex 3.4.

A. Impulse response for the pooled sample of up to 77 advanced and EMDE economies from local projections model, as described in Annex 3.4, over horizons of 1, 3, and 5 years. Dependent variable defined as cumulative slowdown in potential growth after a contraction event using the baseline specification. Bars show coefficient estimates, vertical lines show 90 percent confidence bands.

B. EMDE sample only.

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(1.3 years) but somewhat more severe (-4.4 percent) than in advanced economies (-3.4 percent).

Methodology. Two exercises are conducted to estimate the impact of short-term output shocks on potential growth: an event study and a local projections model (Jorda, Schularick, and Taylor 2013; Mourougane 2017). For the event study, average potential growth during contractions (all years from the year after the peak to the trough of output) is examined over time and compared with average potential growth in all other years. The local projections model is used to estimate impulse responses of potential growth to contractions.

Evolution of potential growth during contractions. Two years following the average contraction, potential growth is still more than 1.2 percentage point below potential growth in the year preceding the contraction (exceeding the decline in actual growth over the same period; Figure 3.4.2). The effect is somewhat stronger in EMDEs than in advanced economies.

The long shadow of contractions. The local projections model helps explore the evolution of potential growth following contractions. Contractions leave a legacy of lower potential growth (about 1 percentage point) four to five years after the onset of the contraction (Figure 3.4.3). The effect is initially stronger, but less persistent, for EMDEs.

Conclusion

For advanced economies, short-term economic disruptions such as output contractions have been shown to reduce *actual* output for several years to come. This box documents that such contractions tend to be associated with weaker *potential* output growth for the following half-decade, although with considerable uncertainty around the magnitude of the effects. Depending on the measure of potential growth, contractions are associated with up to 1 percentage point lower potential growth four to five years after the onset of the contraction. The effect is initially stronger, but less persistent, for EMDEs.

percent in 2015 to 62.3 percent by 2025. In EMDEs, the working-age share of the population peaked at 65.8 percent in 2015 and is expected to stabilize around this level for the next 10 years. While the largest declines are expected in EAP and ECA, working-age shares of the population are expected to rise in Sub-Saharan Africa and South Asia.

In addition to the changing age composition of the population, expanding female labor force participation has increased labor supply, especially in EMDEs. Female labor force participation has been broadly stable over the two decades from 1998-2002 to 2013-17, however with a wide divergence across EMDE regions. Supported by surging school enrollment and completion rates, female labor force participation rates in LAC rose by almost 6 percentage points between 1998-2002 and 2013-17. In contrast, despite some (more modest) improvements in education, they declined in SAR by almost as much over the same period. Among EMDEs, female labor force participation remains less than three-quarters of male labor force participation.

The role of demographics in potential growth. The overall effect of demographics on potential growth—via TFP growth and labor supply growth—can be assessed using the production function approach. The estimates compare baseline potential growth estimates against counterfactual scenarios in which the composition of the population for all age groups and genders remains at their 1998 values (Annex 3.1).[14] The results suggest that, in 2013-17, demographic trends had lowered global potential growth by 0.2 percentage point from its 2003-07 average. Advanced economies accounted for all of this decline. In EMDEs, with the exception of ECA, growing and younger working-age populations lifted potential growth marginally over the same period. Trends in female labor force participation benefited some EMDE regions' potential growth while weighing on others'. Over the longer-term (1998-2017), higher female labor force participation contributed 0.3 percentage point to potential growth in LAC, while it did not contribute appreciably to longer-term potential growth in SAR.

Prospects for potential growth: What could happen?

Factors weighing on potential growth over the past five years are likely to persist over the next decade. Demographic trends are expected to become less favorable. This will weigh on potential growth even if trend improvements in human capital and female labor force participation continue. Although investment growth is expected to recover from its recent weakness, it is unlikely to return to elevated pre-crisis levels. Short of unexpected surges in productivity growth—perhaps as a result of dissipating crisis legacies or unanticipated technological breakthroughs—these trends imply an outlook for mediocre potential growth.

Baseline scenario assumptions. The forward-looking scenario presented here applies the production function approach to assumed paths for capital, population statistics, and education and health outcomes.

- The size of the global population and its composition are assumed to grow in line with a median fertility scenario (as in the UN Population Projections).[15]
- Past trend improvements in EMDE education and health outcomes are expected to continue.
- In line with the historical experience, investment growth is assumed to remain constant at its long-term average.

Evolution of drivers of global potential growth. Under this baseline scenario, the fundamental drivers of potential growth all point to continued softening.

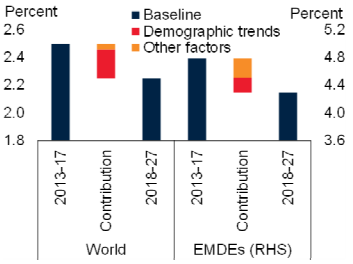
[14] Such thought experiments are widely used to assess the impact of demographics on growth or growth projections (Bloom, Canning, and Fink 2010; European Commission 2015).

[15] This scenario also assumes that migration flows continue on past trends.

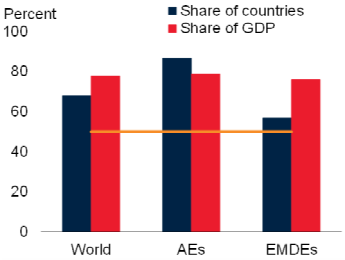
FIGURE 3.8 Potential growth prospects

Over the next decade, trends in fundamental drivers of potential growth suggest that global potential growth may slow by another 0.2 percentage point and EMDE potential growth by 0.5 percentage point. This slowdown will likely be broad-based: 69 percent of economies, accounting for more than 78 percent of global output, are expected to have potential growth below its longer-term average.

A. Potential growth



B. Share of countries and GDP of countries with potential growth in 2018-27 below its longer-term average



Source: World Bank estimates.
A. GDP-weighted averages. Derived using the production function-based potential growth as described in Annex 3.1. "Other factors" reflects declining population growth, convergence-related productivity growth, policy changes, cohort effects, and a slowdown in investment growth relative to output growth. "Contribution" reflects the percentage-point changes between the averages of 2013-17 and 2018-27.
B. Share of countries and share of GDP of 80 countries in which potential growth in 2018-27 is below longer-term average potential growth (1998-2017), in percent of all countries or global GDP among 80 advanced economies and EMDEs. Horizontal line indicates 50 percent.
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- A slowing pace of capital accumulation, especially in China, will be offset by growing capital accumulation in advanced economies. In EMDEs other than China, the pace of capital accumulation will remain broadly steady as investment growth keeps pace with recovering output growth after its pronounced weakness of 2015-16.

- Subdued investment and less room for catchup productivity growth as per capita income differentials narrow for EMDEs will sap productivity growth. This could reduce potential growth by about 0.1 percentage point.

- Even if education and health outcomes continue to improve in line with their longer-term trends, aging populations combined with withdrawal from the labor market of older cohorts of workers could reduce global potential growth by another 0.2 percentage point on average.

Global potential growth. Thus, absent significant policy changes or productivity breakthroughs, global potential growth could decline by 0.2 percentage point, to 2.3 percent a year in 2018-27 (Figure 3.8). Two-thirds of the sample's economies, accounting for 78 percent of global output, would be left with potential growth below the longer-term average. Advanced-economy potential growth could slow by 0.1 percentage point to 1.3 percent a year.

EMDE potential growth could slow by 0.5 percentage point to average 4.3 percent a year during the next decade, well below its longer-term average. This slowdown would mostly reflect demographic trends (across most EMDEs) and weaker capital accumulation in China, as China's policy-guided investment slowdown continues (elsewhere capital accumulation is expected to recover partially from its post-crisis weakness). While China will account for 0.4 percentage point of the 0.5-percentage-point decline in EMDE potential growth, the decline will be broad-based, affecting almost two-thirds of EMDEs in the sample.

The slowdown would also be sizable for the largest EMDEs, which could generate adverse spillovers to other EMDEs that the production function approach does not explicitly account for.[16] Largely owing to weakening demographic trends and China's slowing capital accumulation, potential growth in the seven largest emerging markets (EM7) is expected to slow by 1.1 percentage point on average, of which China accounts for more than three-quarters. Aging (and, in some cases, shrinking) populations are expected to reduce G7 potential growth by 0.2 percentage point on average.

Regional potential growth. Potential growth is expected to slow over the next decade in all regions and fall below the longer-term average in all regions except SSA. In most regions, working-age shares of the population are expected to shrink. In SAR and SSA, working-age shares of the

[16] A 1-percentage-point decline in growth in the seven largest emerging markets (EM7) could slow growth in other EMDEs by 0.9 percentage point over the following three years. A similarly-sized decline in G7 growth could have a one-half to three times larger impact than an EM7 slowdown (Huidom, Kose, and Ohnsorge 2017).

population are expected to rise, but a shift is expected within the working-age population towards older cohorts with weaker labor market attachment.

- *EAP, LAC.* Potential growth is expected to moderate in EAP as policy efforts in China succeed shifting towards more sustainable growth engines, and the region's working-age population ages. China's potential growth is expected to slow to 6.5 percent, on average in 2018-27, from 9.1 percent on average during 1998-2017 (Figure 3.4). Elsewhere in EAP, potential growth is expected to remain solid. In LAC, demographic trends and the legacy of weak investment over the past half-decade will weigh on potential growth.

- *ECA, SAR, SSA.* Shrinking labor supplies and weak investment will weigh on potential growth in ECA and SAR as investment fails to return to the elevated levels seen before the oil price plunge and onset of policy uncertainty in mid-2014. In SSA, an expected slowdown in potential growth largely reflects population aging in South Africa, while elsewhere in SSA potential growth is expected to remain broadly steady at a robust 5 percent.

- *MNA.* Potential growth is expected to strengthen somewhat in the Middle East and North Africa. Investment and productivity growth are expected to firm provided conflict and geopolitical risks do not intensify again.

Policy options to lift potential growth

The production function framework can be applied to examine stylized policy scenarios. The impact of better policy outcomes is estimated as the difference between potential growth under a counterfactual scenario of higher growth of physical or human capital or labor supply compared with the baseline scenario (Annex 3.1). All counterfactual scenarios model a repeat of a country's best ten-year improvement, up to reasonable ceilings. The potential growth dividend of the scenarios therefore depends on each country's track record as well as its room for improvement. For productivity-raising reforms not easily measured or explicitly modelled in the production function, such as improvements to governance or business climates, an event study provides some guidance about possible effects. The estimate provided in these stylized scenarios may well be lower bounds because they disregard nonlinearities in reform impacts as well as synergies between different reform measures.

