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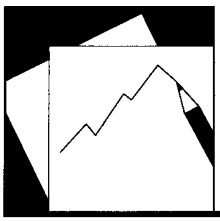

IMF Working Paper

Enhancing China's Medium-Term Growth Prospects: The Path to a High-Income Economy

Malhar Nabar and Papa N'Diaye

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Enhancing China's Medium-Term Growth Prospects: The Path to a High-Income Economy

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Abstract

China's current growth model— which has delivered steady and robust growth for two decades and lifted some 500 million individuals out of poverty—has become too reliant on credit and investment, and has begun to experience diminishing returns. Delays in advancing the government's reform agenda will mean that vulnerabilities continue to grow and the probability of stalled convergence increases. On the other hand, with reforms to accelerate TFP growth and shift the economy away from its continued reliance on capital accumulation, China can grow at a healthy pace and maintain its convergence toward the level of high income economies. Evidence from China's provinces indicates that there is room to improve productivity and sustain such a convergence toward the level of more prosperous economies.

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Keywords: China, convergence, capital accumulation, total factor productivity

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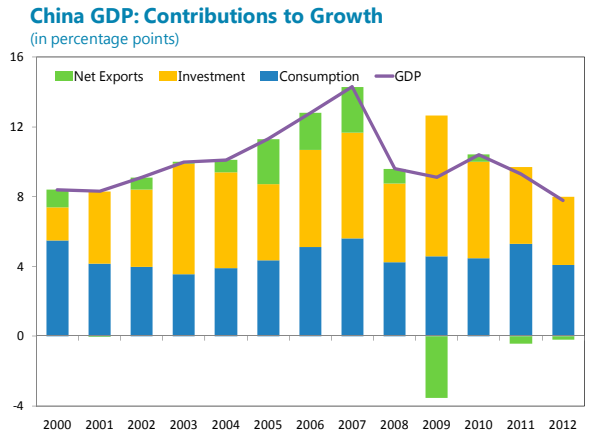
I. INTRODUCTION

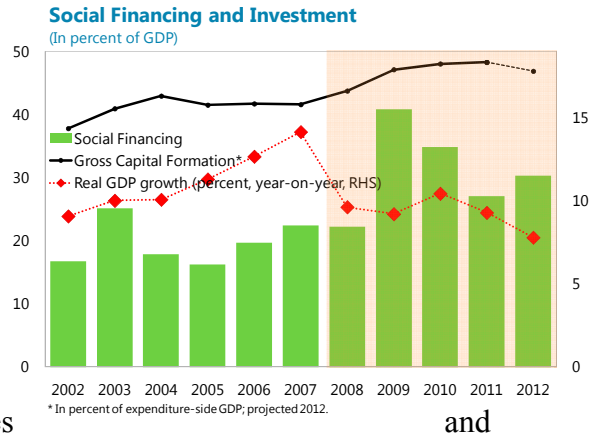
Will China successfully transition from a middle- to a high-income economy? After years of growing at double digits and achieving rapid convergence toward the level of middle-income economies, the Chinese economy has entered a period of more moderate expansion.

Undoubtedly, the slowdown in China's growth is in many ways related to the damages the global financial crisis has inflicted on advanced economies. Output in advanced economies remains well below potential and this has contributed to lower demand for Chinese exports—a key source of growth for China.



But this is not the only reason. China's growth has slowed even as investment has risen and the reliance on credit has increased. Credit as a share of GDP has jumped from a little under 130 percent of GDP in the last quarter of 2008 to slightly less than 200 percent of GDP in the first quarter of 2013. At the same time, investment as a share of the economy has risen to 47 percent over 2008-2012 (from 41 percent over 2002-2007).

The combination of slower growth, higher investment, and rapid expansion of credit (both bank and nonbank) suggests diminishing returns and limits to how far the economy can grow by relying on physical capital accumulation and absorption of surplus labor from the countryside into factories—China's extensive growth model may be running out of steam. Attempting to push the limits of this extensive growth model raises the risk of widening vulnerabilities and increases the probability that China's convergence process toward a high-income economy stalls.



Historical experience suggests that failure to adapt such an extensive growth model typically leads countries to maintain loose macroeconomic policies over a longer period of time than necessary, which contributes to further macroeconomic and financial imbalances and

ultimately ends in a crisis.[2] The Chinese authorities recognize the limits to this extensive growth model and have expressed their intention to re-energize their reform effort to accelerate the transition to a more inclusive, services-oriented, consumer-based economy. Achieving such a transformation would ensure China transitions successfully to a high-income economy, but this will not be an easy endeavor and requires the skillful implementation of a package of reforms that will make the economy more reliant on total factor productivity and less on factor accumulation. In particular, this reform package includes greater contestability of markets, financial and service sector reform, and hukou reform. Ultimately, the pace at which China implements this reform package will determine China's medium-term growth prospects and success in transitioning from a middle- to a high-income country.

