Special Feature A

Global Productivity Trends

Introduction

Recent empirical research has documented a downshift in total factor productivity (TFP) growth[1] across a wide range of advanced economies since the early 2000s (Fernald, 2012; Fabina and Wright, 2013). Notably, the slowdown in TFP growth appears to have preceded the Global Financial Crisis (GFC), and thus possibly reflects an underlying structural decline in efficiency gains rather than a temporary fall in factor utilisation. The deceleration in TFP growth has, in turn, dampened labour productivity growth[2] and hence the growth rate of potential output in the advanced economies.

In comparison, TFP growth has generally held up in the Asian economies over the last decade, following its relatively poor performance in the 1990s. However, gains in labour productivity weakened over the 2000s in some of the Asian economies. The catch-up of the *level* of output per worker or per hour to the productivity frontier, as defined by the US, appears to have slowed and even stalled in a number of regional economies since the late 1990s, possibly due to a fall in capital intensity. This Special Feature reviews these regional and global productivity trends.[3]

Productivity Trends in the Developed World

Chart 1 shows that the average annual rate of TFP growth was lower in almost all the advanced economies in the 2000s compared to the 1990s. In some cases, TFP levels actually declined over the last decade. Across the 20 developed economies, TFP levels, on average, fell by 0.3% p.a. in the 2000s compared to an annual gain of 0.8% p.a. in the 1990s. While this was partly due to significant capital and labour hoarding during the GFC and subsequent Eurozone crisis, TFP growth was also demonstrably weaker in all but four countries over 2001–06. In fact, TFP growth across the developed economies over this period averaged only 0.2% p.a. or 0.6% point lower than in the 1990s.

Consequently, most of the advanced economies saw a fall in their annual growth rate of labour productivity in the 2000s. Chart 2 shows that labour productivity growth fell, on average, to 1.0% p.a. in the 2000s, from 2.1% p.a. in the preceding decade. Only Sweden, Switzerland, and the Netherlands saw an improvement in their average rate of labour productivity growth compared to the 1990s. On the whole, growth in output per hour worked in the advanced economies averaged 0.6% point p.a. lower over 2001–06, almost entirely due to the decline in TFP growth.

This synchronised slowdown in productivity growth across the developed world suggests the presence of a common underlying force. In this regard, principal component analysis (PCA) is a useful modelling tool to extract the key common factors that may be able to explain the bulk of

[1] TFP growth can be thought of as growth that is not accounted for by increases in the factors of production and thus is the efficiency with which an economy uses factor inputs to produce goods and services. In the neoclassical view, it reflects the rate of technical change and is the only source of economic growth in the long run.

[2] In the growth accounting model, labour productivity growth can be decomposed into contributions from capital per unit of labour input, changes in input quality and TFP.

[3] The source for all data in this Feature is the Conference Board's *Total Economy Database*.

Chart 1
Average Annual Total Factor Productivity Growth in Advanced Economies

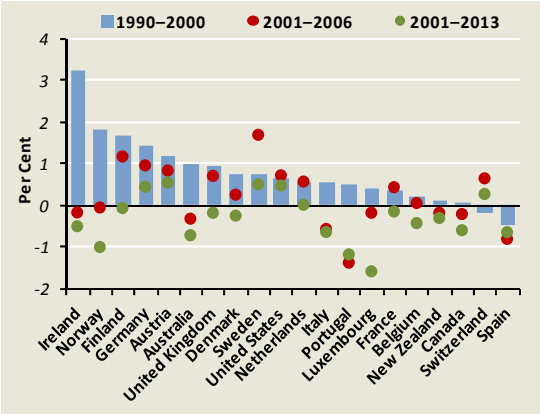
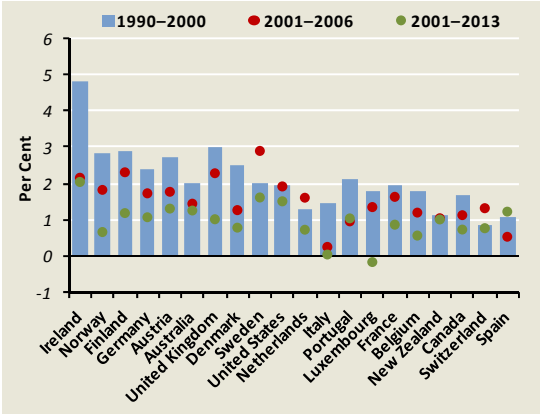


