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China's Long-Term Growth Potential: Can Productivity Convergence Be Sustained?

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Abstract

This study estimates the growth rate of China's economy until 2035 based on the assumption that productivity will continue converging to that of frontier economies and assesses the feasibility of such an outcome. Our estimates imply that the size of China's economy can potentially double by 2035 as long as the country follows the "catch-up" process achieved by other East Asian economies. However, given the circumstances that China faces, such as the need to maintain agricultural output levels, limits to the growth of its export-dependent manufacturing industry, and the aging of the population, the obstacles to following the other East Asian economies' catch-up process are substantial. To overcome these obstacles and proceed with catch-up, China will need to boost TFP growth by promoting innovation and making steady progress in addressing institutional and resource allocation issues.

JEL classification：E21, E22, J11, O11, O47

Keywords: China, Catch-up Process (Convergence), Aging of the Population,
Savings Rate, Total Factor Productivity (TFP) Growth

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1. Introduction

At the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China (CPC) held in the autumn of 2020,[1] the Chinese authorities indicated that they are aiming for China to become a "moderately developed country" by 2035. President Xi Jinping was more specific, affirming his stance of maintaining a high growth rate by saying that it was perfectly possible to double the size of the economy and per capita income by 2035.

China has enjoyed high growth rates since around 1980, when it began with institutional reforms and outward-looking policies in earnest,[2] with the economy growing at an average annual rate of about 10 percent. The driving force behind this growth has been the increase in labor productivity. The opening up of the economy, symbolized by Deng Xiaoping's southern tour[3] and China's accession to the WTO, facilitated technology absorption from abroad and increased the productivity of the manufacturing sector.[4] Moreover, the increase in agricultural productivity that accompanied the introduction of the "household responsibility system"[5] led to a shift of surplus rural labor to the more productive manufacturing and service sectors in urban areas, which also boosted economic growth (Bosworth and Collins, 2008). As a consequence of this increase in productivity, rising income levels and the allocation of household savings to infrastructure and business fixed investment led to a virtuous cycle between capital deepening and higher growth. However, since the mid-2000s, this situation has been changing. That is, the shift of labor from agriculture, where labor productivity is low, to other industries has slowed. Under these circumstances, the decline in the labor share of income has stalled and the pace of capital accumulation has decelerated. This can be interpreted as a "rebalancing" of the economy away from

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[1] At this important meeting of the CPC, the five-year plan for 2021–2025 and the long-term goals for 2035 were discussed.

[2] At the Third Plenary Session of the 11th CPC held in December 1978, the policy of promoting reform and opening up based on the "Four Modernizations" (industry, agriculture, national defense, and science and technology) was announced. This led to a review of the existing planned economy system and the introduction of market principles, consisting of agricultural reforms, reforms of state-owned enterprises (SOEs), and the subsequent opening up of the economy, including accession to the WTO, to increase the size and efficiency of the economy.

[3] In 1992, Deng Xiaoping visited Shenzhen and other cities in southern China and stressed the importance of accelerating reform and opening up in his so-called "Southern Tour Speech." Subsequently, the Central Political Bureau Meeting passed a communiqué to accelerate the pace of reform and opening up, which led to the subsequent expansion of direct investment in China.

[4] Price liberalization and institutional reforms such as reforms of SOEs also contributed to growth (Kroeber, 2016).

[5] As part of the introduction of the "household responsibility system", farmers that used to be part of the collective farming system were allowed to independently sell any products beyond what they owed to the government.

excessive dependence on investment, helping the economy to achieve more sustainable growth (Fukumoto and Muto, 2012).

With China's economy continuing to undergo structural changes, assessing the long-term growth potential of the economy is becoming increasingly difficult. Although China's economy now accounts for about 20 percent of global nominal GDP, the country's per capita GDP and labor productivity are still only about 20 percent of those of the United States. Thus, there is a lot of room for China's labor productivity level to converge to that of the United States, and based on the growth paths followed by Japan, South Korea, Taiwan, and Singapore (referred to as the "East Asian 4" hereafter), many optimistically argue that China can maintain a high growth rate of 5–6 percent per year on average through 2030 (World Bank, 2020; Huang et al., 2021). Economists at the central banks of Canada and Australia, countries with close economic ties with China, also believe that a growth rate of around 4–5 percent is sustainable (Bailliu et al., 2016; Roberts and Russell, 2019). Relatively pessimistic studies, in contrast, suggest that China's growth could slow down substantially in the future. For example, examining the historical growth rates of more than 100 economies and finding that there is a strong tendency for economies that grew at an above average pace to subsequently slow down, Pritchett and Summers (2014) expected China's annual growth rate to average only about 3.9 percent from 2013 to 2033. Moreover, Higgins (2020), based on the growth rates of economies that had reached the equivalent of China's income level as of 2018, estimated that the average annual growth rate could decelerate to about 2.7 percent over the period 2018–2028 due to the slowdown in the pace of capital accumulation and in total factor productivity (TFP) growth.

This study provides a novel perspective to these recent studies on China's long-term growth potential. Specifically, the study makes two major contributions.

The first is that it deepens previous research on China's catch-up. Using data on various economies, we estimate the speed of convergence to the productivity frontier in these at a more detailed industry level than previous studies and use the estimated coefficients to forecast China's future growth. Our results suggest that if China's economy can follow the same catch-up process as the East Asian 4 in the past, it is possible for the economy to double in size by 2035.

The second major contribution is that we quantitatively examine the substantial obstacles that need to be overcome to follow such a catch-up process. The catch-up estimates are based on the assumptions that (1) the shift of labor across industries smoothly proceeds and (2) China manages to continue to catch up at the speed achieved by other economies in the past. The East Asian 4 economies were able to meet these two conditions when their per capita GDP was about the same as China's level today. However, China's economy differs from those of the East Asian 4 at the time in that (1) China has a much larger population and places importance on a high rate of food self-sufficiency to ensure food security, (2) China already accounts for a large share of global manufacturing, so that it will not be easy to expand exports at a rate much faster than the current pace of growth of the world economy, and (3) demographic trends mean that China is getting old before it is getting rich. These differences imply that it will be difficult for China to meet the assumptions required for its economy to follow the growth path of the East Asian 4. This study provides a quantitative examination of these issues and shows that a doubling of the size of the economy requires China to raise labor productivity growth, especially TFP growth, given that there are limits to growth through capital deepening alone.

The remainder of this study is organized as follows. Section 2 provides the estimates of the speed of growth convergence in seven industries based on a sample of 40 economies and uses the results to forecast China’s future growth until 2035. Next, Section 3 quantitatively examines the obstacles China faces in achieving such a productivity convergence to the frontier by comparing China's future growth path with the catch-up process of the East Asian 4 economies. Finally, Section 4 briefly discusses issues that need to be addressed for China to overcome these obstacles.

2. China's growth outlook based on a catch-up approach

2.1 Estimation approach

China's per capita GDP over the past several decades has grown at roughly the same pace as that of the East Asian 4 during their periods of rapid growth. Nevertheless, despite such growth, China's per capita GDP remains lower than the per capita GDP of the East Asian 4 at similar stage in their catch-up process (Exhibit 1). Moreover, in the manufacturing sector, which has grown remarkably since 1990, labor productivity remains at only slightly more than 20 percent of the U.S. level and the productivity gap is even larger in the service sector, which has been slow to open up to international competition. Given that emerging economies tend to have higher growth rates than advanced economies, there is a lot of room for the Chinese economy to grow in the future by catching up with frontier economies that are leading the global economy (Romer, 2018; Barro and Sala-i-Martin, 2003).[6,7]

In general, in emerging economies' catch-up with frontier economies, labor productivity in the economy increases through two channels: (1) the movement of labor across industries, and (2) increases in labor productivity within industries (i.e., the catch-up within individual industries). In the growth process of the Chinese economy, both of these channels have played an important role. Beginning with the movement of labor across industries, China has seen a progressive shift of labor from agriculture, where labor productivity is low, to manufacturing and services, where labor productivity is higher, and this has boosted overall labor productivity. However, this productivity-boosting effect of the movement of labor has been gradually declining. Reasons include that (1) the pace of the movement of labor from agriculture to other industries has slowed; and (2) labor has started to shift from manufacturing to services with relatively lower labor productivity (Exhibit 2).[8]

Next, looking at the rate of labor productivity growth by sector shows that in all sectors China has achieved higher rates of growth than the East Asian 4 (Exhibit 3). Further, decomposing China's labor productivity growth into the contribution of changes in labor productivity within sectors and changes in the sectoral composition of the workforce indicates that while both of these factors have made a substantial contribution to productivity growth, the contribution of labor reallocation across sectors has declined in recent years (Exhibit 4).

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[6] Regarding whether emerging economies tend to grow faster than advanced economies, i.e., whether economic growth tends to converge, economists distinguish between two types of convergence: (1) "unconditional convergence" (all countries converge to the same steady state), and (2) "conditional convergence" (economies with different state variables converge to the steady state of their respective groups). Applying the results of the latter type of analysis assuming "conditional convergence" to China, Barro (2016) observes that China's growth rate since 1990 has outperformed the average growth path suggested by the estimates.

[7] As highlighted by Branstetter (2001), in addition to the catch-up with global frontier firms through the incorporation of foreign technologies, productivity convergence by domestic firms to domestic frontier firms is also important for improving firm productivity. Against this background, Iida et al. (2018), using Chinese firm-level data, have shown that firms with low levels of TFP are making progress in catching up with frontier firms and argue that this will support future TFP growth.

[8] This shift reflects the general tendency for the employment share of the manufacturing sector to decline as a country's income level rises (see, e.g., Rodrik, 2016). The reason, as highlighted by Lawrence and Edwards (2013), is that the pace of productivity growth in the manufacturing sector is faster than in other industries, and if the elasticity of substitution between goods and services is low, the labor savings associated with higher productivity will exceed the increase in demand due to the lower relative prices of goods, resulting in lower demand for labor in the manufacturing sector.

A recent study estimating China's medium- to long-term growth potential based on a catch-up approach taking the above-mentioned changes in the sectoral composition of the workforce into account is that by Zhu et al. (2019). In this study, we follow their approach. The procedure is as follows.

As a first step, we assume that the labor productivity growth rate in industry i in China in each year is essentially determined by the labor productivity gap and catch-up speed vis-à-vis the frontier country at that time (in this study, we assume that the United States is the frontier country). That is:

$$\hat{y}_{it}^{China} = \hat{y}_{it}^{frontier} + \beta\left(lny_{it}^{China} - lny_{it}^{frontier}\right) \quad (1)$$

where $\hat{y}_{it}^{j}$ is the labor productivity growth rate in industry *i* in country *j* in year *t*, and y_{it}^{j} is the labor productivity level in industry *i* in country *j* in year *t*.[9] The labor productivity performance of each economy is calculated using data on industry-level real gross value added (GVA) from the United Nations and on the number of workers by industry from the International Labour Organization (ILO). We distinguish seven industry categories, which are based on the International Standard Industrial Classification (ISIC4).[10]

As a second step, we estimate the industry-level output by multiplying the projected industry-level labor productivity calculated as described above by the projected industry-level number of workers, and then estimate the future level of real GDP by aggregating the results.

Leaving aside the somewhat technical issue of the future labor productivity growth rate of each industry in the United States,[11] the future growth rate of the emerging country (China) in the above setting is determined by (1) the future number of workers in each industry and (2) the convergence rate (β).

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[9] We add the average forecast error of this model over the past 10 years to the estimate of the labor productivity growth rate in order to control for country/region- and industry-specific fixed effects.

[10] Specifically, the seven industry categories based on ISIC4 are (1) agriculture, hunting, forestry, and fishing; (2) mining and utilities; (3) manufacturing; (4) construction; (5) wholesale, retail trade, restaurants and hotels; (6) transport, storage, and communication; and (7) other services (including finance, real estate, education, health, and social services).

[11] We assume that the GVA of industries in the United States continues to grow at the average annual growth rates observed from 2016 to 2019.

2.2 Assumptions for the estimation

In our baseline estimation, we make the following assumptions regarding (1) developments in the number of workers by industry and (2) the convergence rate (β).

First, we follow Zhu et al. (2019) in assuming that the future number of workers by industry is given by the trend in industries' employment share over the past decade multiplied by the total number of workers estimated from working-age population projections by the United Nations (Exhibit 5).[12] This assumption means that the impact of future demographic changes on labor input is incorporated into the growth projections. While assuming that the trend in industries' employment share remains unchanged allows us to take changes in the industrial structure and the movement of labor across industries into account, it is a rather strong assumption. In the next section we therefore discuss the validity of this assumption and the impact that changes in these trends would have.

Next, we turn to the convergence rate (β). Using Rodrik's (2013) estimation result for the convergence rate in the manufacturing sector based on data for 118 economies, Zhu et al. (2019) assume that the convergence rate in the service sector is identical to that in manufacturing and set $\beta=-0.029$ for all industries. However, the assumption that the convergence rate is identical across industries is a strong one. For example, examining convergence in European countries, Sondermann (2012) concludes that whether there is convergence and, if so, the speed of convergence to the frontier country, differs by industry.

We therefore estimate industry-level convergence rates using the Groningen Growth and Development Center's (GGDC) GGDC 10-Sector Database for the period 1950–2013. Specifically, we estimate a fixed effects model[13] employing the value added in constant prices[14] and the number of workers by industry[15] of 40 economies as a sample. The model is specified as follows:

[12] More specifically, we extended the number of workers taken from ILO beyond 2020 using the growth rate of the working-age population in the United Nations projections.

[13] When estimating growth convergence using panel data (i.e., regressing the per capita GDP growth rate on lagged per capita GDP), including fixed effects, as we do here, has the advantage of preventing omitted variable bias. On the other hand, it is well known that when the time-series dimension in panel data is short, the inclusion of fixed effects may cause downward bias in the coefficient on lagged per capita GDP (i.e., convergence speed β is overestimated) (Nickell, 1981). We avoid this issue to a certain extent by using the GGDC data set, which spans about 60 years.

[14] The GGDC data set consists of 10 industry categories based on the International Standard Industrial Classification (ISIC) 3.1. We group the two industries (1) mining and (2) utilities, into a single category, "mining and utilities", and the three industries (1) business services, (2) government services, and (3) personal services into a single category, "other services", resulting in seven industries.

[15] There are large discrepancies in the number of workers in China in the data from the National Bureau of

$$\hat{y}_{ijt} = \beta^{i} lny_{ijt} + D_j + D_t + \varepsilon_{ijt} \quad (2)$$

where D_j represents a set of country/region dummies and D_t represents year dummies.

The estimation results show that β is negative and statistically significant in all industries, and that labor productivity converges to the frontier (Exhibit 6). While the estimation here has the advantage that it gauges the speed of convergence at the industry level, a disadvantage is that it is based on a relatively small number of economies in the sample. Therefore, in addition to using our own estimate, we also estimate China's growth rate following Zhu et al.'s (2019) approach applying Rodrik's (2013) convergence estimates to all industries.