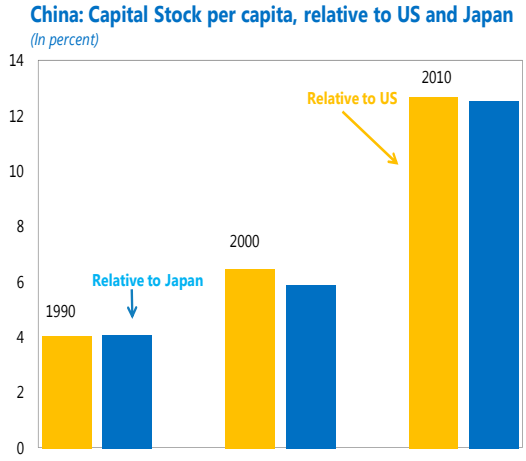
Against this backdrop, section II of this paper looks at the risks from delaying reforms; section III illustrates the benefits of reforms; section IV looks at development trends and prospects for reform at the provincial level; and section V concludes.

II. Reform Delays or Inaction: Risks of Stalled Convergence

Five years after the global financial crisis, China's economy has seen its current account surplus retreat from a peak of over 10 percent of GDP in 2007 to about 2¼ percent of GDP in 2012. This development has been achieved at the cost of rising domestic imbalances, as the investment share rose markedly, reaching one of the highest levels in the world.

A. Stocks versus Flows

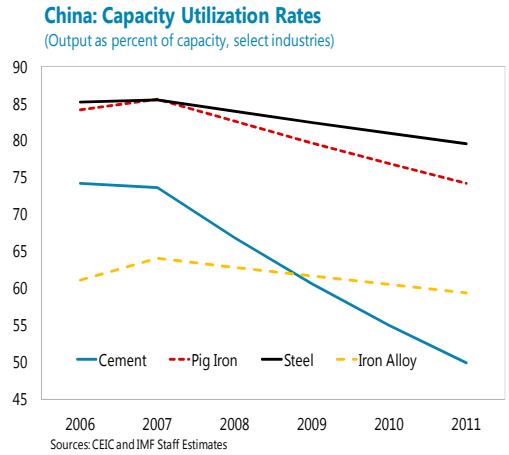
While many analysts and institutions consider that China is overinvesting, with some estimates of overinvestment as high as 10 percent of GDP, others disagree and consider China's rapid investment as consistent with its current level of development. In the latter camp, the argument often put forward is that China's capital stock per capita is relatively low compared with that of more advanced economies, which means there is room for a lot more investment. Indeed, China's capital stock per capita is only about 12 percent of that in the United States



[2] N'Diaye (2010).

and Japan and there are undeniable needs for infrastructure in rural areas and urban amenities.

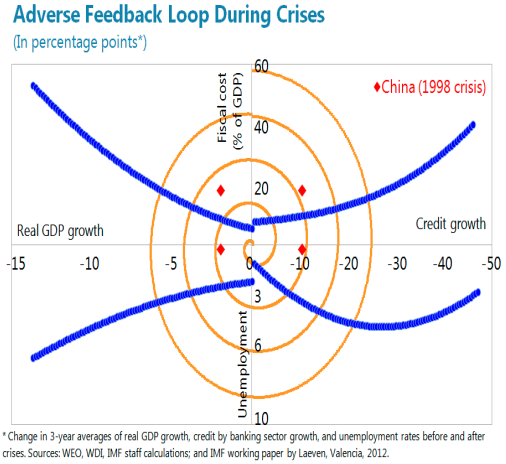
However, the issue is one of speed of convergence and the pace at which China is adding to its stock of capital. Rapid investment growth over the past decade, initially mainly in the manufacturing sector and coastal areas, and more recently in real estate and infrastructure, has meant that China has put in place substantial capacity ahead of demand. Capacity utilization in key sectors of the economy has been running below pre-crisis average, and estimates of China's output gap show substantial amount of slack in the economy.[3]



B. Risks Associated with High Investment

Will China or the rest of the world be able to generate enough demand to absorb the large capacity China has put in place in the past few years? While demand from the rest of the world is expected to recover over the medium term, it is projected to remain below its pre-crisis level held back by balance sheets repairs. Failure to lift China's domestic demand could hence mean falling prices for a wide range of manufacturing goods and a return on investment much lower than envisaged. This would imply lower profits, rising bankruptcies, and large financial losses, which would hamper growth and employment in China and have large negative spillovers to the rest of the world.

