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Challenges for the Future of Chinese Economic Growth

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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.

Keywords: China, growth, potential

JEL classifications: E27, O47

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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 2011 real GDP growth averaged about10 percent per year, resulting in a more than 20-fold increase in the level of output. Can this continue? Eichengreen et. al. (2011) argue that the evidence from other countries suggests it cannot, and in fact the economy has already slowed in the past couple of years.

Although some of the recent slowing may be cyclical, there also has likely been some cooling in the rapid pace of trend growth. This is not surprising-a continuation of growth rates near 10 percent as the Chinese economy becomes more developed would be unprecedented. The real question is by how much and over what period is Chinese economic growth likely to slow further. The purpose of this paper is to try to provide some perspective on this question by looking at some of the supply-side factors that influence the rate of Chinese GDP growth.

The GDP growth rate is the sum of the growth in employment and the growth in output per employee. China faces challenges in both of these categories. The rate of working-age population growth has fallen from 2½ percent in 1979 to less than one percent in 2011, and is expected to turn negative before 2020. With nearly 80 percent of the working-age population already employed, there is not much room for employment growth to exceed working-age population growth. Thus, in all likelihood, virtually all of the increase in Chinese GDP over the next couple of decades will have to come from increased output per worker, or labor productivity.

Productivity gains are in fact already providing the bulk of Chinese economic growth. As illustrated in figure 1, the contribution of employment growth to overall GDP growth (the blue bars) has fallen considerably over the past three decades. Productivity growth (the combination of the red and green bars) has so far risen to offset the decline. Most of the productivity gain has come from increases in efficiency within sectors, the red bars. However, a substantial shift of employment from the lower productivity primary (mainly agriculture) sector to the higher-productivity secondary (mainly manufacturing) and tertiary (services) sectors also has contributed to aggregate productivity growth, as measured by the green bars.

There may be limits to the extent to which each of these factors can continue to contribute to productivity growth. Within-sector productivity growth has been facilitated by very high rates of investment that may be difficult to sustain as living standards improve and demand for consumer goods picks up. Furthermore, as the capital stock grows an increasing share of investment needs to be devoted to replacement, leaving less room for net investment. Also, as the capital-labor ratio continues to rise as employment is flat or falling, the marginal product of the additional capital is likely to fall.

In addition, while there is still considerable scope for labor to move from the primary to the other sectors, it is diminishing over time. The share of employment in the primary sector has already fallen from 70 percent in 1978 to around 35 percent in 2011. The share of the secondary sector is now about half of GDP, much higher than in most other countries. This suggests that further movement out of the primary sector in China is more likely to be into the tertiary sector, where the productivity dividend is lower.

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) Will the current high rate of investment to GDP be sustained?

(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 a significant decline in the employment-population ratio as the workforce continues to urbanize?

(4) Will future labor reallocation be dominated by shifts from the primary to the tertiary sector rather than to the secondary sector?

(5) To what extent will increases in human capital be able to offset some of the potential negative effects?

The paper first attempts to arrive at a reasonable baseline scenario for Chinese economic growth over the next two decades and then outlines some of the risks that could result in a much weaker outturn. 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. Some of the factors that could contribute to a stronger outcome, such as more human capital growth, are more difficult to quantify, but are addressed in a discussion of other risk factors for both better and worse outcomes.

The paper is organized as follows: section 2 describes the data, section 3 provides an overview of historical developments, section 4 describes the methodology, and section

5 presents the results of a baseline and five alternative scenarios. Section 6 discusses some of the issues that are not covered in the alternatives, but which could have an important effect on the outcome. Section 7 concludes.

II. Data

Capital Stock

There is no official capital stock or price-adjusted investment series for China. Capital stock series have been constructed by a number of analysts, including Yanrui Wu (2009), Chow and Li (2002), Holz (2006), and Perkins and Rawski (2008). Of these, only Wu constructs capital stock by sector.

The capital stock series from the various studies are compared in table 1. All of the estimates in the table are in 2000 RMB. Both Holz and Perkins and Rawski calculated their estimates in 2000 prices; Chow and Li and Wu presented their estimates in 1978 RMB. The latter series have been converted to 2000 RMB for comparison using an investment deflator that was calculated from Chinese annual national accounts data using nominal gross capital formation divided by a constructed series for real gross capital investment. The real series was calculated in the following way: the published series on the contribution of gross capital investment to real GDP growth was used to calculate the change in real investment in 2000 RMB using the formula:

$$IC = \Delta I / GDP_{-1}$$

where IC = contribution of investment to GDP growth, I is investment, and GDP is in 2000 RMB. The 2000 level of investment was then extended backward and forward using the calculated changes to obtain a series in 2000 RMB. *Holz computes a number of different series using different rates of depreciation. The one shown here is the one he considers the most reliable.

Although Wu's estimated capital stock for 1998 is similar to that of Chow and Li, both are considerably larger than those found by the other authors. The differences between the Wu estimate and those of both Perkins and Rawski and Holz also increase over time. In addition, although Wu's average depreciation rates appear to be reasonable (1.6 percent for the primary sector, 5.2 percent for the secondary sector and 4 percent for the tertiary sector), the aggregate implied investment series that can be backed out using the capital stock and depreciation rates is also considerably larger than the published investment series, as shown in figure 2.

Because the analysis in this paper requires data on capital stock by sector, the Wu data is the most appropriate. However, the large discrepancy in Wu's aggregate series compared with other estimates is problematic, particularly since the paper looks at the issue of whether the marginal product of capital is likely to fall as the capital stock increases. In addition, the Wu series only extend through 2006, and it is desirable to extend it using the official investment series.

Therefore, the sectoral capital stock data were recalculated using investment series that were derived by taking Wu's implied sectoral investment series and multiplying them by the ratio of his aggregate investment series divided by the official series. Wu's depreciation rates were used. While this method is obviously imperfect, it does results in capital stock estimates of 30.4 and 42.3 2000 RMB for 2002 and 2005 respectively, much closer to the estimates from the other studies.

The investment series were extended through 2011 using growth rates of investment from the National Income Accounts. It is assumed that the investment shares of the sectors are fixed over this period and that the depreciation rates remain the same as in the historical series.

Employment, Labor Force, and Working-Age Population

The 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.

III. 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.:

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

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].

The acceleration in GDP from a growth rate of 9.1 percent in the 1980s to 9½ percent in the middle period and to nearly 10 percent in the most recent period occurred as the contribution of productivity growth picked up sharply, from 6¼ percent to 9¼ percent, while the contribution of employment growth dropped from nearly 3 percent to about ½ percent, largely mirroring the decline in the rate of growth of the working-age population. In addition, the employment/population ratio increased a little in the 1980s but has been falling more recently (figure 3).