2.3 Estimation of China's growth rate

Based on the approach just explained, we estimate China's future growth rate assuming that the economy continues to follow a catch-up process (Exhibit 7). In this baseline estimation, the growth rate follows a gradual downward trend due to the decrease in labor input and a deceleration of productivity growth as the productivity gap between China and the frontier narrows; nevertheless, growth remains relatively high at an annual average rate of about 4.8 percent until 2035. As a result, the size of China's economy will grow by a factor of 2.02 between 2020 and 2035.[16] A broadly similar result is obtained in the alternative estimation using Rodrik's (2013) convergence rate.[17]

Based on the baseline estimates, labor productivity in China's manufacturing sector

Statistics of China and the GGDC between 1989 and 1990. Wu et al. (2015) have pointed out that this is due to the fact that the number of workers before 1990 does not include labor such as informal workers and have published their own estimates of the number of workers by industry since 1980 in the China Industrial Productivity (CIP) Database available on the website of the Research Institute of Industry, Economy and Trade. For our estimations, we proceed as follows. (1) For 1990 onward, we use the number of workers by industry from the GGDC; (2) for 1980–1989, we apply the year-on-year rate of change in the CIP data to the number of workers by industry in the GGDC; and (3) for the period before 1980, we use the year-on-year rate of change in the GGDC and apply this to the number workers by industry obtained in (2).

[16] It should be noted that growth convergence analyses potentially suffer from a number of problems such as (1) sample selection bias (observations tend to be biased toward advanced economies that are already industrialized) and (2) measurement error (issues regarding the accuracy of data spanning several decades) (see, e.g., Romer, 2018). Similarly, Maliszewski and Zhang (2015), who examined China's growth potential, pointed out that when forecasting future growth rates based on the convergence rate of other economies, the results can differ widely depending on the choice of economies included in the analysis. In this study, we try to mitigate these issues by using data estimated based on uniform standards in both a time series and a cross-country direction, such as data from the United Nations, the Penn World Table, and the GGDC 10-Sector Database.

[17] Specifically, the estimated average annual growth rate through 2035 is about 4.6 percent, and the size of the economy increases by a factor of 1.95 over the period 2020–2035.

will increase to about 40 percent of the U.S. level in 2035, labor productivity in the service sector will be less than 30 percent, and labor productivity in agriculture will be only about 10 percent (Exhibit 8). The relatively sluggish increase in productivity in the service sector is likely due to the fact that the barriers to entry for foreign firms are higher than in OECD countries. Labor productivity in agriculture also remains low, partly because of the slow pace of productivity growth to date.

Our baseline estimates are somewhere in the middle of the range of estimates of the medium- to long-term growth potential of China's economy obtained in previous studies. Specifically, while our estimates for the corresponding periods are lower than the World Bank's (2020) and Bank of Canada's (Bailliu et al., 2016) estimates, they are higher than the estimates obtained by Pritchett and Summers (2014) and Higgins (2020) (Exhibit 9). Note that, as highlighted by Higgins (2020), there is a high degree of variability in the growth path during the catch-up process and that there is a high degree of uncertainty in the projections. However, comparing our baseline estimate with the growth paths followed by almost 100 other economies shows that although our estimates are slightly higher than the median, they are still within the 25 to 75 percentile band (Exhibit 10).[18] Moreover, the baseline estimate is generally consistent with the average growth path of the East Asian 4 in the past, and based on the experience of these economies, there appears to be ample potential for the Chinese economy to realize the growth path based on this estimate.

3. Obstacles to overcome in the catch-up process

In the previous section, we estimated China's future growth if the economy continues to follow a steady catch-up process and showed that China's economy could double in size from its current level by 2035. Let us call this our baseline projection.

While the baseline projection can be said to be based on the average experience of other economies including the East Asian 4, it assumes that (1) the movement of labor across sectors will continue in line with past trends, and (2) the catch-up speed (i.e., the growth rate of labor productivity in each sector) will remain at a level consistent with the past experience of other economies. These assumptions generally held in the catch-up process of the East Asian 4. However, China's economy differs from those of the East Asian 4 in the past in several respects, and these assumptions might not hold. In this context, the

[18] We use the purchasing power parity-adjusted real GDP from Penn World Table 10.0 for almost 100 economies whose per capita real GDP had reached China's 2019 level.

following three issues are particularly important: (1) China has a large population and the government places importance on a high rate of food self-sufficiency to ensure food security; (2) China already accounts for a large share of global manufacturing, so that it will not be easy for the country to further increase its presence in export markets; and (3) demographic trends mean that China is growing old before it is getting rich.

Difficulties in ensuring food self-sufficiency and expanding the manufacturing sector may stifle the reallocation of labor across industries. Moreover, the aging of the population could affect both the reallocation of labor and labor productivity growth within industries. That is, a decline in labor input could make it difficult to maintain output levels in agriculture, which could slow down the movement of labor. In the following, we examine these obstacles in more detail.

3.1 Food security and the movement of labor: Will the shift of labor across industries continue?

The first issue concerns the balance between food security on the one hand and the shift of labor from agriculture to other industries on the other. In China, agriculture at present accounts for a larger share of GDP than in the East Asian 4 when they were at a similar per capita GDP level, reflecting the Chinese government's policy of achieving a rate of food self-sufficiency of 95 percent or higher.[19] However, in the baseline estimate, the employment share of agriculture and the share of agriculture in GDP will decrease significantly in the future due to a combination of the movement of labor across sectors and the effects of the aging of the population (Exhibit 11). As a result, real output in agriculture would drop to less than 40 percent of the current level, which means that China would have to effectively abandon food self-sufficiency.

However, in practice, it is unlikely that the Chinese government will tolerate such a change in industrial structure from the perspective of food security. Therefore, to consider a more realistic path, we assume that the shift of labor from agriculture will be limited to an extent that maintains the current level of real output in agriculture (Exhibit 12). In this case, GDP in 2035 would be about 10 percent lower than in the baseline estimate and only 1.87 times the current level (Exhibit 13). This means that if the level of agricultural output is to be maintained, then for the economy to double in size, either (1) labor productivity in agriculture must be increased to support a smooth shift of labor, or (2) labor productivity in the manufacturing and service sectors must grow at a rate well above

[19] For instance, the Outline of the Medium- and Long- term Plan for National Food Security (2008–2020) set the goal of a food self-sufficiency rate of 95 percent or higher as of 2020 in order to ensure food security.

the baseline rate of convergence. Given that the shift of labor from agriculture to other industries has slowed in recent years, progress in agricultural reforms will play an important role in boosting China's medium- to long-term growth potential.

3.2 The sustainability of manufacturing-led growth: Too big to grow?

The second issue is the sustainability of manufacturing-led growth. According to the baseline estimate, the GDP share of the manufacturing sector at around 26 percent in 2035 will remain more or less unchanged from the current level of around 28 percent (Exhibit 14).[20] In other words, it is assumed that value added in the manufacturing sector will increase about 1.8 times by 2035. Under this scenario, China's share in global manufacturing would likely increase further from its current level of about 25 percent (Exhibit 15). In the past, the East Asian 4 were able to maintain a high export-led manufacturing share in their catch-up process. However, it will likely not be easy for China's economy to follow a similar path, given the tensions between the United States and China as well as the declining growth rate of global trade volume (Exhibit 16). Therefore, for China's manufacturing sector to maintain a high rate of growth, stimulating domestic demand will be important.

The potential certainly exists: if urbanization, which still lags behind advanced economies, continues and incomes rise as a consequence, there still appears to be ample room for China to expand domestic demand (Exhibit 17). Household income in urban areas is about twice as high as in rural areas, and demand for durable goods such as automobiles is likely to increase (Exhibit 18). In fact, the Chinese government has set the goal of raising the urbanization rate from 60.6 percent in 2019 to 65 percent by 2025 during the period of the 14th Five-Year Plan (2021–2025). However, increased urbanization may lead to a reduction in agricultural output through a decrease in the number of agricultural workers. Therefore, to achieve both an increase in the size of the manufacturing sector and maintaining agricultural output levels, China will need to simultaneously promote urbanization and further raise labor productivity within industries.

[20] This estimate is in line with plans announced at the Fifth Plenum in autumn 2020 discussing China's long-term economic plan to essentially hold the share of the manufacturing sector stable.

3.3 The impact of the aging of the population on capital accumulation: Is China getting old before getting rich?

The third issue is the impact of the aging of the population on capital accumulation. Unlike the East Asian 4, which entered the catch-up process when their working-age population was growing, China is already experiencing a decline in its working-age population, at a much earlier stage in the catch-up process (Exhibit 19). The baseline projection in Section 2 takes the impact of the aging of the population on labor input into account. However, the impact of demographics on economic growth is far-reaching and goes beyond the issue of labor input.

Of particular importance to the Chinese economy is the impact of the decline in the savings rate associated with the aging of the population on capital accumulation. Given the size of the Chinese economy and the capital controls in place, it is likely that much of the domestic investment will have to be financed by domestic savings,[21] and a lower savings rate may force a shift away from investment-led growth. While the East Asian 4 were able to finance capital deepening mainly through domestic savings during the catch-up process, China's population may be aging before sufficient capital stock is accumulated – that is, China is "growing old before it is getting rich." In this case, to achieve catch-up (higher labor productivity) on par with the East Asian 4, higher TFP growth must compensate for the slowdown in capital accumulation.

To examine this issue quantitatively, in the following we (1) estimate China's future savings rate based on the overlapping-generations model of Curtis et al. (2015), (2) estimate the path of future investment and the capital stock, and (3) using standard growth accounting, compute the level of TFP growth required to achieve the baseline growth rate described above.

<u>Step 1: Estimating the savings rate</u>

We estimate the future savings rate using the three generations model employed by Curtis et al. (2015) to describe the Chinese economy.[22] In this model, the savings rate depends on the population shares of the following three generations: (1) children, who do not save, (2) workers, who save, and (3) retirees, who draw down their savings. The three

[21] If capital inflows from other economies increase substantially in the future as a result of the liberalization of capital flows, the investment rate could exceed the savings rate. However, we assume that the two will be identical, taking into account the observation that domestic savings and domestic investment tend to be highly correlated as highlighted by Feldstein and Horioka (1980), and that the IMF forecasts that China's future gross national savings rate and domestic investment rate will be roughly the same.
[22] For details of the model, see Curtis et al. (2015), Curtis et al. (2017), and Zhang et al. (2018).

generations are defined as follows.

Children (age 0 to 19): Consume from the income of workers (parents)

Workers (age 20 to 63): Earn wage income and save to pay for their own and their children's consumption, and transfer a fraction of their wages to retirees through informal family support networks and through formal pension contributions

Retirees (age 64 to 85): Live off informal transfers from workers as well as formal pensions and their own savings accumulated built up when they were working; savings will be used up by age 85

The increase in the number of retirees in China will exert downward pressure on the savings rate. On the other hand, the utility function of workers is assumed to be of the type assumed by Barro and Becker (1989), in which altruistic parents value their children's consumption. As the birthrate declines, parents allocate less income to their children's consumption, which exerts upward pressure on the savings rate. Moreover, if workers expect the population to age, they have an incentive to increase their savings since they can expect informal transfers from working-age family members when they retire to be smaller than at present. Thus, the link between the aging of the population and the savings rate is determined by a complex configuration of interrelated factors that can change depending on the age structure.[23]

We estimate the household savings rate using the overlapping-generations model employing the parameter estimates of Curtis et al. (2015) and the long-term population projections for China by the United Nations.[24] The results suggest that (1) the model generally tracks the actual household savings rate to date, and (2) the future savings rate will decline due to the shrinking working-age population, i.e., the generation responsible for saving (Exhibit 20). Further, our estimates of the gross national savings rate, which we obtain by running a simple regression of the gross national savings rate on the household savings rate, show that this is also projected to decline in the future (Exhibit 21).

[23] If real wages rise as the population ages, demand for capital will increase as capital will be more abundant relative to labor in the economy. As a consequence, the savings rate may rise through higher real interest rates. We should note that the model by Curtis et al. (2015) does not incorporate this channel.

[24] Our estimates are based on the replication codes published by Curtis et al. (2015), using data on household savings rates, United Nations population estimates, and other data. Pensions are assumed to be based on a pay-as-you-go system, and it is assumed that a certain percentage of workers' wages is transferred to retirees. Households' projections of future demographic trends before the introduction of the one-child policy in 1979 are assumed to be based on the United Nation's world population estimates released in 1978, while those after 1979 are assumed to be based on the latest population estimates.

Step 2: Future capital stock

Next, based on the projections for the gross national savings rate, we estimate the future capital stock and examine the contribution of capital accumulation to growth based on growth accounting.

As mentioned earlier, for the time being, domestic investment in China is likely to be financed primarily by domestic savings. Therefore, under the assumption that the investment rate equals the gross national savings rate, we estimate the future capital stock based on the perpetual inventory method. For the capital stock and capital depreciation rate, we use the data estimated by Herd (2020) using Chinese statistics.[25] Specifically, we estimate

$$K_t = I_t + (1 - \delta)K_{t-1} \qquad (3)$$

where K_t is the capital stock, I_t is investment, and δ is the capital depreciation rate.

Step 3: Assessing the impact of the aging of the population on capital accumulation

Finally, based on the capital stock calculated in equation (3) and United Nations projections for the working-age population, we calculate the TFP growth rate necessary to achieve the baseline growth rate using growth accounting. Specifically, we calculate the TFP growth rate ($\hat{A}_t$) necessary to achieve the growth rate estimated in Section 2 by subtracting the growth contribution of increases in labor input ($\alpha\hat{L}_t$) and capital stock ($(1-\alpha)\widehat{K}_t$) from the baseline growth rate above based on the following Cobb-Douglas production function:

$$\hat{Y}_t = \hat{A}_t + \alpha\hat{L}_t + (1 - \alpha)\widehat{K}_t \qquad (4)$$

where $\hat{Y}_t$ is China's real GDP growth rate, $\hat{A}_t$ is the TFP growth rate, $\hat{L}_t$ is the year-on-year rate of change in labor input, $\widehat{K}$ is the year-on-year rate of change in the capital stock, and α is the labor share.

Our calculations (Exhibit 22) indicate that not only will the negative growth contribution of labor input become more pronounced, but the positive growth contribution of increases in the capital stock will also gradually decrease through the projection period, as the savings rate declines with the aging of the population. For this reason, a gradual increase in the TFP growth rate will be required to achieve the baseline growth rate.[26]

[25] Herd (2020) estimates the capital stock using data on China's fixed asset investment, industrial sector assets, etc. For the capital depreciation rate from 2020 onward, we use the value for China for 2019.

[26] The results are generally the same when using the capital stock and capital depreciation rates from Penn

Given that the TFP growth rate tends to decline as the productivity gap vis-à-vis the frontier narrows, this is a high hurdle to overcome. Of course, the estimates of the savings rate here reflect only the effects of demographics, and the estimates should be interpreted with some latitude. For example, if workers transfer less money to retirees, or if the retirement age is raised, the pace of decline in the savings rate will be slower.[27] However, as pointed out by Zhang et al. (2018), who examined the factors underlying changes in China's savings rate, the impact of demographics on the savings rate is substantial[28] and should not be underestimated.

4. Challenges to Achieving Catch-Up and Policy Responses

As seen above, if China's economy continues its catch-up process, it could double in size by 2035. However, the obstacles to achieving this scenario (the baseline estimate) are quite high. Given demographic trends and other constraints, China faces a range of challenges that need to be addressed in order to increase labor productivity within industries and ensure the movement of labor across industries.

The Chinese government of course is aware of these challenges and has indicated that it is planning to address them. In addition, it has expressed its goals with regard to agriculture and urbanization, as discussed in the previous section. For instance, in agriculture, consolidating farmland and introducing large-scale farming to increase labor productivity is not an easy task. However, the Chinese government has demonstrated its determination to emphasize agriculture in this year's "No.1 Central Document"[29] as well as by espousing policies to improve the supply capacity of agriculture products.[30] Similarly, the government in recent years has been pursuing reforms to promote urbanization, such as easing the requirements for obtaining household registration in

World Table 10.0.

