Challenges For the Future of Chinese Economic Growth

Jane Haltmaier*

Board of Governors of the Federal Reserve System

August 2011

Preliminary

*Senior Advisor in the Division of International Finance. Mailing address: Division of International Finance, Board of Governors, Federal Reserve System, Mail Stop 20, Washington D.C. 20551, U.S.A. Email: Jane.T.Haltmaier@frb.gov. Telephone: (202)-452-2374; fax (202)-263-4850.

The views in this paper are those of the author and to not necessarily reflect those of the Board of Governors.

Challenges for the Future of Chinese Economic Growth

Abstract

The Chinese economy has been growing at a rapid pace for over thirty years. Most of this growth has come from higher labor productivity, while growth of employment has diminished along with a slower rate of increase in the working-age population. This paper looks at the challenges that China will face over the next two decades in maintaining its rapid pace of economic growth, especially as working-age population growth slows further and then begins to decline. Key questions include whether China will be able to continue to devote nearly half of its GDP to investment, whether such investment will become less productive as the capital-labor ratio continues to rise, whether labor participation and employment rates will fall as the population becomes less rural, and whether future shifts out of rural employment will go more toward the services rather than the manufacturing sector, where productivity is higher. In the baseline scenario economic growth falls gradually from its current pace of about 10 percent to near 6½ percent by 2030. However, a combination of less optimistic, but still reasonable assumptions, results in a reduction in the growth rate to about 1½ percent by 2030.

Challenges for the Future of Chinese Economic Growth

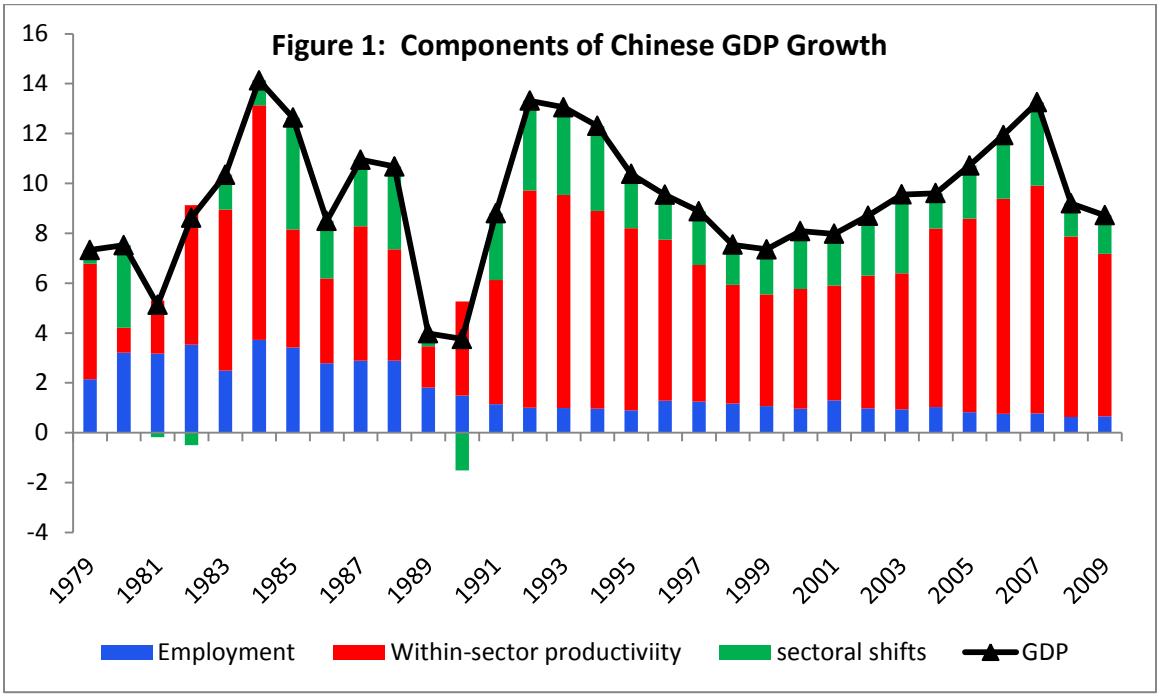
I. Introduction

The Chinese economy has been growing at a rapid pace for over thirty years. From 1978 to 2009 real GDP growth averaged about10 percent per year, resulting in a nearly 20-fold increase in the level of output. The bulk of this increase came from an average increase of 8 percent per year in productivity (output per employed person), while employment rose by a little less than 2 percent per year, similar to the rate of growth of the working-age population.

The economy also has changed dramatically over this period, with the share of employment in the low-productivity primary sector (mainly agriculture) falling from 70 percent to less than 40 percent, while the shares of the higher-productivity secondary (mainly manufacturing) and tertiary (services) sectors increased about 10 and 20 percentage points respectively. The shift in employment shares from lower to higher-productivity sectors contributed about 1½ percentage points on average to the increase in aggregate productivity growth over this period (figure 1). Nevertheless, most of the increase in aggregate productivity has come from within-sector growth (6½ percentage points on average).

However, the relative importance of these factors has shifted somewhat over time. Notably, the contribution of employment growth has declined steadily from just over 2 percent in 1979 to ¾ percent in 2009, reflecting the drop in the rate of growth of the working-age population that has occurred in response to Chinese efforts to control the birth rate. This decline is expected to continue, with the growth rate of employment turning negative between 2015 and 2030. The slower growth in employment has been

offset so far by higher productivity growth, but it is an open question how long this can continue, as there are several factors that may depress productivity growth going forward.



First, even though the contribution of sectoral shifts has been smaller than that of within-sector productivity growth, it has been mostly positive. With nearly 40 percent of the population still employed in the primary sector, there would appear to still be plenty of room for further realignment, but with the secondary sector now accounting for nearly half of economic output, workers moving out of the primary sector may be more likely to go into services, where the productivity differential is smaller. Furthermore, the large increase in productivity has occurred in association with rapid growth in the capital stock, with investment climbing to nearly half of GDP. It is likely to become increasingly difficult to maintain such a large share of investment as living standards improve and demand for consumer goods picks up. In addition, with employment growth stagnating, the effect on productivity growth of further increases in capital could be increasingly smaller.

The purpose of this paper is to try to assess the extent to which the factors outlined above could contribute to a slowing in Chinese economic growth over the next two decades. It begins with a baseline case that contains fairly optimistic assumptions and then looks at the effect on growth of more pessimistic assumptions for all of its major determinants. It is of course entirely possible that growth could be stronger than projected in the base case. However, it seems unlikely that the Chinese economy will be able to outpace the 10 percent average growth of the past decade, suggesting that might be considered a reasonable upper bound. The objective here, then, is to try to estimate a plausible lower bound for Chinese economic growth over the next 20 years.