The increase in productivity growth has occurred across all three major sectors, but the most striking was in the secondary sector, which had an especially impressive performance (average annual growth over 10 percent) in the 1990s. In the more recent decade productivity growth has slowed in the secondary sector while increasing in both of the other two sectors. The substantial shift of employment out of the lower-productivity primary sector into the secondary and tertiary sectors (figure4) resulted in a contribution to aggregate growth of about 1¾ percentage point in the 1980s. The

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

contribution picked up to 2 percentage points in the 1990s and has remained around that rate.

The increase in within-sector productivity was facilitated by rapid growth in the capital stock, reflected in sizable estimated increases in the capital-labor and capital-output ratios (figure 5) since the early 1990s. However, as illustrated in figure 6, 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 diminishing returns to adding more and more capital to a shrinking labor force.

The shift in employment toward the secondary sector in conjunction with its rapid productivity growth has resulted in a dramatic gain in the sector's share of output (figure 7), from about 30 percent in 1978 to just over 50 percent in 2011. Over the same period the primary sector's share of output dropped from 40 percent to 8 percent, while the share of the tertiary sector climbed from 30 percent to 40 percent.

As indicated in figures 8-10, these output shares, especially for the secondary and tertiary sectors, are unusual compared with other countries. In 2011, the latest year for which data are available, the primary sector accounted for 10 percent of nominal value added, the secondary sector for 47 percent, and the tertiary sector for 43 percent. (The shares in real terms, which are for the projections, are a little different. The value added shares are shown here for comparison with other countries.)

Output of the primary sector in China is still high relative to most other countries, suggesting that resources are likely to continue to migrate to the other sectors. The average primary share of output is 5 percent for all countries, with the share in the advanced economies at less than 2 percent while the emerging market share averages 8 percent. However, the share of the secondary sector in China (47 percent) is extremely high compared with most other countries. The average for all economies is 30 percent, 26 percent for advanced and 35 percent for emerging markets. The Chinese share of the tertiary sector differs from that of most other countries in the opposite direction—the Chinese share is only 43 percent, compared with an average of 65 percent for all countries, 73 percent for advanced and 56 percent for emerging markets. China, Indonesia, Thailand, and Vietnam are the only countries where the share of the secondary sector is greater than that of the tertiary sector. This suggests that the migration away from the primary sector is increasingly likely to be toward the tertiary sector. The secondary sector is also likely to begin to shrink in relative terms as China becomes more developed.

IV. 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 forecasts for employment growth are based on the U.N. projections for working-age population along with an assumption for the employment-population ratio:

(1) $E = epr * WAP$

where E is employment, epr is the ratio of employed persons to 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 1¾ percent between 2011 and 2030. The growth rate is slightly positive until 2016, a little less than ½ percent on average, before dropping gradually almost to a negative ½ percent by 2030. The population projection was used for all the scenarios, both the baseline and the alternatives. The employment-population ratio was assumed to stay at its current rate for the baseline scenario and was varied for the alternative projections.

The projection for labor productivity is based on assumptions for the changes in the sectoral capital-labor ratios and the implications for 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) $(\dot{y}/l) = \dot{a} + \alpha\,(\dot{k}/l)$

where lower-case letters are natural logs.

The results from these equations are shown in table 3. The elasticity of productivity to changes in the capital-labor ratio is near .5 for the primary and secondary sector and about .4 for the tertiary sector. The constant term, which represents average total factor productivity growth over the estimation period is .02 for the primary sector, .05 for the secondary sector, and .03 for the tertiary sector. It should be emphasized that, these estimates should be viewed as having a wide range of uncertainty, particularly given the quality of the data, and are only a starting point for the baseline scenario. Alternative scenarios assess the effect of using different estimates for the coefficients.

The GDP forecast is obtained in several steps:

(1) The population projection and the assumption for the employment-population ratio generate total employment. Using assumptions for the evolution of the employment shares by sectors, total employment for each sector is obtained.

(2) Assumptions are made for the rate of investment as a share of previous period's GDP to allow for forecasts to be made iteratively going forward. Capital stock by sector is projected using the resulting projection for total investment, along with assumptions for each sector's share of investment and the historical depreciation rates.

(3) Sectoral capital stock and employment forecasts are used to calculate the capital-labor ratios, which are then used in the equations discussed above to obtain projections for productivity.

(4) The productivity and employment projections are combined to produce forecasts of GDP.

Each scenario thus requires assumptions for: the employment-population ratio, the rate of investment relative to GDP, and the sectoral shares of employment shares and investment. These assumptions, as well as the coefficients in the productivity equations, are all varied in the alternative scenarios.

V. Baseline and Alternative Scenarios

Baseline Assumptions

The baseline scenario incorporates the following assumptions:

(1) the employment-population ratios stays at its current level. As this ratio has been declining for most of the past two decades, an alternative scenario assesses the possibility that the decline will continue.

(2) investment stays at its current high level of nearly 45 percent of GDP. A decline in this rate is incorporated into one of the alternatives.

(3) employment continues to shift away from the primary sector. The share of employment in this sector is assumed to fall from 35 percent in 2011 to 12 percent in 2030 (figure 11). The share of employment in the secondary sector is assumed to increase a little more, from 30 percent in 2011 to about 32 percent in 2017, and to then begin to drop back, reaching 20 percent by 2030, as the country becomes more developed. Employment in the tertiary sector rises to about 68 percent by 2030.

(4) investment also is assumed to shift away from the primary and secondary sectors toward the tertiary sector. The share of investment falls from 4 percent in 2011 to 3 percent in 2030 in the primary sector and from 51 percent in 2011 to 41 percent in 2030 for the secondary sector (figure 12).

The employment and investment assumptions result in a decline in the share of output of the primary sector from 8 percent in 2011 to 3 percent in 2030, a decline in the share of output of the secondary sector from 51 percent in 2011 to 47 percent in 2030, and an increase in the share of output of the tertiary sector from 41 percent in 2011 to 50 percent in 2030 (figure 13). These changes would bring the distribution of Chinese output a little closer to that of most other countries, but it would still be quite different. An alternative scenario will look at the effect of a more significant change in the distribution of output.

Baseline Results

Under the baseline assumptions, real GDP growth declines gradually from 10½ percent in 2012 to 8½ percent in 2020 and to just over 6 percent in 2030 (figure 14).

About a quarter of this decline is due to a fall in the contribution of employment, which goes from .4 percent in 2011 to -.4 percent in 2030. Productivity growth falls nearly 10 percent to 6 ½ 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 15).