Raising physical capital

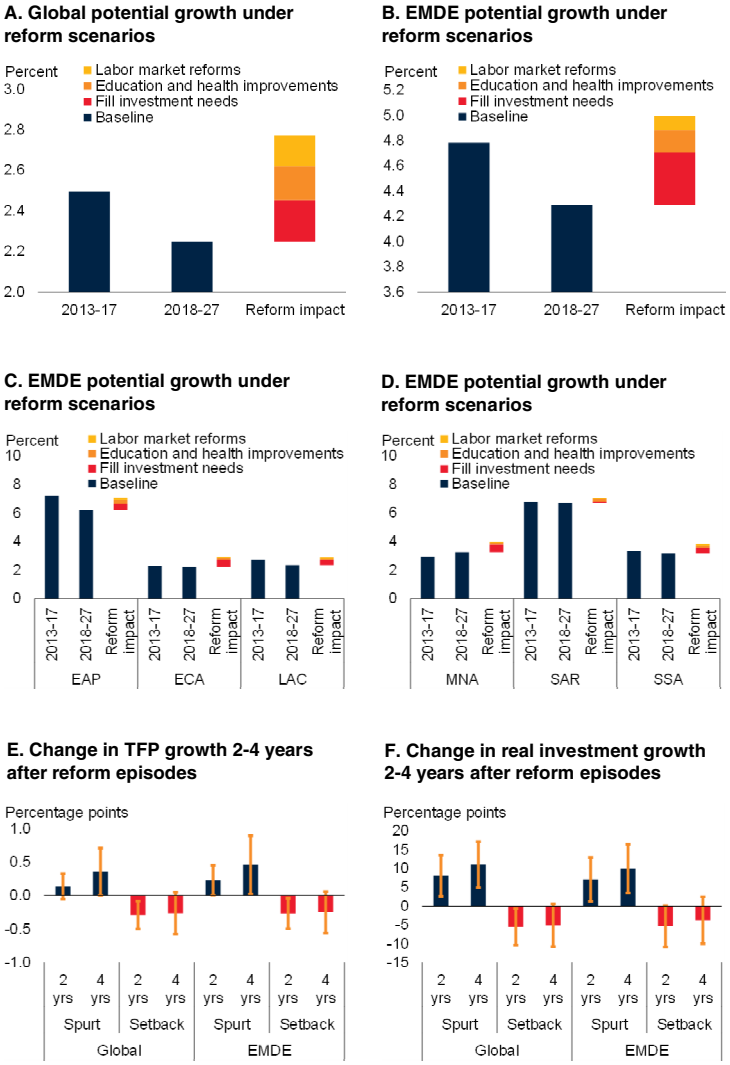
All EMDE regions have sizable investment needs (Vashakmadze et al. 2017). UNCTAD (2014) estimated that unfilled global investment needs amount to up to 3 percent of global GDP. Depending on the availability of financing, these could be filled through either public or private investment or a combination of both in public-private partnerships. Increasing public investment can be an effective policy tool to support short-term demand while also helping to raise future potential growth (World Bank 2017a; Calderón and Servén 2010a, 2010b, and 2014). Although the rapid increase in public debt over the past decade has constrained fiscal space in most countries, there remains scope to shift existing government expenditures toward public investment to make government operations more growth-friendly (World Bank 2017b). Moreover, in many countries, government revenue ratios remain low, indicating that in some cases tax revenues could be raised, including by expanding tax bases or improving the quality of tax administration (World Bank 2015).

In addition, policies can support productivity-enhancing private investment. Innovation-related investment tends to be low in EMDE firms, partly because of limited availability of complementary inputs such as trained engineers or effective organization techniques (Cirera and Maloney 2017). Policy efforts to expand the supply of complementary inputs and capabilities and to raise the returns on investment through intellectual property right protection may foster private investment.

If, over the next decade, each country raised its investment growth as much as its largest increase

FIGURE 3.9 Policies to stem declining potential growth

A combination of additional investment, education, and health improvements and labor market reforms could stem the expected decline in global potential growth over 2018-27.



Source: World Bank estimates.
Note: GDP-weighted averages.
A. B. Derived using the methodology described in Annex 3.1.
E. F. Regression coefficients of potential TFP growth (E) and real investment growth (F) on dummies for structural reform spurts and setbacks—defined as statistically significant changes in four *Worldwide Governance Indicators*—from local projections model for lags of two and four years, for a sample of 136 EMDEs and 38 advanced economies during 1996-2015. Vertical bars show 90 percent confidence interval. A detailed methodology is available in Annex 3.5.
Click here to download data and charts.

over any historical ten-year interval, global investment-to-GDP ratios would rise by 2.3 percentage points of GDP. Investment-to-GDP ratios would rise somewhat more in EMDEs, by 2.9 percentage points of GDP. It is estimated that such an investment boost would raise global potential output by 2 percent by 2027, reversing the slowdown under the baseline scenario. EMDE potential output would rise even more (5 percent cumulatively by 2027; Figure 3.9).

Implicit in these scenarios is the premise that the additional investment will be used productively. In the context of EMDEs, there is some evidence that absorptive capacity can limit the success of large scaling-up of public investment, although this adverse effect is small in lower-income and capital-scarce countries (Presbitero 2016).

Raising human capital

Measures to raise human capital could lift both labor supply and TFP growth: A better educated workforce is more securely attached to the labor market and more productive. In particular, a better-educated workforce may be better able to adjust to technological disruptions that reduce employment and wages by replacing jobs (Acemoglu and Restrepo 2017a).[17] In the framework used here, human capital has two dimensions, educational attainment and health outcomes (proxied by life expectancy).

Education. While secondary school enrollment rates are near advanced-economy levels in the average EMDE, tertiary school enrollment rates (40 percent) and secondary and tertiary school completion rates (27 and 10 percent, respectively) were less than two-thirds of the advanced-economy average in 2013-17 on average. In addition to expanding access to education, such as captured by these measures, improving the quality of education to improve education outcomes is critical (World Bank 2017c).

There are a number of policies that can improve education outcomes. At the national level, these include policies targeted at better training for teachers, greater teacher accountability, and performance incentives (Evans and Popova 2016). The development of metrics to assess and accelerate progress toward learning goals is a

[17] The impact of such technological disruptions on output may not be clear-cut. For example, in aging societies, technological change to replace jobs may relieve pressures resulting from a shrinking labor supply (Acemoglu and Restrepo 2017b and 2017c). In addition, automation may expand labor demand by creating new tasks for which labor has a comparative advantage (Acemoglu and Restrepo 2016).

prerequisite for policy actions to improve educational outcomes (World Bank 2017c).[18] At the student-level, useful policies include efforts to tailor teaching to the requirements of students (Kremer, Brannen, and Glennerster 2013). Grants may encourage school attendance by disadvantaged students (Glewwe and Marulidharan 2015). Better early childhood nutrition and cognitive development improve students' capacity to learn (Tsimpo Nkengne, Etang Ndip, and Wodon 2017).

In a stylized policy scenario, education-related policy indicators—secondary and tertiary enrollment and completion rates—are assumed to rise over 2018-27 in each EMDE by as much as their largest historical improvement in any ten-year period. This would imply that EMDEs, on average, would raise secondary school completion rates by 5 percentage points and secondary and tertiary enrollment rates by 7 percentage points, on average, during the next decade. In EMDE regions that have made particularly large strides in improving education outcomes but still have ample room for further improvements, such as SAR, secondary school completion rates could rise as much as 16 percentage points over the next decade.

Health policies. At 71 years on average in 2013-17, life expectancy in EMDEs is still below that in advanced economies (82 years). Although regions such as SAR and SSA have made large improvements, raising life expectancy by 4-7 years over the past two decades, it remains about one-eight below advanced-economy levels.

Policy interventions to improve public health, and to ensure productive working lives, range widely. Better sanitation and access to clean water would improve public health: 9 percent of the global disease burden may be attributable to unsafe water, inadequate sanitation, and insufficient hygiene (WHO 2008). In addition, improvements in health care provision can be spurred by well-defined and regularly monitored performance indicators (Bradley et al. 2010). Comprehensive coverage of health services has been followed by better health outcomes in countries with higher per capita incomes (Maeda et al. 2014). At the local level, programs targeted at local health service providers or groups of patients have generated considerable improvements in health care services and outcomes. For example, in Rwanda, performance-based incentive payments helped significantly improve health indicators for children (Gertler and Vermeesch 2012). In India, enhanced training of primary health care providers led to better identification and treatment of patient ailments (Das et al. 2016).

In a stylized scenario of improved health, life expectancy is assumed to rise over 2018-27 in each EMDE by as much as its largest improvement over any historical ten-year period. This would imply an increase in life expectancy in EMDEs by 2.5 years, on average, but as much as 3.8 years in MNA over the next decade.

Impact on potential growth. These stylized scenarios suggest that improvements in education and health outcomes—via their effect on labor supply and TFP growth—could lift global and EMDE potential growth by 0.2 percentage point on average. In some EMDE regions with a strong track record of boosting human capital and ample room for improving education and health outcomes, such as in EAP, potential growth could rise by one-and-a-half times as much.

Impact on inequality. Better education and longer life expectancy will not only raise potential growth but also have implications for income inequality. While economic development may exert pressures for higher income inequality (e.g., because of growing urbanization), better education may alleviate some of these pressures (Special Focus 2).

Raising labor supply

At 49 percent, on average, in 2013-17, global female labor force participation remains two-thirds that of men (75 percent), and it is even lower in EMDEs. Similarly, in both EMDEs and advanced economies, the average labor force participation rate among workers aged 55 years or older is about one-half that of 30-45-year-old workers, and labor

[18] Other measures such as reducing student-teacher ratios or additional years of schooling have effects that differ widely depending on country circumstances (Evans and Popova 2016; Hanushek and Woessman 2008).

force participation among 19-29 year-olds is only four-fifths that of their 30-45-year-old peers.

Labor supply can be raised by drawing a greater share of the working-age population into the labor force. This can be achieved through policies to "activate" discouraged workers or groups with historically low participation rates, such as women and younger or older workers.

In advanced economies and EMDEs, active labor market policies and reforms to social benefits were followed by higher labor force participation rates (Betcherman, Dar, and Olivas 2004; Card, Kluve, and Weber 2010). Less rigid employment protection regulation and lower minimum wages have had mixed effects on employment and labor force participation and, at times, unintended side effects such as lower labor force participation of disadvantaged groups (Betcherman 2014).

In EMDEs, policies aimed at other objectives have sometimes brought important collateral benefits that improve labor force participation. For example, in Nigeria, improved access to finance and training programs increased female labor force participation by encouraging firm startups (Brudevold-Newman et al. 2017). In Uruguay, the extension of the school day was associated with higher adult labor force participation (Alfaro, Evans, and Holland 2015). In Eastern Europe and Central Asia, shifting health care systems towards services targeted at the elderly has helped extend productive life times, and providing support services to women with families has helped encourage labor force participation (Bussolo, Koettl, and Sinnott 2015).

Female labor force participation rates—along cohort-, age-, and country-specific dimensions—are assumed to rise, over the next decade, by the largest historical ten-year improvement in each EMDE (in a stylized labor market reform scenario), although they will not exceed the rates of same-aged men. On average, this would imply raising female labor force participation rates by 10 percentage points by 2027. The premise underlying this assumption is that, over the decade, sufficient jobs will be created to absorb this additional labor supply.

Impact on potential growth. In such a stylized labor market reform scenario, global and EMDE potential growth could rise by 0.2-0.1 percentage point, respectively, on average, over 2018-27. Again, such a renewed reform push could yield the largest dividends for EMDE regions with both a strong track record and sizable remaining gaps between male and female labor force participation rates (e.g., LAC).

Raising productivity

Institutional reforms could help lift productivity growth. Better institutional quality, such as control of corruption, application of the rule of law, and improved political stability, has accompanied higher and more stable growth. At the firm-level, more friendly business climates have favored firm productivity and a shift from informal activities to more productive formal activities (Box 3.5).