The paper is organized as follows: section 2 provides a brief overview of historical developments, section 3 describes the methodology, and section 4 presents the results obtained for a baseline and five alternative scenarios. Section 5 concludes.

II. Review of Historical Developments

Chinese GDP has grown very rapidly since the late 1970s, most noticeably in the past two decades. Table 1 breaks GDP growth into two major components, total employment and output per employed person (labor productivity), i.e.:

$$(1) \quad \dot{Y} = \dot{P} + \dot{E}$$

where Y = GDP, P = labor productivity, and E = employment (a dot over a variable indicates percent change).

Productivity is further divided into the portion due to productivity growth within sectors and the part that is due to the shift from lower-productivity to higher-productivity sectors, i.e.:

(2) $\dot{P} = \Sigma \dot{p}_i y_i + \Sigma \dot{e}_i y_i$

where P is total productivity, p_i is sectoral productivity, e_i is the share of employment in sector i, and y_i is each sector's share of GDP. The first term represents within-sector productivity growth and the second is the effect of sectoral employment shifts[1].

Table 1: Components of Chinese Growth
Average Annual percent change except as noted

	1978-1990	1990-2000	2000-2009
GDP	8.6	9.9	10.0
Contribution to GDP Growth:			
Productivity	5.8	8.9	9.1
Within-sector	4.4	6.3	6.9
Sectoral Shifts	1.4	2.5	2.2
Employment	2.8	1.1	0.9
Working-Age Pop.	2.5	1.2	1.3
Participation Rate (average change)	.2	.0	-.3
Employment Rate (average change)	.0	-.2	.0
Sectoral Productivity Growth			
Primary*	4.1	4.8	6.3
Secondary**	4.9	11.4	7.5
Tertiary***	4.6	4.9	7.5
Change in Emp. Share (percentage points)			
Primary	-10.4	-10.1	-11.9
Secondary	4.1	1.1	5.3
Tertiary	6.3	9.0	6.6
Productivity Levels (2000 yuan, average over period)			
Primary	212	353	548
Secondary	677	1885	4276
Tertiary	932	1552	2849
Rate of Increase in the Capital-Labor Ratio			
Total	7.0	11.0	11.4
Primary	3.4	9.2	11.8
Secondary	5.0	10.1	8.5
Tertiary	5.5	8.0	10.0

***** Agriculture, forestry, and fishing. ** Mining, manufacturing, and utilities ***Services

[1] There is also a small interaction term in discrete data, but in this dataset it is never greater than .1 percent.

The acceleration in GDP between the 1980s and the 1990s occurred as the contribution of productivity growth picked up sharply, while the contribution of employment growth dropped along with the rate of growth of the working-age population.

There was some increase in productivity growth in all three major sectors, but the most striking was in the secondary sector, which had an especially impressive performance in the 1990s. At the same time, the substantial shift of employment out of the lower-productivity primary sector into the secondary and tertiary sectors resulted in a contribution to aggregate growth of 1-2 percentage points over this period.

The increase in productivity was facilitated by rapid growth in the capital stock, reflected in enormous increases in the capital-labor and capital-output ratios (figure 2), especially since the early 1990s. However, as illustrated in figure 3, as the capital-output ratio rises, an ever-increasing share of investment in GDP is required just to maintain such high capital stock growth, as a larger portion of investment must go to replacement. Furthermore, as noted above, there may be rapidly diminishing returns to adding more and more capital to a shrinking labor force.

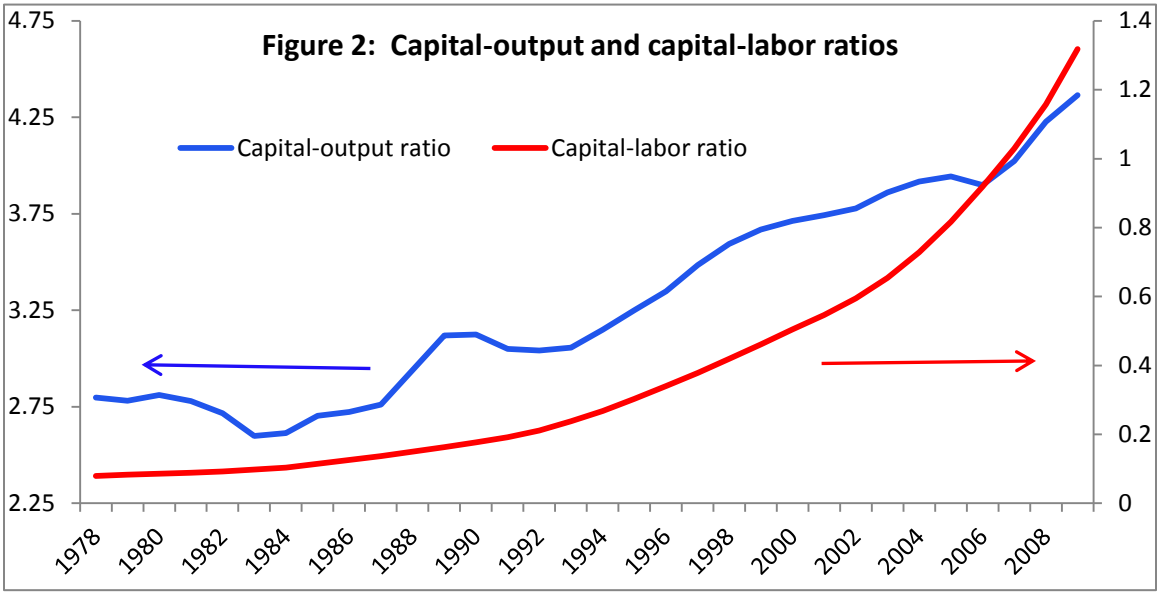
As we look forward, some of the key factors that will determine the extent to which China is able to maintain its current rapid growth rate are:

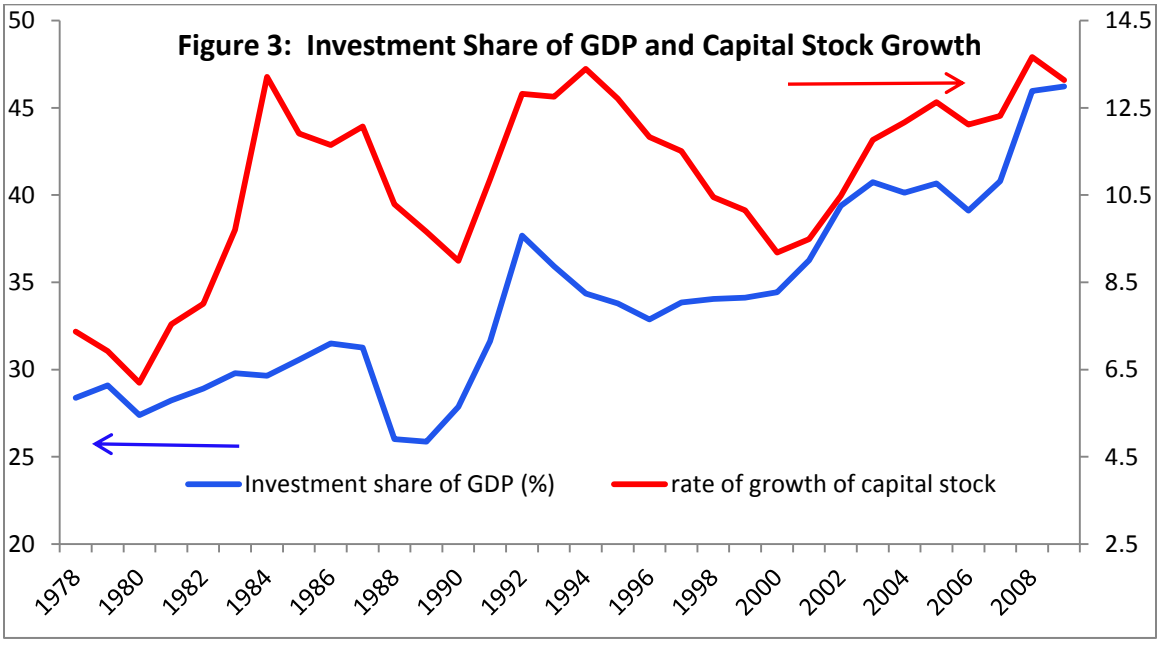
(1) How much of GDP will be devoted to investment?

(2) Will diminishing marginal returns to increases in the capital-labor ratio accelerate as the capital stock continues to grow while the labor force does not?

(3) Will growth of employment match that of the working-age population, or will there be significant changes in either or both the labor force participation rate and the equilibrium employment rate?

(4) What will happen to the share of the secondary sector, now that it is already nearly half of the economy? Will future labor reallocation instead be dominated by shifts from the primary to the tertiary sector?





III. Metholodogy

In order to analyze the prospects for Chinese GDP growth through 2030, projections were made for total employment and productivity (defined as output per employee). The forecast for employment growth is based on the U.N. projections for working-age population along with assumptions for employment and participation rates:

(1) $E = er * pr * WAP$

where E is employment, er is the ratio of employed persons to the labor force (1 minus the unemployment rate), pr is the ratio of the labor force to the working-age population, and WAP is the working-age population.

U.N. population projections suggest that working age population will drop by a total of about 1 percent between 2010 and 2030. The growth rate is slightly positive until 2015, about ½ percent on average, before dropping gradually to a negative ½ percent between 2025 and 2030.

The projection for labor productivity is based on assumptions for the changes in the sectoral capital-labor ratios and their effect on labor productivity. Productivity growth by sector is projected using simple equations that relate the log change in productivity to the log change in the capital-labor ratio (essentially a Cobb-Douglas production function), i.e, :

(2) $Y = A K^{\alpha} L^{(1-\alpha)}$

(3) $\dot{(y/l)} = a + \alpha \dot{(k/l)}$

where lower-case letters are natural logs.

For most countries that do not have data on capital services (i.e., capital stock adjusted for utilization), it is difficult to estimate such an aggregate equation econometrically because cyclical changes in the measured capital-labor ratio tend to produce a negative correlation between it and productivity. However, the lack of cycles in the Chinese economy over the estimation period means that reasonable coefficients can be obtained (table 2), although they are higher than usually associated with Cobb-Douglas production functions. The coefficients for the primary and tertiary sector are near .5 and the constant term in both of these equations is 1.6, indicating that total factor productivity growth in both of these sectors is just over 1½ percent per year. Both of these coefficients are even higher for the secondary sector, where the effect of increases in the capital-labor ratio is estimated to be nearly .7, while total factor productivity growth is 2¾ percent. It should be emphasized that, particularly given the quality of the data, these estimates should be viewed as having a wide range of uncertainty and are only a starting point for the baseline scenario. Alternative scenarios assess the effect of using smaller estimates.

Table 2: Productivity Equation Estimates
Sample Period 1979 – 2009

	Coefficients (standard errors in parenthesis)		Equation standard error
	K/L ratio	Constant	
Primary	.46 (.12)	.016 (.010)	.027
Secondary	.68 (.19)	.028 (.015)	.036
Tertiary	.54 (.14)	.016 (.011)	.025