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 4.

1) Slower Growth in Employment

This scenario assumes that the employment/population ratio declines by about 10 percentage points between 2011 and 2030, from 78 percent to 69 percent. The decline of about ½ percentage point per year is similar to the average change in the actual rate since the late 1990s, and would bring the ratio more in line with that of most other countries. In 2009 (the latest year for which a full set of data are available), the rate averaged 67 percent across 42 countries, 71 percent for the advanced and 64 percent for emerging markets. In addition, as the median age of the population continues to increase (from 34 in 2010 to 42 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 nearly 25 percent by 2030. Furthermore, 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.

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.

2) Lower investment as a Share of GDP

In this scenario it is assumed that the ratio of investment to GDP falls gradually from 44 percent in 2010 to 34 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 5.4 percent by the end of the projection period. Productivity growth falls to just under 6 percent in 2011 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.

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

At the same time, 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 gradually to .3 for all three sector (from near .5 in the primary and secondary sectors and .4 in the tertiary sector). Under these assumptions the rate of GDP growth falls sharply, to a little under 3 percent by 2030, as productivity growth drops to 3¼ percent.

4) Drop in GDP Share of Manufacturing

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 gradually to 34 percent by 2030, about equal to the current average for emerging market economies, although still higher than the overall average of 30 percent. The share of the primary sector is still assumed to decline to 3 percent, while the share of the tertiary sector increases to 63 percent.

Under this scenario the growth rate of real GDP falls to 4 percent by 2030. Productivity growth falls to about 4½ percent, as the effect of sectoral shifts turns to a negative 5½ 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 5 percent by 2020 and declines further to under 1 percent by 2030. By that time employment is contracting by a little over 1 percent per year, and productivity growth has fallen to just 2 percent, with within-sector productivity growth contributing less than 4 percentage points, while the effect of sectoral shifts subtracts nearly 2 percentage points.

VI. Other Factors

The alternatives explored above obviously do not exhaust the potential influences on Chinese growth, both positive and negative, that could contribute to very different outcomes than those obtained here. A major factor that is omitted because of lack of data is human capital. Although data on educational attainment for China are sketchy, a recent Gallup poll showed that the percentage of people aged 25 and older with at least a high school education was about 28 percent, much lower than the 87 percent for the same age group in the United States. This suggests that there is significant room for increased educational attainment to contribute to productivity growth going forward. Of course, this factor has also likely played an important role in China's rapid productivity growth in recent years. The large discrepancy among age groups—47 percent of 25-29 year-olds are high school graduates, compared with just 18 percent for people aged 50 and over—is an indication of the significant increase in educational opportunities that has already occurred.

Although the rise in human capital should contribute to an increase in total factor productivity, it should be noted that the rate of increase in TFP assumed here, as measured by the constant term in the productivity equations, is fairly high at 2 percent for the primary sector, 5 percent for the secondary sector, and 3½ for the tertiary sector. This translates into a weighted average of sectoral TFP growth of about 4 percent over the forecast period, which is very similar to its recent rate of growth. The average rate does not vary much across the alternatives, as the constant term is assumed to remain the same.

Another factor that is hard to quantify is the possibility that continued movement toward a more market-determined allocation of capital may result in a substantial rise in efficiency that could help to offset potential diminishing marginal returns from a rising capital-labor ratio. The fact that the Chinese economy is still catching up to more advanced economies may allow them to continue to import more advanced technologies for an extended period of time, thus also providing some offset to the factors contributing to lower productivity growth.

VII. 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.

In addition, it is extremely likely that the high-productivity secondary sector will need to shrink going forward as the economy rebalances away from relying so heavily on exports to a greater share of production for domestic demand. Although the enormous Chinese market will obviously have a large appetite for manufactured goods, consumers will be likely to demand that overall output includes a greater proportion of services, more in line with other countries. The positive contribution to overall growth that is currently due to shifts between sectors is thus likely to lessen going forward and possibly turn negative at some point.

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.

Most people would probably agree that the Chinese economy cannot maintain the extremely rapid growth rates it has seen over the past three decades indefinitely. The question is thus not whether the Chinese economy will slow by when and by how much.

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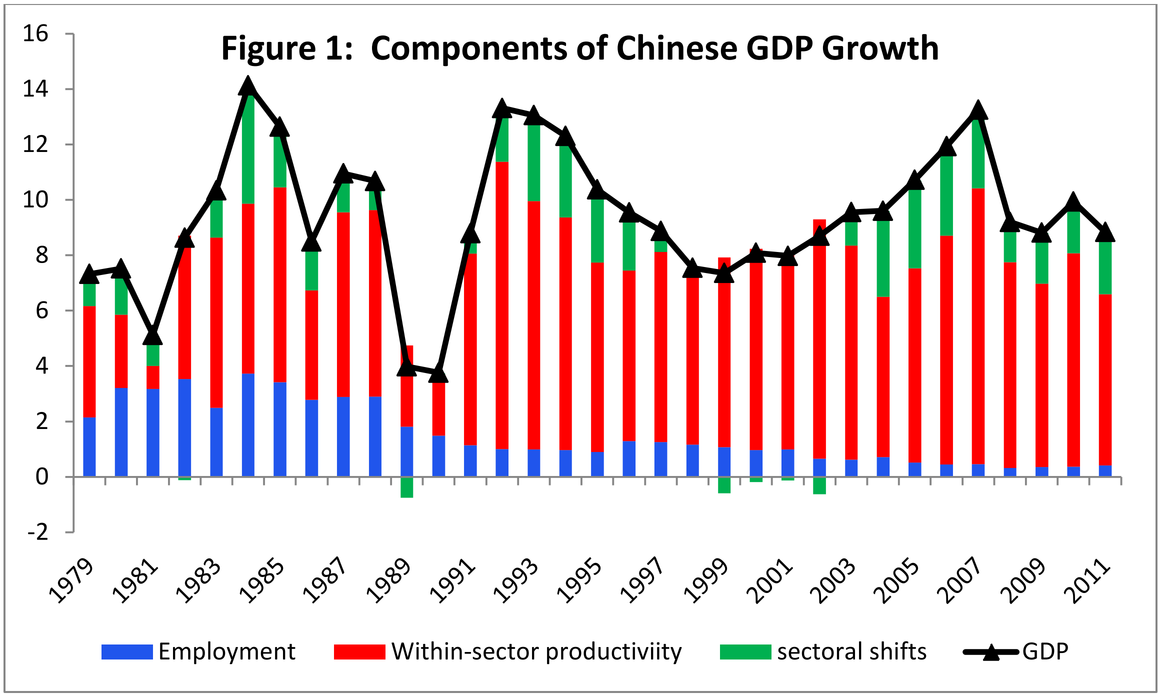