Reforms that lift microeconomic distortions and frictions can unlock productivity growth by fostering reallocations at the sectoral, firm, and worker level. Reforms that increase product market flexibility or competition (e.g., trade integration) could raise aggregate productivity growth by encouraging a reallocation of resources away from unsuccessful firms to more productive ones (Melitz 2003; Bernard, Jensen, and Schott 2006). Labor market reforms that improve the allocation of talent, such as broadening access to occupations, can generate considerable productivity growth (Hsieh et al. 2013). Reforms to level the playing field (e.g., state-owned enterprise reforms) could encourage entry of more productive firms and, thus, raise aggregate productivity (Brandt, van Biesebroek, and Zhang 2012).

Reforms to strengthen competition could have synergies with reforms to improve human capital. Firms in EMDEs tend to innovate in marginal process and product improvements rather than engaging in significant technology adoption or new product imitation (Cirera and Maloney

BOX 3.5 Productivity and investment growth during reforms

Wide-ranging governance and business climate reforms have been associated with higher potential growth through an increase in TFP growth and investment growth over the subsequent two to four years.

In many emerging market and developing economies (EMDEs), enterprises claim that a wide range of institutional problems constitute significant obstacles to doing business. Recent World Bank enterprise surveys for more than 10 percent of EMDEs rank law and order, customs and trade regulation, and tax administration among the top three non-financial obstacles to doing business.[1] Weak governance, often manifested in corruption and large informal sectors, was also a common complaint.

By removing obstacles to firms' operations, governance and business climate reforms can raise potential growth through their impact on productivity and investment growth.[2] This box addresses the following questions.

- How do weak governance and business climates affect growth?
- How has TFP and investment growth evolved during major reform episodes?

How do weak governance and business climates affect growth?

Institutional quality. Improved institutional quality clarifies and protects property rights, facilitates contracts between non-related parties and, therefore, promotes a more efficient allocation of resources (Acemoglu and Johnson 2005). Institutional quality is associated with higher and more stable long-term growth. In particular, less corruption typically accompanied higher growth and investment, although such dividends have depended on country circumstances (Hodge et al. 2011; de Vaal and Ebben 2011; Shleifer and Vishny 1998). Greater political stability encourages stronger growth, investment, and lower levels of government spending (Aisen and Veiga 2013). Aspects of the rule of law, such as the provision of security and the protection of property rights, are correlated with higher growth or lower growth volatility (Haggard and Tiede 2011; Acemoglu, Johnson, and Robinson 2001; World Development Report 2017).

Business climate. Poor business climates encourage anticompetitive practices, curtail innovation and hold back an efficient allocation of factors of production (Bourles et al. 2013; Buccirossi et al. 2013; Aghion and Schankermann 2004). While they be intended to provide social protection, stringent labor regulations often encourage informal employment and constrain firm size (Bruhn 2011; La Porta and Shleifer 2014; Loayza, Oviedo, and Servén 2005; Loayza and Servén 2010). Weak business environments dampen the crowding-in effects on domestic investment that would otherwise accrue from public and foreign direct investment (Kose et al. 2017). Burdensome business regulations amplify the adverse effect of corruption on firms' labor productivity (Amin and Ulku forthcoming). Trade restrictions are associated with lower firm productivity, especially when accompanied by heavy domestic industrial regulation (Topalova and Khandelwal 2011). Conversely, reforms that implement major improvements in business environments are associated with increased output growth (Divanbeigi and Ramalho 2015; Kirkpatrick 2014).

How has TFP and investment growth evolved during major reform episodes?

To illustrate the linkages between major governance and business climate reform efforts and TFP (or investment) growth, an event study and a local projections model are employed.[3] Two sets of events are defined, based on two different datasets of structural indicators. Major reform spurts and setbacks are either defined as those that lift or reduce at least one of four *Worldwide Governance Indicators* (government effectiveness, control of corruption, rule of law, and regulatory quality) by at least 2 standard errors over two years as in Didier et al. (2015).[4] Alternatively, major reform spurts and setbacks are defined as those that lift or reduce the "distance to the frontier"[5] for at least one of the ten *Doing Business* indicators by at

Note: This box was prepared by Sinem Kilic Celik.

[1] This ranking excludes the two financial obstacles, access to finance and tax rates.

[2] Reform payoffs may take some time to materialize and their growth dividend will depend on the country's stage of development and the technology level of the country (Dabla-Norris 2016).

[3] This box analyzes potential TFP growth to assess the long-term effect of structural reforms. Hence, TFP growth refers to potential TFP growth throughout the box.

[4] This yields 247 events in 136 EMDEs and 38 advanced economies during 1996-2015.

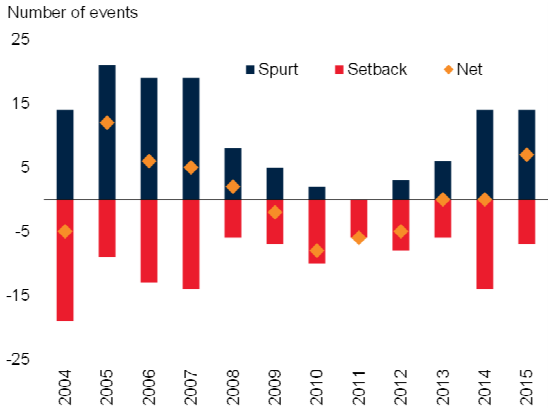
[5] An economy's distance to frontier is indicated on a scale from 0 to 100, where 0 represents the lowest performance and 100 the frontier, which is constructed from the best performances across all economies and across time.

BOX 3.5 Productivity and investment growth during reforms *(continued)*

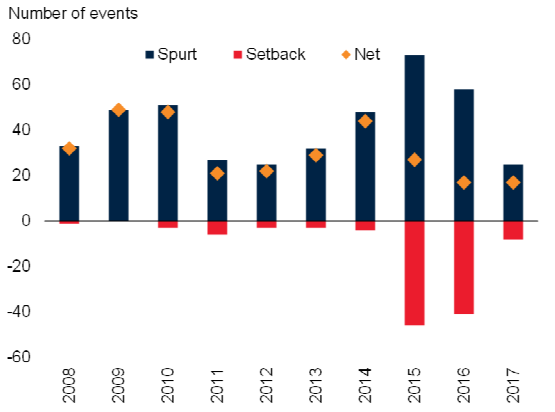
FIGURE 3.5.1 Reform spurts and setbacks

Progress in reforms has been mixed since 2014, with some evidence that the pace of governance reforms has accelerated more than that of business climate reforms.

A. Worldwide Governance Indicators: Number of reform spurts and setbacks



B. Doing Business indicators: Number of reform spurts and setbacks



Source: World Bank.
Note: A detailed methodology is available in Annex 3.5.
A. For *Worldwide Governance Indicators*, reform events are defined as two-standard-error changes in one of four *Worldwide Governance Indicators* for 136 EMDEs and 38 advanced economies during 1996-2015.
B. For *Doing Business* indicators, reform events are defined as two-standard-deviation changes in distance to frontier in one of ten *Doing Business* indicators in 127 EMDEs and 34 advanced economies during the same period during 2002-17.
Click here to download data and charts.

least two standard deviation over two years.[6] Details of the methodology are described in Annex 3.5.

Progress in reforms has been mixed since 2014, with some evidence that the pace of *governance* reforms has accelerated more than that of business climate reforms. Over 2014-15 (the last available data), governance reform spurts have become more common while reform setbacks have become less common compared to the immediate post-crisis period (Figure 3.5.1). In 2015, for the first time since the global financial crisis, reform spurts outnumbered reform setbacks. For *business climate* reforms, however, a surge in reform spurts in 2015-16 was largely offset by a surge in reform setbacks. As a result, while reform spurts have continued to outnumber setbacks, the pace of net improvements has not accelerated compared to the immediate post-crisis period (Figure 3.5.1). Around reform episodes, potential TFP and investment growth has tended to be higher than during "normal" years.

- Reform spurts reflected in *Worldwide Governance Indicators* were, on average, associated with about 1 percentage point higher TFP growth globally and somewhat more in EMDEs during the spurt (Figure 3.5.2).[7] Investment growth was 9 percentage points higher during the average reform spurt and about 2 percentage points lower during the average reform setback.
- When reform spurts reflected in *Doing Business* indicators exceeded reform setbacks, TFP growth typically rose by 0.2 percentage point among EMDEs. During these episodes investment growth in EMDEs was about 1.6 percentage points above that in "normal" years (Figure 3.5.2).

The local projections model suggests that the effects of governance reform spurts and setbacks build over time.

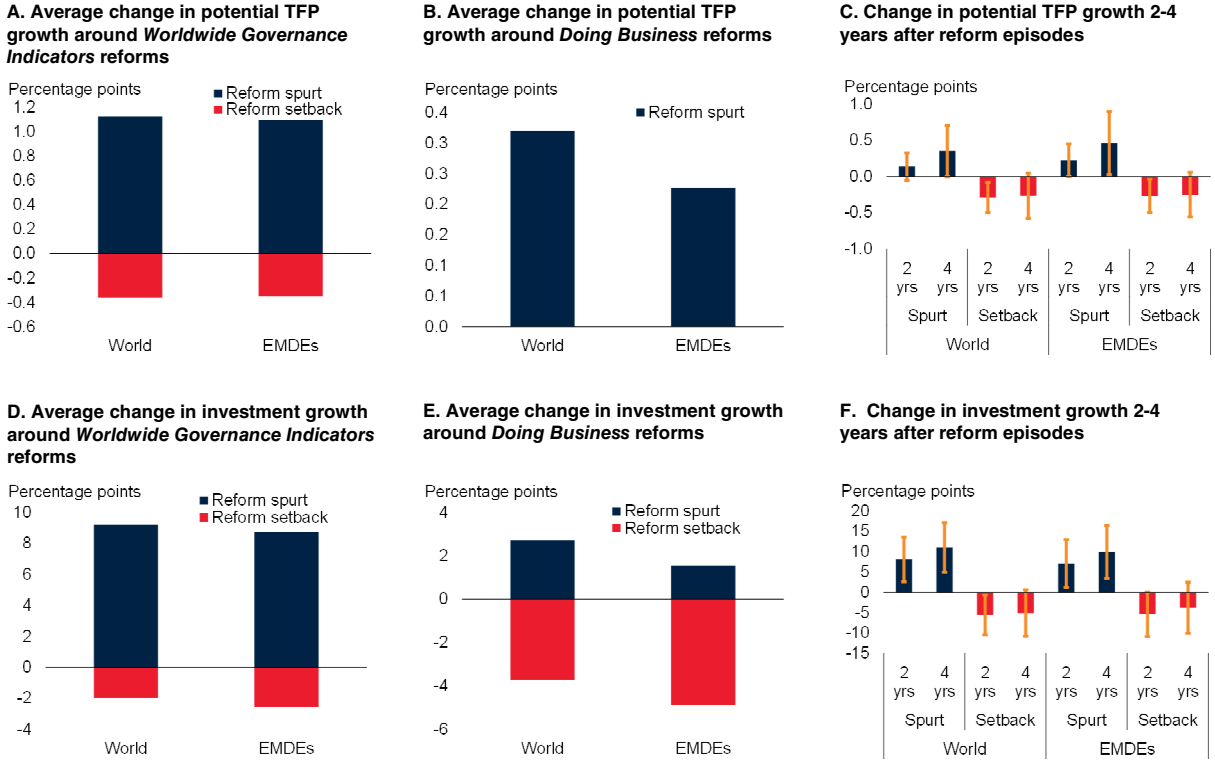
[6] This yields 44 events in 127 EMDEs and 34 advanced economies during 2002-17. The sample for potential TFP growth is smaller so there are no setbacks identified in the case of *Doing Business* among this smaller sample.