China's own and other countries' experience with financial crisis suggest that such financial and employment losses could be amplified by an adverse feedback mechanism between domestic demand, bank lending, real estate, and local government finances. Such crises are costly to clean up not only because of the direct cost of asset purchases and bank recapitalizations. In addition, the subsequent deleveraging by the banking sector and diminished fiscal space means that there is less public and private investment, which lead



[3] See Box 8, International Monetary Fund (IMF), 2012, "People's Republic of China Article IV Consultation—Staff Report." IMF Country Report 12/195.

to slower growth, rising unemployment, further deterioration of asset quality—all of which contribute to foregone revenue and ultimately a larger fiscal burden. The text chart summarizes, based on 65 crisis episodes in advanced, emerging, and developing economies, the costs of crises along the four dimensions of slower growth, rising unemployment, retrenchment of credit, and the fiscal cost.[4] China's banking crisis of the late 1990s—represented by the red diamonds in each quadrant—cost as much as 18 percent of GDP and was associated with a GDP growth decline of around 2 percentage points below previous trend, credit growth declining by 10 percentage points, while the unemployment rate rose slightly by ¼ percentage points. The experience of other countries with financial crises, recounted through the intersections between the blue and orange lines on the text chart above, suggests more dire outcomes than in China in 1998. Moreover, China's situation today looks very different from the past. More specifically:

- ***Bank lending***. With a large portion of investment being financed through debt held by banks, financial losses could impair banks' balance sheets and their ability to lend. At the same time, credit creation by banks—and now increasingly by non-banks—has reached a scale and pace where it will be very difficult to clean up the system without derailing the real economy or significantly increasing sovereign debt. China's domestic bank assets (excluding interbank loans) have expanded by close to USD seven trillion over 2008-2012, which is equivalent to 60 percent of the stock of assets aggregated across all domestically-chartered commercial banks in the United States as of December 2012 (20 percent of the euro area—17 commercial bank assets as of June 2012). Beyond bank loans, other credit instruments—including those originated by trust companies—have also expanded very rapidly in China in recent years. In other economies, credit expansions of this kind have often been associated with large mispricing of risk and a build-up of crisis vulnerability. This would mean tighter credit for all sectors of the economy as well as higher market interest rates, which would further dampen growth and employment.

- ***Growth***. In the past, double-digit aggregate growth helped restore bank balance sheets. But with the economy now entering a more moderate phase of expansion this mitigating factor cannot be considered a given anymore.

[4] These episodes are drawn from Laeven and Valencia (2012).

C. Implications of Delaying the Transformation of the Economy

Since the launch of the 12th Five-Year Plan in 2011, progress has been made in increasing the tertiary share of employment, the private consumption share of GDP, advancing financial sector reform (notably more flexibility of interest and exchange rates), as well as targeting a higher share of R&D expenditure in GDP to promote innovation.[5] However, the economic transformation still has a long way to go to make the growth model less reliant on investment. An illustrative scenario summarizes the potential implications for growth from a lack of further progress in rebalancing the economy. It assumes continued reliance of investment through 2018 and delays in implementing reforms lead to a further build-up of excess capacity and misallocation of resources. More specifically, delays in implementing reforms to rebalance growth means that the demand that is necessary to absorb the capacity put in place through 2018 does not materialize.

At the same time, demographic changes imply a diminishing labor input along the lines of Das and N'Diaye (2013) with the labor force declining after 2015 and China's surplus labor vanishing around 2020.[6] This would mean higher labor cost and progressively lower returns on investment than envisaged, which would cause bankruptcies and financial losses along the lines described above. As a result, growth falters and headline GDP follows the path of other countries which stalled in their convergence process at levels of income close to China's over the medium term. The scenario assumes that the investment-to-GDP ratio corrects sharply downward (by about 10 percentage points) in line with Lee and Syed (2012) estimate of excess investment in China.[7]

The scenario suggests that continuing with the current growth model reliant on factor accumulation and efficiency gains related to labor relocation (across sectors from the countryside into factories) could cause the convergence process to stall with the economy growing at no more than 4 percent, and GDP per capita remaining about a quarter of that of the United States through 2030. Average TFP growth would be less than 3 percent per year, around 1 percentage point below the historical average for China.

III. Medium-Term Growth Prospects With Reforms

If China instead implements reforms to accelerate and sustain TFP growth from within-sector productivity gains, enhances the efficiency of credit allocation and reduces the dependence

[5] Under the 12-Five-Year Plan, the target for R&D expenditure is 2.2 percent of GDP in 2015, up from 1.8 percent of GDP in 2012.

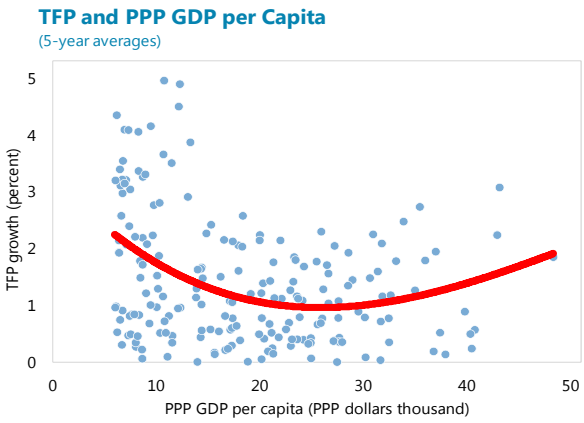
[6] See Das and N'Diaye (2013) for analysis of China's demographic trends and their impact on the workforce.