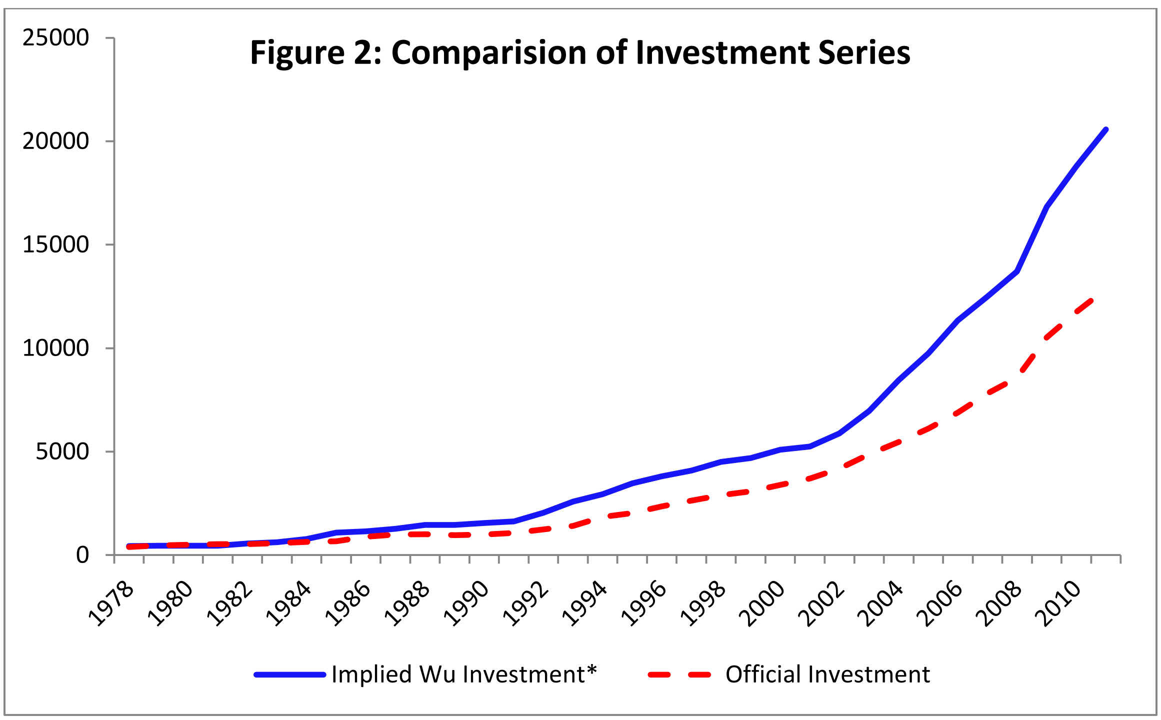

* calculated using the formula; $I = K - (1\text{-}\delta)^*K_{-1}$

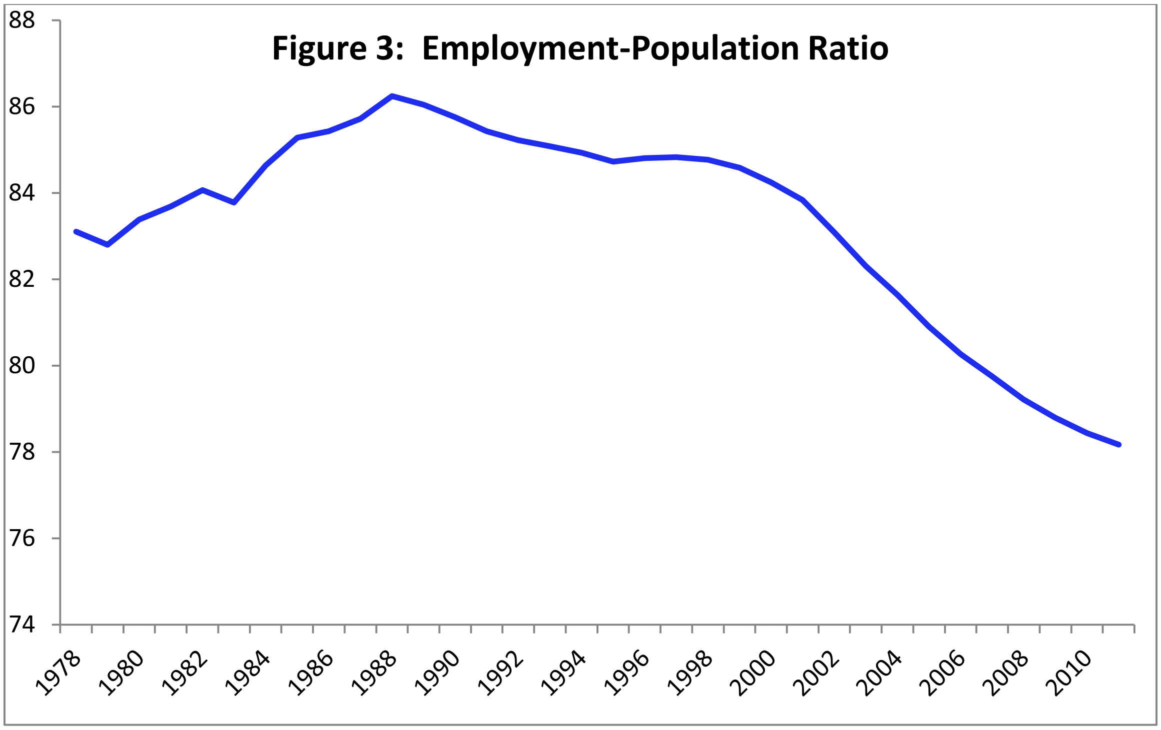
Figure 3: Employment-Population Ratio
88
86
84
82
80
78
76
74
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