Chart 2
Average Annual Labour Productivity Growth in Advanced Economies



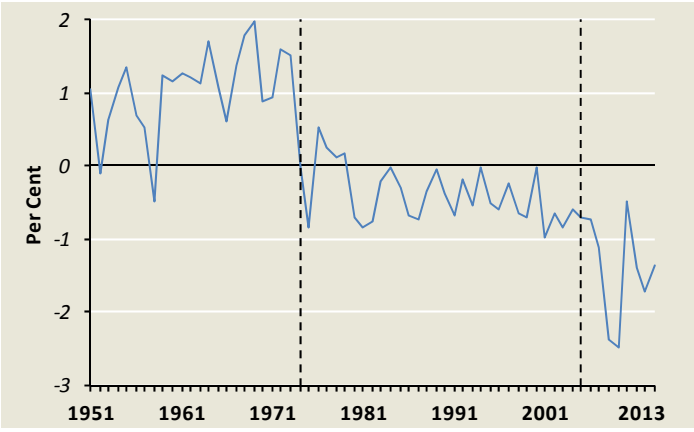
information within the sample covariance matrix of the observed variables, which in this case, refers to productivity growth across countries. With the productivity growth rates of N economies, there are N common factors, which are linear combinations of individual productivity rates as follows:

$$GR_{i,t} = \Psi_i f_{i,t} + \epsilon_{i,t}$$

where $GR_{i,t}$ denotes the productivity growth rate of country i at time t, $f_{i,t}$ represents the common factor, Ψ_i comprises the response of each economy's productivity growth to the common factor, and $\epsilon_{i,t}$ captures the influence of domestic shocks within each country. The common factors are constructed and ordered so that the first factor explains the largest proportion of the covariance matrix of cross-country productivity growth rates.

Chart 3 shows the first common factor extracted from the labour productivity growth rates of the 20 developed economies. The series, which plausibly captures the pace of underlying global technological progress, not only exhibits significant volatility since the GFC but also shows the possibility of multiple structural breaks in its mean. This observation is validated by a Bai-Perron test for multiple break-points, which indicates the presence of structural breaks in 1974 and 2005.[4] Both breaks are associated with downshifts in the common factor of labour

Chart 3
Common Factor of Labour Productivity Growth in Advanced Economies



Note: Dashed vertical lines indicate estimated structural breaks.

[4] The Bai-Perron (2003) method of testing for L+1 versus L sequentially determined breaks was used. This test allows for serial autocorrelation in the data as well as differences in the error distribution across breaks. A 15% trimming parameter was used. The breaks were found to be significant at the 5% level.

productivity growth across the 20 developed economies, with the second break occurring prior to the GFC.

Adopting a different methodology, Benati (2007) similarly finds that US labour productivity growth saw a marked deceleration in the early 1970s, likely to be associated with the first oil shock. Moreover, he noted that there was early evidence that the US productivity acceleration in the 1990s had likely plateaued by the early 2000s. More recently, Fernald (2012) finds evidence of regime changes in US trend labour productivity growth, with the mean rate of growth shifting down from 2003. In related studies, Gomez-Salvador *et al*. (2006) documents a structural break in Euro area labour productivity growth in 1973, while Benati (2007) finds that the average growth rate of Eurozone output per hour worked was significantly lower after 2001. It seems likely, therefore, that labour productivity growth in the developed world experienced a distinct downshift in the early to mid-2000s, after the last collective episode in the early 1970s.

One possible explanation for these findings is that the decline in organisational capital investment in the early 2000s led to a deceleration in TFP growth. In the US, these largely intangible investments that helped to organise factors of production around new technologies likely surged following the rapid accumulation of ICT capital stock in the 1990s. (Oliner *et al*., 2007) Since the peaking of US' ICT capital investment in 2000 however, investment in organisational capital also waned, resulting in the slowing of US' TFP growth. However, Fabina and Wright (2013) point out that in a number of advanced economies, investment in ICT capital stock continued to grow strongly into the 2000s, and yet almost all of these economies saw a decline in TFP growth.