[7] For comparison, using industry-level data, Bourles et al. (2013) estimate that a removal of all anti-competitive regulations in upstream industries might have raised TFP growth by 1.7 percentage points per year in the average OECD country during 1995-2007. Dabla-Norris et al. (2015) estimate that the full elimination of labor and product market distortions would lift TFP in 13 advanced economies by 3.8-19.5 percent. Studies of aggregate growth find better business climates are associated with 1 percentage point higher actual growth in EMDEs or 0.8 percentage point higher per capita growth in a broader sample of countries (Didier et al. 2015; Divanbeigi and Ramalho 2015).

BOX 3.5 Productivity and investment growth during reforms *(concluded)*

FIGURE 3.5.2 Potential TFP and investment growth around reform spurts and setbacks

Reform spurts were, on average, associated with a statistically significant 0.1 percentage point per year increase in TFP growth above its "normal-year" average (0.8 percent) and 2.8-3.5 percentage points per year increase in investment growth above its "normal-year" average (6.4 percent) two-four years after the reform spurts.



Source: World Bank staff estimates.

Note. TFP growth refers to potential TFP growth, as estimated in Annex 3.1. A detailed methodology is available in Annex 3.5.

A. B. D. E. Simple averages of potential TFP (A and B) and investment (D and E) 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"). For Worldwide Governance Indicators (A and D), based on an event study of statistically significant 247 reform events—defined as two-standard-error changes in one of four *Worldwide Governance Indicators*—for 136 EMDEs and 38 advanced economies during 1996-2015. For *Doing Business* indicators (B and E), based on an event study of 44 reform events—defined as two-standard-deviation change in one of ten Doing Business Indicators—in 127 EMDEs and 34 advanced economies during the same period during 2002-17. TFP data not available for the 4 reform setback events in *Doing Business* indicators (A).

C. F. Regression coefficients of potential TFP (C) and investment (F) growth on dummies for structural reform spurts and setbacks—defined as two-standard-error changes in one of four *Worldwide Governance Indicators*—from local projections model for lags of two and four years, for a sample of 136 EMDEs and 38 advanced economies during 1996-2015. Vertical bars show 90 percent confidence interval.

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Typically, while it takes four years for growth dividends to materialize after governance reform spurts, the adverse impact of reform setbacks materializes faster (within about two years) and is less persistent for governance reform setbacks. Potential TFP growth is, on average, about 0.1 percentage point per year above its "normal-year" average (0.8 percent) four years after reform spurts and about 0.2 percentage point per year below two years after setbacks. Investment growth is, on average, about 2.8-3.5 percentage points per year above its "normal-year" average (6.4 percent) two-four years after governance reform spurts and about 2.7 percentage points per year below two years after reform setbacks.

Conclusion

Governance reforms have accelerated over the past three years while mixed progress has been made on business climate reforms. A renewed boost to both types of reforms promises sizable dividends for both productivity growth and investment.

2017). This can partly be attributed to weak managerial capabilities. Better education, especially if combined with greater competition, can induce an upgrading of managerial skills that can foster more ambitious innovations.

An event study suggests that major reform episodes are followed by higher potential TFP growth and investment growth over several years, and conversely for major reform reversals. Major reform packages are defined as those that significantly improve governance (proxied by *Worldwide Governance Indicators*) or business climates (proxied by *Doing Business* indicators). Four years after governance reform spurts in advanced economies and EMDEs, potential TFP growth was about 0.1 percentage per year above the average in years without spurts (0.8 percent) and investment growth was about 2.8-3.5 percentage points per year above its average in years without spurts (6.4 percent; Figure 3.9, Box 3.5). Reform setbacks were followed by slower TFP and investment growth.

Other reforms, including fiscal structural reforms, could also yield important productivity dividends. Several studies have highlighted the long-term growth dividends of fiscal reforms, especially when combined with other structural reforms (IMF 2015b). In OECD countries, the growth-enhancing effects of a budget-neutral shift in government spending towards health, education, and transport often becomes apparent after five years (Barbiero and Cournède 2013). More broadly, low- and lower-middle-income countries with a greater share of non-wage government spending tend to have higher long-term growth (Gupta et al. 2005). On the revenue side, also, a budget-neutral increase in the efficiency of the tax system could raise long-term growth. Sixty percent of fiscal reform episodes in 112 countries—such as switching from labor taxation to consumption taxation and shifting spending towards health, education, and infrastructure—were followed by growth accelerations of more than 1 percentage point (IMF 2015b). Over the longer-term, fiscal reforms such as the establishment of fiscal rules have also proven growth enhancing in EU countries (Miyazaki 2014; Castro 2011; Afonso and Jalles 2012).

Reforms for growth: More important should history repeat itself

The stylized scenarios above suggest that a combination of additional investment, better educational and health outcomes, labor market or business climate and governance reforms could stem or even reverse the expected decline in potential growth over the next decade (Figure 3.9). The human and physical capital and labor market reform scenarios above are associated with 0.7 percentage point higher EMDE potential growth. This would more than offset the 0.5-percentage-point slowdown in EMDE potential growth expected under the baseline scenario.

However, good policies could be thwarted by bad luck. If one or several global and country-specific risks to growth materialize, some EMDEs could experience a crisis that is associated with deep output contractions (Chapter 1). Moreover, historically, the global economy has experienced a major recession in every decade of the last half-century (Kose and Terrones 2015). Although these global recessions were triggered by different types of shocks, each of them was accompanied by a financial crisis somewhere. In 1975, oil price surges coincided with recessions in major advanced economies and crises in some EMDEs. In 1982, monetary policy tightening in major advanced economies preceded recessions in those economies and debt crises in many EMDEs. In 1991, an abrupt tightening of credit in the United States coincided with banking and currency crises in many European countries. And in 2008-2009, there were particularly deep financial crises in major advanced economies. The global economy slowed significantly during the 1997-98 Asian Crisis and the 2001 dot-com crash, and these coincided with recessions in major advanced economies and some EMDEs.

If this pattern is any guide, it may not be unreasonable to anticipate that the global economy could experience another recession or slowdown over the next ten years. This could again be accompanied by financial upheaval in one or more countries. It is impossible to know when

and where the next crisis might occur and what would trigger it, but past crises have often been associated with severe short-term output losses. Short-term contractions, in turn, were followed by highly persistent losses in output levels in both advanced economies and EMDEs.

A recession would also have lasting effects on potential growth, in addition to the obvious short-term output disruptions. Box 3.4 estimates the impact of severe output contractions on potential growth over the next 1-5 years. Among 49 EMDEs during 1990-2016, there were 77 such events and, among 32 advanced economies, 47 such events. Contractions in EMDEs, on average, lasted 1.3 years and were associated with annual average growth of -4.4 percent. On average, they were followed by about 1 percentage point lower potential growth five years after the event.

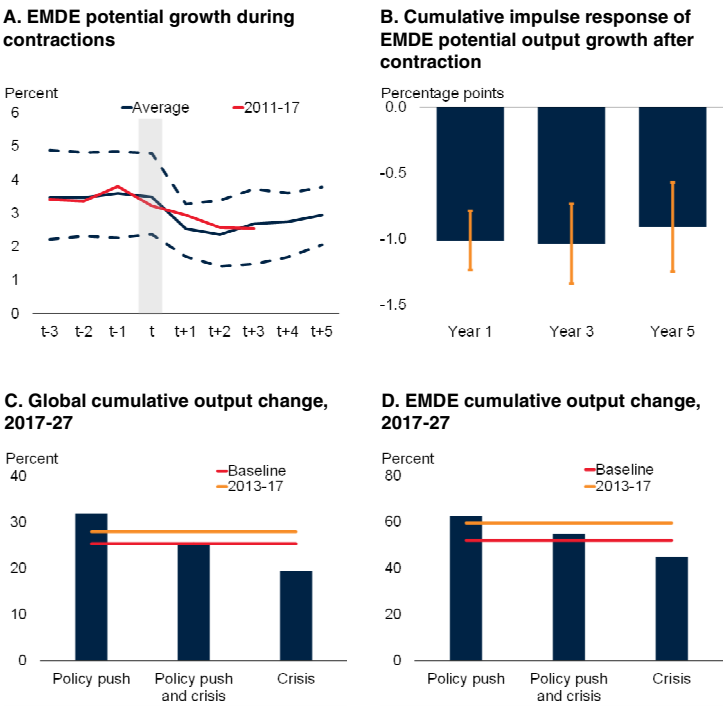
What would be the implications of a crisis that induced a severe recession in the event of another economic shock during the next decade? Three stylized scenarios are considered to illustrate the impact of a possible crisis on potential output: a baseline scenario consistent with potential growth prospects for 2018-27, a scenario in which a crisis triggers a severe recession, and a scenario that involves a crisis accompanied with a sustained policy push as described in the previous section.[19]

Under the baseline scenario, EMDE potential output a decade from now would be 52 percent above current levels (Figure 3.10). However, in the crisis scenario, these output gains could be 7 percentage points lower. Crises have at times been associated with growing inequality and setbacks in development goals (Ötker-Robe and Podpiera 2013; Feyen 2009). It would take a decade's worth of sustained policy efforts to reverse potential output losses. Absent a crisis, a similar policy push could lift EMDE potential output by 11 percentage points over the baseline over the next decade.

Any reform package has to take into account several additional considerations.

FIGURE 3.10 Growth and crisis scenarios

If one or several global and country-specific risks to growth materialize, some EMDEs could face a crisis that generates deep output contractions. Past experience suggests that such a deep recession could reduce potential growth by about 1 percentage point over half a decade. A sustained policy push would be needed to reverse such output losses.



Sources: Huidrom, Kose, and Ohnsorge (2016); World Bank; World Economic Outlook, International Monetary Fund.

A. Contractions are defined as the years of negative output growth from the year after the output peak to the output trough, as in Huidrom, Kose, and Ohnsorge (2016). Sample includes 44 contraction events in EMDEs during 1989-2016 (Annex 3.4). Figure shows unweighted averages of potential growth as estimated by the production function approach during contractions. t=0 denotes the peak preceding the contraction. 2011-17 is the unweighted average for countries with contraction episodes after a peak in 2014. Dotted lines indicate interquartile range.

B. Contractions are defined as the years of negative output growth from the year after the output peak to the output trough, as in Huidrom, Kose, and Ohnsorge (2016). Sample includes yields 44 contraction events in EMDEs during 1989-2016 (Annex 3.4). Figure shows impulse responses from local projections model (Annex 3.4), over horizons of 1, 3, and 5 years. Dependent variable defined as cumulative slowdown in potential growth after a contraction event using the baseline specification. Bars show coefficient estimates, vertical lines show 90 percent confidence bands.

C. D. GDP weighted averages. Derived using the production function-based potential growth as described in Annex 3.1. Baseline scenario as described in Annex 3.1. Policy push scenario assumes 0.5 percentage point increase in global potential growth (0.7 percentage point for EMDE potential growth) during 2018-27 compared with 2013-17 because of investment boost (0.2 percentage point), improved human capital (0.2 percentage point) and increased labor supply (0.1 percentage point). Crisis scenario assumes that potential growth is reduced by 1 percentage point for five years and then reverts to baseline scenario ("Crisis") or to policy push scenario ("Policy push and crisis").