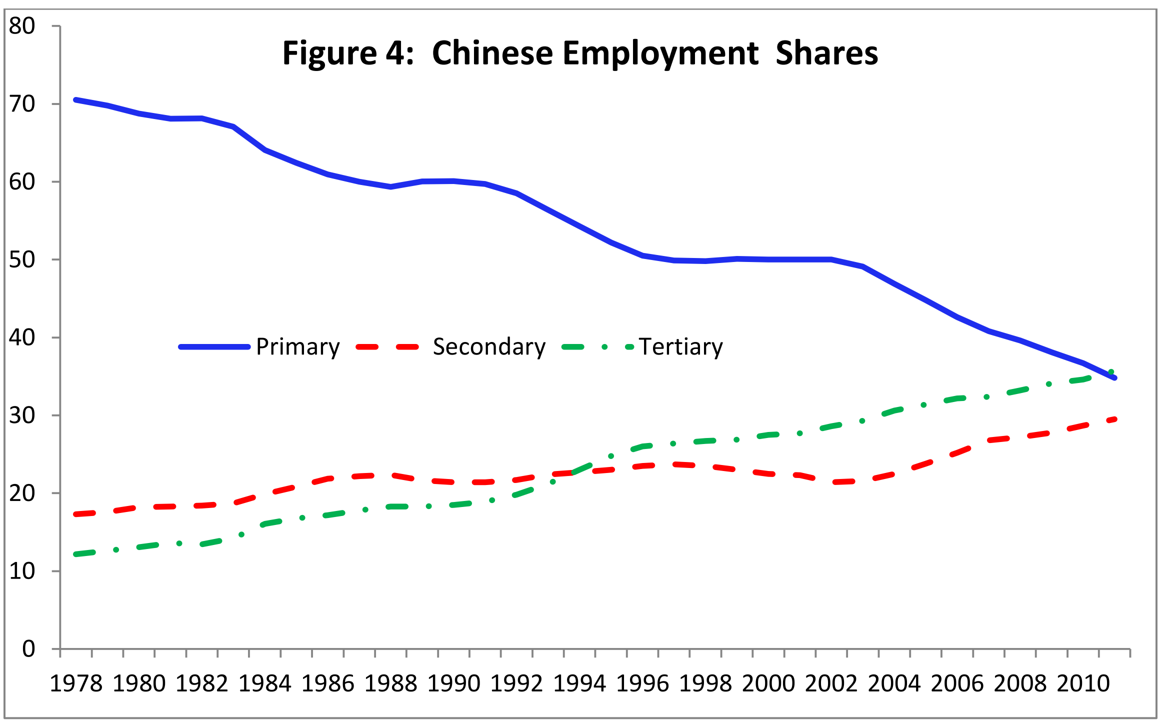
Figure 4: Chinese Employment Shares
80
70
60
50
40
30
20
10
0
Primary
Secondary
Tertiary
1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010

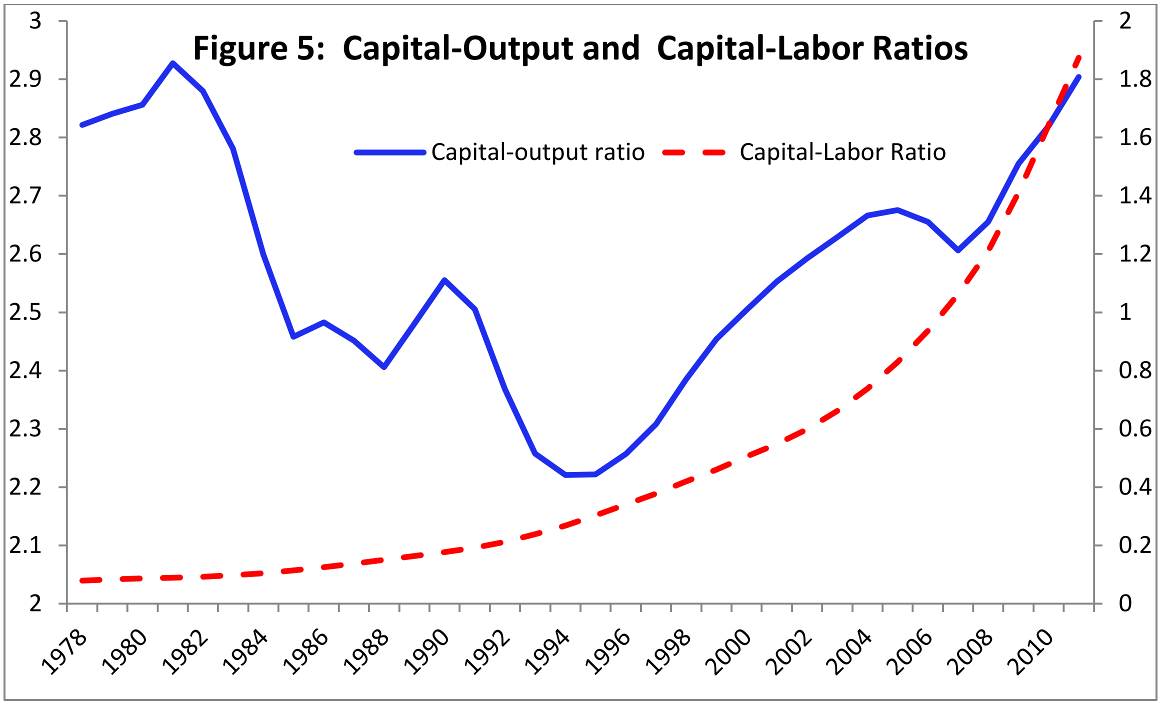
Figure 5: Capital-Output and Capital-Labor Ratios
Capital-output ratio
Capital-Labor Ratio
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010