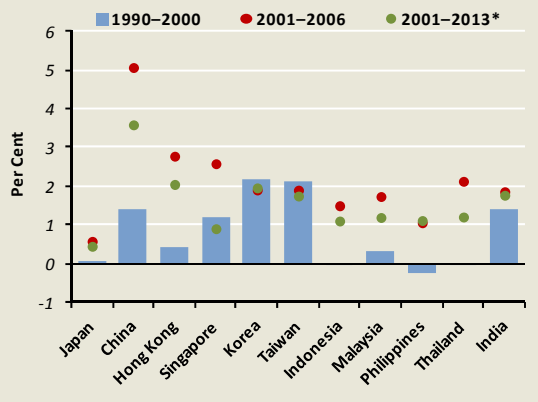
In the case of the US, which is widely regarded as the leader in technology and productivity on many fronts, Gordon (2013) argues that the main impact of the computer and internet revolution on productivity has largely dissipated over the last few years. For instance, many of the inventions that automated tedious and repetitive tasks occurred in the 1970s and 1980s, which boosted productivity growth for a short period of time from approximately 1996–2004. In contrast, new innovation has largely centred on entertainment and communication devices, which in his view, are less likely to fundamentally improve the growth rate of labour efficiency.

Productivity Trends in Asia

In Asia, total factor productivity growth generally held up in the 2000s, following the relatively weak showing in the 1990s. (Chart 4) Apart from the NIEs of Singapore, Korea and Taiwan, TFP growth in the Asian economies was actually stronger in the 2000s than in the 1990s. Across the ASEAN-4 countries, TFP growth averaged 1.1% p.a. in the 2000s compared to negligible gains in the 1990s, while in Hong Kong and China, average TFP growth was 1.6% points and 2.2% points higher in the 2000s, respectively. Japan and India's average TFP growth also rose by 0.4% point and 0.3% point, respectively, over the preceding decade. Among the NIEs with lower TFP growth, the average decline was only 0.3% point in the 2000s, or about half of that experienced in the advanced economies. In particular, while Asia's TFP growth in the 1990s was, in part, depressed by the effects of the 1997–98 Asian Financial Crisis (AFC), TFP growth in the early 2000s was still broadly stronger than that in the first half of the 1990s, with the exception of Korea, Taiwan and Indonesia.

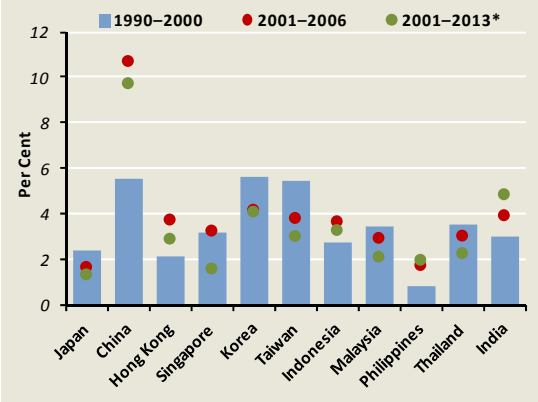
The improvement in TFP growth over the 2000s was a boon to labour productivity in China, Hong Kong, Indonesia and the Philippines. (Chart 5) In China, the acceleration in TFP gains accounted for over half of the increase in labour productivity growth in the 2000s, while in Hong Kong, Indonesia and the Philippines, it accounted for the entire pickup in labour productivity growth—and helped to offset the drags from the decline in the investment rate. China clearly stands out as an exception given its strong total factor and labour productivity performance, with the latter enhanced by a significant rate of capital deepening. In the other Asian economies,

Chart 4
Average Annual Total Factor Productivity Growth in Asia



*Data is up to 2012 where 2013 is unavailable.
Note: Total Factor Productivity growth for ASEAN-4, China and India are based on Output per worker data.

Chart 5
Average Annual Labour Productivity Growth in Asia

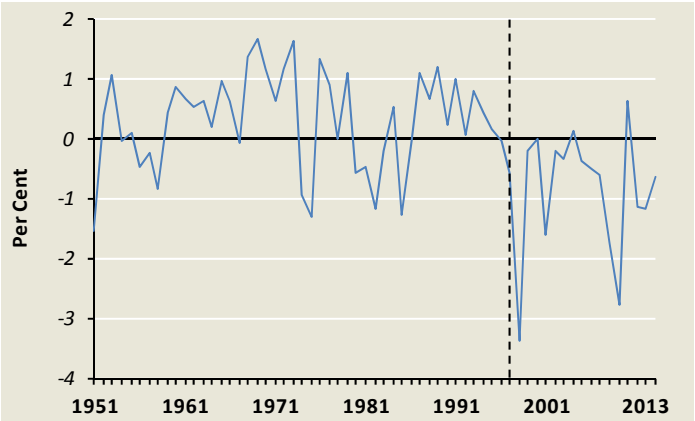


*Data is up to 2012 where 2013 is unavailable.
Note: Labour productivity growth for ASEAN-4, China and India are based on Output per worker data.