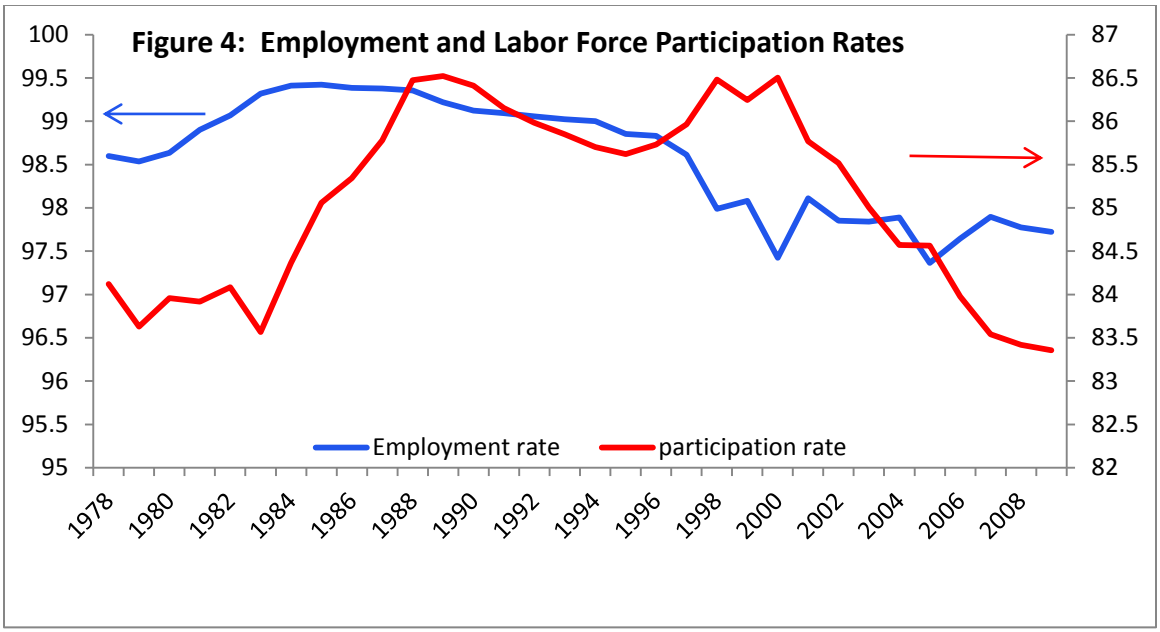
IV. Results

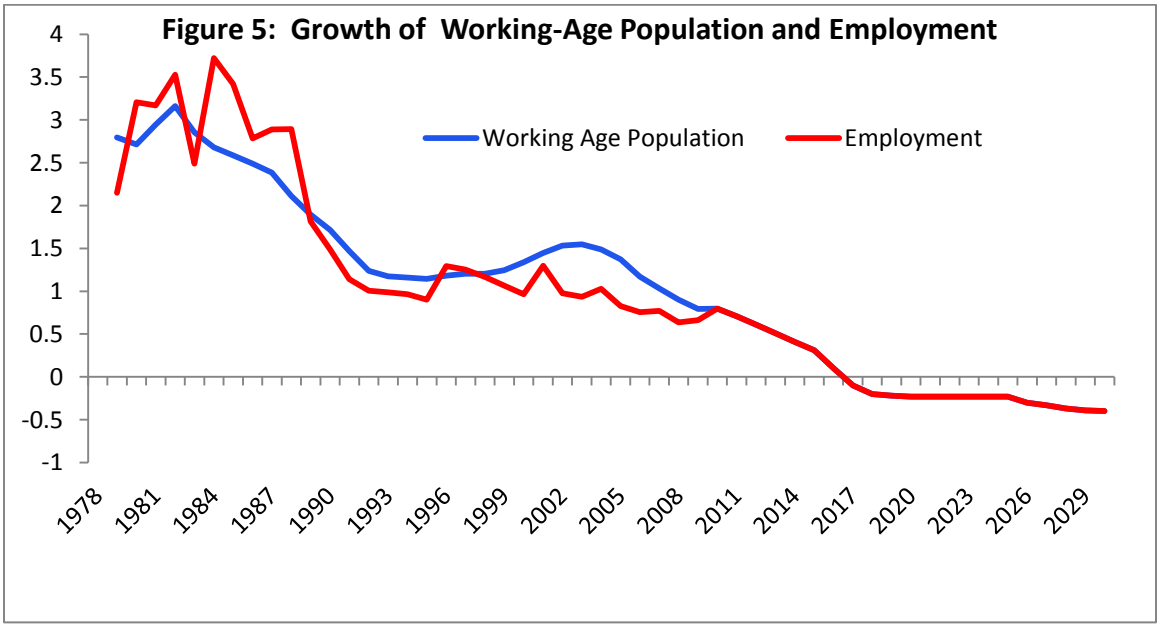
Baseline Assumptions

In the baseline scenario, it is assumed that investment stays at its current high level as a percent of GDP and that both employment and investment continue to shift away from the primary sector. It also is assumed that the share of employment in the secondary sector falls by about 5 percentage points, while the share of investment falls by 10 percentage points. Given the higher productivity growth in this sector, these assumptions still result in an increase in the GDP share of the secondary sector from 49 to 52 percent. These assumptions are intended to strike a middle ground between the fact that the share of manufacturing (the largest portion of this sector) in Chinese GDP is currently much higher than in most of the rest of the world (34 percent in 2009 vs. a world share of 17 percent and a share for Korea of 28 percent), which may suggest that it is likely to fall over time, versus the traditional Chinese government favoritism for this sector. The tertiary sector is assumed to see increases in its shares of both employment and investment. All of these assumptions are varied in the alternative scenarios. The specific assumptions are:

(1) Employment. Both the employment rate (percent of labor force employed) and the labor force participation rate (labor force as a percent of working-age population) are assumed to remain at present levels. As shown in figure 4, the employment rate has been fairly constant at a high level (between 97 and 98 percent) for the past decade. The participation rate has been trending down since 2000, although it still quite high at over 80 percent. Together with working-age population projections from the U.N. database (figure 5), these assumptions determine the growth of aggregate employment. This

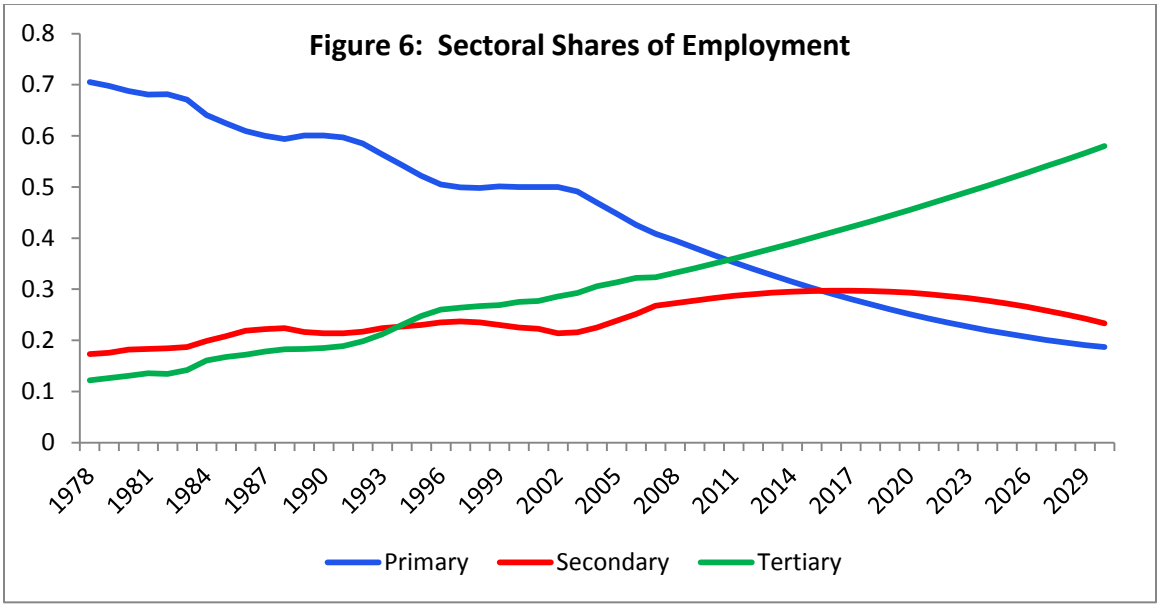
growth rate drops gradually, turning negative in 2017 and reaching –½ percent by 2030. An alternative scenario looks at the effect of assuming that the participation rate continues to fall over the next 20 years, a distinct possibility as the population ages, which would cause employment growth to fall more rapidly, and that the employment rate declines to about 95 percent as the country becomes more industrialized.