[27] Curtis et al. (2015), citing findings by Lee and Xiao (1998) and Xie and Zhu (2009) on children's financial support for parents, suggest that the share of income transferred by workers to their elderly parents has declined in recent years. Moreover, at the Fifth Plenum in autumn 2020, it was announced that the legal retirement age would be raised in stages.

[28] Specifically, examining the determinants of changes in China's household savings rate from 1955 to 2016, Zhang et al. (2018) find that demographics are the most important driver, explaining more than half of the changes in the savings rate.

[29] The "No. 1 Central Document" is a document issued by the Communist Party of China and the State Council at the beginning of the new year, and this year marks the eighteenth year in a row that agriculture has been the focus of the document.

[30] In January 2019, as part of efforts to consolidate land, the transfer of contractual management rights for agricultural land was approved, and in April 2020, the government further clarified its intention to allow a market for agricultural land to be liquidated in the future.

urban areas, especially in medium and small cities.[31] These reforms pose difficult challenges and their progress warrants careful monitoring.

Moreover, as shown by the impact of the aging of the population on capital accumulation, raising labor productivity without relying on increased investment – in other words, boosting TFP growth – continues to be important for achieving the catch-up shown in the baseline estimation. Again, the government is well aware of this and has highlighted the importance of innovation policies, as exemplified by the goal of achieving "self-reliance and self-sufficiency" in science and technology, and of improving resource allocation through the market-based allocation of production factors,[32] including the aforementioned reforms in agriculture and the household registration system. The following briefly summarizes China's current situation and challenges with regard to these issues.

4.1 Issues surrounding the promotion of innovation

Innovation occurs through a number of channels, including investment in research and development (R&D), the accumulation of human capital, and technology absorption through international trade. However, as highlighted by Acemoglu et al. (2006), the type of innovation required depends on a country's (or firm's) stage in the growth process. That is, while catch-up can be achieved by imitating other countries when there is a large productivity gap vis-à-vis frontier economies, "entrepreneurial skills" are essential as the gap shrinks. Moreover, Aoki et al. (2017) point out that in the catch-up process, economies can fall into a self-perpetuating low productivity trap; that is, they find themselves stuck in an equilibrium in which productivity does not converge toward that of the frontier. To avoid this, firms need to innovate and the government needs to support these efforts to generate a positive feedback loop of firm and government efforts.[33]

Therefore, in the following, we (1) examine China's recent trends in technology absorption from abroad, which is necessary for catch-up growth, and then (2) examine

[31] Under China's household registration system, citizens are broadly divided into urban and rural residents. Holders of a rural household registration are restricted from obtaining an urban household registration even if they live and work in an urban area, greatly restricting the public services they can access in urban areas.

[32] In April 2020, the Chinese government unveiled guidelines on improving market-based allocation of factors of production. The policy aims to (1) mobilize the labor force by easing the conditions for obtaining an urban household registration, (2) increase the liquidity of land supply by, for example, allowing market transactions of rural land, and (3) improve access to capital by deregulating capital markets.

[33] Aoki et al. (2017) further highlight that Japan's distance from the frontier has widened since the 1990s due, in part, to the collapse of the bubble economy, as well as insufficient investment in R&D by firms and lackluster efforts by the government to promote structural reforms.

developments in R&D investment to achieve "self-reliance and self-sufficiency" in science and technology as part of building the "entrepreneurial skills" that will become increasingly important for China to maintain economic growth.

First, to catch up with the technology level of other economies, it is important for China to increase its involvement in global supply chains through foreign direct investment (FDI) and trade (Kee and Tang, 2016). Looking at developments in practice, FDI in China has continued to grow and the use of intellectual property from the United States has been increasing, indicating that China has continued to absorb technology from abroad (Exhibit 23). However, a closer look reveals that FDI in the manufacturing sector, which had contributed to the rise in productivity, has begun to decline, and FDI by Taiwanese firms, which were at the forefront of the construction of China's highly productive IT supply chains, has fallen markedly (Exhibit 24). Furthermore, as a result of tensions with China, the United States has tightened restrictions on exports of products that use U.S. technology, and these measures have more or less been maintained under the Biden administration (Exhibit 25). It is therefore possible that technology absorption from abroad will weaken in the future.

Next, turning to R&D investment, which becomes more important as an economy gets closer to the technology frontier, the Chinese government has announced a policy of strengthening R&D investment in its "Made in China 2025" industrial policy unveiled in May 2015, as part of which the government has been providing support for R&D through tax cuts and other measures. Against this background, R&D investment has continued to grow at an annual rate of more than 10 percent. Moreover, China's ratio of R&D investment to GDP is remarkably high for an emerging economy (Exhibits 26 and 27). Looking at human resources, the number of individuals with a master's or doctoral degree in science and technology has surpassed that of the United States (Exhibit 28).[34] The number of international patents obtained has also increased rapidly, suggesting that the policy of emphasizing science and technology is bearing fruit (Exhibit 29). With the government having clearly stated its plan to aim for technological self-reliance on occasions such as the Fifth Plenum in autumn 2020, R&D investment can be expected to continue to increase in the future.

However, China also faces challenges in promoting innovation. For example, most of China's R&D investment is directed toward applied and experimental research, and the share of basic research is lower than in other economies (Exhibit 30). Studies have shown

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[34] The comparison refers to the total number of graduates with a master's or doctoral degree in science and engineering fields in China, and in engineering, biosciences, computer sciences etc., in the United States.

that basic research has the effect of boosting economic growth by lowering the difficulty of applied research (Aghion and Howitt, 1996; Segerstrom, 1998). Moreover, although China accounts for a large number of international patents and research papers, the number of citations of those studies in other research is low, and there appears to be room for improvement in terms of the quality of R&D (Exhibit 31).[35] While the Chinese government has stated that it aims to increase the share of basic research in R&D investment from about 6 percent to more than 8 percent during the period of the 14th Five-Year Plan (2021–2025), this would still be far lower than in other economies.

4.2 Improving the efficiency of resource allocation

Banerjee and Duflo (2005) and Hsieh and Klenow (2009) have highlighted the importance of efficient resource allocation for TFP growth in the economy overall when firm-level productivity is heterogeneous. For example, Foster et al. (2001), using data on business establishments in the United States, point out that the metabolism of firms through entry and exit – make an important contribution to productivity growth. Further, to increase the efficiency of resource allocation, the efficient allocation of funds is key (Cong et al., 2019; Midrigan and Xu, 2014).

In China, the role of the private sector in the economy is increasing both in terms of sales and employment (Exhibit 32). Moreover, the average age of listed firms is relatively young (Exhibit 33). Entrepreneurship is also active, and given that China has produced many so-called unicorn companies, the metabolism of the corporate sector seems to be quite high. Through a variety of reforms, resource allocation in the Chinese economy, including via the market mechanism, is gradually improving.

Nevertheless, state-owned enterprises (SOEs) still account for about 40 percent of total assets in the industrial sector, and a fair number of them suffer from poor profitability as measured by their return on assets (ROA, Exhibit 34).[36] In China, where firms finance their investment mainly through bank loans, SOEs account for more than half of the amount of bank loans outstanding (Exhibit 35). Against this background, to examine the reallocation of funds through bank loans more rigorously, we measure the Lilien index

[35] In this context, it is worth pointing out that studies using patent citation information suggest that even in the United States and Japan, where the share of basic research in R&D investment is higher than in China, the efficiency of R&D investment is declining recently (Bloom et al., 2020; Oh and Takahashi, 2020).
[36] Hsieh and Klenow (2009) pointed out that if the allocation of resources in China's manufacturing sector improved to a level comparable to that of the United States, this would raise TFP by 30–50 percent.

for China using domestic lending for investment in fixed assets.[37] Specifically, we calculate the Lilien index by aggregating the differences between the annual rate of change in domestic lending in each industry and the annual rate of change in total lending. A larger value of this index points to a more active movement of funds across industries (i.e., a greater degree of reallocation of funds). The index is calculated as follows:

$$\sigma_t^L = \left[\sum_{i=1}^{N}\left(\frac{l_{it}}{L_t}\right)\left(\frac{\Delta l_{it}}{l_{it}} - \frac{\Delta L_t}{L_t}\right)^2\right]^{1/2} \quad (5)$$

where L_t represents domestic lending to all industries in year t, and l_{it} stands for domestic lending to industry i in year t. The number of industries (N) in our calculation is 80.

Our results show that the Lilien index for loans in China has been on a downward trend since 2009 (Exhibit 36). Given that the Lilien index for the number of workers by industry, which we calculated in a similar manner, has been on an upward trend during this period, pointing to active reallocation of labor (Exhibit 37). This suggests that the reallocation of funds through banks may also be slowing relative to the allocation of labor. In this context, Cong et al. (2019) point out that (1) the massive stimulus package in 2009 in response to the global financial crisis led to a concentration of credit to SOEs, and this pattern has continued since then, and (2) implicit government guarantees[38] for SOEs encourage higher lending to SOEs when the probability of distress increases. Such loans to low-productivity SOEs may have led to inefficient investment and the accumulation of debt (Exhibit 38). These findings suggest that finding the right balance between growth and financial stability is an important policy issue.

Of course, since the latter half of the 2010s, the Chinese government has also been promoting deleveraging to ensure financial stability. It has also been taking measures against implicit government guarantees – one of the causes of distortions in the allocation of resources – by prohibiting local governments from providing implicit guarantees. However, since the outbreak of the COVID-19, the credit-to-GDP gap,[39] which had once

[37] Saita and Sekine (2001) use the same index to measure the reallocation of funds in Japan.
[38] Lam et al. (2017) provide specific examples of implicit guarantees, including (i) SOEs' ability until 2002 to receive land from the state based on allocations or negotiated sales at book value, and since then preferential land use fees, (ii) price and tax incentives when purchasing natural resources such as oil and natural gas, and (iii) fiscal support such as tax exemptions. They point out that, as a result, SOEs have higher credit ratings than private firms and can raise funds at lower costs. Moreover, IMF (2019) points out that implicit government guarantees for SOEs contribute to the inefficient allocation of funds.
[39] The credit-to-GDP gap is a measure of the extent to which the ratio of credit to the nonfinancial private sector to GDP deviates from its long-term trend. The Bank for International Settlements argues that the probability of a banking crisis occurring within three years rises if this indicator exceeds a threshold of 9

narrowed, has begun to widen again (Exhibit 38), and close monitoring of future developments is required.

5. Conclusion

This study examined the likelihood that China's economy will continue its catch-up process and achieve relatively high growth rates in the future and discussed the obstacles that need to be overcome.

China's per capita GDP is still only about 20 percent of that of the United States, and the potential for growth through catching up with advanced economies is correspondingly large. If China follows the catch-up process that the East Asian 4 have followed to date, it will be possible for China to double the size of its economy and per capita income by 2035.

However, this does not mean that a doubling of the size of the economy can be achieved without reforms. Rather, given the circumstances that China faces, such as the need to maintain agricultural output levels, the limits to export-dependent manufacturing growth, and the effects of an aging of the population, it seems fair to say that the obstacles to achieving catch-up are substantial.

In order to overcome these obstacles, it will be essential to raise the TFP growth rate. To this end, in addition to promoting innovation, it will be necessary to steadily address issues such as institutional reforms in agriculture and the household registration system, as well as more efficient resource allocation through the use of the market mechanism.

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percentage points (Aldasoro et al., 2018). Note that the indicator for China exceeded the threshold at 10.7 percentage points at the end of September 2020.

References

Acemoglu, D., Aghion, P., and Zilibotti, F. (2006). "Distance to Frontier, Selection, and Economic Growth," *Journal of the European Economic Association*, 4, 37-74.

Aghion, P. and Howitt, P. (1996). "Research and Development in the Growth Process," *Journal of Economic Growth*, 1, 49-73.

Aldasoro, I., Borio, C., and Drehmann, M. (2018). "Early Warning Indicators of Banking Crises: Expanding the Family," BIS Quarterly Review, March 2018, 29-45, Bank for International Settlements.

Aoki, K., Hara, N., and Koga, M. (2017). "Structural Reforms, Innovation and Economic Growth," Bank of Japan Working Paper Series 17-E-2, Bank of Japan.

Bailliu, J., Kruger, M., Toktamyssov, A., and Welbourn, W. (2016). "How Fast Can China Grow? The Middle Kingdom's Prospects to 2030," Bank of Canada Staff Working Paper 2016-15, Bank of Canada.

Banerjee, A., and Duflo, E. (2005). "Growth Theory through the Lens of Development Economics," *Handbook of Economic Growth*, Vol. 1, chapter 7.

Barro, R. J. (2016). "Economic Growth and Convergence, Applied to China," *China and World Economy*, 5, Vol. 24, 5-19.

Barro, R. J., and Becker, G. S. (1989). "Fertility Choice in a Model of Economic Growth," *Econometrica*, 57(2), 481-501.

Barro, R. J., and Sala-i-Martin, X (2003). *Economic Growth Second Edition*, The MIT Press.

Berlingieri, G., Blanchenay, P., and Criscuolo, C. (2017). "The Great Divergence(s)," OECD Science, Technology and Industry Policy Papers, No. 39, OECD.

Bloom, N., Jones, C. I., Reenen, J. V., and Webb, M. (2020). "Are Ideas Getting Harder to Find?" *American Economic Review*, 110(4), 1104-1144.

Bosworth, B., and Collins, S. M. (2008). "Accounting for Growth: Comparing China and India," *Journal of Economic Perspectives*, 22, 45-66.

Branstetter, L. G. (2001). "Are knowledge spillovers international or intranational in scope? Microeconometric evidence from the US and Japan," *Journal of International Economics*, 53(1), 53-79.

Cong, L. W., Gao, H., Ponticelli, R. J., and Yang, X. (2019). “Credit Allocation Under Economic Stimulus: Evidence from China,” Macro Finance Research Program of the Becker Friedman Institute, 3413-3460.

Curtis, C. C., Lugauer, S., and Mark, N. C. (2015). “Demographic Patterns and Household Saving in China,” *American Economic Journal: Macroeconomics*,7 (2), April, 58-94.

Curtis, C. C., Lugauer, S., and Mark, N. C. (2017). “Demographics and aggregate household saving in Japan, China, and India,” *Journal of Macroeconomics*, 51, 175-191.

Feldstein, M., and Horioka, C. (1980). “Domestic Saving and International Capital Flows,” *Economic Journal*, 90, 314-329.

Foster, L., Haltiwanger, J., and Krizan, C. J. (2001). “Aggregate Productivity Growth: Lessons from Microeconomic Evidence,” *New Developments in Productivity Analysis*, University of Chicago Press, 303-372.

Fukumoto, T., and Muto, I. (2012). “Rebalancing China’s Economic Growth: Some Insights from Japan’s Experience,” *China and World Economy*, 1, 20, 62-82.

Herd, R. (2020). “Estimating Capital Formation and Capital Stock by Economic Sector in China; the Implications for Productivity Growth,” World Bank Policy Research Working Paper 9317, World Bank.

Higgins, M. (2020). “China’s Growth Outlook: Is High-Income Status in Reach?” Economic Policy Review 26, 4, Federal Reserve Bank of New York.