[7] Lee and Syed (2012) use benchmarks from cross-country analysis and characteristics of the Chinese economy to calculate a norm for the investment share of GDP and find that China's actual share exceeds its norm by around 10 percentage points.

on capital accumulation, and boosts the service sector share of GDP and employment, the economy will be well placed to transition out of middle into high-income status. Two scenarios are constructed to illustrate growth possibilities.

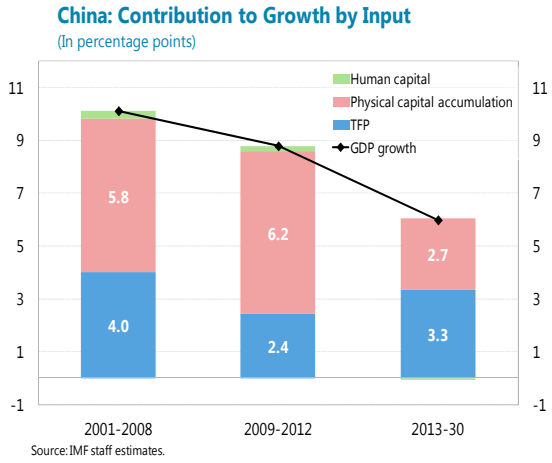
The upside reform scenario envisages China's convergence process follows the path of Korea—a country that also had an export-led growth strategy—between 1981 and 1997, the longest uninterrupted expansion period this country has experienced. Financial sector and resource pricing reform slow capital accumulation gradually (as opposed to the abrupt correction of the crisis scenario outlined above) and eliminate excess investment by 2030. Firms in the manufacturing sector, where excess capacity is relatively more pervasive, will likely invest less, while firms in non-manufacturing, especially the services sectors, gradually increase investment, lured by prospects for future profits. However, higher investment in non-manufacturing is unlikely to fully offset the decline in manufacturing investment.[8] As a result, the share of investment to GDP declines from over 45 percent in 2012 to around 35 percent in 2030.

Labor input is dictated by demographics, similar to the crisis scenario. Assuming China follows the same convergence path as Korea during 1981 and 1997 and given U.S. medium-term growth of 2½ percent (corresponding to the current estimate of U.S. potential growth) and demographic trends, implies China's output growth of about 7 percent on average during 2013-30. The TFP growth underlying such a high growth would be 4¼ percent, about 10 percent above China's historical average TFP growth. Raising TFP growth, for a country at China's level of development, appears challenging and runs against international experience, which shows a tendency for TFP growth to slow during countries' transition from middle- to high-income. Such a typical slowdown in TFP growth is explained by the shift from manufacturing to services that accompany the transition to high-income status.

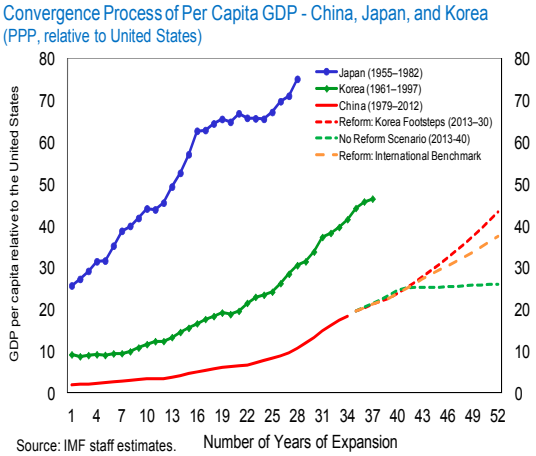


[8] See Chapter VII, International Monetary Fund "People's Republic of China: Spillover Report for the 2011 Article IV Consultation and Selected Issues." IMF Country Report No. 11/193.

An alternative scenario envisages a TFP growth path more in line with typical convergence processes starting from China's current level of income. Average TFP growth falls below its pre-crisis level, to 3¼ percent, a decline consistent with the typical slowdown in TFP growth most countries go through during their transition from middle to high-income. This, together with a declining labor force and a gradual unwinding of excess investment, means average GDP growth could fall to 6 percent during 2013–30 (down from a pre-crisis average GDP growth rate of 10 percent). At such a pace, China's per capita GDP would be about 40 percent of that of the United States by 2030 and 45 percent by 2035.