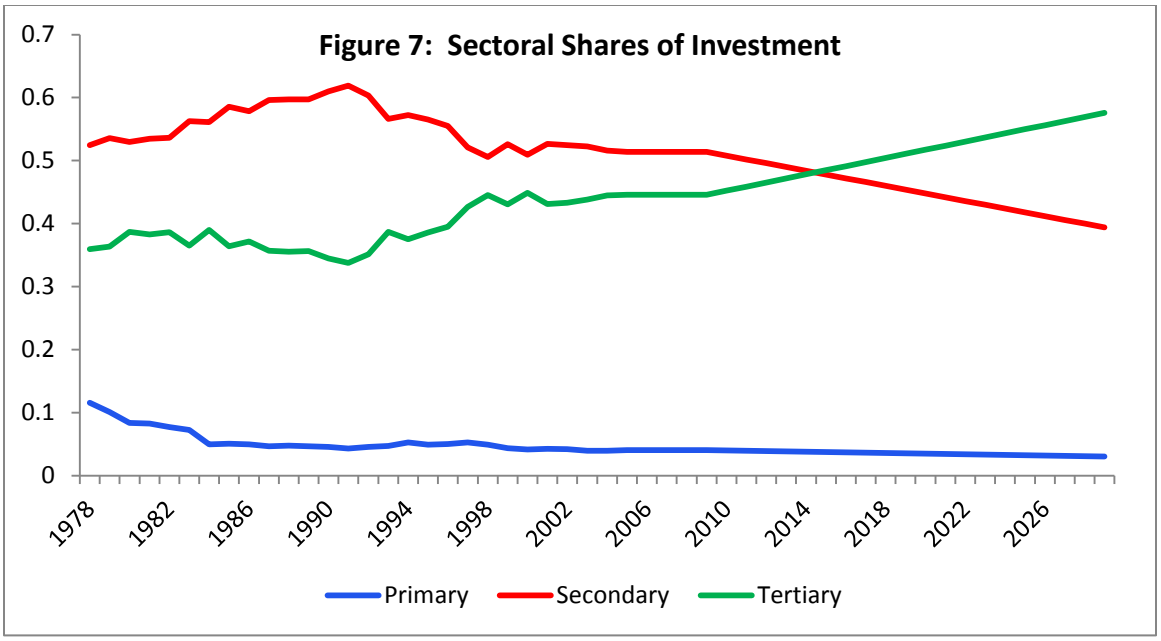


(2) Investment. Aggregate investment is assumed to remain around 45 percent of GDP, where it has been the past two years. As was shown in figure 3, however, this rate is exceptionally high in historical terms. An alternative scenario will look at the effect on GDP growth of a gradual decline in the share of investment to 35 percent over the 20-year projection period.

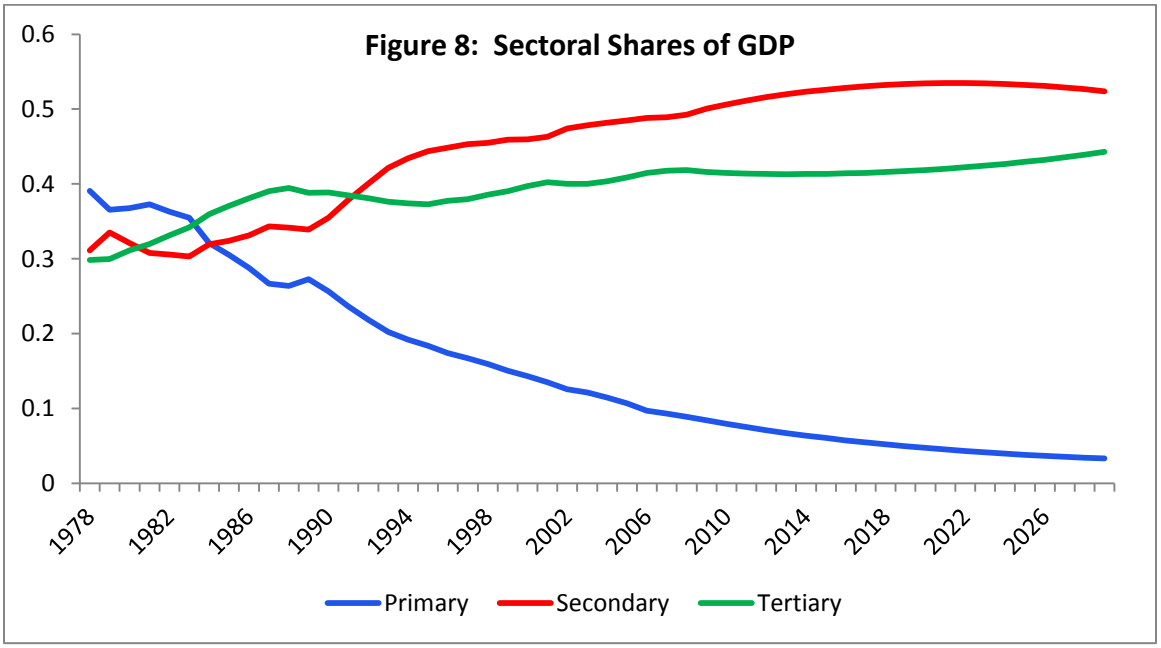
(3) Employment shares. The base case assumes that the shift out of primary employment continues, with the share falling from the current rate of 40 percent to about 20 percent in 2030 (figure 6). The share of secondary employment also is assumed to increase, but at a slowing rate, for about the first half of the projection period, then to fall about 5 percentage points over the second half.



(4) Investment shares. The share of investment in the primary sector is assumed to continue to decline very gradually (figure 7), going from 4 percent in 2010 to 3 percent by 2030. The share of the secondary sector also is assumed to fall, by about 10 percentage points, from near 50 percent in 2010 to about 40 percent in 2030. The share of the tertiary sector increases from 45 percent in 2010 to 57 percent in 2030.