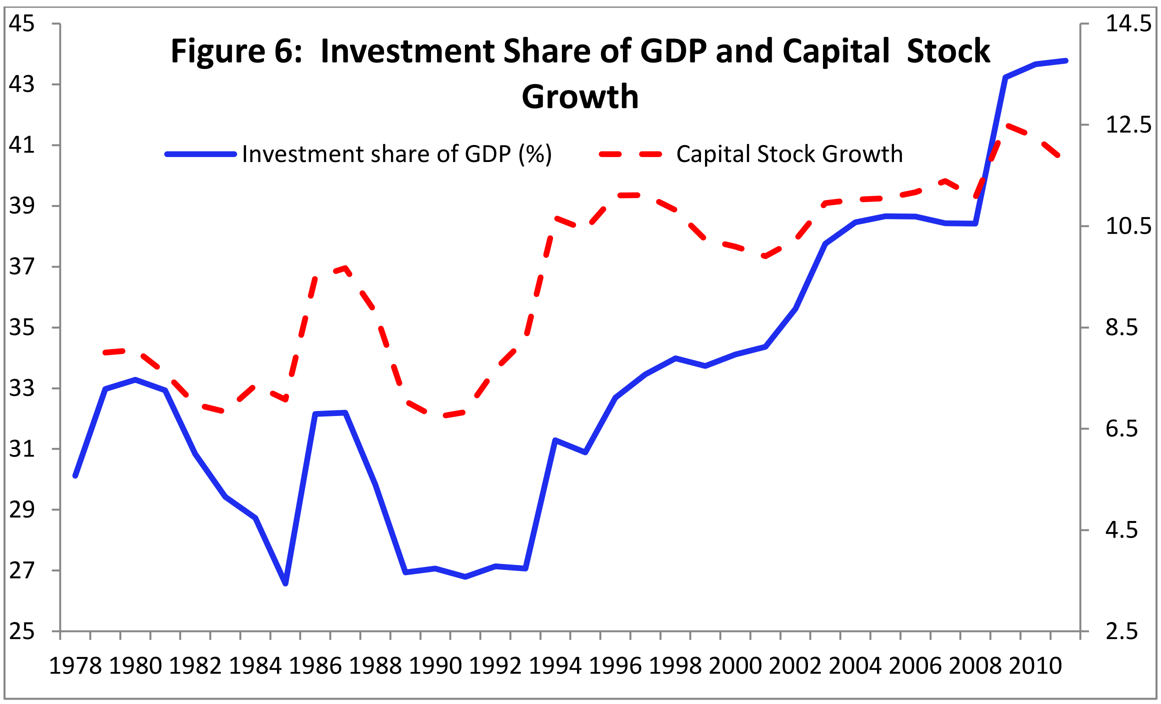
Figure 6: Investment Share of GDP and Capital Stock Growth
Investment share of GDP (%)
Capital Stock Growth
45
43
41
39
37
35
33
31
29
27
25
14.5
12.5
10.5
8.5
6.5
4.5
2.5
1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010

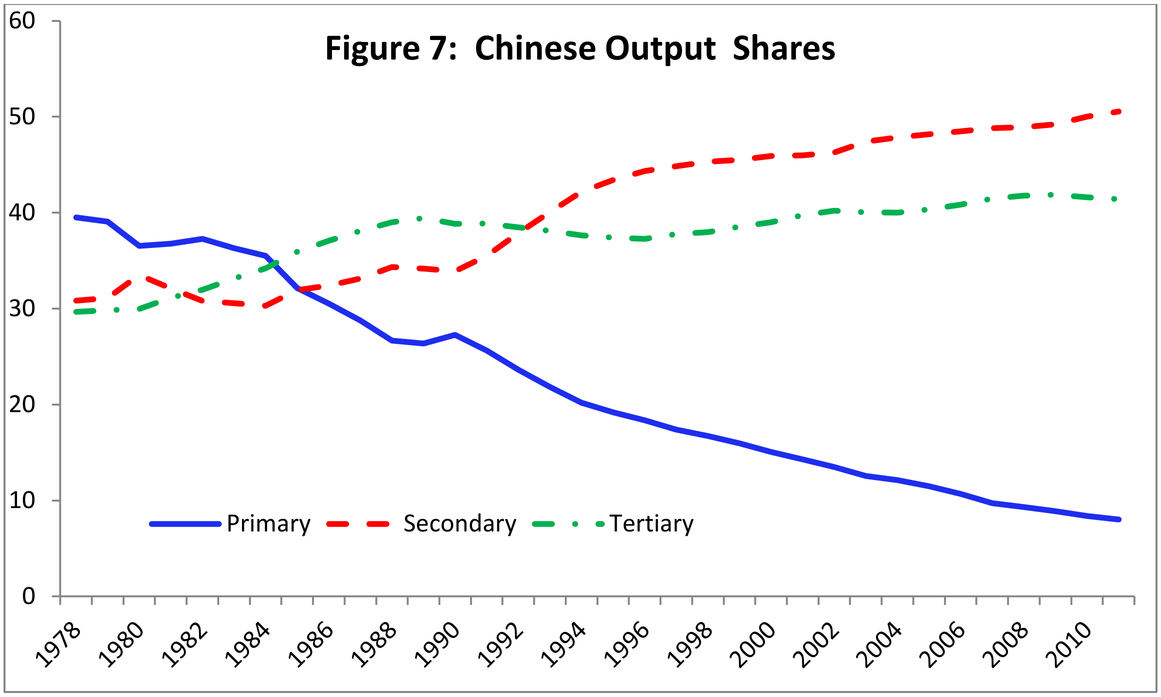
Figure 7: Chinese Output Shares
60
50
40
30
20
10
0
Primary
Secondary
Tertiary
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

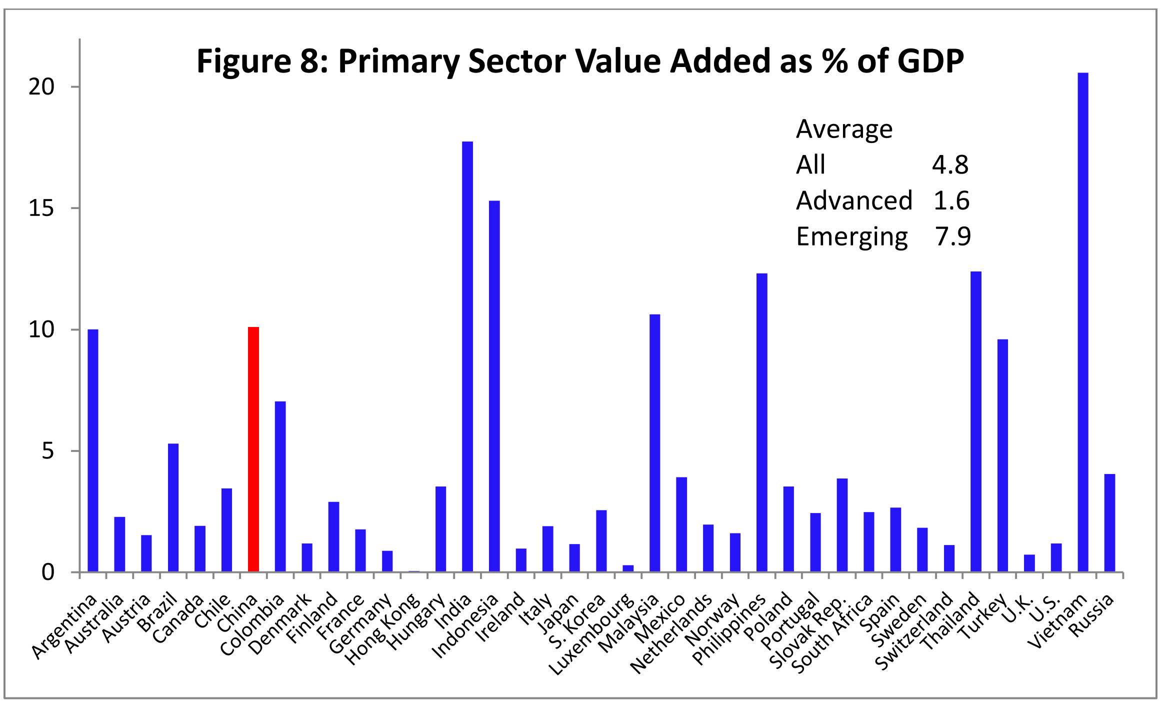
Figure 8: Primary Sector Value Added as % of GDP
20
15
10
5
0
Average
All 4.8
Advanced 1.6
Emerging 7.9
Argentina
Australia
Austria
Brazil
Canada
Chile
China
Colombia
Denmark
Finland
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
S. Korea
Luxembourg
Malaysia
Mexico
Netherlands
Norway
Philippines
Poland
Portugal
Slovak Rep.
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
U.K.
U.S.
Vietnam
Russia