however, labour productivity growth broadly fell over the last decade—particularly in Japan, Malaysia and Thailand—even as TFP growth picked up. Meanwhile, the 1.6–2.5% points drop in labour productivity growth in Singapore, Taiwan and Korea considerably exceeded their declines in TFP growth.

Chart 6 shows the common factor extracted from the labour productivity growth rates of the eleven Asian economies. The Bai-Perron test is significant at the 5% level and suggests a single structural break in the average level of the series in 1997, during the AFC. From a growth accounting perspective, the decline in labour productivity growth can largely be traced to a subdued pace of investment following the AFC, even as TFP growth recovered. While this was to some extent a correction of the excesses in the lead-up to the crisis, relatively low rates of investment have persisted in a number of Asian countries. For instance, in the ASEAN-4 economies, the average investment to GDP ratio has remained low at around 26% after the AFC compared to the pre-crisis average of 35% over 1988–97; while among the NIEs, the investment ratio dipped to 24% from 33% over the same period. From one perspective, this has manifested itself in poor or deteriorating public infrastructure, which Aiyar *et al*. (2013) has identified as being associated with growth slowdowns in middle-income countries.

Chart 6
Common Factor of Labour Productivity Growth in Asia



Note: Dashed vertical line indicates the estimated structural break.

Convergence in Labour Productivity Levels

Critically, the productivity performance in Asia also needs to be assessed in light of the region's relatively lower level of economic development and overall global productivity trends. Assuming similar structural parameters, neoclassical theory predicts that less developed economies grow at a faster rate than richer economies and, therefore, achieve convergence in per capita incomes over time. Charts 7 and 8 show a variant of this hypothesis using output per hour worked for the NIEs, and output per worker for ASEAN-4 and China, respectively. Over the very long run, real PPP-adjusted output per unit of labour input in Asian economies has generally been converging to that in the US, albeit at different speeds.

The rate of convergence has, however, noticeably slowed in most Asian economies—with the clear exception of China—since the late 1990s, following the structural break caused by the AFC. Among the NIEs, this is more evident in Singapore and, to a lesser extent, Hong Kong and Taiwan. In Singapore, the level of PPP-adjusted output per hour worked, relative to the US, has remained broadly unchanged from that in the late 1990s. By contrast, labour productivity in Korea, one of the countries most affected by the AFC, has continued to converge to that in the US at about the same rate, albeit from a lower base.

Among the ASEAN-4 economies, labour productivity growth in Malaysia and Thailand appears to have just marginally exceeded that in the US over the last decade. This was broadly the case for the Philippines and Indonesia as well, where, despite the slight pickup in labour productivity growth in the 2000s, output per worker has remained around 10% of that in the US since the early 1990s. These findings contrast sharply with China's experience over the last two decades.

The slowdown in Asia's rate of convergence partly reflects the well-documented acceleration in labour productivity growth in the US from the mid-1990s to early 2000s (Fernald, 2012 and Gordon, 2013). Notably, productivity catch-up across a broad range of advanced economies also slowed or reversed from the mid-1990s as the US frontier pulled ahead. However, the decline in US labour productivity growth to an average of 1.1% p.a. since 2006, from 2.4% p.a. in the preceding decade, has been broadly matched by Asia and Europe. Accordingly, across a range of low, middle and high income economies, the process of productivity catch-up has continued to stall.