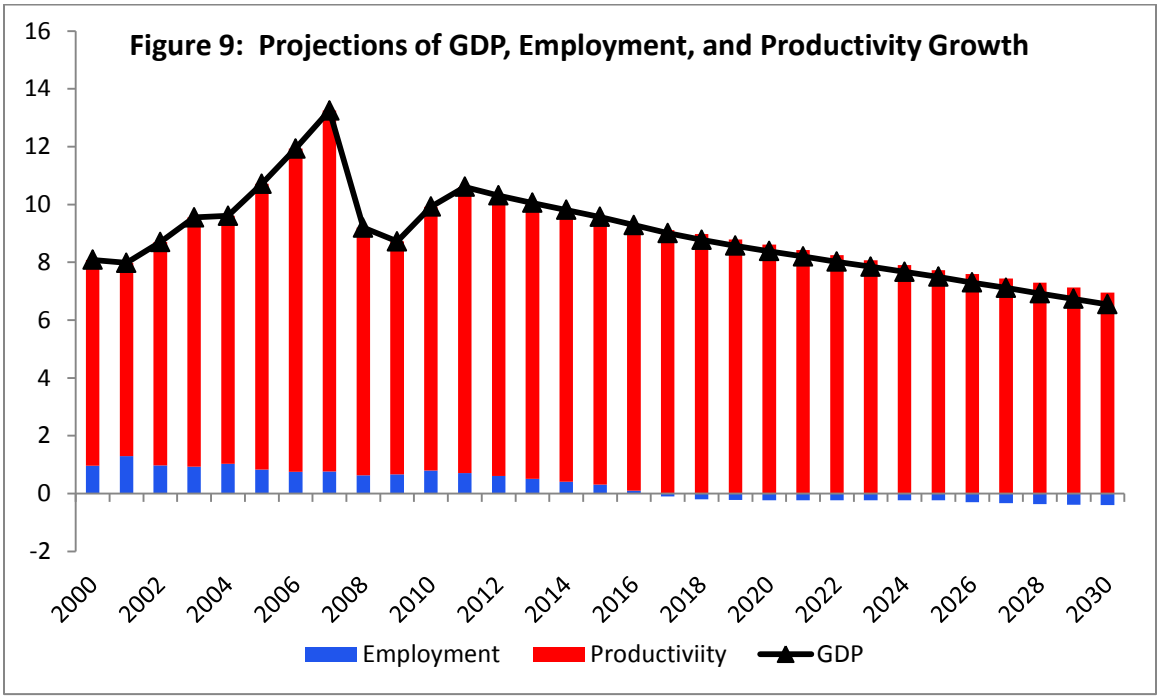


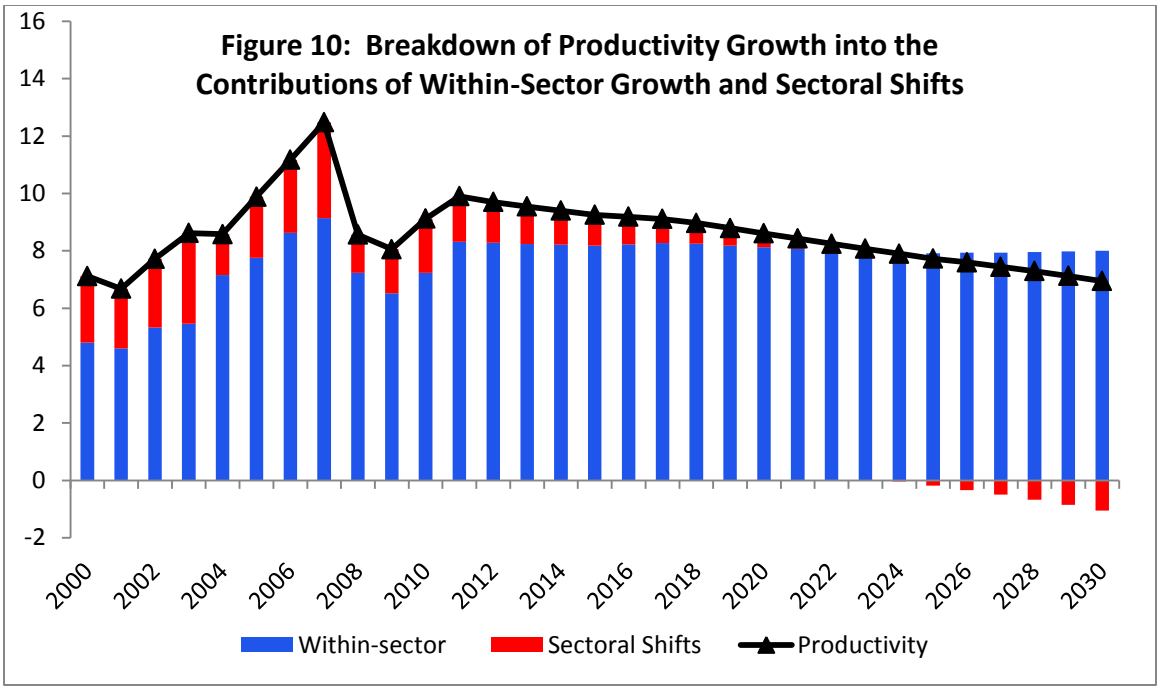
The assumptions for the changes in employment and investment shares together result in a decline in the GDP share of the primary sector (figure 8) from 9 to 3 percent, along with an increase in the share of the secondary sector from 50 to 52 percent, and an increase in the share of the tertiary sector from 41 to 44 percent. An alternative scenario assumes a larger increase in the share of the tertiary sector as the economy matures.