To recap, the scenario analysis suggests that continuing down the current path may buy relatively higher growth (compared to the two reform scenarios) for a short while, but ultimately the two reform paths put China on course for permanently higher living standards. Reforms may entail slower growth in the short run relative to the baseline of extending the status quo but the benefit of reforms will be seen in higher growth over the medium- to long-run.



IV. Province Level Development Trends

The previous sections highlighted the vulnerabilities of China's current economic model and outlined growth scenarios based on international experience to trace out potential paths of convergence through 2030. The main message is that in order to avoid a situation where the convergence process stalls, China will need to accelerate reforms that shift the growth model to one more reliant on total factor productivity growth. What specific reforms would help in this regard and is there room for achieving the kind of productivity gains needed to lift China out of middle-income status? This section turns to the development experience of China's provinces to answer these questions.

The approach followed is one of development accounting (see Hall and Jones 1999; Hsieh and Klenow, 2010). Using an aggregate production function approach, province level GDP per worker is calculated as a function of provincial physical capital, labor input, and human capital, and the unobserved TFP—which is backed out as a residual. The development

accounting methodology decomposes differences in output per worker into separate components— differences in physical capital input, human capital input, and TFP. Gaps between the richest and poorest provinces can then be calculated along these different dimensions. And by comparing the gaps at different points in time, it is possible to see whether the poorer provinces are converging to the level of the richest in output per worker and also in levels of physical and human capital input. But this approach does not assume that poorer provinces achieve that convergence by relying on the same sources of sectoral growth as richer provinces. Those sources of growth could stem from sectors other than those that have been the main drivers of growth in the richest provinces. For example, it is not the case that a poor province that would be narrowing its income gap relative to, say, Shanghai would be assumed to become a financial center during the convergence process.

Specifically, aggregate GDP in province *i* is given by:

$$Y = A * K^{\propto}(hL)^{1-\propto}$$

Where the usual notation applies: Y is real output, K is physical capital, h is human capital per worker, and L is labor input (see Appendix for descriptions on how each of these is constructed) and $\propto$ is the capital share of income.

This equation can be rearranged as in Hall and Jones (1999) to give output per worker as a function of human capital per worker, the capital-output ratio, and technology:

$$y = Y/L = A * h * (\frac{K}{Y})^{\frac{\propto}{1-\propto}}$$

Here, the physical capital input is the capital-output ratio (rather than the more standard capital per worker) to enable a clearer separation of the role of technology from that of physical capital. Since technology is often embedded in machinery, the typical measure of capital input—capital per worker—will reflect the influence of both technological progress and investment in physical capital, making it more difficult to separate the two influences on output per worker.

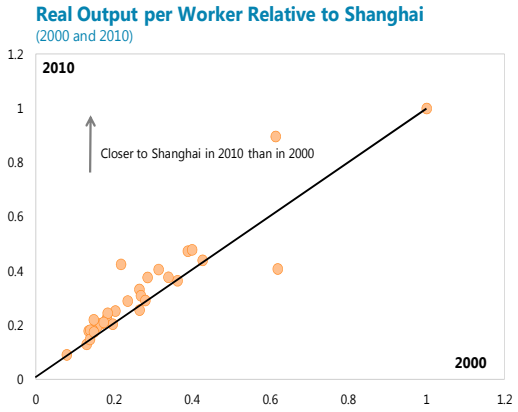
Once the individual province-level decompositions of output per worker are calculated, it is possible to compare each province to the most productive one and estimate gaps in output per worker, physical capital input, human capital per worker, and the residual TFP.[9] Over the period of analysis (2000–10), Shanghai was the most productive province as measured by

[9] The residual in this case also captures any measurement error in output or any of the inputs. For instance, province-level human capital stocks are calculated using provincial educational attainment data from NBS. To the extent that the educational attainment of the actual workforce in each province differs from the educational attainment of the provincial population, the human capital stock will be measured with error. In addition, the analysis does not consider other factors of production, such as natural resources and land supply, which would affect the calculation of capital share of income and hence TFP.

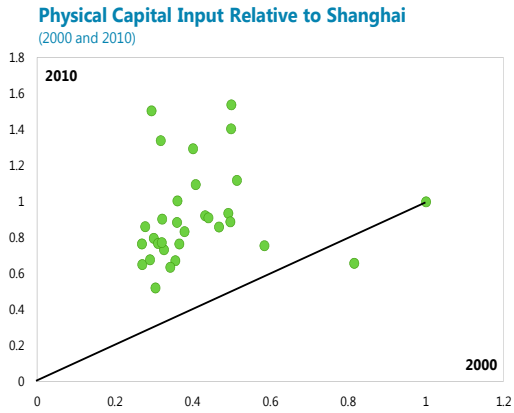
output per worker. Gaps between each province *i* and Shanghai (SHG) can be calculated as follows:

$$\frac{y_i}{y_{SHG}} = \frac{A_i}{A_{SHG}} * \frac{h_i}{h_{SHG}} * \frac{\left(\frac{K}{Y}\right)_i^{\frac{\propto_i}{1-\propto_i}}}{\left(\frac{K}{Y}\right)_{SHG}^{\frac{\propto_{SHG}}{1-\propto_{SHG}}}}$$