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[19] In the baseline scenario, EMDE potential growth is assumed to be 4.3 percent on average over 2018-27. In the crisis scenario, EMDE potential growth is assumed to fall to 3.8 percent on average during 2018-27 (3.3 percent during 2021-26 and 4.3 percent otherwise). In the policy-push-and-crisis scenario, EMDE potential growth is assumed to average 4.5 percent during 2018-27 (4 percent on average during 2021-26 and 5 percent otherwise). The stylized nature of these scenarios implies that the calculation ignores a wide range of factors that could affect the cost of crises. In particular, the exercise does not take into account the nature of the crisis that would determine the severity of its impact; the underlying shock that would trigger the crisis; the initial conditions that determine an economy's vulnerability to shocks; the geographical distribution of costs; or the likely policy response that could mitigate the impact of the crisis (Claessens and Kose 2014).

- *Synergies.* Implementing multiple reforms simultaneously rather than piecemeal can generate mutually-reinforcing synergies. For example, in OECD countries, labor and product market reforms, FDI, and trade regulation potentially yield important synergies (OECD 2017). In another example, land, fiscal, and social benefit reforms yield larger growth benefits in China when implemented jointly (Ran et al. 2011). In addition, cross-country synergies from coordinated reforms may arise. The potential for growth spillovers puts a premium on reform efforts in advanced economies that have large repercussions for their EMDE trading partners.

- *Country-specific reform priorities.* In practice, reform priorities differ across countries, calling for tailored policies (Dabla-Norris 2016). For example, school enrollment and completion rates in several economies in the MNA region exceed the EMDE average. However, education reforms continue to be needed to address poor scores on international tests and pervasive skills mismatches in the labor market (World Bank 2008 and 2013). Region-specific reform priorities are discussed in detail in Boxes 2.1-2.6.

- *Timing.* Reform payoffs may take more time to materialize than in the stylized scenarios discussed here. There is some evidence that reforms have had the largest growth dividends when they were well-timed—at least in the context of advanced economies. For example, labor market reforms may lift growth more during economic upswings, when job entrants can more easily find jobs appropriate to their skills, than downturns (IMF 2016c).

The current cyclical upswing is an auspicious time to implement reforms that may yield long-term gains. There can be no quick fix for reversing the expected slowdown in potential output growth at the global level, since it reflects underlying economic factors that are not susceptible to rapid change. More importantly, if history repeats itself, a possible crisis over the next decade may have a substantial adverse impact on potential growth prospects. Mitigating pressures from the short-term risks and long-term headwinds requires the adoption of appropriate policies over time. A package that delivers substantial material benefits at an early date is more likely to be politically viable, and stands more chance of success in the long run.

ANNEX 3.1 Potential output estimates using the production function approach

The production function approach assumes that potential output can be captured by a Cobb-Douglas production function:

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

where Y_t is potential output, A_t is potential total factor productivity (TFP), K_t is the potential capital stock, and L_t is potential employment. To extend the sample beyond 2014—the latest available data from Penn World Tables—TFP was recalculated as the Solow residual of output, employment (extended using data from Haver Analytics) and capital (extended using investment data from Haver Analytics and the perpetual inventory method). Labor and capital shares are the within-country averages of those reported in Penn World Tables. Two of the three components of potential output—potential TFP and potential employment—are proxied by the fitted values from panel regression estimates. The third component, the contribution of capital to potential growth, is assumed to be the same as the contribution of capital to actual growth. This approach yields an unbalanced panel dataset for 32 advanced economies and 63 EMDEs for 1992-2027 (Table 3.1.1).

Capital stock data from Penn World Table 9.0 is used until the latest available year in the data set (2014 for most countries in the sample). For 2015-17, investment data are compiled from national statistics offices and Haver Analytics, while the capital stock is estimated from investment data by the perpetual inventory method using historical average depreciation rates.[1]

Estimating potential total factor productivity

Potential TFP growth is defined as the fitted value of a panel fixed effects regression for 37 advanced economies and 74 EMDEs for 1983-2017 of Hodrick Prescott-filtered trend of actual TFP growth (the Solow residual) on determinants of productivity. These include GDP per capita relative to advanced economies, education (secondary school completion rate), the working-age share of the population, and the five-year moving average real investment growth (as in Abiad, Leigh, and Mody 2007; Bijsterbosch and Kolasa 2010; Turner et al. 2016; Feyrer 2007).[2] To allow for nonlinearities in the productivity dividends from education, schooling is interacted with a dummy for schooling in the bottom two-thirds across the sample. A dummy for commodity exporters between the period 2003-07 captures the impact of credit boom in commodity exporters.

$$dtfp_{i,t} = \alpha_0 + \alpha_1\, GDP\ per\ capita_{i,t} + \alpha_2\, wap_{i,t} + \alpha_3\, education_{i,t} + \alpha_4\, education_{i,t} * d_{edu_{i,t}}^{bottom\ two\text{-}thirds} + \alpha_5\, dceb_{i,t} + \alpha_6\, dinv_{i,t} + \varepsilon_{i,t}$$

where *dtfp* is the logarithmic first difference of trend TFP, *GDP per capita* is GDP per capita in percent of advanced economies per capita GDP, *wap* is the working-age share of the population, *education* is the percent share of the population who completed secondary school, *dinv* is the five-year moving average real investment growth, $d_{edu}^{bottom\ two\text{-}thirds}$ is a dummy variable taking the value of 1 if the secondary completion rate is in the bottom two-thirds of the distribution, and *dceb* is a dummy variable taking the value 1 if the country is a commodity exporter for the period 2003-07.

The data were compiled using UN Population Statistics (for population growth, the working-age share of the population), Barro and Lee (for secondary school completion), the World Development Indicators (for GDP per capita relative to the advanced economies, and life expectancy), and Haver Analytics (for investment).

[1] Implicitly, this approach does not account for the possibility that inefficient investment is written off during downturns but depreciates only gradually. Hence, it may overstate the capital stock during downturns.

[2] The results are robust to using GDP per capita instead of GDP per capita in percent of advanced-economy GDP per capita. GDP per capita relative to a frontier (advanced economies) is used here to proxy the catch-up effect highlighted in the literature on stochastic frontier analysis (Growiec et al. 2015).

The results are broadly in line with the existing literature (Annex Table 3.1.2). TFP growth slows as per capita incomes converge toward advanced-economy levels (Barro and Sala-i-Martin 1997). A younger and better-educated population and accelerated investment lift TFP growth. However, the effect of education diminishes as education levels rise toward advanced-economy levels (Kato 2016; Benhabib and Spiegel 1994 and 2005; Coe, Helpman, and Hoffmaister 1997). As a result, the coefficient on secondary school completion rates is only significant for countries with completion rates below the top third.

Estimating labor force participation rates

Potential employment is defined as the product of the working-age population and the fitted value of age- and gender-specific regressions of labor force participation rates ($lfpr_{a,g,t}$) on their structural determinants ($X_{a,g,t}$) and controlling for cohort effects, fixed effects, and the state of the business cycle, defined as the deviation of the logarithm of real GDP from the Hodrick-Prescott-filtered trend. The vector $X_{a,g,t}$ includes gender-specific education outcomes (secondary and tertiary completion and enrollment rates), age-specific fertility rates and life expectancy. The vector $C_{a,g,t}$ includes all the control variables.

$$lfpr_{a,g,t} = \alpha_{a,g} + \beta_{a,g} X_{a,g,t} + \gamma_{a,g} X_{a,g,t} * d_{emde} + \delta_{a,g} C_{a,g,t} + \varepsilon_{a,g,t}$$

Data on the working-age population comes from the UN *Population Statistics Database*. Data for age- and gender-specific labor force participation rates are available from *Key Indicators of the Labor Market* (KILM) of the ILO *Population Statistics Database* for 1990-2016 for up to 35 advanced economies and 133 EMDEs.[3] Completion rates of secondary and tertiary education are from Barro and Lee (2013); age-specific fertility rate and life expectancy are from the UN's *World Population Projections* database; gender-specific secondary and tertiary school enrollment rates are from the *World Development Indicators*.[4] The results are broadly in line with findings in the existing literature (Annex Table 3.1.3).

Fertility rates. Higher fertility rates reduce labor force participation of women aged 25-49 years. This could reflect caregiving for young children or challenges in rejoining the labor market after temporary exit (Bloom et al. 2007). Among teen-age and younger women, fertility rates increase labor force participation as mothers are more likely to discontinue their education and participate in the labor force, at least in advanced economies (Fletcher and Wolfe 2009; Azevedo, Lopez-Calva, and Perova 2012; Herrera, Sahn, and Villa 2016). This effect is more muted in EMDEs, potentially reflecting an earlier average age of marriage, which tends to reduce female labor force participation (UN 2012).

Educational enrollment and attainment. Educational attainment, in the years when the age group was at the relevant age, increases participation rates, except for young men and women aged 20-24 in EMDEs. The positive correlation between completion rates and labor force participation may partly reflect higher compensation for more educated workers. For the young age groups in EMDEs, higher secondary and tertiary educational attainment reduces labor force participation. This might reflect the lack of demand for employment in sectors where these educated workers would expect to be employed, discouraging them from labor force participation (Klasen and Pieters 2013). For men aged 50-64 and all workers aged 65 years and older, education becomes an insignificant determinant of labor force participation (as in Fallick and Pingle 2007). Secondary and tertiary enrollment rates in all relevant age groups reduce labor force participation as students devote time to completing their degree (Linacre 2007; Kinoshita and Guo 2015; and Tansel 2002).

Life expectancy. Life expectancy is one of the main determinants of participation for workers

[3] This is an unbalanced sample because some of the exogenous variables are not available for the full period for all countries. However, the regression results are robust to restricting the sample to the balanced panel with fully available data.

[4] UN data for life expectancy is for five-year periods so life expectancy for historical years is used from the *World Developing Indicators* database and then spliced with UN *World Population Statistics and Prospects* data for the projection years or if the data are not available in the *World Development Indicators* database.

aged 50 and above (Fallick and Pingle 2007). For the younger ones among them, between the ages of 50-64, higher life expectancy raises labor force participation, possibly reflecting the need to accumulate savings for a longer retirement period or the positive association between better health among older workers and higher incomes (Haider and Loughran 2001). Among those aged 65 years or older, higher life expectancy increases labor force participation in advanced economies, but does not significantly change participation in EMDEs. Life expectancy may be a weak proxy for a healthy old age in EMDEs with less-developed health care systems or where differences in life expectancy might mostly reflect differences in infant mortality (Eggleston and Fuchs 2012). The effect of life expectancy on labor force participation of workers aged 65 years or older also depends on the business cycle. The increased participation of older workers in a weaker economy might reflect the increased desire for part-time positions for this age group when they are healthier (as proxied by higher life expectancy). It may also reflect rising employer interest because this age group, if healthy, can act as a highly flexible source of employment (Buddelmeyer, Mourre, and Ward 2004; Baer 2015).