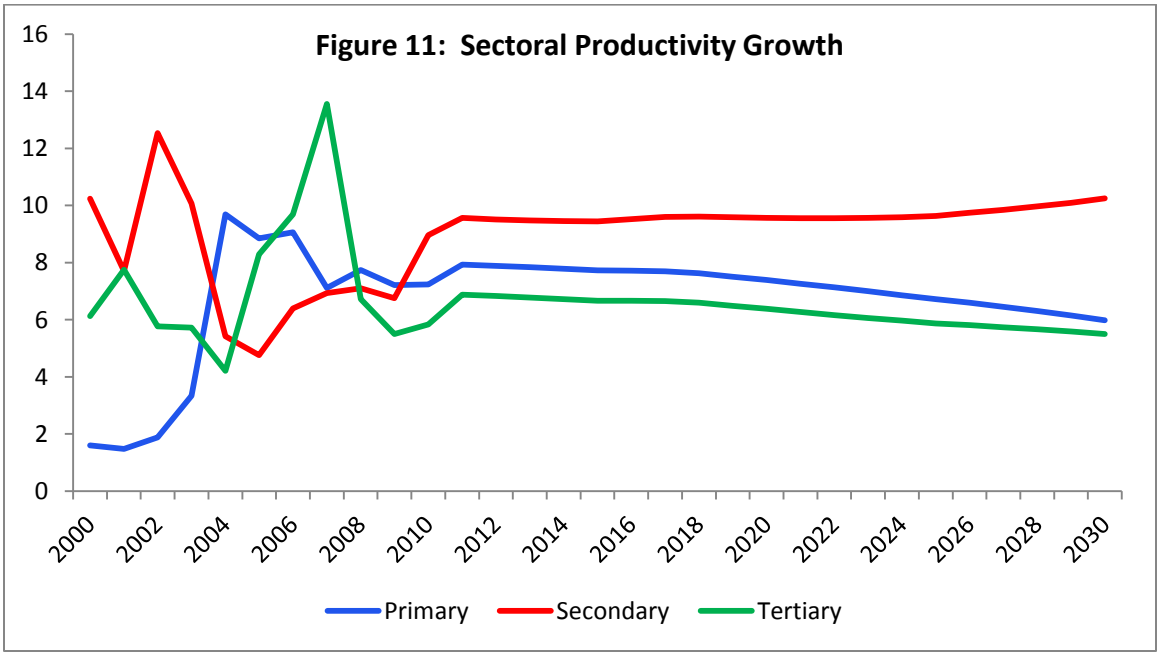


Baseline Results

Under the baseline assumptions, real GDP growth declines gradually from 10½ percent in 2011 to 8½ percent in 2020 and to 6½ percent in 2030 (figure 9). About one-third of this decline is due to a fall in the contribution of employment, which goes from .8 percent in 2010 to -.4 percent in 2030. Productivity growth falls from 9.5 percent to 7 percent. The decline in productivity growth is due mostly to the reduced boost from shifts in employment shares, which becomes increasingly less positive over the first half of the period and turns negative in the second half, as employment begins to shift from the secondary to the tertiary sector (figure 10). Sectoral productivity growth (figure 11) dips a little in the primary and tertiary sectors and rises a little in the secondary sector, leaving the contribution of within-sector productivity growth at around 8 percent.







Thus, in the baseline scenario, even though within-sector productivity growth stays near its present level, the diminishing rate of working-age population growth and likely increase in the share of the tertiary sector over the next 20 years puts significant downward pressure on China's rapid rate of GDP growth.

Alternative Scenarios

The main results from the alternative scenarios are shown in table 3.

Table 3: Results						
	Base	**Lower Investment**	**Lower Investment Coefficient**	**Lower Employment Growth**	**Lower Secondary Share**	**Combination**
GDP Growth						
2010	9.9	9.9	9.9	9.9	9.9	9.9
2020	8.4	7.5	6.9	7.8	8.2	3.9
2030	6.5	5.3	3.7	5.8	5.8	1.3
Employment Growth						
2010	.8	.8	.8	-.1	.8	-.1
2020	-.2	-.2	-.2	-1.2	-.2	-1.2
2030	-.4	-.4	-.4	-1.4	-.4	-1.4
Productivity Growth						
2010	9.1	9.1	9.1	10.0	9.1	10.0
2020	8.6	7.7	7.1	9.0	8.5	5.1
2030	6.9	5.7	4.1	7.3	8.8	2.7
Within-Sector Contribution to Productivity Growth						
2010	7.2	7.2	7.2	8.1	7.2	8.1
2020	8.1	7.3	6.6	8.5	8.3	4.8
2030	8.0	6.7	5.0	8.3	8.8	4.5
Effect on Productivity Growth of Sectoral Shifts						
2010	1.9	1.9	1.9	1.9	1.9	1.9
2020	.5	.5	.5	.5	.2	.3
2030	-1.1	-1.0	-.9	-1.1	-2.7	-1.8
Rate of Growth of the Capital-Labor Ratio						
2010	12.3	12.3	12.3	13.2	12.3	13.2
2020	10.4	9.0	9.7	11.0	10.3	7.7
2030	8.5	6.4	6.9	9.0	8.2	4.7

1) Lower investment as a Share of GDP

In this scenario it is assumed that the ratio of investment to GDP falls gradually from 46 percent in 2010 to 36 percent in 2030. The projections for the employment and participation rates and for the sectoral shares of employment and investment are assumed to be the same as in the baseline case.

In this case real GDP growth drops to 5¼ percent by the end of the projection period. Productivity growth falls from just under 10 percent in 2011 to 5¾ percent in

2030, as the contribution of within-sector productivity growth declines to 6¾ percent. Productivity growth falls in all three sectors. The capital-labor ratio continues to rise, but at a slower rate, with the rate of increase dropping to about 6½ percent by 2030.

2) Reduced effect of Increases in the Capital-Labor Ratio

The simple production function used to project productivity implicitly assumes diminishing marginal returns to increases in the capital-labor ratio, i.e., as the capital/output ratio rises the absolute size of the increase in labor productivity will fall for a given increase in the capital-labor ratio:

(4) $\delta(Y/L)/\delta(K/L) = \alpha A (K/L)^{\alpha-1} = \alpha (Y/K)$

Nevertheless, the percentage increase in productivity for a given percentage increase in the capital-labor ratio remains constant (equal to α). However, as noted earlier, the estimated coefficients for these equations are quite high, and it is possible that they will begin to drop off, particularly as employment stagnates and further gains in the ratio come entirely from adding more capital to a constant (and ultimately declining) workforce. This scenario examines the effect on growth if the estimated elasticity of labor productivity relative to increases in the capital-labor ratio declines from .45 to .25 for the primary sector, from .68 to .4 for the secondary sector, and from .52 to .3 for the tertiary sector.

Under these assumptions the rate of GDP growth falls sharply, to 3¾ percent by 2030, as productivity growth drops to 4 percent. Within-sector productivity growth falls from about 8 percent in 2011 to 5 percent in 2030.