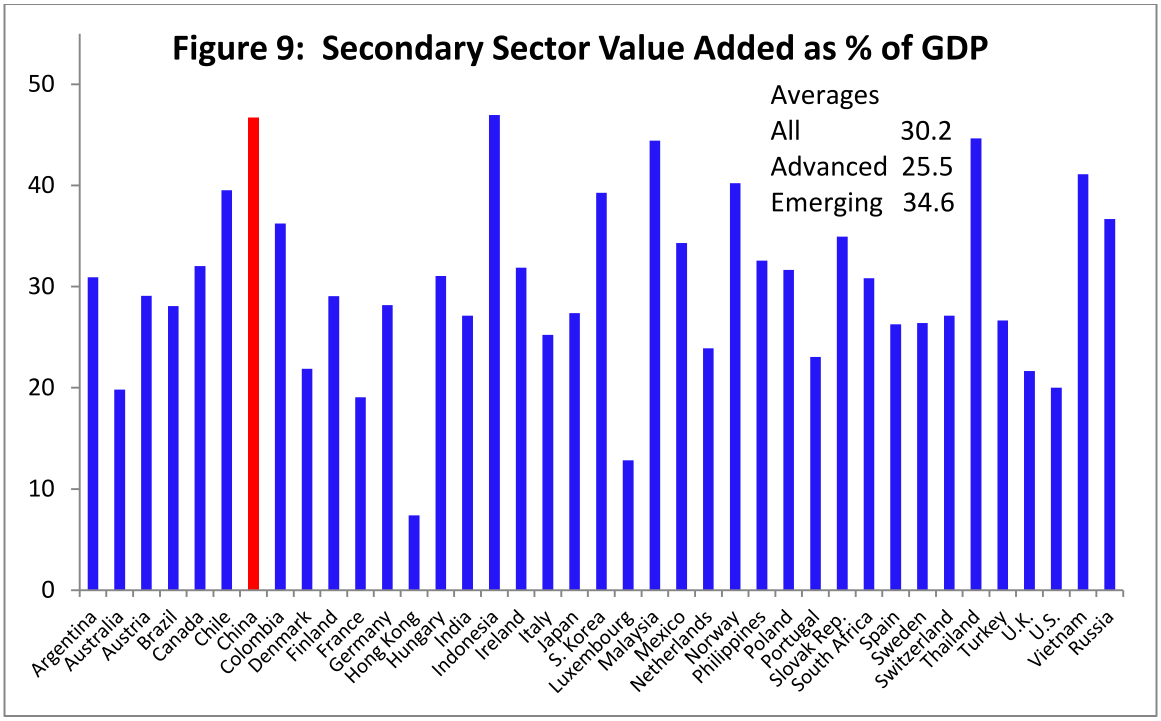
Figure 9: Secondary Sector Value Added as % of GDP
Averages
All 30.2
Advanced 25.5
Emerging 34.6
0
10
20
30
40
50
Argentina
Australia
Austria
Brazil
Canada
Chile
China
Colombia
Denmark
Finland
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
S. Korea
Luxembourg
Malaysia
Mexico
Netherlands
Norway
Philippines
Poland
Portugal
Slovak Rep.
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
U.K.
U.S.
Vietnam
Russia

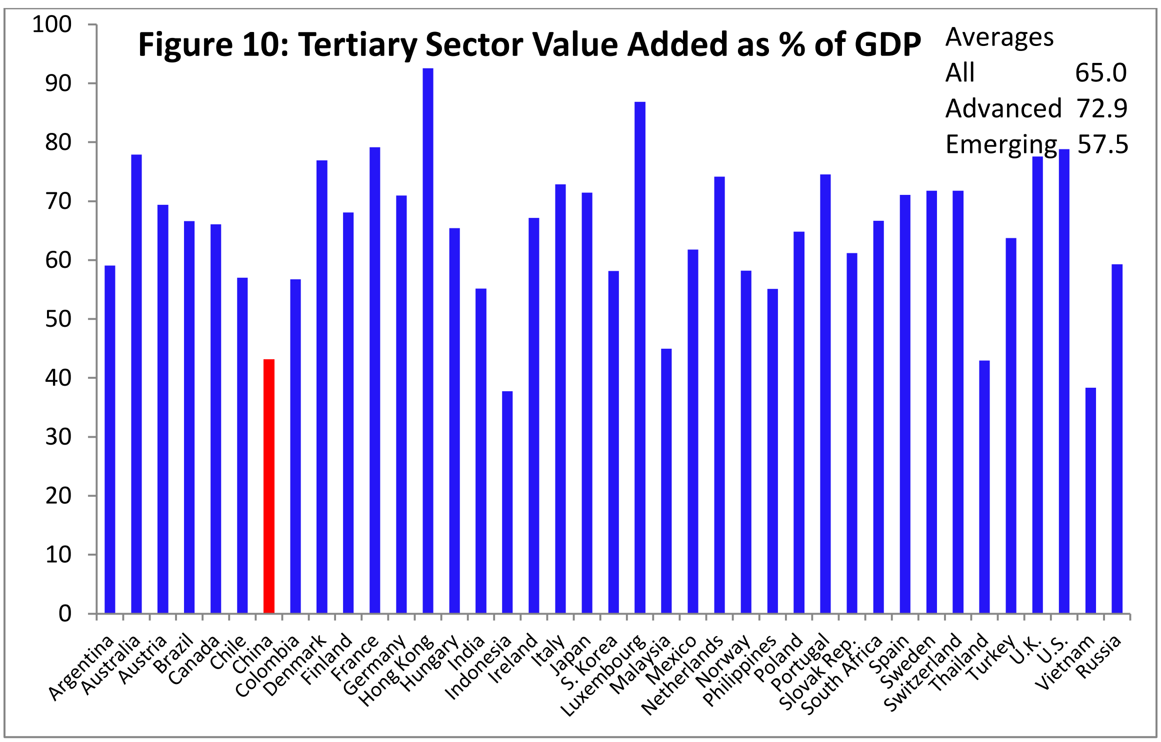
Figure 10: Tertiary Sector Value Added as % of GDP
Averages
All 65.0
Advanced 72.9
Emerging 57.5
0
10
20
30
40
50
60
70
80
90
100
Argentina
Australia
Austria
Brazil
Canada
Chile
China
Colombia
Denmark
Finland
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
S. Korea
Luxembourg
Malaysia
Mexico
Netherlands
Norway
Philippines
Poland
Portugal
Slovak Rep.
South Africa
Spain
Sweden
Switzerland
Thailand
Turkey
U.K.
U.S.
Vietnam
Russia