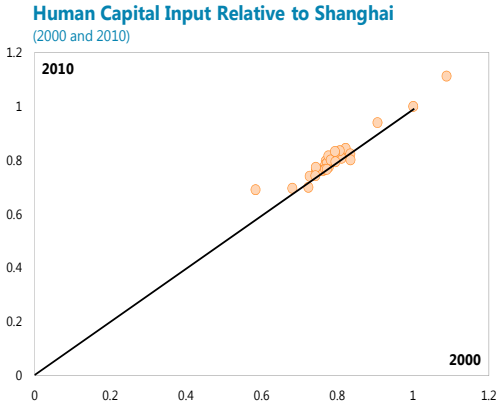
The province-level trends are captured in the accompanying scatter-plot by comparing the ratio of output per worker relative to Shanghai at different points in time. Specifically, the horizontal axis shows output per worker relative to Shanghai in 2000. The vertical axis tracks this ratio in 2010. All points above and to the left of the 45 degree line indicate convergence toward Shanghai over the decade, i.e. the ratio of output per worker relative to Shanghai is higher in 2010 than in 2000. As the chart shows, several provinces have slightly narrowed the gap relative to Shanghai over the first decade of the 2000s.



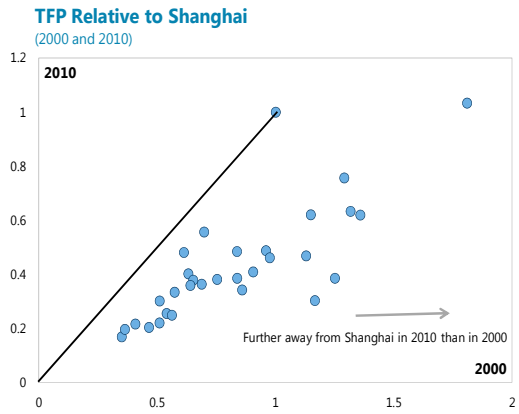
What accounts for the changes seen over 2000 to 2010? The mild closing of the gap in output per worker is mainly accounted for by convergence in physical capital input relative to Shanghai. As the chart shows, in 2000 almost all provinces operated with less than 60 percent of Shanghai's physical capital input. By 2010, barring one case, the remaining provinces had narrowed the gap relative to Shanghai in terms of physical capital input. Reflecting the vast increase in investment across the country over 2000-2010, several provinces have either achieved or exceeded the level of Shanghai's physical capital input by the end of the decade.



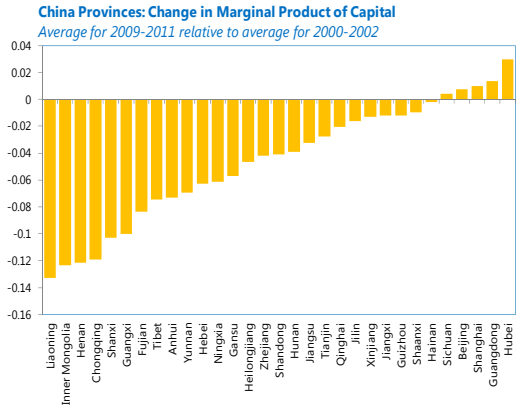
In terms of human capital input, most provinces were relatively close to Shanghai's level in 2000, and have grown closer to Shanghai as the decade progressed. This is seen from all points in the chart lying to the left and above the 45 degree line.



The remaining component of the development accounting exercise is the unobserved residual, TFP. This can be backed out from the measurable factors in the equation above. The picture that emerges is one of divergence in TFP levels away from Shanghai. In 2000, most provinces had TFP levels between 50 to 140 percent that of Shanghai's. But by 2010, the relative TFP level had declined to between 15 and 80 percent that of Shanghai's.



The accounting exercise shows that the rapid convergence in physical capital to the levels of the richest provinces has to a large extent been offset by the widening of the gap in TFP, resulting in only mild convergence in output per worker over the period 2000-2010. While investment in the central and western parts of China, especially in infrastructure over the past few years, could eventually contribute to TFP gains through closer integration with the coastal areas, the patterns so far indicate that the country-wide build-out in investment in recent years has been associated with diminishing returns to capital accumulation. The production function approach allows for a quantification of the return to capital.[10] As the chart shows, the return on capital has declined across most provinces over the course of the decade.