Hsieh, C. T., and Klenow, P. J. (2009). “Misallocation and Manufacturing TFP in China and India,” *The Quarterly Journal of Economics*, 124(4), 1403-1448.

Huang, Q., He, J., and Ni, H. (2021). “Research on the Goal and Strategy of China’s New Industrialization in the Two Stages of the New Journey,” *Nanjing Journal of Social Sciences*, 2021(1).

Iida, T., Shoji, K., and Yoneyama, S. (2018). “What Drives China's Growth? Evidence from Micro-level Data,” Bank of Japan Working Paper Series, 18-E-19, Bank of Japan.

International Monetary Fund (2019). “The People’s Republic of China selected issues,” IMF Country Report No. 19/274, International Monetary Fund.

Kee, H. L., and Tang, H. (2016). "Domestic Value Added in Exports: Theory and Firm Evidence from China," *American Economic Review*, 106(6), 1402-1436.

Kroeber, A. (2016). "Should We Worry about China's Economy?" Aspen Institute Congressional Program, 9-12.

Lam, R., Rodlauer, M., and Schipe, A. (2017). *Modernizing China: Investing in Soft Infrastructure*, International Monetary Fund.

Lawrence, R. Z., and Edwards, L. (2013). "US Employment Deindustrialization: Insights from History and the International Experience," Peterson Institute for International Economics, Policy Brief No. PB13-27.

Lee, J. Y., and Xiao, Z. (1998). "Children's Support for Elderly Parents in Urban and Rural China: Results from a National Survey," *Journal of Cross-Cultural Gerontology*, 13, 39-62.

Lu, Y., and Cai, F. (2014). "China's Shift from the Demographic Dividend to the Reform Dividend," Deepening Reform for China's Long-term Growth and Development book, ANU Press, The Australian National University.

Maliszewski, W., and Zhang, L. (2015). "China's Growth: Can Goldilocks Outgrow Bears? " IMF Working Paper 113, International Monetary Fund.

McMillan, M. S., and Rodrik, D. (2011). "Globalization, Structural Change and Productivity Growth," Making Globalization Socially Sustainable, 2, 49-84, International Labour Organization and World Trade Organization.

Midrigan, V., and Xu, D. Y. (2014). "Finance and Misallocation: Evidence from Plant-Level Data," *American Economic Review*, 104(2), 422-458.

Nickell, S. (1981). "Biases in Dynamic Models with Fixed Effects," *Econometrica*, 49 (6), 1417-1426.

Oh, Y., and Takahashi, K. (2020). "R&D and Innovation: Evidence from Patent Data," Bank of Japan Working Paper Series, 20-E-7, Bank of Japan.

People's Bank of China (2021). "Measurement of China's Potential Output and Driving Force of Economic Growth During the 14th Five-Year Plan Period," PBC Working Paper, No.2021/1, People's Bank of China.

Pritchett, L., and Summers, L. H. (2014). "Asiaphoria Meets Regression to the Mean," NBER Working Paper 20573.

Roberts, I., and Russell, B. (2019). “Long-term Growth in China,” Reserve Bank of Australia.

Rodrik, D. (2013). “Unconditional Convergence in Manufacturing,” *Quarterly Journal of Economics*, 128(1), 165-204.

Rodrik, D. (2016). “Premature Deindustrialization,” *Journal of Economics Growth*, 21, 1-33.

Romer, D. (2018). *Advanced Macroeconomics Fifth Edition*, McGraw-Hill Education.

Saita, Y., and Sekine, T. (2001). “Sectoral Credit Shifts in Japan: Causes and Consequences of Their Decline in the 1990s,” Bank of Japan Working Paper Series, 01-E-16, Bank of Japan.

Segerstrom, P. S. (1998). “Endogenous Growth without Scale Effects,” *American Economic Review*, 88, 1290-1310.

Sondermann, D. (2012). “Productivity in the Euro Area any Evidence of Convergence?” ECB Working Paper 1431, European Central Bank.

World Bank (2020). “From Containment to Recovery,” East Asia and Pacific Economic Update, October 2020, World Bank.

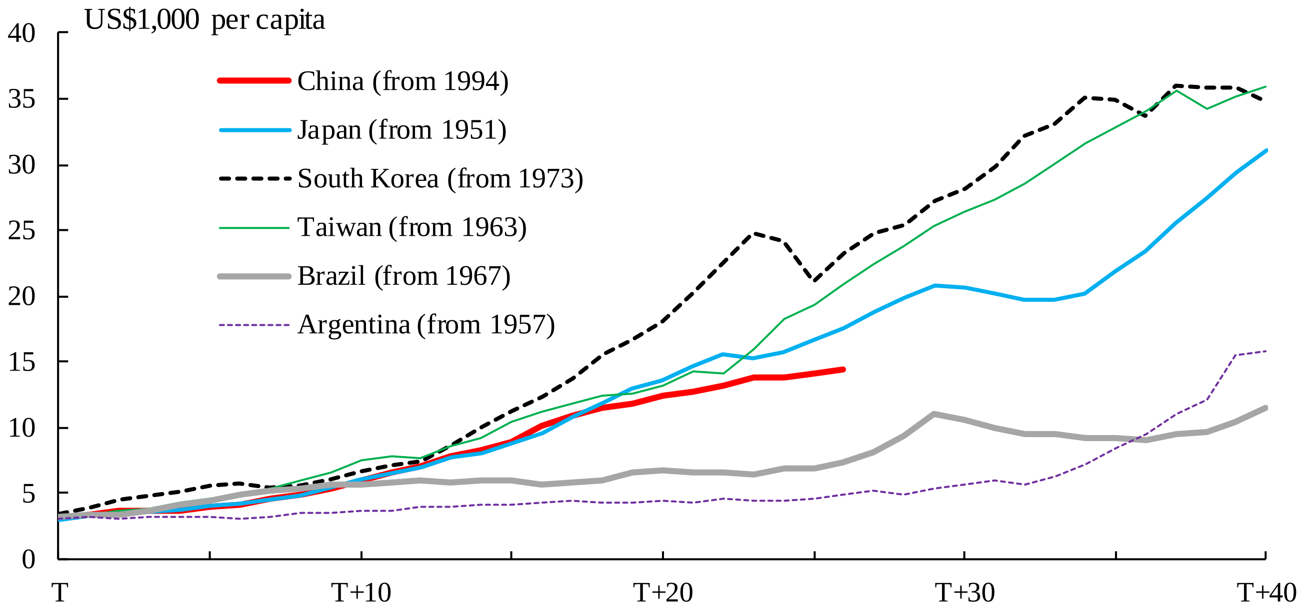
Wu, X., Yue, X., and Zhang, G. (2015). “Constructing Annual Employment and Compensation Matrices and Measuring Labor Input in China,” RIETI Discussion Paper Series 15-E-005.

Xie, Y., and Zhu, H. (2009). “Do Sons or Daughters Give More Money to Parents in Urban China?” *Journal of Marriage and Family*, 71, 174-186.

Zhang, L., Brooks, R., Ding, D., Ding, H., He, H., Lu, J., and Mano, R. (2018). “China’s High Savings: Drivers, Prospects, and Policies,” IMF Working Paper 18/277, International Monetary Fund.

Zhu, M., Zhang, L., and Peng, D. (2019). “China’s Productivity Convergence and Growth Potential -A Stocktaking and Sectoral Approach,” IMF Working Paper 19/263, International Monetary Fund.

Exhibit 1. Comparison of Per Capita GDP

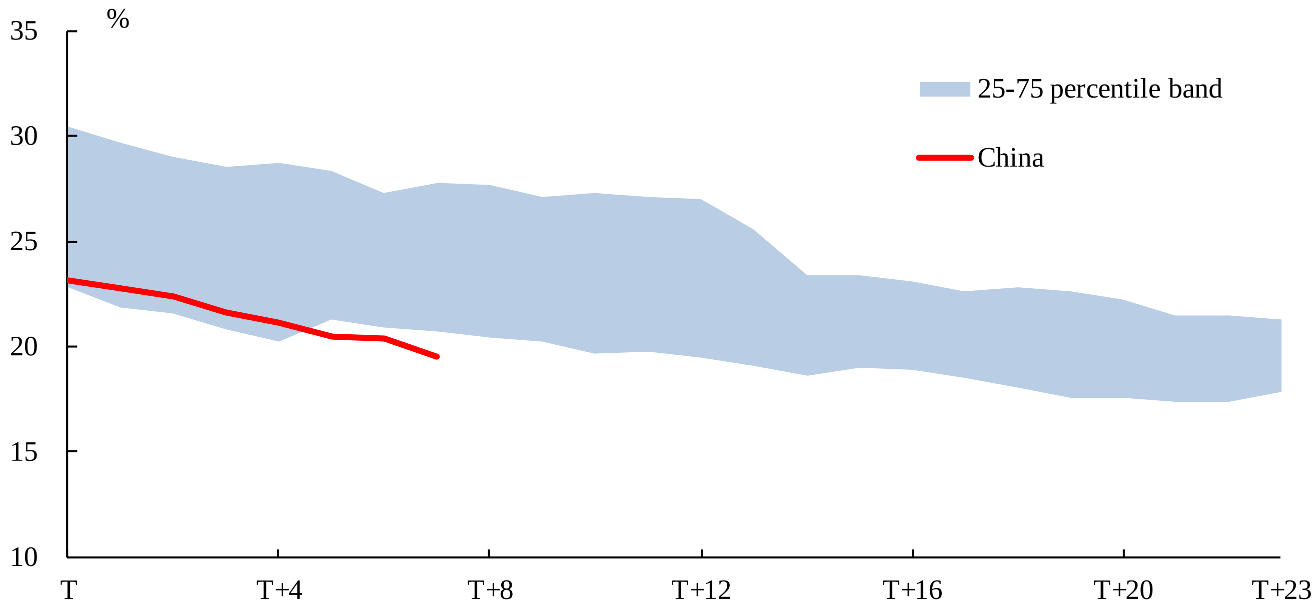


Notes:

1. Year T is defined as the year when the GDP per capita of each economy surpassed US$3,000. Figures are based on output-side real GDP at chained PPPs (in mil. 2017 US$).
2. The latest figure for China is for 2020. Figures through 2019 are from Penn World Table 10.0; figures for 2020 were extrapolated using the real GDP and population growth rates in 2020.

Sources: Penn World Table 10.0, CEIC, Haver Analytics.

Exhibit 2. Manufacturing Sector Employment Share

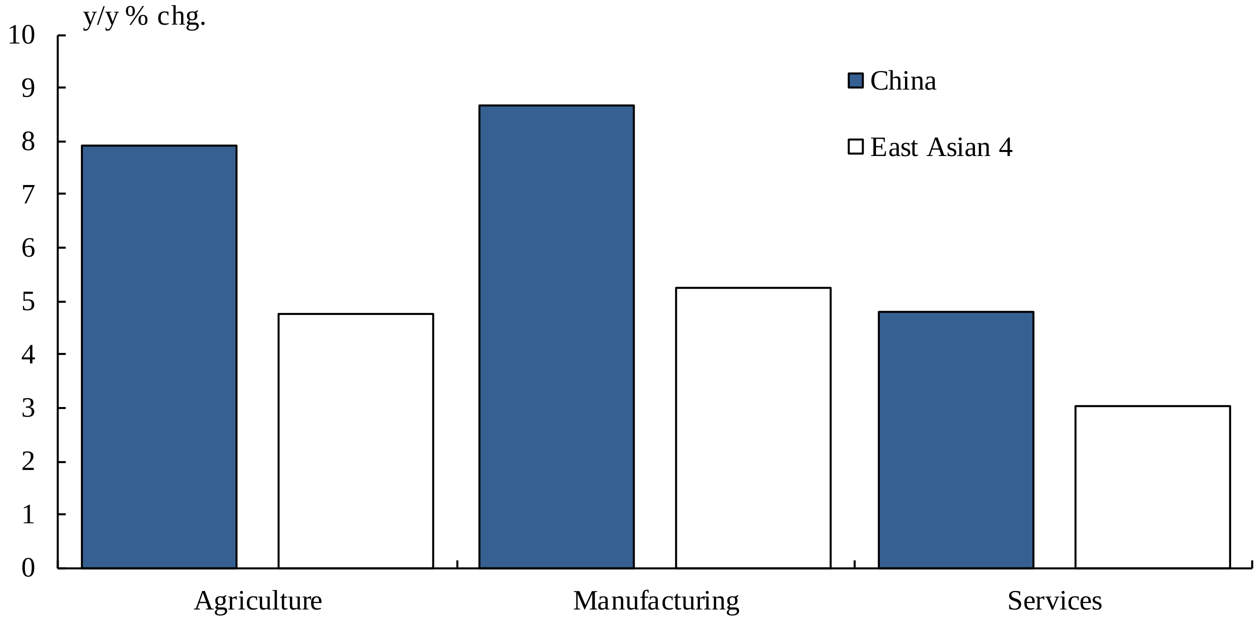


Notes:

1. Year T is defined as the year in which the share of workers engaged in the manufacturing sector peaked. Year T for China is 2012. The latest figure (from the ILO) is for 2019.
2. The shaded area shows the 25 to 75 percentile band of the manufacturing employment share (data from the GGDC) of economies that had reached China's 2019 per capita real GDP.

Sources: International Labour Organization (ILO), Groningen Growth and Development Centre (GGDC).

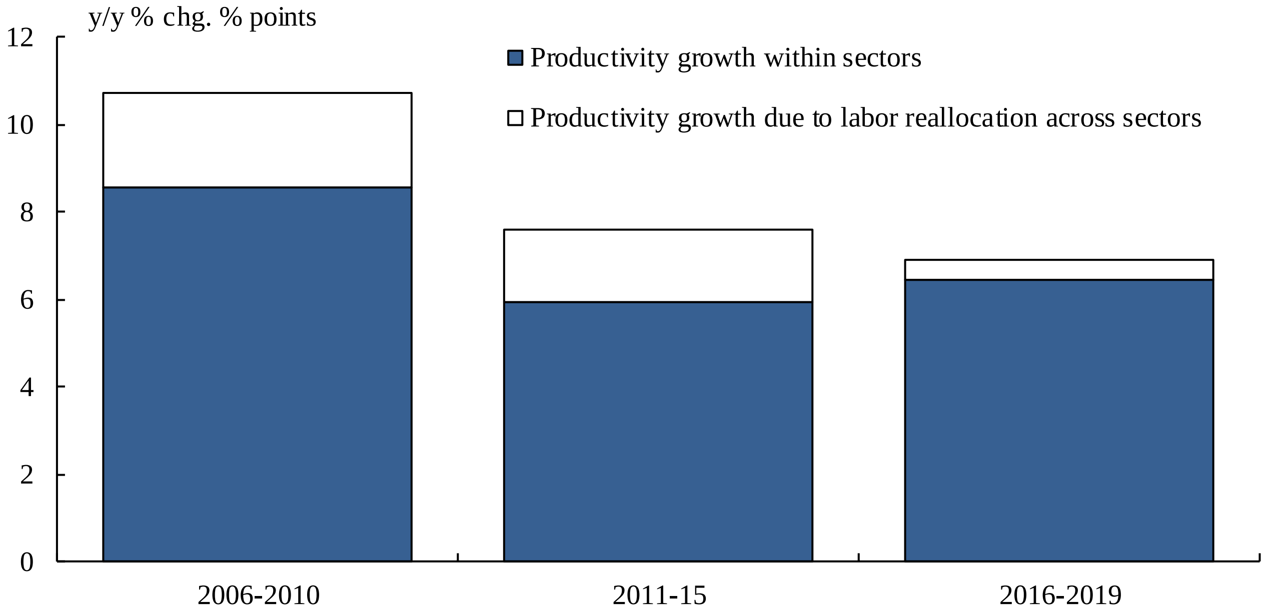
Exhibit 3. Labor Productivity Growth Rate by Sector



Note: Average annual rates of change. The figures for China are for 2010–2019 (based on UN and ILO data). The figures for the East Asian 4 are the simple averages of the labor productivity growth rates of Japan, South Korea, Taiwan, and Singapore since they surpassed China's 2010 per capita real GDP (based on GGDC data). Services consist of the weighted average of "wholesale, retail trade, restaurants and hotels," "transport, storage and communication," and "other services."

