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

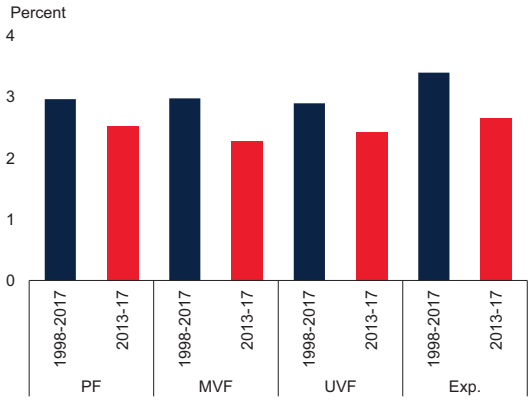
Note: This box was prepared by Sinem Kilic Celik, M. Ayhan Kose, Franziska Ohnsorge, and Yirbehogre Modeste Some.

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

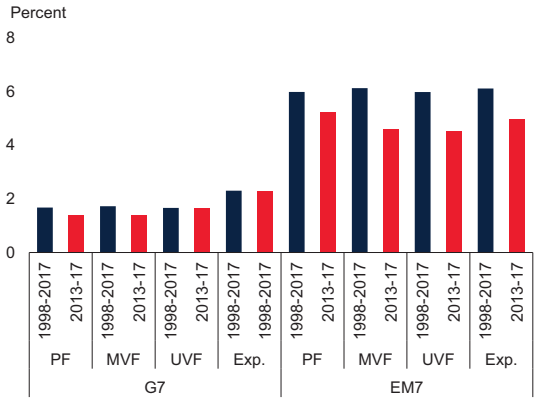
FIGURE 3.1.1 Potential growth estimates

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.

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.