3) Slower Growth in Employment

This scenario assumes that the participation rate continues to trend down rather than remaining constant as in the baseline scenario. This assumption is plausible for several reasons. First, the current participation rate is still remarkably high at nearly 83½ percent despite a 3-percentage point decline over the past decade. Secondly, as the median age of the population continues to increase (from 34½ percent in 2010 to 42½ in 2030), it is likely that a greater percentage of this population will opt out of the labor force. This may be part of explanation for the decline in the ratio that has already occurred, as the median age increased by nearly 5 years between 2000 and 2010. Similarly, the percentage of the population aged 60 and over increased from 10 percent in 2000 to 12 percent in 2010 and is expected to reach 24½ percent by 2030. Thirdly, as more of the population moves out of rural areas, where the entire family may be helping to work the family farm, it is likely that more people will exit the labor force. In this scenario it is assumed that the participation rate declines gradually to 70 percent (about equal to the present South Korean rate).

In addition, the employment rate is also remarkably high at 97.7 percent, equivalent to an unemployment rate of only 2.3 percent. This may also be a function of the still-high share of the rural population in the total. As employment continues to shift away from the agricultural sector, the unemployment rate is likely to rise. This scenario assumes a fairly modest, gradual increase in the unemployment rate to 5 percent by 2030.

Together, these assumptions reduce the growth rate of employment to -1.4 percent in 2030, about a percentage point less than in the baseline scenario. The growth rate of GDP is 5¾ percent that year, ¾ percentage point lower than in the

baseline, as higher productivity growth due to a higher-capital output ratio offsets some of the slower growth in employment

4) Drop in GDP Share of Manufacturing

As noted above, the assumptions in the baseline case result in a small increase in the GDP share of the secondary sector, to 52 percent, which is very high compared with other economies. The share of the secondary sector also remains considerably larger than that of the tertiary sector (44 percent). However, as the population becomes more affluent, it is likely that the demand for services will increase relative to the demand for goods. In this scenario it is assumed that the share of the secondary sector drops to 46 percent by 2030, while the share of the tertiary sector increases to 50 percent. The share of the primary sector is assumed to remain around 3-4 percent.

Under this scenario the growth rate of real GDP falls to 5¾ percent by 2030. Productivity growth falls to about 6 percent, as the effect of sectoral shifts turns to a negative 2¾ percentage points of GDP.

5) Combination

This scenario combines all of the assumptions in the four previous alternatives into a kind of worst-case scenario. Investment falls as a share of GDP and becomes less productive, employment growth is slower than in the baseline, and output shifts from the manufacturing to the services sector as the economy matures. It should be noted that these are all in fact very reasonable assumptions.

Nevertheless, the effects on the Chinese economy are startling. Real GDP growth drops to 4 percent by 2020 and declines further to 1¼ percent by 2030. By that time employment is contracting by 1.4 percent per year, and productivity growth has fallen to

just 2¾ percent, with within-sector productivity growth contributing 4½ percentage points, while the effect of sectoral shifts subtracts nearly 2 percentage points.

Conclusion

Although Chinese economic growth has consistently out-performed most analysts' expectations over the past 30 years, there are some important reasons to believe that such a rapid pace of expansion may not be able to continue indefinitely. As employment growth slows along with that of the working-age population, further increases in GDP will depend on gains in productivity. Such gains will in turn depend to an important extent on increases in the capital-labor ratio. However, it may be difficult for China to continue to devote nearly half of its GDP to investment, and such investment may well become less productive as the capital-labor ratio continues to soar. These factors are likely to put downward pressure on China's rapid growth rate.

Despite major differences in the two economies, the Japanese experience may be instructive, particularly in light of the fact that Japan is also facing a shrinking labor force. As shown in table 4, Japanese GDP growth from the mid-1950s to the mid-1960s was only about a percentage point lower than the current rate of Chinese growth (although the ratio of investment to GDP, at 20 percent, was less than half of the Chinese rate). The rate of growth of employment was 1½ percent, a little higher that the current Chinese rate. However, even though the investment rate subsequently increased and the rate of growth of the capital-labor ratio picked up as well, the growth rate of productivity has steadily declined and was just 1 percent over the past two decades. Although the slow pace of expansion partly reflects sluggish growth in Japanese demand as the

economy has struggled, it may also reflect the inherent difficultly in continuing to maintain rapid productivity growth while the workforce is stagnating.

Table 4: Components of Japanese Growth
Average annual percent change except as noted

	1956-1967	1967-1978	1978-1990	1990-2000	2000-2010
GDP	9.0	6.1	4.5	1.2	.7
Productivity	7.5	5.3	3.2	.9	1.0
Employment	1.5	.9	1.2	.3	-.3
K/L ratio	8.5	9.5	5.2	3.7	1.9
Inv/GDP (%)	20.0	29.0	26.9	27.3	22.3

Of course, China still has plenty of room to increase human capital by continuing to invest in education, and scientific advances could increase total factor productivity enough to offset these other forces. Nevertheless, the serious challenges that China could face in extending its rapid rate of economic expansion should not be underestimated.

Data Appendix

Employment, Labor Force, and Working-Age Population

The labor force and employment series are from the Chinese State Statistical Office, obtained via Haver Analytics. There is a break in these series in 1990 that has been smoothed using a growth rate for that year that is an average of the growth rates for the preceding and following years.

The working-age population is obtained from the U.N. population database for five-year intervals and is interpolated to an annual basis.

GDP and Labor Productivity

The GDP data are from the Chinese National Bureau of Statistics, also compiled by Haver Analytics. Both the total and the industry series are indexes equal to 100 in 1978, converted to 2000 yuan using nominal GDP for that year.

Labor productivity is calculated as the ratio of GDP in 2000 yuan to employment.

Capital Stock

The capital stock series by sector were taken from Yanrui Wu (2009). The data are annual and cover the years 1978-2006. The series were converted to the base year 2000 using the GDP deflator. Average depreciation by sector was used to estimate sectoral investment using the formula:

$I = K – (1-\delta) * K\text{-}1$

The sectoral series are summed to obtain an estimate of total investment. The investment series were extended through 2009 using growth rates of investment from the National Income Accounts, which follow a similar trajectory, although the level is smaller than the summed series. This is likely because the National Income Accounts series nets out purchases and sales of existing assets. It is assumed that the shares of the sectors are fixed over this period in order to extend the sectoral investment series. These series and the depreciation rates, which are also assumed to remain constant, are used to extend the capital stock series.

References

Eichengreen, Barry, Donghyun Park, and Kwanho Shin, "When Fast Growing Economies Slow Down: International Evidence and Implications for China," NBER Working Paper 16919, March 2011.

Li, Kui-Wai, "China's Capital and Productivity Measurement Using Financial Resources," Yale University Economic Growth Center Discussion Paper 851, February 2003.

Wu, Yanrui, "China's Capital Stock Series by Region and Sector," University of Western Australia Business School Discussion Paper 09.02, 2009.