Sources: United Nations, IMF, ILO, GGDC, Penn World Table 10.0.

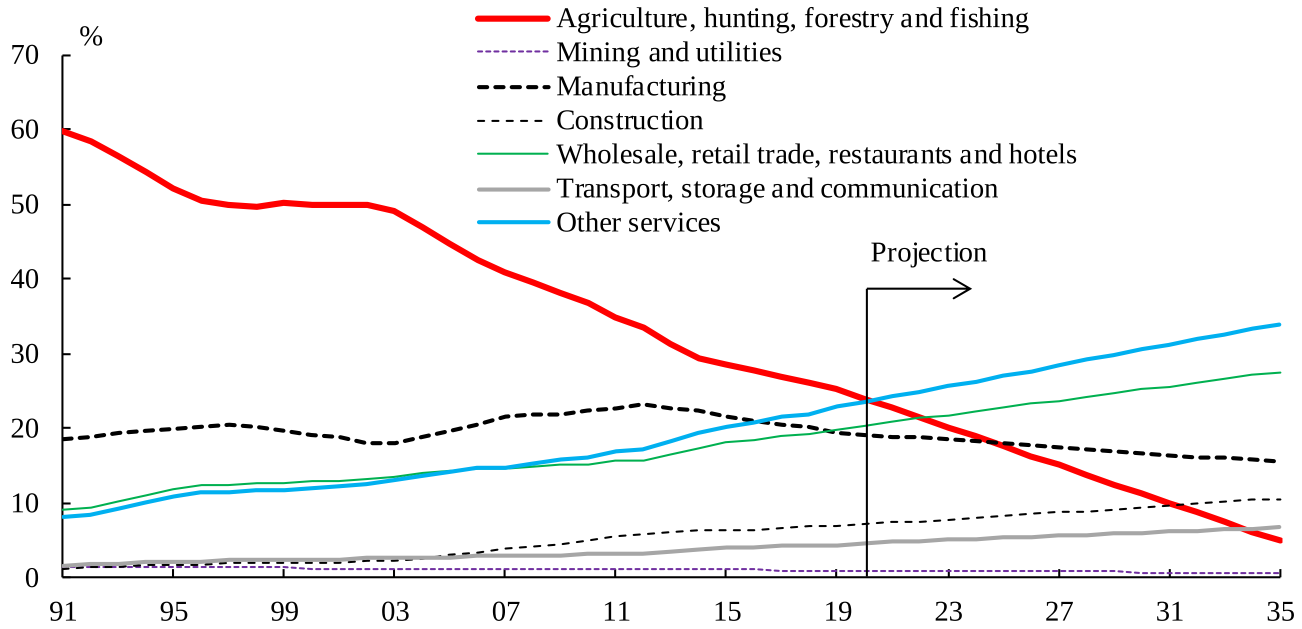
Exhibit 4. Decomposition of Labor Productivity Growth



Note: Average annual rate of change. Calculated based on the decomposition approach employed by McMillan and Rodrik (2011).

Sources: United Nations, IMF, ILO.

Exhibit 5. Employment Shares by Industry



Note: Employment shares from 2020 onward are extrapolated using the trend in the most recent 10 years.
Source: Authors' calculations based on ILO data.

Exhibit 6. Convergence Rate of Labor Productivity by Industry

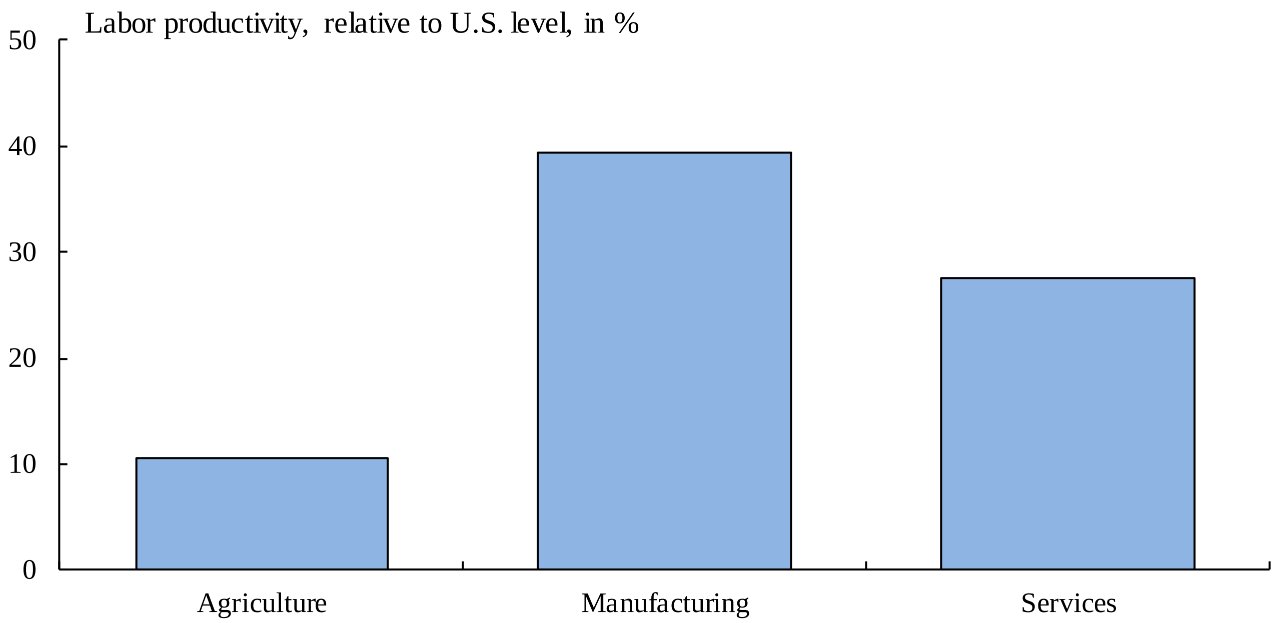
	Agriculture, hunting, forestry and fishing	Mining and utilities	Manufacturing	Construction	Wholesale, retail trade, restaurants and hotels	Transport, storage and communication	Other services
log(labor productivity)	-0.0456 *** (0.0101)	-0.0472 *** (0.0079)	-0.0341 ** (0.0153)	-0.0508 *** (0.0098)	-0.0273 *** (0.0059)	-0.0411 *** (0.0075)	-0.0217 * (0.0114)
N	391	391	391	391	391	391	292
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively. Standard errors are robust standard errors clustered at the country level.
Sources: GGDC, China Industrial Productivity Database (CIP).

Exhibit 7. Estimated Growth Rate Until 2035

Note: The latest figure for real GDP is for 2020. The projected growth rate is obtained by linking the actual year-on-year growth rate of real GDP from the IMF from 1980 to 2019 and our growth estimates from 2020 to 2035, and smoothing the series using the Hodrick-Prescott filter.
Sources: United Nations, IMF, ILO, GGDC, CIP.

Exhibit 8. China's Labor Productivity in 2035 Compared to U.S. Productivity Level



Note: The figure for services is the weighted average of "wholesale, retail trade, restaurants and hotels," "transport, storage and communication," and "other services."
Sources: United Nations, IMF, ILO, GGDC, CIP.

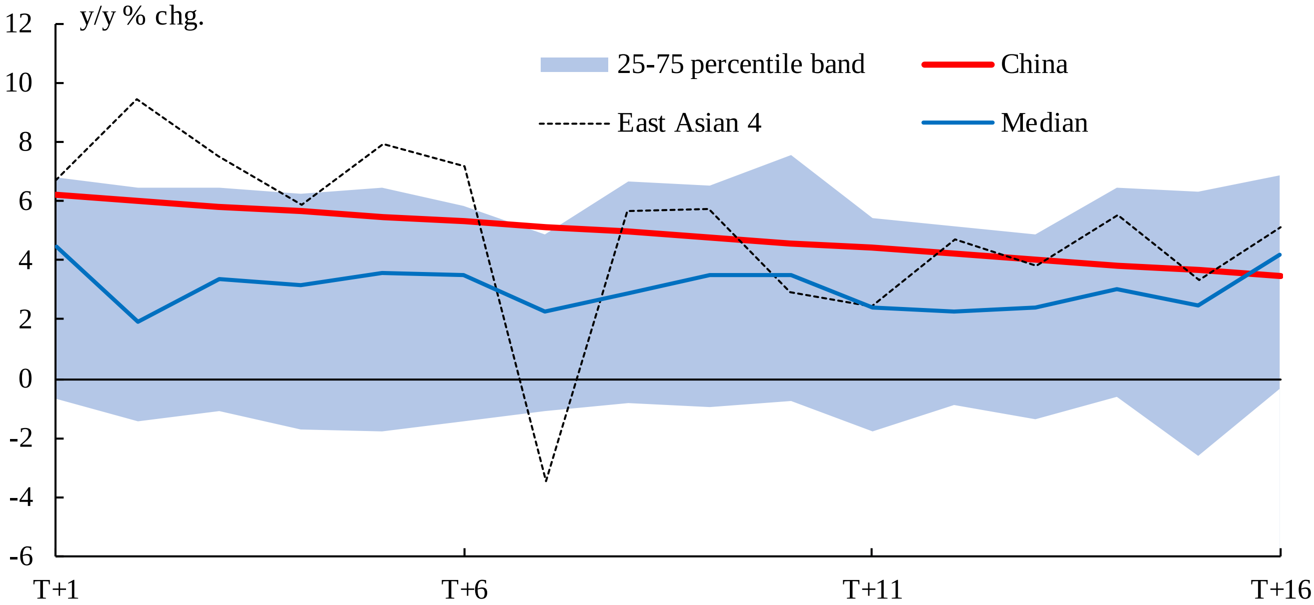
Exhibit 9. Comparison of Estimation Results of China's Long-Term Growth Rate with Previous Studies

y/y % chg.

	2025	2030	2018-28	2021-25	2016-30	2020-30	2013-33
This study	5.3	4.4	5.6	5.7	5.6	5.2	5.7
IMF Zhu et al. (2019)	5.0	4.0-4.2					
World Bank (2020)						6.0	
Chinese Academy of Social Sciences Huang et al. (2021)						5.3	
Reserve Bank of Australia Roberts and Russel (2019)						Over 4%	
Bank of Canada Bailliu et al. (2016)		5.0					
Lu and Cai (2014)					5.5		
Pritchett and Summers (2014)							3.9
Higgins (2020)			2.7-4.9				
People's Bank of China (2021)				5.4			

Note: For the growth rate for Roberts and Russel (2019) paper, we compute the value based on their estimates.

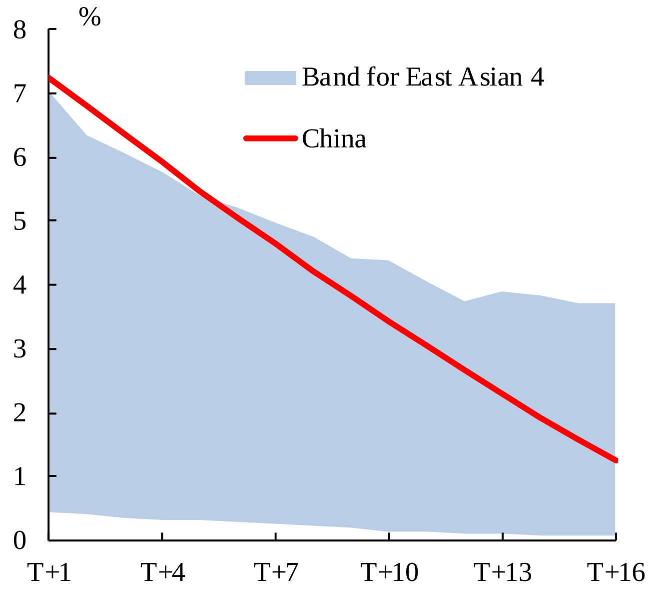
Exhibit 10. International Comparison of Growth Paths



Note: Year T is defined as the year in which a country's per capita real GDP surpassed the level of China's per capita real GDP in 2019. The line for China shows the baseline results from 2020 onward. The shaded area shows the 25 to 75 percentile band of the per capita real GDP growth rates from year T＋1 onward of 97 economies once they had surpassed China's 2019 per capita real GDP. The line for the East Asian 4 shows the simple average of the year-on-year growth rates of Japan, South Korea, Taiwan, and Singapore.

Source: Penn World Table 10.0.

Exhibit 11. Value Added Share of Agriculture

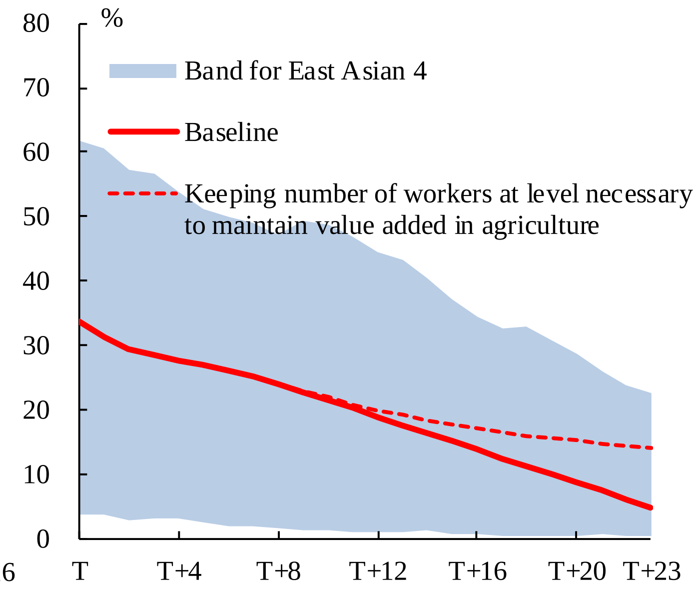


Notes:

1. Year T＋1 is set to 2020 for China and to the year after which their per capita real GDP surpassed China's 2019 level for the East Asian 4. The East Asian 4 are Japan, South Korea, Taiwan, and Singapore.
2. The shaded area shows the range between the maximum and the minimum for the East Asian 4 (based on GGDC data).

Sources: United Nations, ILO, GGDC.