Business cycle. Labor force participation is procyclical—albeit less so in EMDEs than in advanced economies—in most age groups until the age of 50 and even for men aged above 65.[5] As the working age population increases, the sensitivity to cyclicality decreases and participation eventually becomes countercyclical (Duval, Eris, and Furceri 2011; Balakrishnan et al. 2015). This may reflect greater ability of more experienced workers to remain employed or return into employment after spells of unemployment (Shimer 2013; Elsby, Hobijnb, and Sahin 2015). However, participation becomes pro-cyclical again for workers aged 65 and above as they become eligible to retire and may be readier to drop out of the labor force in a weaker economy.

[5] In several instances, there were no statistically significant differences between advanced economies and EMDEs in the cyclicality of their labor force participation. Hence, the interactions were omitted from the regressions.

Scenario analysis

Contribution of aging to potential growth. The contribution of aging to potential growth is calculated as the difference between actual potential growth and a counterfactual derived from an "unchanged demographics" scenario. The counterfactual scenario is one in which population shares are fixed at 1998 levels (for historical contributions) or 2017 levels (for forward-looking scenarios) in the calculation of labor force participation rates and TFP growth. All other variables, including fitted labor force participation rates for each age group and gender, remain the same in both scenarios. Hence, aggregated labor supply differs between the two scenarios only because different age groups (with different inclinations to participate in the labor force) have different population shares.

Baseline scenario. The baseline scenario is one of "business as usual" in that it assumes that all policy variables follow their long-term average trends. The scenario assumes that all population-related variables (including age and gender structure of the population, fertility, and life expectancy) evolve as in the UN Population Projections under the assumption of median fertility and normal mortality.[6]

- Secondary and tertiary *enrollment* rates by gender are assumed to grow through the forecast horizon at their average growth during 1998-2017 but are capped at 100 percent. Economy-wide averages are calculated as the population-weighted (2000-16) average of these gender-specific rates.

- Secondary and tertiary education *completion* rates by gender and age group are assumed to grow at their average rate during 1998-2017. Economy-wide averages are calculated as the

[6] UN *World Population Prospects* defines medium fertility in which total fertility in all countries eventually converges toward a level of 1.85 children per woman. Under normal mortality, mortality is projected on the basis of models of life expectancy based on recent trends in life expectancy by gender. Life expectancy projections are capped at 100 years.

population-weighted (2000-16) average of these gender and group-specific rates.

- Cohort effects are assumed to stay constant at their latest level throughout the forecast horizon, starting in 2018.

- The investment growth rate is assumed to remain constant at its longer-term average throughout the forecast horizon.[7]

Based on these assumptions about drivers of TFP, capital stock, and labor supply, potential growth is estimated using the production function approach detailed above.

Policy scenarios. The policy scenarios are "best-on-record" scenarios. Each policy variable is assumed to rise as much as its biggest ten-year improvement on record, subject to ceilings.

- *Meeting investment needs.* The investment growth rate in each country is assumed to rise by its largest increase in any ten-year period during 1998-2017.

- *Better human capital.* Educational outcome indicators—secondary and tertiary enrollment and completion rates—are assumed to rise in each country by as much as the maximum improvement over any ten-year period during 1998-2017. Enrollment rates remain capped at 100 percent. Completion rates are capped at the maximum across advanced economies in 2016. Life expectancy is assumed to rise in each country as much as the largest improvement over any ten-year period during 1998-2017, but not above the median advanced-economy life expectancy in 2016 (capped at 100 years).

- *Labor market reform.* For each age group in each country, female labor force participation rates are assumed to rise by the largest increase over any ten-year period during 1998-2017, but not to exceed male labor force participation rates in the same age group.

[7] Considering the policy-driven rebalancing away from investment in China, investment growth rates are assumed to be constant at their last five-year average (2013-17).

ANNEX TABLE 3.1.1 Country and year coverage

Country	Sample period	Country	Sample period	Country	Sample period
Argentina	1994-2028	Hong Kong SAR, China	1993-2028	Norway	1988-2028
Austria	1994-2028	Hungary	1994-2028	Panama	1994-2028
Bahrain	2013-2028	Iceland	1994-2028	Paraguay	1994-2028
Barbados	1994-2028	India	1994-2028	Peru	1993-2028
Belgium	1994-2028	Indonesia	1993-2028	Philippines	1993-2028
Benin	1994-2028	Iran, Islamic Rep.	1994-2028	Poland	1994-2028
Botswana	1994-2028	Ireland	1994-2028	Portugal	1994-2028
Brazil	1997-2028	Israel	1994-2028	Russia	1997-2028
Bulgaria	1994-2028	Italy	1988-2028	Rwanda	2000-2028
Burundi	1994-2028	Jamaica	1994-2028	Saudi Arabia	1994-2028
Cameroon	1994-2028	Japan	1988-2028	Senegal	1994-2028
Canada	1988-2028	Jordan	1994-2028	Serbia	2004-2028
Chile	1994-2028	Kazakhstan	1997-2028	Slovak Republic	1997-2028
China	1994-2028	Kenya	1994-2028	Slovenia	1996-2028
Colombia	1994-2028	Korea, Republic of	1988-2028	South Africa	1993-2028
Costa Rica	1994-2028	Kuwait	1994-2028	Spain	1994-2028
Côte d'Ivoire	1994-2028	Latvia	1995-2028	Sri Lanka	1994-2028
Croatia	1996-2028	Lesotho	1994-2028	Sudan	2004-2028
Cyprus	1994-2028	Lithuania	2000-2028	Swaziland	1994-2028
Czech Republic	1998-2028	Luxembourg	1994-2028	Sweden	1988-2028
Denmark	1994-2028	Malta	2003-2028	Switzerland	1993-2028
Dominican Republic	2001-2028	Mauritania	2009-2028	Thailand	1994-2028
Ecuador	1994-2028	Mauritius	1994-2028	Togo	2013-2028
Egypt, Arab Rep.	1994-2028	Mexico	1994-2028	Tunisia	1994-2028
Estonia	1996-2028	Moldova	1998-2028	Turkey	1994-2028
Finland	1994-2028	Mongolia	1999-2028	Ukraine	1997-2028
France	1988-2028	Morocco	1994-2028	United Kingdom	1988-2028
Gabon	2013-2028	Mozambique	1994-2028	United States	1988-2028
Germany	1995-2028	Namibia	2013-2028	Uruguay	1994-2028
Greece	1994-2028	Netherlands	1988-2028	Venezuela, RB	2013-2028
Guatemala	1994-2028	Nicaragua	2013-2028		
Honduras	1994-2028	Niger	1994-2028		

ANNEX TABLE 3.1.2 Regression results of total factor productivity

Dependent variable: TFP growth	
GDP per capita relative to advanced economies	-0.05*** (0.000)
Working-age population	3.95* (0.086)
Secondary completion rate	0.003 (0.766)
Secondary completion rate (bottom two-thirds)	0.018** (0.009)
Investment growth (five-year moving average)	0.058** (0.002)
Commodity exporters credit boom dummy	0.43** (0.001)
Number of observations	576
Number of countries	114
Within *R*-squared	0.24

Note: Estimated under fixed effects model. *P*-values are in parentheses. *, **, and *** indicate *p*-values smaller than 0.05, 0.01, and 0.001, respectively.

ANNEX TABLE 3.1.3 Regression results of labor force participation rates

	15-19-year old		20-24-year old		25-49-year old		50-64-year old		65+-year old	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Fertility	0.026* (0.017)		0.072*** (0.000)		-0.007*** (0.000)					
Secondary enrollment	-0.247*** (0.000)	-0.188*** (0.000)								
Tertiary enrollment			-0.056*** (0.000)	-0.099*** (0.000)						
Completion of secondary education			0.936*** (0.000)	0.645*** (0.000)	0.432*** (0.000)	0.273*** (0.000)	0.592*** (0.000)	0.044 (0.507)		
Completion of tertiary education			0.519*** (0.000)	2.002*** (0.000)	0.510*** (0.000)	0.776*** (0.000)	1.229*** (0.000)	0.288 (0.086)		
Life expectancy							0.447*** (0.000)	0.930*** (0.000)	0.108** *(0.000)	0.225*** (0.000)
Business cycle	19.74*** (0.000)	27.27*** (0.000)	0.88 (0.416)	21.57*** (0.000)	3.642** (0.006)	0.505 (0.061)	-1.056 (0.285)	-0.71 (0.471)	3.823* (0.039)	62.85* (0.024)
Business cycle * life expectancy									-0.075** (0.008)	-0.773* (0.042)
Fertility * EMDE	-0.0276* (0.035)		-0.064*** (0.000)							
Secondary enrollment * EMDE	0.108** (0.001)									
Completion of secondary education * EMDE			-0.952*** (0.000)	-0.800*** (0.000)						
Completion of tertiary education * EMDE			-0.713*** (0.000)	-2.179*** (0.000)						
Life expectancy * EMDE									-0.079* (0.011)	-0.489*** (0.000)
Business cycle * EMDE	-19.98*** (0.000)	-28.53*** (0.000)		-22.88*** (0.000)	-4.353** (0.002)					-51.33 (0.066)
Business cycle * life expectancy * EMDE										0.559 (0.143)
Joint coefficient of fertility in EMDEs	-0.001 (0.740)		0.007 (0.127)		-0.007*** (0.000)					
Joint coefficient of secondary enrollment in EMDEs	-0.132*** (0.000)	-0.188*** (0.000)								
Joint coefficient of secondary education in EMDEs			-0.016 (0.739)	-0.155*** (0.000)						
Joint coefficient of tertiary education in EMDEs			-0.194* (0.020)	-0.177 (0.074)						
Joint coefficient of cycle in EMDE	-0.24 (0.737)	-1.26 (0.108)		-1.31 (0.273)	-0.711 (0.120)					
County-cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age fixed effects	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	3,456	3,617	2,758	2,854	17,349	17,997	11,061	11,097	4,400	4,400
Number of countries	157	164	143	148	149	154	141	141	168	168
Adjusted R-square	0.997	0.997	0.998	0.999	0.997	0.999	0.985	0.993	0.998	0.999

Note: *P*-values are in parentheses. *, **, and *** indicate *p*-values smaller than 0.05, 0.01, and 0.001, respectively.

ANNEX 3.2 Potential output estimates using statistical filters

Univariate filters

A univariate statistical filter decomposes a series y_t into trend and cyclical components. Univariate filters (UVF) have the advantage of being simple to implement, since the only data required in the estimation is y_t (here, real GDP). The trend component is used as a proxy for potential output. However, the resulting estimates do not ensure consistency between cyclical output and other cyclical indicators or between potential output and its fundamental drivers. Moreover, the so-called "end-point problem" inherent in purely statistical techniques often implies significant revisions of output gaps toward the end of the sample, as new data becomes available.

Five univariate filters are applied to estimate potential output: filters based on Hodrick and Prescott (1997), three band-pass filters (Christiano and Fitzgerald 2003; Baxter and King 1999; Butterworth 1930), and the Unobserved Components Model. Confidence bands for all univariate filters are based on the confidence bands estimated by the Unobserved Components Model.

The *Hodrick-Prescott* (HP) filter minimizes deviations of a series y_t from its trend τ_t, assuming a degree of smoothness λ of the trend.[1] The three band-pass filters aim to isolate fluctuations in a time series which lie in a specific band of frequencies. They eliminate slow-moving components (trend) and very high frequency components and define the intermediate components as business cycles. Specifically, the three band-pass filters differ in their approximations of the optimal linear filter (also known as the "ideal" band-pass filter) to deal with finite time series.