Chart 7
PPP-adjusted Output per Hour Worked Relative to the US in NIE-4

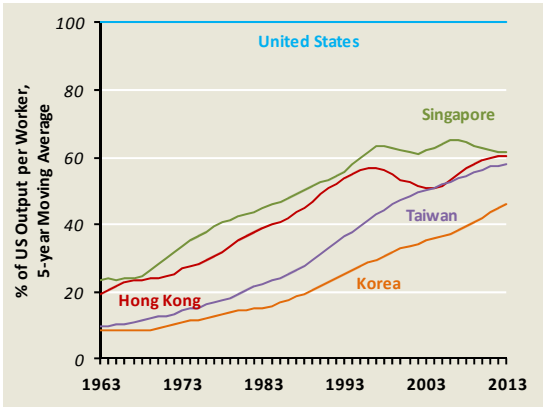
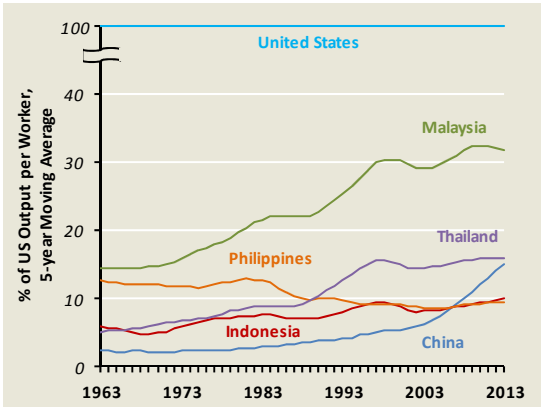


Chart 8
PPP-adjusted Output per Worker Relative to the US in China and ASEAN-4



Future Developments in Global and Regional Productivity

The Global Financial Crisis was arguably one of the biggest productivity shocks to the developed world in the last half century. At present, it is difficult to tell whether this crisis, and the subsequent fallout in the Eurozone, will compound the pre-recession slowing of productivity growth in the advanced economies. According to research by Abiad *et al*. (2009), total factor productivity typically reverts to the *levels* predicted by its pre-crisis trend over the medium term, implying that productivity growth accelerates over the recovery period. In the case of the US, however, Fernald (2012) finds that both total factor productivity and labour productivity growth have only recovered to their anaemic rates of the mid-2000s, rather than the higher medium-term trend from the mid-1990s to the early 2000s. In a similar vein, Gordon (2013) postulates that trend productivity growth in the US is poised to slow to the rates seen in the 1970s and 1980s as the main effects of the computer and internet revolution completely dissipate. Meanwhile, Asia's experience following the Asian Financial Crisis suggests that even when underlying TFP growth is unimpaired by a major crisis, lasting effects on the rate of investment can be a major drag on labour productivity growth in the medium term.

Nevertheless, Baily *et al*. (2013) and Brynjolfsson and McAfee (2014) find reasons for optimism in the US, pointing to technological opportunities in advanced manufacturing, the exponential growth of data availability and the continuously increasing computing power of machines. Moreover, the latter authors hypothesise that the global economy may be on the cusp of a new IT and digital communication age, that will not just increase the efficiency of 'old things' and lower their costs of production, but will create new market opportunities in the form of 'new products' and 'new services' which will change the way people live and businesses operate.

In developing Asia, the level of labour productivity remains only a fraction of that in the US, implying considerable scope to accelerate productivity growth for years to come. As China's experience shows, a critical part of the catch-up can stem from high rates of capital investment. Across Asia, there are signs that governments have finally begun to refocus on infrastructure development following a period of under-investment. Most ASEAN-4 economies have unveiled ambitious plans for infrastructure development over the medium term, including high-speed railways in Thailand, new MRT lines in Malaysia and a subway system in Jakarta. Fernald (1999) argues that these public investments can often themselves be a source of productivity growth as well as a trigger for the crowding-in of private investment. Over time, the improvement of human capital across the region will also support medium-term productivity growth. Governments in the region, in partnership with the private sector, should also press ahead with reforms to maximise the contribution of factor inputs, including the promotion of competition in services and other non-tradable sectors of the economy. Over the longer term, however, Asia will still largely depend on the advanced economies to push the frontiers of technology and efficiency. A lasting slowdown in productivity growth in the advanced economies would thus likely dampen long-run growth rates in Asia, even if the previous pace of convergence is resumed.

It is unclear if new advances in technology and innovation will have a transformative impact on key macroeconomic trends, such as global productivity growth. However, historical experience shows that without macroeconomic and financial stability, supportive institutions and structural reform of factor and product markets, disruptive innovations and technological breakthroughs are less likely to bear fruit and fundamentally alter the way in which our economies grow and their long term trajectory.

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