Exhibit 12. Employment Share of Agriculture

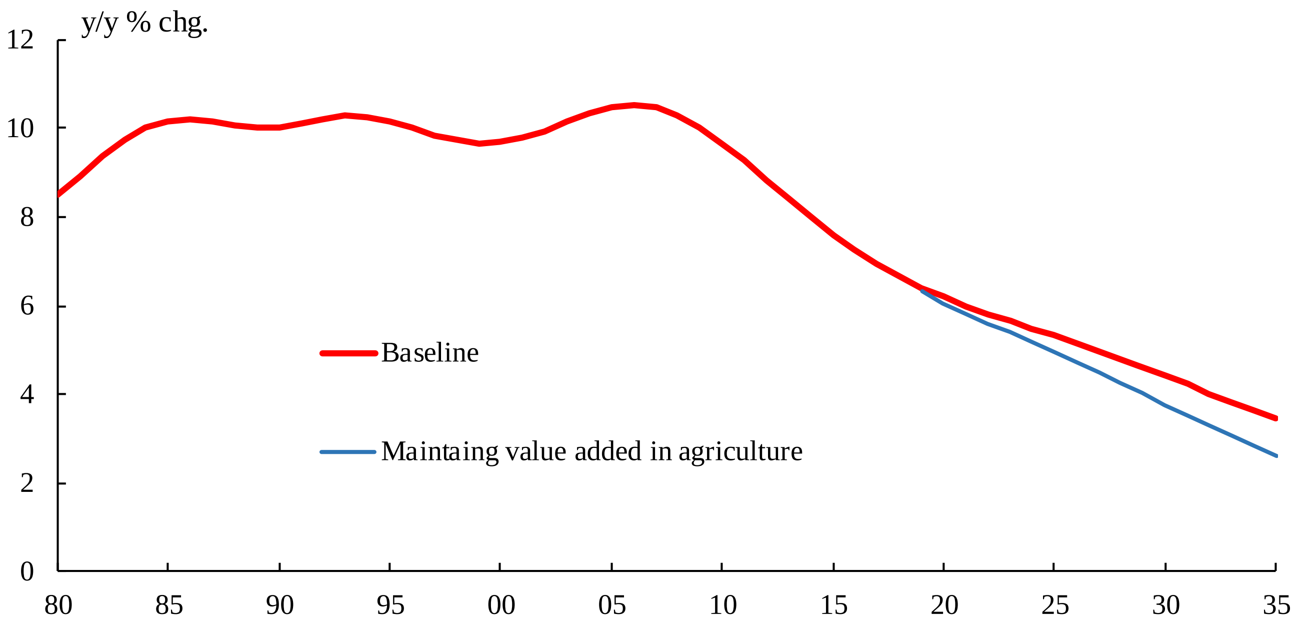


Notes:

1. Year T is defined as the year in which the share of workers engaged in the manufacturing sector peaked. The East Asian 4 are Japan, South Korea, Taiwan, and Singapore.
2. The shaded area shows the range between the maximum and the minimum of for East Asian 4 (based on GGDC data).

Sources: ILO, GGDC.

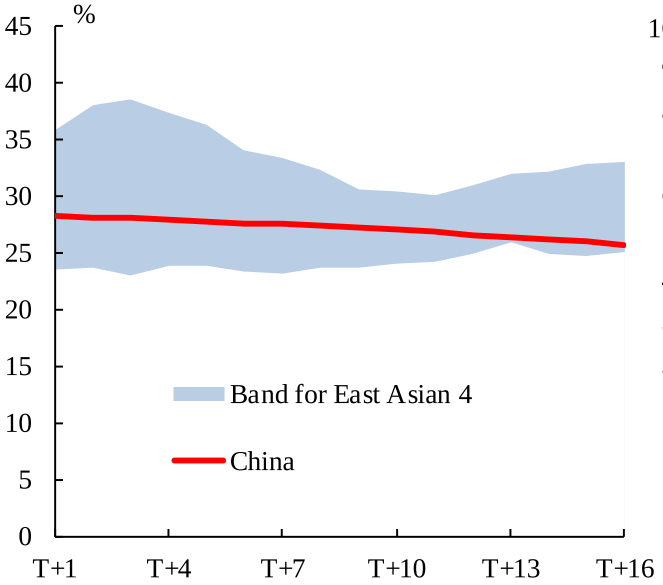
Exhibit 13. Growth Rate if Value Added in Agriculture Remains Unchanged from 2020



Note: The growth rate is obtained by linking the actual year-on-year growth rate of real GDP from the IMF from 1980 to 2019 and our growth estimates from 2020 to 2035, and smoothing the series using the Hodrick-Prescott filter.

Sources: United Nations, IMF, ILO, GGDC, CIP.

Exhibit 14. Value Added Share of Manufacturing

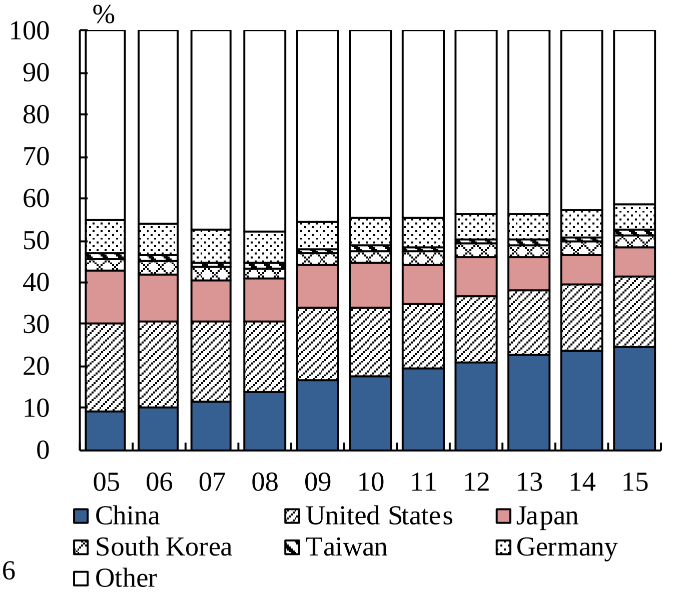


Notes:

1. Year T＋1 is set to 2020 for China and to the year after which their per capita real GDP surpassed China's 2019 level for the East Asian 4. The East Asian 4 are Japan, South Korea, Taiwan, and Singapore.
2. The shaded area shows the range between the maximum and the minimum for the East Asian 4 (based on GGDC data).

Sources: United Nations, ILO, GGDC.

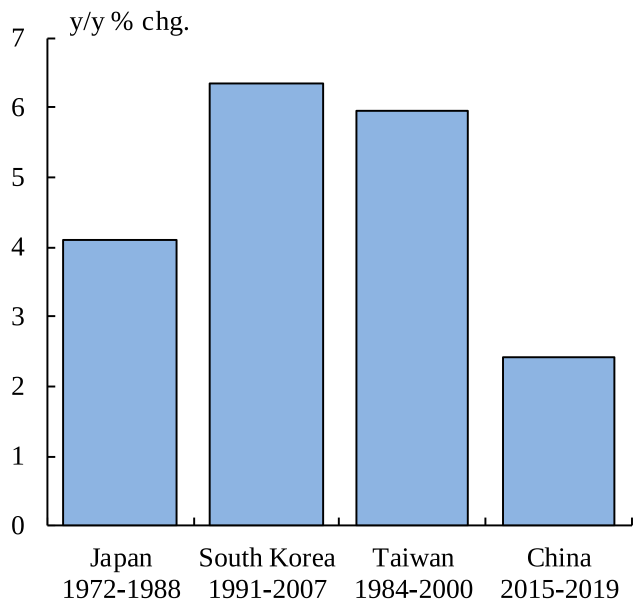
Exhibit 15. Economies' Share in Global Manufacturing



Note: The latest figures are for 2015. Calculated using manufacturing sector value added from the OECD Trade in Value Added (TiVA) database.

Source: OECD.

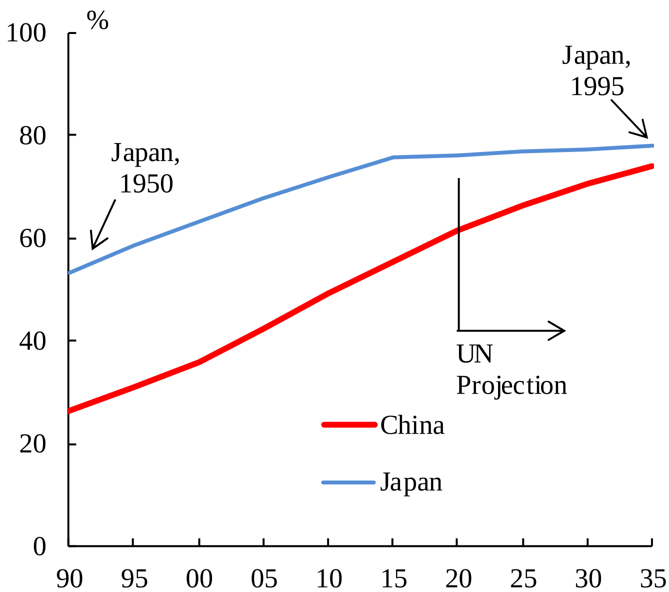
Exhibit 16. Growth Rate of Global Trade Volume During Catch-up Process



Note: World trade volume is based on the volume of exports. The chart shows the annual average growth rate of global trade volume in the 16 years after each economy surpassed China's 2019 per capita real GDP.

Sources: Penn World Table 10.0, WTO.

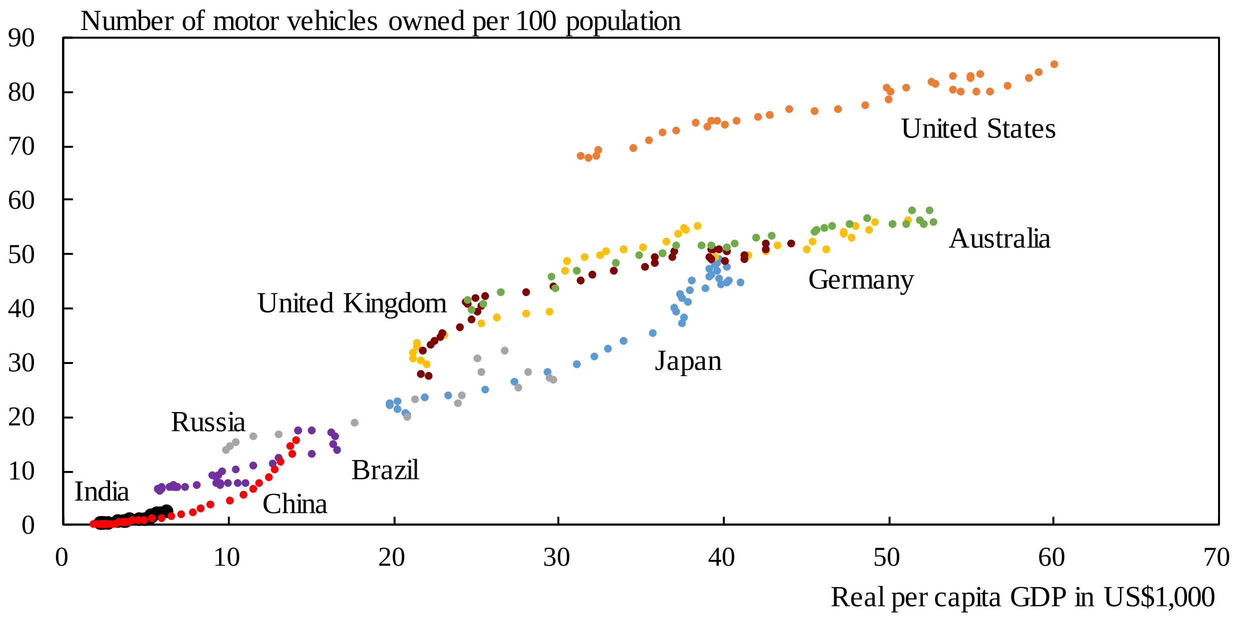
Exhibit 17. Percentage of Population in Urban Areas



Note: Based on United Nations, *World Urbanization Prospects*. Percentage of population living in urban areas. The figures for China from 2020 onward are projections by the United Nations.

Source: United Nations.

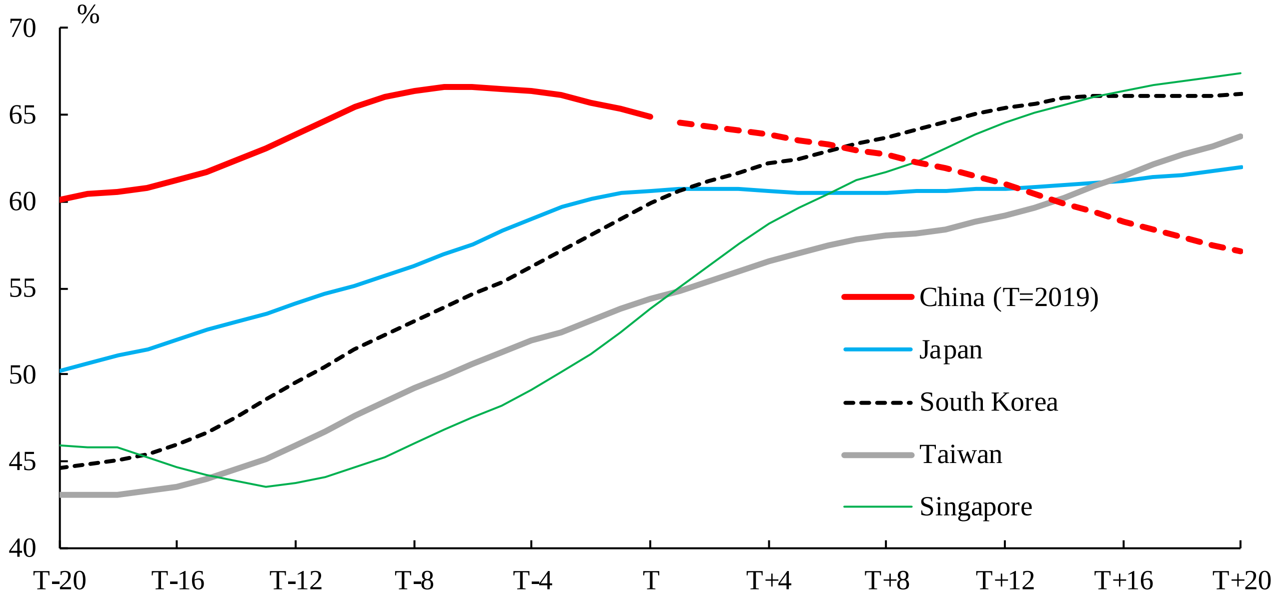
Exhibit 18. Link Between Income and Car Ownership Rates



Note: Figures are for 2019 for Japan and China and for 2017 for the other countries. The figures for the United States are the total for passenger vehicles and trucks. Per capita real GDP figures are from Penn World Table 10.0.

Sources: CEIC, World Motor Vehicle Statistics, Penn World Table 10.0.

Exhibit 19. Share of Working Age Population

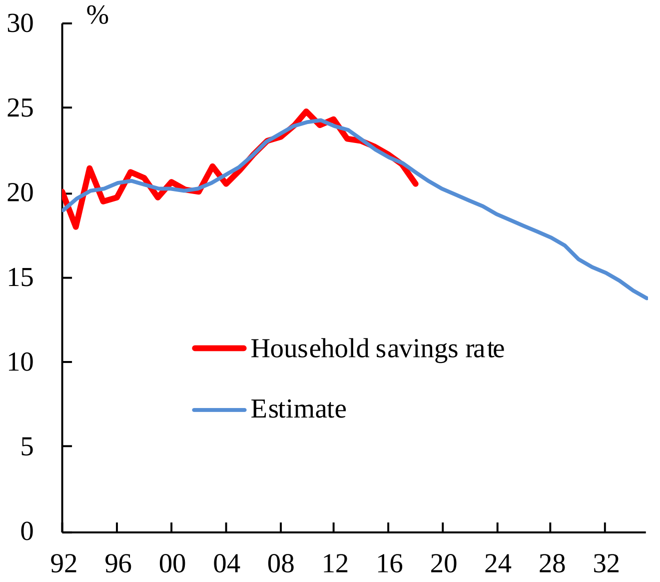


Notes:

1. Year T is defined as the year in which an economy's per capita real GDP surpassed the level of China's per capita real GDP in 2019. The working age population consists of those aged 20 to 64.
2. The solid part of the line for China is for 1999–2019. The broken part of the line is calculated by the authors using the United Nation's *World Population Prospects* (2019 edition; median estimate).