- The *Baxter and King (BK) filter* is a moving average of the data with symmetric weights on lags and leads. Therefore, it loses observations in the beginning and towards the end of the sample.[2] It is particularly well-suited when the raw series follows a near independent and identically distributed process (Christiano and Fitzgerald 1999).
- The *Christiano and Fitzgerald* (CF) filter is a one-sided moving average of the data with weights that minimize the distance between the approximated and the "ideal" filter. Since the filter is one-sided, it does not lose observations towards the end of the sample. It is most suitable for random-walk series.[3]
- The *Butterworth* (BW) filter—widely used in electrical engineering for signal extraction—isolates only low-frequency fluctuations, not high-frequency ones. It is particularly suitable for series with sharp changes in the underlying trend.

In contrast to other univariate filters, the *Unobserved Components Model* does not impose specific parameter assumptions about the degree of smoothing, lead and lag windows, or business cycle frequencies. Instead, it relies on assumptions about the underlying process followed by output gaps and potential growth, and is estimated in a Kalman filter (Harvey 1990):

$$LY_t = L\overline{Y}_t + YGAP_t \quad (1)$$

$$L\overline{Y}_t = L\overline{Y}_{t-1} + G_t + \varepsilon_t^{\overline{Y}} \quad (2)$$

$$G_t = (1 - \tau)G_{ss} + \tau G_{t-1} + \varepsilon_t^{G} \quad (3)$$

$$YGAP_t = \beta_1 YGAP_{t-1} + \beta_2 YGAP_{t-2} + \varepsilon_t^{YGAP} \quad (4)$$

where LY is the log of seasonally adjusted quarterly real GDP, $L\overline{Y}$ the log of potential output, $YGAP$ the output gap, G_t potential output growth, G_{ss} the steady state growth, and $\varepsilon_t^{\overline{Y}}$ and ε_t^{G} are independently and identically distributed disturbances. Note that the shock $\varepsilon_t^{\overline{Y}}$ shifts the level of potential output whereas ε_t^{G} is a shock to potential

[1] A larger λ indicates a smoother trend. For λ=0, the trend is equal to the actual series and for $\lambda \to +\infty$ the trend is a linear time trend with a constant growth rate. Typically, the value of λ is set at 1600 for quarterly data (Hodrick and Prescott 1997). The trend is estimated based on past values as well as projected values of the series y_t.

[2] This implies a loss of k observations on both ends of the sample, with a higher k approaching closer to the ideal filter. Baxter and King (1999) suggest using of k = 3 for annual and quarterly data.

[3] The Baxter-King and Christiano-Fitzgerald filters require an assumption about business cycle frequencies. The default business cycle frequencies used here are 1.5 to 8 years.

output growth. Equation (3) assumes that potential growth converges (at a speed of convergence τ) to its steady level G_{ss} after a shock. The output gap follows a commonly used second-order autoregressive process (equation 4).

Multivariate filters

The unobserved components model can be expanded to include additional indicators of domestic demand pressures to help identify the output gap (Benes et al. 2015). The most commonly used indicators are inflation and the unemployment rate. Specifically, the univariate model of equations (1)-(4) is augmented with a Phillips Curve relationship between inflation and output gaps (equation 5), an Okun's Law relationship between unemployment rates and output gaps (equations 6-9), and a relationship between capacity utilization and output gaps (equations 10-13).

Phillips Curve. The Phillips Curve relates inflation to output gap, controlling for the impact of supply side shocks such as import prices on domestic inflation.

$$\pi_t = \rho\pi_{t-1} + (1 - \rho)\pi_{t+1} + \alpha_1 YGAP_t + \lambda_1\pi^{m}_{t-1} + \varepsilon^{\pi}_t \quad (5)$$

where π_t is quarter-on-quarter inflation at time t and π_t^{m} is import price inflation at time t. Expectations are assumed to be an average of adaptive and rational expectations, weighted by ρ.

Okun's Law. The Okun's Law relates unemployment gap $UNGAP_t$ (defined as the difference between the actual unemployment rate UN_t and the equilibrium (or natural) unemployment rate UN_t in equation 6) to $\overline{UN}_t$ the output gap as:

$$UNGAP_t = UN_t - \overline{UN}_t \quad (6)$$

$$UNGAP_t = \gamma UNGAP_{t-1} - \alpha_2 YGAP_t + \varepsilon_t^{UNGAP} \quad (7)$$

Following Blagrave et al. (2015), the equilibrium unemployment rate process is specified in deviation from steady state. Equation (8) specifies the process for $\overline{UN}_t$. It implies that following a shock, the NAIRU converges back to its steady state value $\overline{U}_{ss}$ according to the parameter τ_1 and has a trend component G_t^U which has an autoregression process (9).

$$\overline{UN}_t - \overline{U}_{ss} = \tau_1(\overline{UN}_{t-1} - \overline{U}_{ss}) + G_t^U + \varepsilon_t^{\overline{U}} \quad (8)$$

$$G_t^U = \tau^u G_{t-1}^U + \varepsilon_t^{G^u} \quad (9)$$

Capacity utilization. Since capacity utilization is highly pro-cyclical, it can help identify the cyclical component of output even during jobless recoveries. Equations (10)-(13) describe the relation between capacity utilization and output gaps and the exogenous process for capacity utilization, where $\overline{CAPU}_{ss}$ is the steady state of capacity utilization rate.

$$CAPUGAP_t = \theta CAPUGAP_{t-1} + \alpha_3 YGAP_t + \varepsilon_t^{CAPUGAP} \quad (10)$$

$$CAPU_t = CAPUGAP_t + \overline{CAPU}_t \quad (11)$$

$$\overline{CAPU}_t - \overline{CAPU}_{ss} = \tau_2(\overline{CAPU}_{t-1} - \overline{CAPU}_{ss}) + G_t^C + \varepsilon_t^{\overline{CAPU}} \quad (12)$$

$$G_t^C = \tau^c G_{t-1}^C + \varepsilon_t^{G^C} \quad (13)$$

Output gap. To close the model, a process for the output gap needs to be specified. Inflation and unemployment might fail to capture all domestic demand pressures, such as credit or asset price growth or commodity price cycles. This may lead to an underestimation of the output gap and an overestimation of potential output, especially at the peak of the cycle. Instead of assuming that the output gap process is exogenous, as in the traditional multivariate Kalman filter, three additional indicators are included in the output gap equation: house price, credit, and commodity price growth:

$$YGAP_t = \beta_1 YGAP_{t-1} + \beta_2 hpr_{t-1} + \beta_3 compr_{t-1} + \beta_4 cr_{t-1} + \varepsilon_t^{YGAP} \quad (14)$$

where cr_t, hpr_t, and $compr_t$ are cyclical components of year-on-year private sector credit growth deflated by consumer price inflation, quarterly seasonally-adjusted house prices, and export-weighted real average commodity prices respectively.

Estimation. The model parameters are estimated using Bayesian techniques and the state variables are estimated by a Kalman filter algorithm. A key parameter determining the shape of potential output is the variance of the output gap relative to potential growth innovations. The variance of the innovations ε_t^{YGAP} and ε_t^{G} are set such that the ratio of the variances matched the typically used smoothness parameter of the Hodrick-Prescott filter. All priors for persistence parameters follow a beta distribution. The priors for the slope of the Philipps curve α_1 , the sensitivity of inflation to import prices λ_1 , the elasticities of output gap with respect to house price and credit growth cycles β_2 and β_4, respectively, as well as α_2 and α_3 are set as gamma distributions. The prior for the elasticity of output gap with respect to commodity price β_3 follows a normal distribution to allow for a potentially negative impact of commodity price increases in commodity importers. The prior distributions for all standard deviations are inverse gamma distributions. The standard deviations of $\varepsilon_t^{CAPUGAP}$ and ε_t^{UNGAP} are set as the OLS standard errors of equations (5) and (9) based on Hodrick-Prescott-filtered data. Steady state values of growth, unemployment, and capacity utilization are calibrated to the sample mean of their corresponding HP-filtered series. Confidence bands are constructed based on the variance matrix of the smoothed (filtered) estimates of the state variables provided by the Kalman filter algorithm. The variance of the state variable is computed at the posterior mode of the parameters and does not reflect uncertainty related to model parameters.

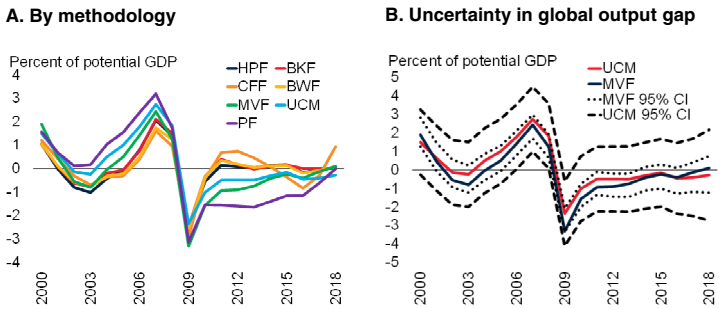
Database

Output gaps and potential growth are estimated for 15 advanced economies and 23 EMDEs, for 1980Q1-2016Q4 (Annex Table 3.2.1). GDP, inflation, unemployment rates, and capacity utilization rates are from Haver Analytics. Private sector credit is from the Bank for International Settlements (BIS), when available, or International Financial Statistics when not available from BIS. House price growth is from Haver Analytics. Commodity prices are from the World Bank's Pink Sheet, and export weights are from UN Comtrade. For the purposes of this chapter, country-specific output gaps are aggregated using real GDP weights at 2010 exchange rates and prices.

Multivariate filter-based estimates of output gaps have narrower confidence bands than those of univariate filters (Figure A.3.2.1). This reflects the use of additional demand pressure indicators in the MVF that help identify the output gap more accurately.

ANNEX FIGURE A3.2.1 Global output gaps

Output gaps implied by univariate filters tend to be narrower than those estimated by the multivariate filter and tend to have wider confidence bands.



Source: World Bank.
A. Figure defines the global output gaps as the real GDP-weighted average of country-specific output gaps based on different methodologies—the five univariate filters (HPF, BKF, CFF, BWF, UCM), the multivariate filter (MVF), and the production function approach (PF). HPF = Hodrick-Prescott filter, BKF = Baxter-King filter, CFF = Christiano-Fitzgerald filter, BWF = Butterworth filter, UCM = unobserved components model.
B. Dashed lines "UCM 95% CI" are 95 percent confidence bands of UCM-based estimates. Dotted lines "MVF 95% CI" are 95 percent confidence bands of MVF-based estimates.
Click here to download data and charts.