The developments at the provincial level clearly indicate that the capital accumulation-based growth strategy of recent years has resulted only in minimal convergence in levels of output per worker to that of the richest province. In order to lift the level of output per worker closer to the more prosperous areas, growth will need to rely more on total factor productivity and less on factor accumulation. The trends also indicate inter-province gaps in TFP have increased in recent years, suggesting there is room to improve productivity and achieve greater convergence in income per worker to the level of the most prosperous, coastal areas.

[10] Starting with the capital share of income and assuming that the return on capital is equal to the marginal product (MPK), it is possible to calculate:

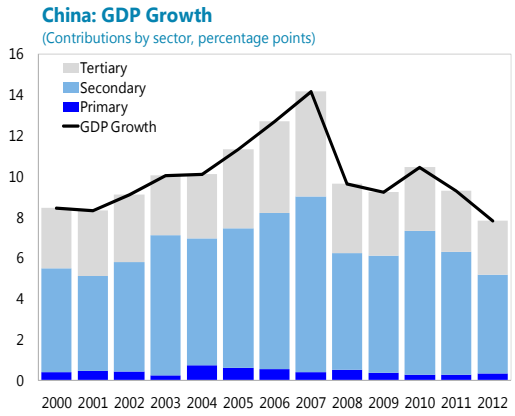
$$MPK = \frac{\propto}{K/Y}$$

A. Reforms to Boost TFP Growth

A package of reforms could help boost province-level TFP growth. This includes:

Contestability of markets

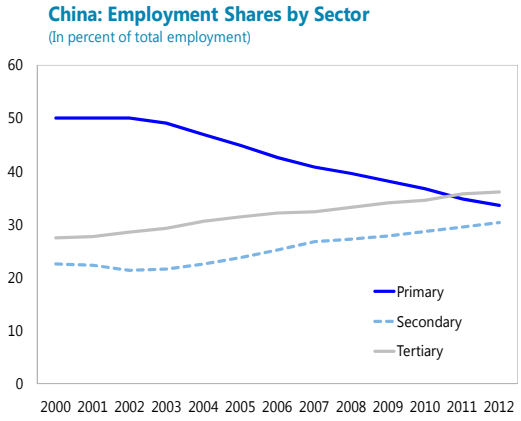
Contestability is measured as the share of foreign direct investment in province-level fixed asset investment. The idea behind this measure is that if markets within a province are more open to entry (i.e. more contestable), this will be associated with a higher ratio of foreign direct investment to total fixed asset investment. With greater entry and more competition, incumbents will be forced to adopt newer technologies and achieve efficiency gains by improving the way they organize the production process. This should lead to faster TFP growth.



Service sector reform

The size of the service sector is measured by the share of service employment in total employment. Previous analysis has shown that the service sector in China particularly lags behind advanced economies in terms of relative productivity (Ahuja, 2012).

At the aggregate economy level, the contribution of tertiary sector (which includes services) to overall growth still falls short of the contribution made by the secondary sector, while the employment share in tertiary sector has only just inched past the employment share in the primary sector.



Deregulation of the service sector and easing access to new entrants—particularly in telecommunications, utilities, and health care—would help diffuse technology, improve the overall allocation of investment, and boost the efficiency of labor input.

Measures to support urbanization

The proxy for urbanization is the share of the province population with non-agricultural hukou (urban household registration permits that provides access to social amenities). Boosting the share of the population that holds urban household registration permits would

help improve labor mobility and relocation to urban areas, fostering a more efficient matching of workers to vacancies. This would also create the demand for services and help capitalize on earlier investments in urban amenities and infrastructure, all of which would improve TFP growth.

TABLE : BASELINE ESTIMATES, ANNUAL DATA, OLS

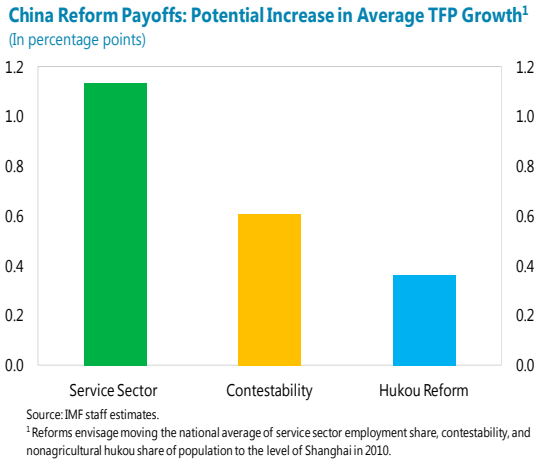
FDI share of FAI	0.0564*** (0.0199)	0.0446** (0.0209)	0.0349 (0.0235)	0.0493** (0.0226)
Non Agricultural Hukou Share of Population		0.0186* (0.0107)		
Service Sector Share of Employment			0.0475* (0.0265)	
Change in SOE Share of Employment				-0.0261 (0.0820)
Year Dummies	YES	YES	YES	YES
SAMPLE YEARS	1998-2010	1998-2010	1998-2010	1998-2010
Number of provinces / regions / municipalities	30	30	30	30
Observations	390	390	390	359
R-Squared	0.2	0.21	0.22	0.2