Sources: Penn World Table 10.0, United Nations.

Exhibit 20. Estimated and Actual Household Savings Rate

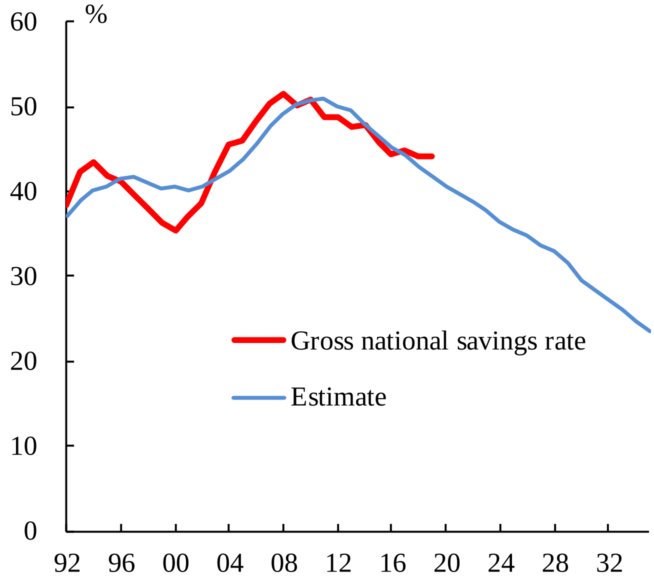


Notes:

1. The household savings rate is calculated by dividing household savings in the flow of funds statistics by GDP. The latest figure is for 2018.
2. The estimated rate is obtained by regressing the savings rate based on the flow of funds statistics on the estimates obtained based on Curtis et al.'s (2015) model.

Sources: Penn World Table 10.0, United Nations, CEIC, Curtis et al. (2015).

Exhibit 21. Estimated and Actual Gross National Savings Rate

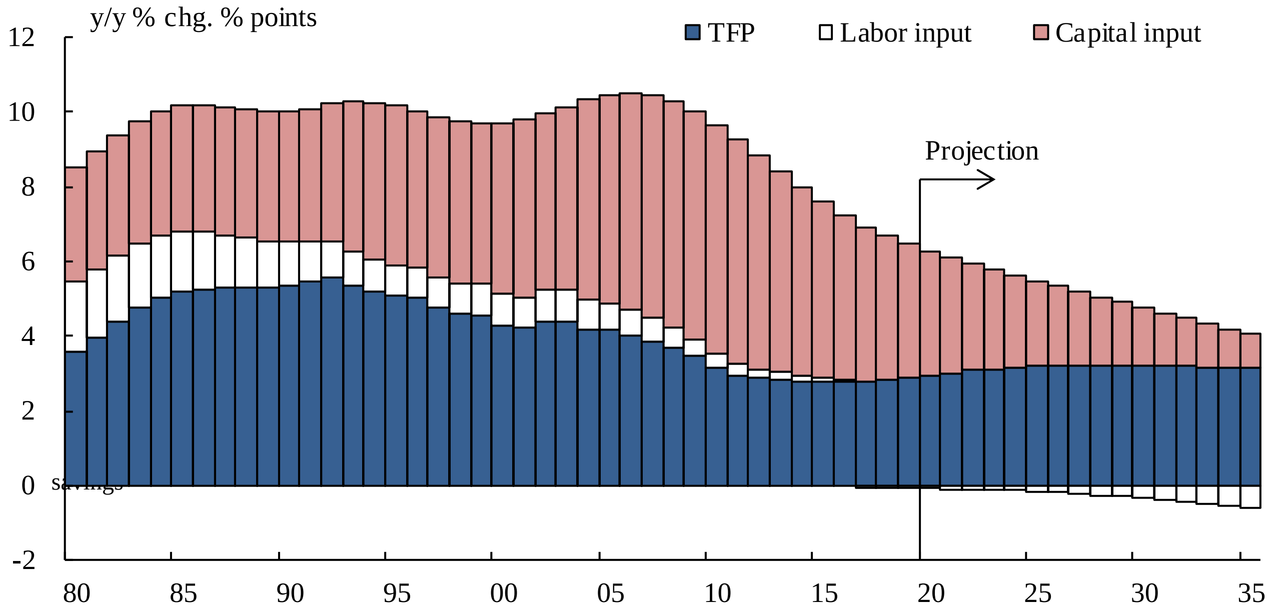


Notes:

1. The gross national savings rate is taken from the IMF and is the ratio to GDP. The latest figure is for 2019.
2. The estimated rate is obtained by regressing the gross national savings rate on the estimates of the household savings rate shown in Exhibit 20.

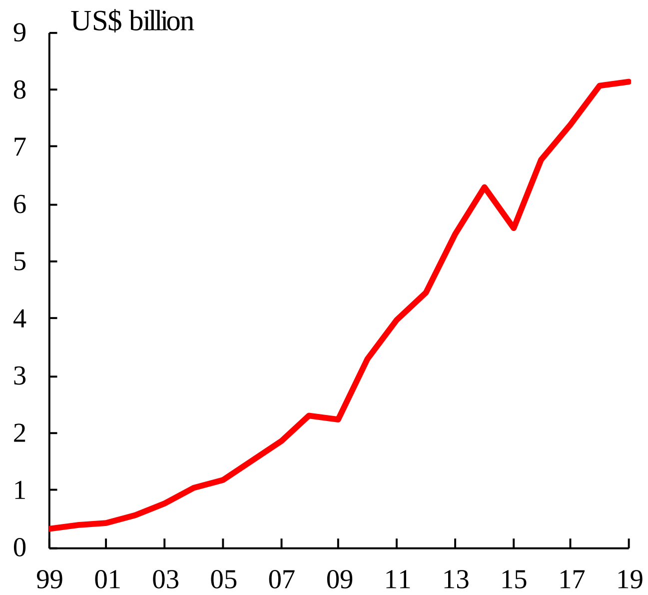
Sources: Penn World Table 10.0, United Nations, CEIC, Curtis et al. (2015).

Exhibit 22. TFP Growth Rate Necessary for the Economic Growth in the Baseline Projection



Sources: Penn World Table 10.0, United Nations, Haver Analytics, IMF, CEIC, Herd (2020).

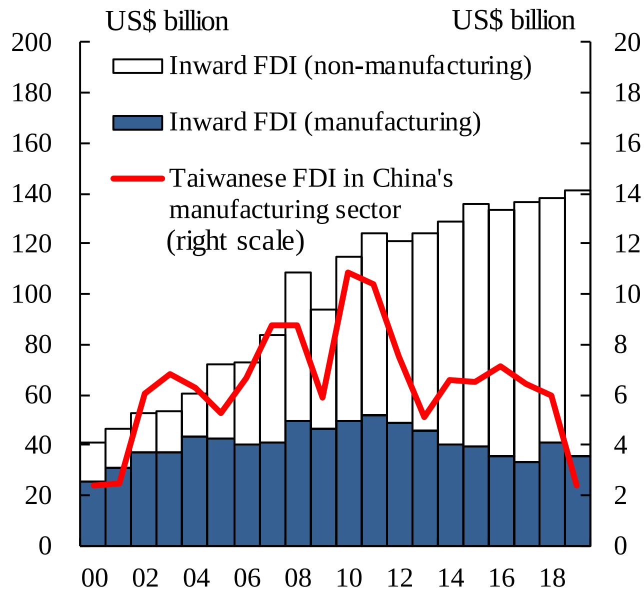
Exhibit 23. China's Payments of Intellectual Property Charges to the United States



Note: The latest figure is for 2019. The figure shows charges for the use of intellectual property n.i.e. in service exports from the United States to China. Figures published by the Bureau of Economic Analysis, U.S. Department of Commerce.

Source: CEIC.

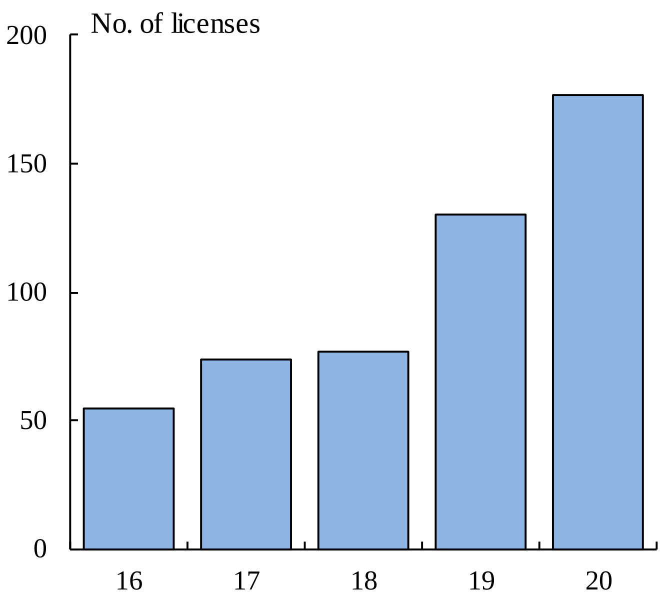
Exhibit 24. Inward Direct Investment



Note: The latest figures are for 2019. Figures for inward FDI are from China's Ministry of Commerce and include FDI in finance-related industries. Figures for Taiwanese FDI are investment amount approved by the Investment Commission, Ministry of Economic Affairs.

Sources: CEIC, Investment Commission, Ministry of Economic Affairs.

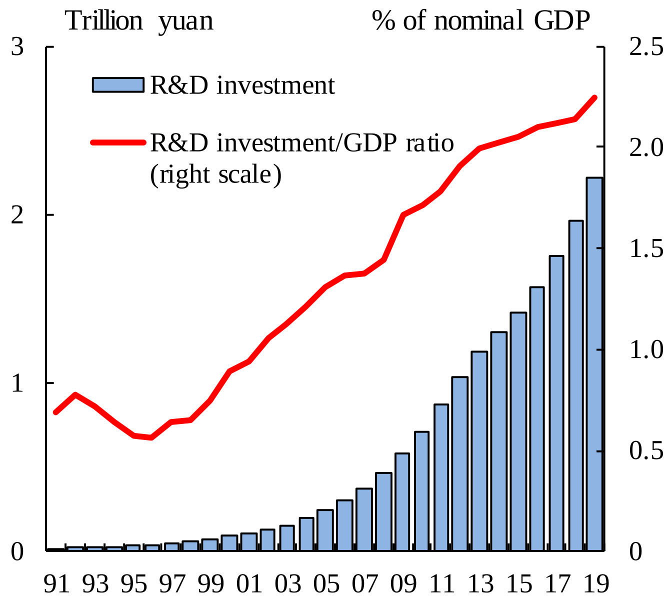
Exhibit 25. Number of U.S. Export Licenses Denied



Note: The latest figures are for 2020. The chart shows the number of applications denied for export or re-export licenses for tangible items, software, and technology for China.

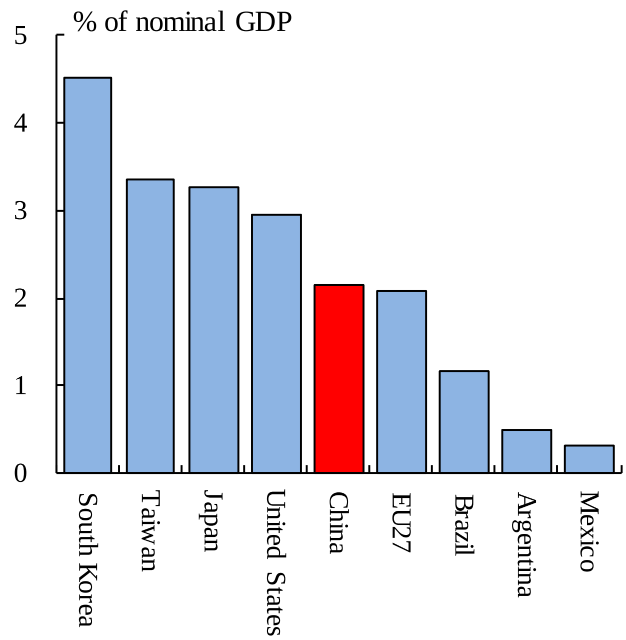
Source: Bureau of Industry and Security, United States Department of Commerce.

Exhibit 26. Amount of R&D Investment and R&D Investment/GDP Ratio



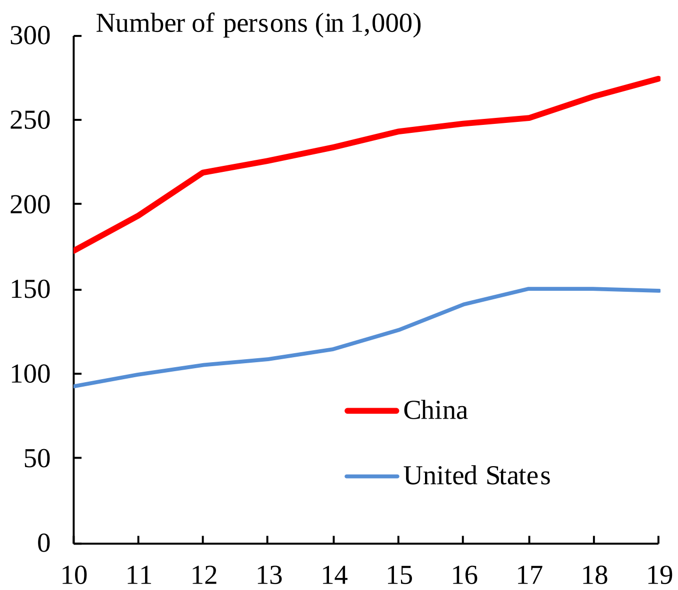
Note: The latest figures are for 2019. Based on data released by the National Bureau of Statistics of China.
Source: CEIC.

Exhibit 27. Comparison of R&D Investment/GDP Ratio



Note: As of 2018. Data for Brazil and Argentina from UNESCO; data for all other countries from OECD.
Sources: OECD, UNESCO.

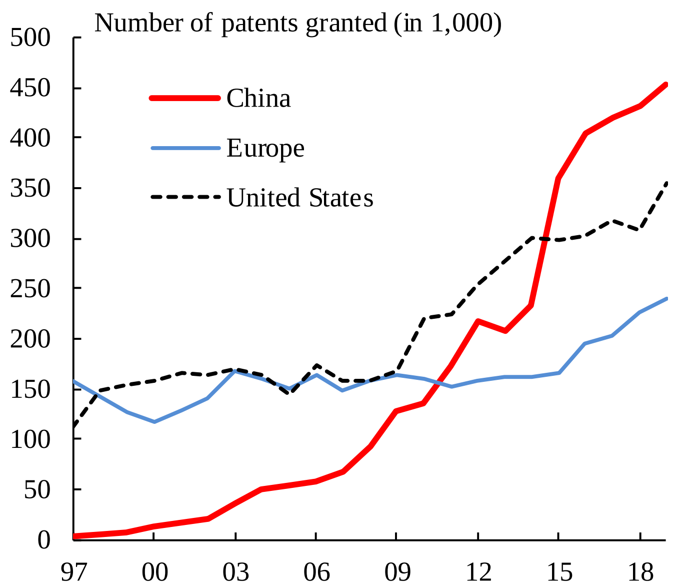
Exhibit 28. Number of Highly Skilled Individuals



Notes:
1. The latest figures are for 2019.
2. The chart shows the total number of graduates with a master's or doctoral degree in science and engineering fields in China, and in engineering, biosciences, computer sciences, etc., in the United States.