ANNEX TABLE 3.2.1 Country and year coverage

Advanced economies	
Country	**Sample period**
Australia	1980Q1-2016Q4
Canada	1980Q1-2016Q4
Denmark	1980Q1-2016Q4
Finland	1980Q1-2016Q4
France	1980Q1-2016Q4
Germany	1980Q1-2016Q4
Italy	1980Q1-2016Q4
Japan	1980Q1-2016Q4
New Zealand	1980Q1-2016Q4
Norway	1980Q1-2016Q4
Spain	1980Q1-2016Q4
Sweden	1980Q1-2016Q4
Switzerland	1980Q1-2016Q4
United Kingdom	1980Q1-2016Q4
United States	1980Q1-2016Q4

Emerging market and developing economies	
Country	**Sample period**
East Asia and Pacific	
China	1992Q2-2016Q4
Indonesia	1983Q1-2016Q4
Malaysia	2005Q1-2016Q4
Thailand	1993Q1-2016Q4
Vietnam	1990Q4-2016Q4
Eastern Europe and Central Asia	
Bulgaria	1997Q1-2016Q4
Croatia	2000Q1-2016Q4
Hungary	1995Q1-2016Q4
Kazakhstan	1999Q1-2016Q3
Poland	1995Q3-2016Q4
Romania	1995Q1-2016Q4
Russia	1995Q1-2016Q4
Serbia	1996Q1-2016Q4
Turkey	1998Q1-2016Q4
Latin America and Caribbean	
Argentina	2004Q1-2016Q4
Bolivia	1990Q1-2016Q2
Brazil	1990Q1-2016Q4
Chile	1996Q1-2016Q4
Colombia	2000Q1-2016Q4
Mexico	1980Q1-2016Q4
Peru	1980Q1-2016Q4
South Asia	
India	1996Q2-2016Q4
Sub-Saharan Africa	
South Africa	1980Q1-2016Q4

ANNEX 3.3 TFP and potential output growth during investment booms and busts

Definitions. An investment boom (bust) is defined as an episode during which investment growth is at least one standard deviation higher (lower) than its sample average for at least two years.[1] The sample covers 94 episodes of investment booms and 32 episodes of investment busts in 40 EMDEs during 1980-2016.

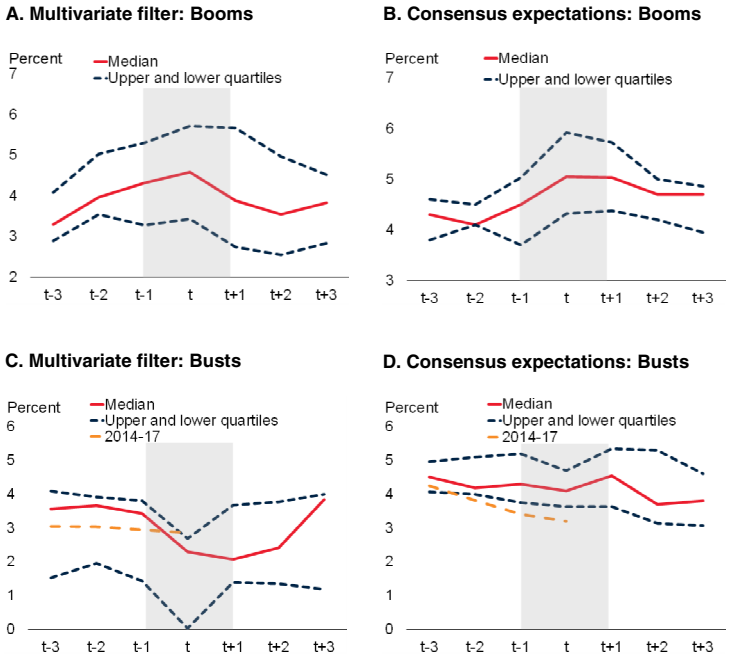
Methodology. The evolution of TFP growth and potential growth 3 years before and after the boom and bust episodes are examined. The results are derived from both simple averages of the evolutions and a panel regression of potential growth on dummy variables for these events, controlling for country- and year-fixed effects. Simple averages illustrate the evolution of TFP growth and potential output growth during events, while the regression approach allows a basic comparison with non-event country-year pairs.

Robustness of results. As a robustness check, the event study is conducted for alternative potential output measures (Figure A3.3.1, Annex Table 3.3.1). Potential growth estimates based on the multivariate filter and 5-year-ahead *Consensus* growth forecasts return similar results to the benchmark case of production function-based potential growth estimates. Both boom and bust dummies are estimated to be statistically significant in most of the cases as shown in Annex Table 3.3.1.

[1] The same exercise was repeated for investment booms or busts of more than one year's duration. Results were qualitatively similar.

ANNEX FIGURE A3.3.1 Potential growth around investment booms and busts in EMDEs: Alternative measures

The correlations between potential growth and investment booms and busts are robust to alternative measures of potential output such as multivariate filter approach and five-year-ahead Consensus *growth forecasts*.



Sources: Consensus Economics, World Bank.

Notes: An investment boom is defined as an episode during which investment growth is at least one standard deviation larger than its long-run (over the sample period) average level. t denotes the average of the investment boom in years. The event studies in this box are conducted using the boom and bust episodes of at least two consecutive years.

Click here to download data and charts.

ANNEX TABLE 3.3.1 Potential growth, TFP growth, and investment

Variables	MVF	PF	UCM	WEO	*Consensus*	TFP
Investment boom	0.74*** [0.235]	0.65*** [0.225]	1.12*** [0.285]	0.49*** [0.160]	0.35 [0.216]	2.80*** [0.657]
Investment bust	-1.55*** [0.386]	-1.28*** [0.169]	-2.12*** [0.536]	-0.46** [0.219]	-0.06 [0.233]	-3.41*** [0.890]
Observations	430	1,295	495	3,362	358	2,798
R-squared	0.31	0.23	0.37	0.02	0.38	0.08
Number of countries	22	64	22	134	20	86

Notes: Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The table presents estimated coefficients of investment boom and bust dummy variables in a panel regression in which time and country fixed effects are controlled. The dataset is annual and covers the period between 1980 and 2016. MVF, PF, UCM, WEO, and *Consensus* stand for potential growth estimates derived using the multivariate filter, the production function approach, the unobserved component model, 5-year ahead *World Economic Outlook* and *Consensus* growth forecasts. *Consensus* Forecasts are available for a highly restrictive sample that reduces the precision of coefficient estimates.

ANNEX 3.4 Long-term effects of output contractions

ANNEX TABLE 3.4.1 Impulse response of potential growth to contraction events

Definition of potential output	*t*	World	EMDEs
Multi-variate filter	0	-0.286**	-0.544***
	1	-0.691**	-1.375**
	2	-0.789**	-1.597**
	3	-0.763**	-1.589**
	4	-0.678*	-1.542**
	5	-0.508*	-1.253**
Production-function approach	0	-0.078	-0.086
	1	-0.833***	-1.01***
	2	-1.041***	-1.144***
	3	-0.916***	-1.035***
	4	-1.007***	-1.10***
	5	-0.879***	-0.91***
Univariate filter	0	-0.333***	-0.458***
	1	-0.774***	-1.088***
	2	-0.839***	-1.245**
	3	-0.745**	-1.31**
	4	-0.655**	-1.51***
	5	-0.531**	-1.51***

Notes: *, **, and *** indicate significance at the 10, 5, and 1 percent level of confidence, respectively. The table represents the estimations of local projections model for change in potential growth (as dependent variable) between the contraction event and the end of the horizon. Regressors include the dummy variable for the contraction event, controlling for lagged potential growth before the shock and country fixed effects. A Hodrick-Prescott filter is used for the univariate filter-based measure of potential growth. For the regression using potential growth based on the production function approach, sample includes 33 events in 29 advanced economies and 32 events in 31 EMDEs. For the regression using potential growth based on the multivariate filter, sample includes 19 events in 15 advanced economies and 21 events in 17 EMDEs. For the regression using potential growth based on the univariate filter, sample includes 19 events in 15 advanced economies and 21 events in 17 EMDEs.

Definition and data. Contractions are identified as in Huidrom, Kose, and Ohnsorge (2016) as peak-to-trough periods when i) output growth is negative and ii) output growth is 1 standard deviation below the country-specific average during 1989-2016. Peaks are defined as the local maxima of real output that precede the contraction. The contraction event is the period from the year after the output peak to the year of the output trough. The definition of contraction events yields up to 47 contraction events in 32 advanced economies and up to 77 contraction events in 49 EMDEs during 1990-2016. However, the sample used in the regression specifications is considerably smaller because of the lack of potential growth measures.

Methodology. A local projections model is used to estimate the cumulative impact of output contractions on potential output growth, following Jorda (2005) and Teulings and Zubanov (2014). In impulse responses, the model estimates the effect of short-term shocks (the contraction event) over a horizon h while controlling for other determinants.

$$y^{pot}_{i,t+h} - y^{pot}_{i,t-1} = \alpha^h + \beta^h shock_{i,t} + \gamma^h dy^{pot}_{i,t-1} + \theta^h X_{i,t} + fixed\ effects + \varepsilon^h_{i,t}$$

where $y^{pot}_{i,t}$ is potential growth. The model controls for country-fixed effects to capture time-invariant cross-country differences. The variable $shock_{i,t}$ is a dummy variable for a contraction event, the main variable of interest. Lagged potential growth $dy^{pot}_{i,t-1}$ controls for the history of potential growth.

Robustness of results. Results are reported in Annex Table 3.4.1. They are broadly robust to the choice of potential growth measure (production function approach, multivariate filter, and Hodrick-Prescott filter).

ANNEX 3.5 Impact of reforms

Defining reform events. Two types of indicators are used to defined major reform events: the World Bank's *Worldwide Governance Indicators* and *Doing Business* indicators.

- *Worldwide Governance Indicators.* Reform spurts (setbacks) are defined as two-year increases (decreases) by two standard errors in one or more indexes of government effectiveness, regulatory quality, rule of law, and control of corruption from the *Worldwide Governance Indicators*. The average of the standards errors at time t and t-2 (the first and last year of the event interval) is used for the standard deviation. This yields 131 reform spurts and 116 reform setbacks for 136 emerging market and developing economies (EMDEs) and 38 advanced economies during 1996-2015.

- *Doing Business Indicators.* Similarly, reform spurts (setbacks) are defined as two-year increases (decreases) by two standard deviation in the distance to frontier of one or more of the ten *Doing Business* indicators: starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency. The standard deviation is defined as the cross-country standard deviation in the event year. This yields 40 reform spurts and 4 reform setbacks for 127 EMDEs and 34 advanced economies during 2002-17.

Methodology. Two exercises are conducted: a comparison of means and a local projection model.

- *Comparison of means.* The difference between the simple average of potential total factor productivity (TFP) (or real investment) growth during all reform spurt (setback) events and simple average of potential TFP (or real investment) growth during all "normal" years without such events is examined (Figure 3.5.2). The averages are calculated both for the full sample and for EMDEs only.

- *Local projection model.* A local projection model as in Jorda (2005) and Teulings and Zubanov (2014) is used to identify the effects of reform events on potential TFP and real investment growth over time. In impulse responses, the model estimates the effect of reform events (the dummy variable $shock_{i,t}$) on cumulative potential TFP (or real investment) growth over a horizon h while controlling for country- and year-fixed effects and lagged changes in potential TFP (or real investment) growth:

$$y_{i,t+h} - y_{i,t-1} = \alpha^h + \beta^h shock_{i,t} + \sum_{J=1}^{2} \gamma_{1,j}^h \; shock_{i,t-j}$$

$$+\sum_{j=1}^{h-1} \gamma_{2,j}^h \; shock_{i,t+h-j} + \sum_{j=1}^{2} \gamma_{3,j}^h \; dy_{i,t-j}$$

$$+ \textit{fixed effects} + \varepsilon_{i,t}^h$$

where y refers to TFP (or real investment) and dy to its growth rate.

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