Notes: Dependent Variable: TFP growth
Robust Standard Errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Regression analysis using provincial data suggests that greater contestability of markets could increase productivity. The first column in the regression table above shows that for every 1 percentage point increase in the FDI share of fixed asset investment, TFP growth increases by 0.06 percentage points. This effect is robust to the inclusion of the other controls, except in the case where the service sector share of employment is added as a determinant, but even in that case the point estimate remains positive. Hukou reform would support the urbanization process and boost productivity by enabling knowledge spillovers and specialization (Column 2). The magnitude of the impact on TFP growth is between one-third and two-fifths of the estimated effect of increasing contestability. Service sector reform (deregulation and increasing the share of labor employed in services) would also lift productivity growth—a percentage point increase in the service sector employment share is associated with an increase of around 0.05 percentage points in the growth rate of TFP (Column 3).

The economic significance of these coefficients can be understood by examining how TFP growth would respond if the gap between the current national average level of each these attributes and the level of Shanghai were to be closed. Specifically, lifting employment share

in the service sector, FDI share of FAI (contestability), and the share of non-agricultural hukou from the current national average to the level of each of these attributes achieved in Shanghai would result in an acceleration of average TFP growth as shown in the accompanying picture. Since the gap between the national average and Shanghai's level is largest for the service sector share of employment, the picture shows that the biggest impact on TFP growth is from service sector deregulation, with smaller effects from improving contestability and hukou reform.



Linking back to the growth scenarios with reform presented in Section IV, the required TFP acceleration in China to achieve the international benchmark growth path is about ¾ percentage points relative to the baseline. Regression results based on China's provincial data indicate that China can achieve the needed increase in TFP growth to match the international benchmark path of convergence with a combination of reforms—service sector deregulation; improving contestability; and hukou reform (all of which are likely to be self-reinforcing). Additionally, eliminating other factor market distortions (energy, water, and land) would help rationalize investment and reduce misallocation of resources.[11]

V. SUMMARY

Headline indicators of China's economic performance in the last ten years make it difficult to question the country's growth and financing model. The stellar record, however, masks variation in performance over the past decade. In the period of accelerating growth (2002–07), the economy expanded at an average rate of 11.2 percent while investment averaged 41 percent share of the overall economy. By contrast, during the later period (2008–11)—admittedly a time of global economic turmoil—growth averaged 9.7 percent, while investment as a share of the economy rose to 47 percent. Moreover, since 2000, investment and capital accumulation has increased across the provinces, but the return to capital has fallen, suggesting potential misallocation and declining TFP growth.[12] The current model has become too reliant on credit and investment, and has begun to experience diminishing returns. Delaying progress on the government's reform agenda will mean that

[11] See International Monetary Fund (IMF), 2011, "People's Republic of China Article IV Consultation—Staff Report." IMF Country Report 11/192.

[12] See Hsieh and Klenow (2009) and Song, Storesletten, and Zilibotti (2011) for more on the TFP implications of resource misallocation in China. See Bai, Hsieh, and Qian (2006) on the evolution of the return to capital in China.

vulnerabilities continue to grow and the probability of stalled convergence increases. On the other hand, with reforms to accelerate TFP growth and shift the economy away from its continued reliance on capital accumulation, China can grow at a healthy pace and maintain its convergence toward the level of high income economies.

Scenario analysis indicates that continuing with the current, capital accumulation-based growth strategy will leave China at most achieving a level of GDP per capita (in PPP terms) around one-fourth that of the U.S. by 2030. In the reform scenario, following a near-term moderate slowdown (as the economy adjusts to relying more on TFP-based growth), convergence continues at a faster pace than under the baseline and income per capita approaches 40 percent of the level of the U.S. by 2030. Evidence from China's provinces indicates that there is room to improve productivity and sustain such a convergence toward the level of more prosperous economies.

VI. Appendix: Data Used for Constructing Provincial Capital Stocks, Human Capital Stocks, Real Output

Unless stated otherwise, all data are sourced from CEIC and NBS.

- **Real GDP.** Province-level nominal GDP is deflated using province-specific GDP deflators. The base year is 1990.

- **Physical capital stock** is calculated using the perpetual inventory method applied to real investment and assuming a depreciation rate of 10 percent. Real investment is calculated by applying the share of province-level nominal investment in nominal GDP to province level real GDP.

- **Human capital** is calculated using province-level education attainment shares from NBS data and returns to education in China, as calculated by Psacharopoulos and Patrinos (2004) and Heckman (2000).

- **Capital share of income** is calculated as the residual after labor income is subtracted from gross provincial income.

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