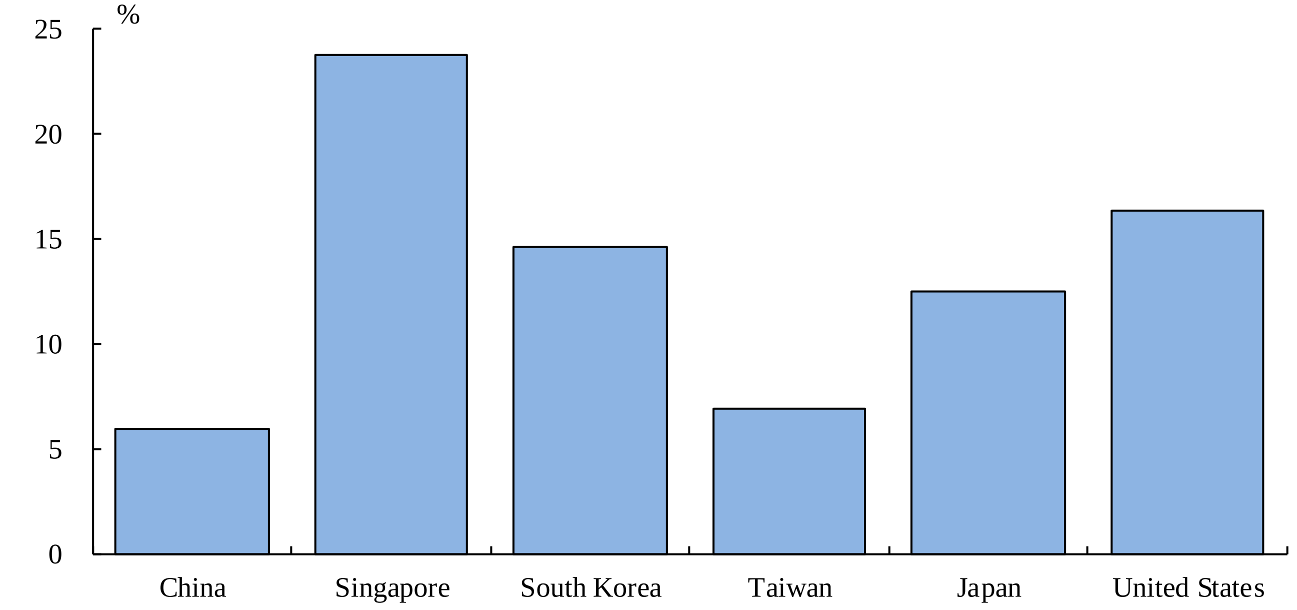
Sources: CEIC, National Center for Education Statistics.

Exhibit 29. Number of International Patents



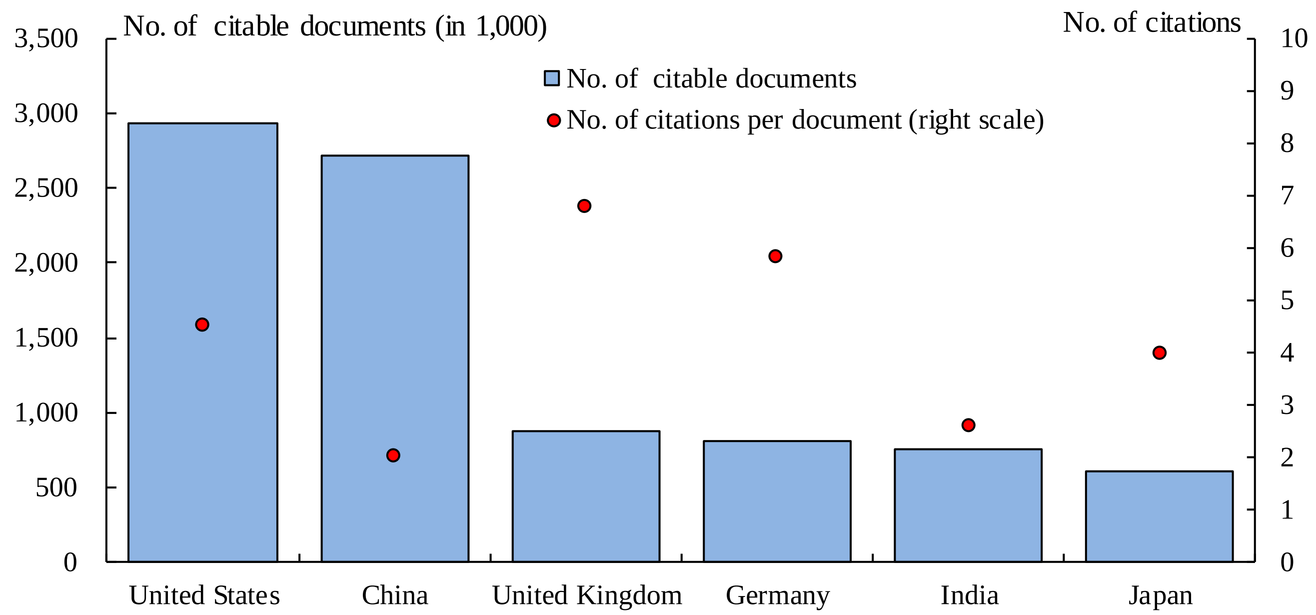
Note: The latest figures are for 2019. The chart shows the total for residents and non-residents.
Source: World Intellectual Property Organization.

Exhibit 30. Share of Basic Research in R&D Investment



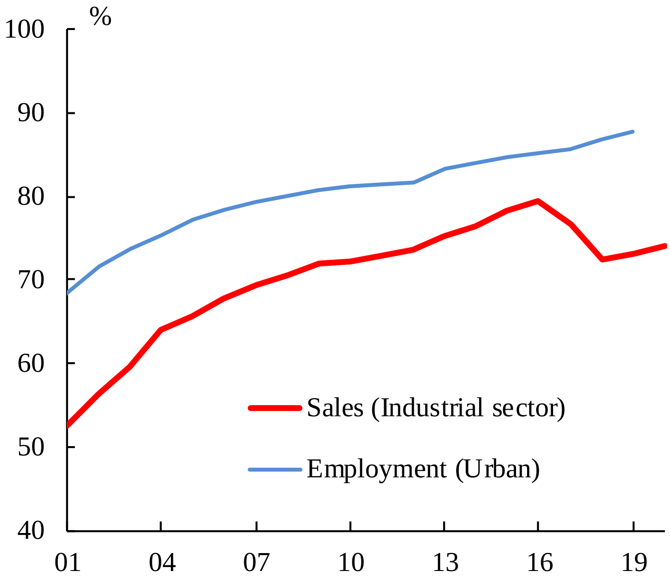
Note: The figure for Singapore is for 2018. Those for all other countries are for 2019.
Source: OECD.

Exhibit 31. Number of Citable Documents and Average Number of Citations by Country



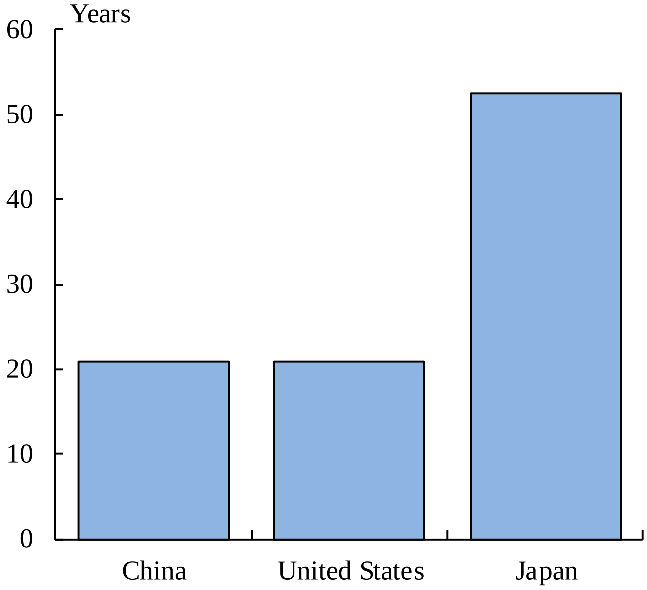
Note: The chart shows the sum of annual figures for 2015–2019. Citations per documents exclude self-citations.
Source: Scimago Journal & Country Rank.

Exhibit 32. Sales and Employment Shares of Firms Other Than SOEs



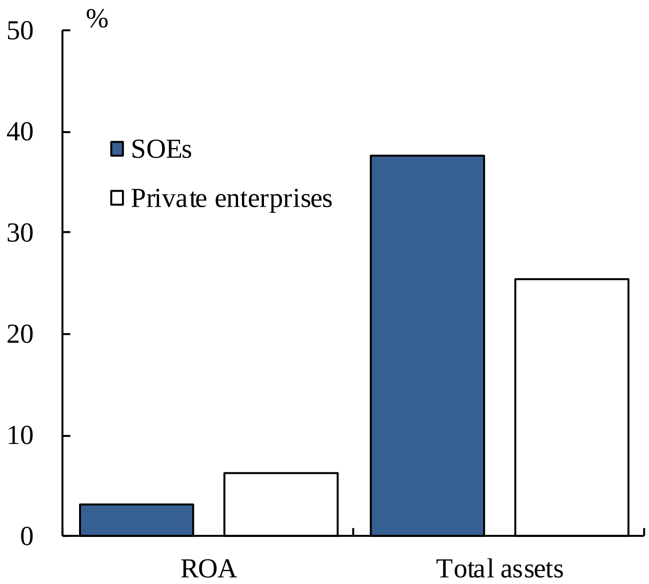
Note: The latest figure for the sales share is for 2020 while that for the employment share is for 2019. "Sales" represents the share of sales of firms other than SOEs (state-owned and state-holding enterprises) in the industrial sector. "Employment" represents the urban employment share of employees other than those at state-owned units.
Source: CEIC.

Exhibit 33. Average Age of Listed Firms



Note: As of 2021.
Source: Bloomberg.

Exhibit 34. Return on Assets (ROA) and Total Assets in Industrial Sectors

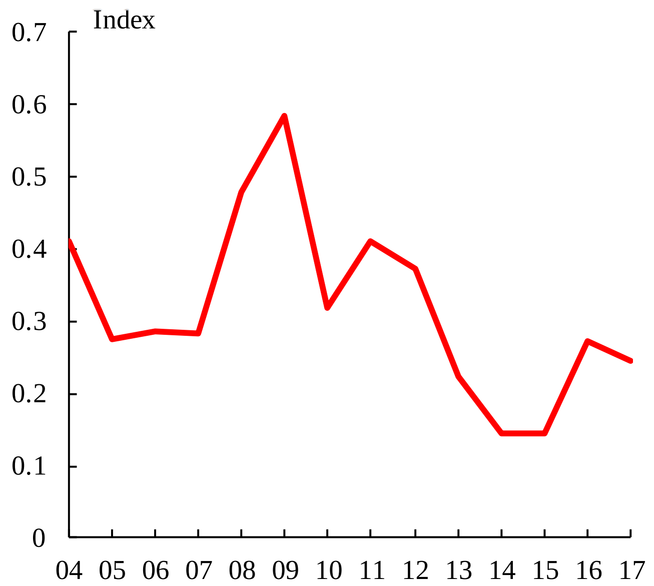


Note: As of 2020. The figures for SOEs are the total for state-owned and state-holding enterprises.
Source: CEIC.

Exhibit 35. SOE's Share of Loans Outstanding

Note: The latest figure is for 2016. The chart shows the share of loans directed toward firms under state control in the outstanding amount of domestic loans to firms (excluding micro-enterprises).
Source: CEIC.

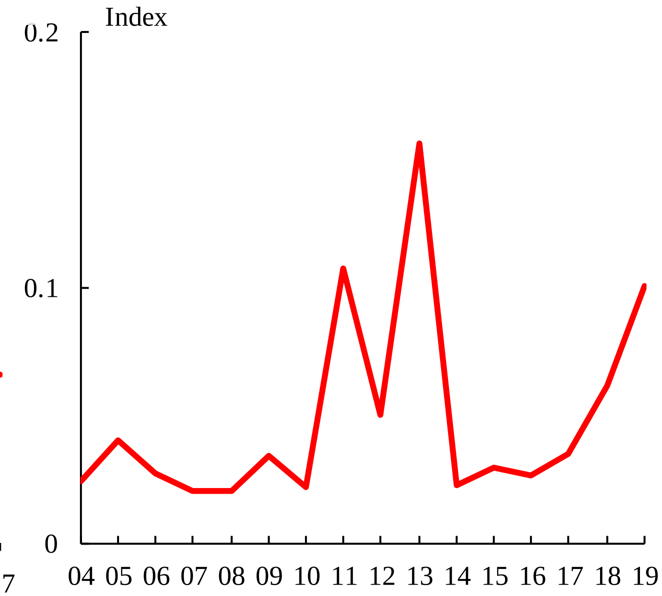
Exhibit 36. Lilien Index for Lending (Reallocation Index)



Note: The latest figure is for 2017. Based on domestic loans as a source of funding for fixed assets investments. Excludes finance, real estate, leasing and commercial services industries, etc. Industries were reclassified when industry classifications changed.

Source: Wind.

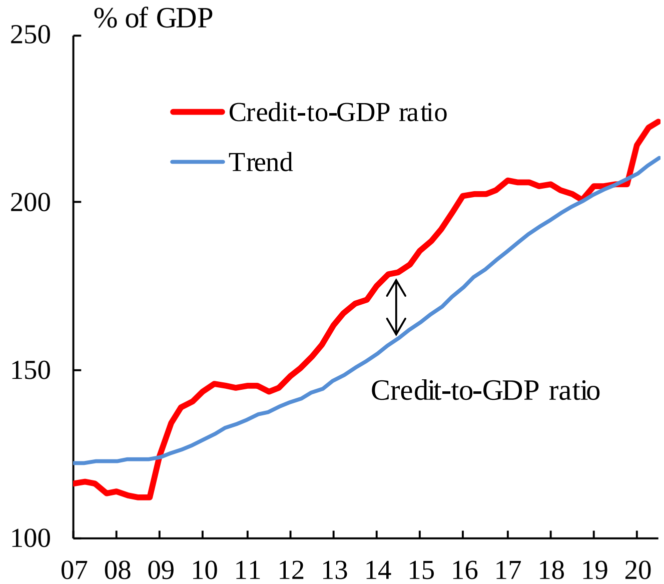
Exhibit 37. Lilien Index for Employment



Note: The latest figure is for 2019. Based on the number of employed persons in urban non-private units.

Sources: China Labour Statistical Yearbook, China Statistical Yearbook.

Exhibit 38. Credit-to-GDP Gap



Note: The latest figures are for 2020/3Q. The trend line shows estimates by the Bank for International Settlements using the one-sided HP-filter.

Source: BIS.