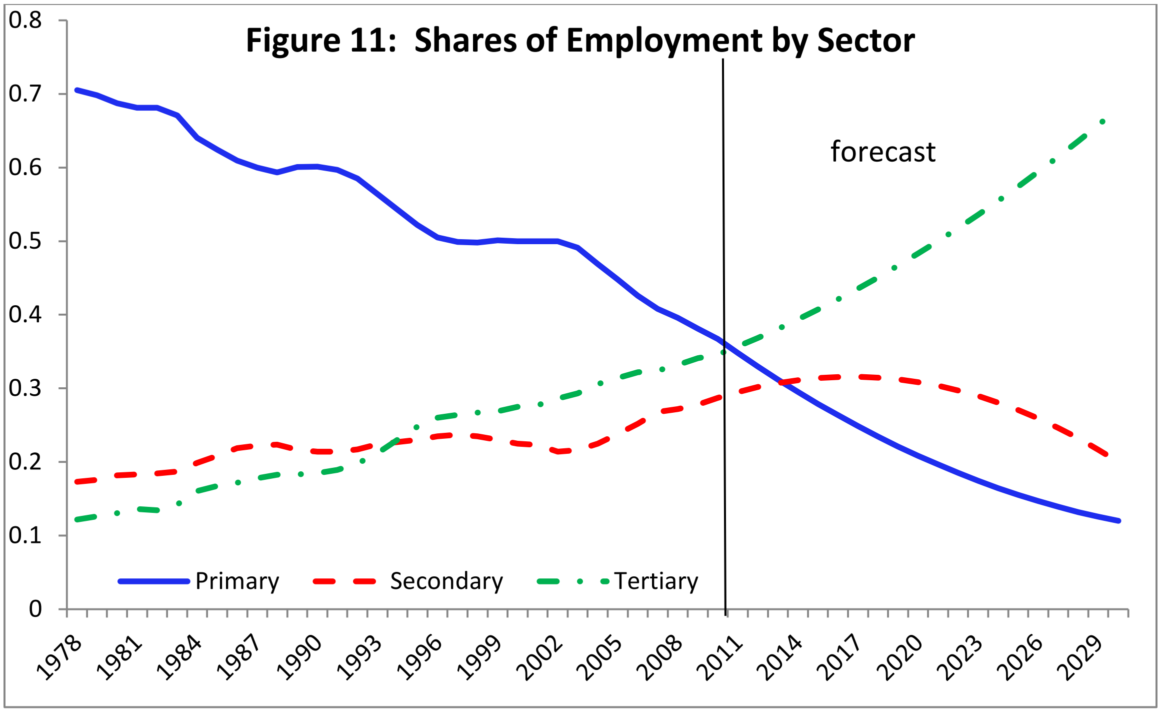
Figure 11: Shares of Employment by Sector
forecast
Primary
Secondary
Tertiary
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029

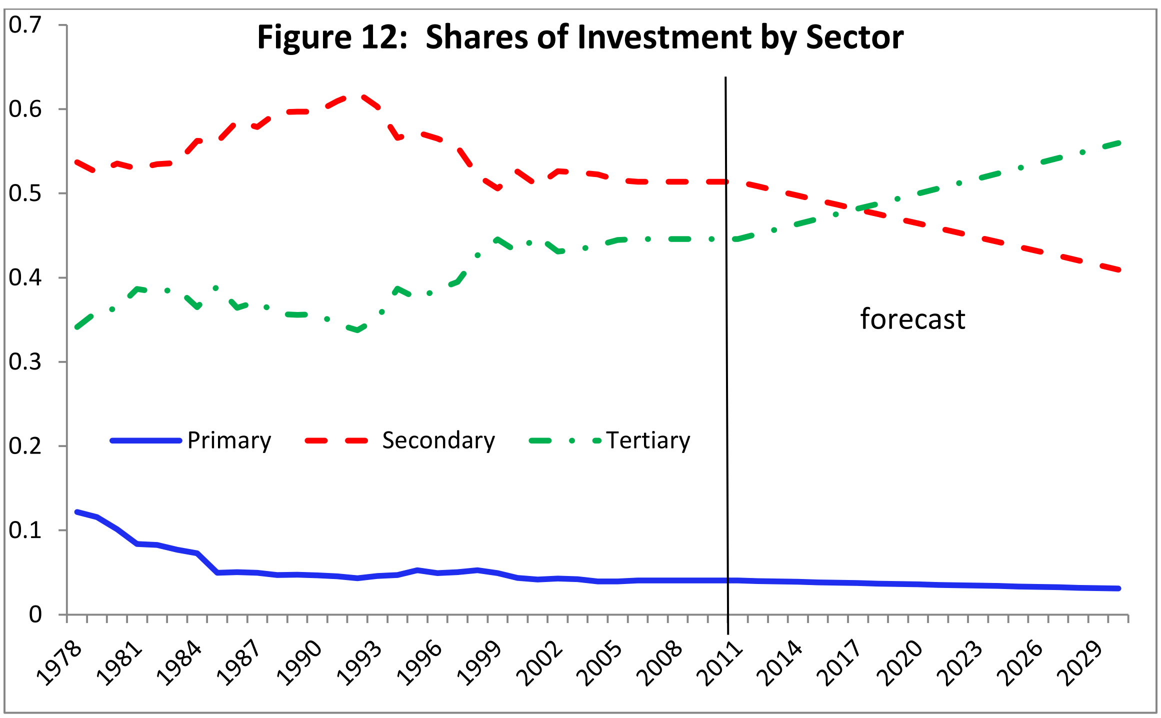
Figure 12: Shares of Investment by Sector
forecast
Primary
Secondary
Tertiary
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029

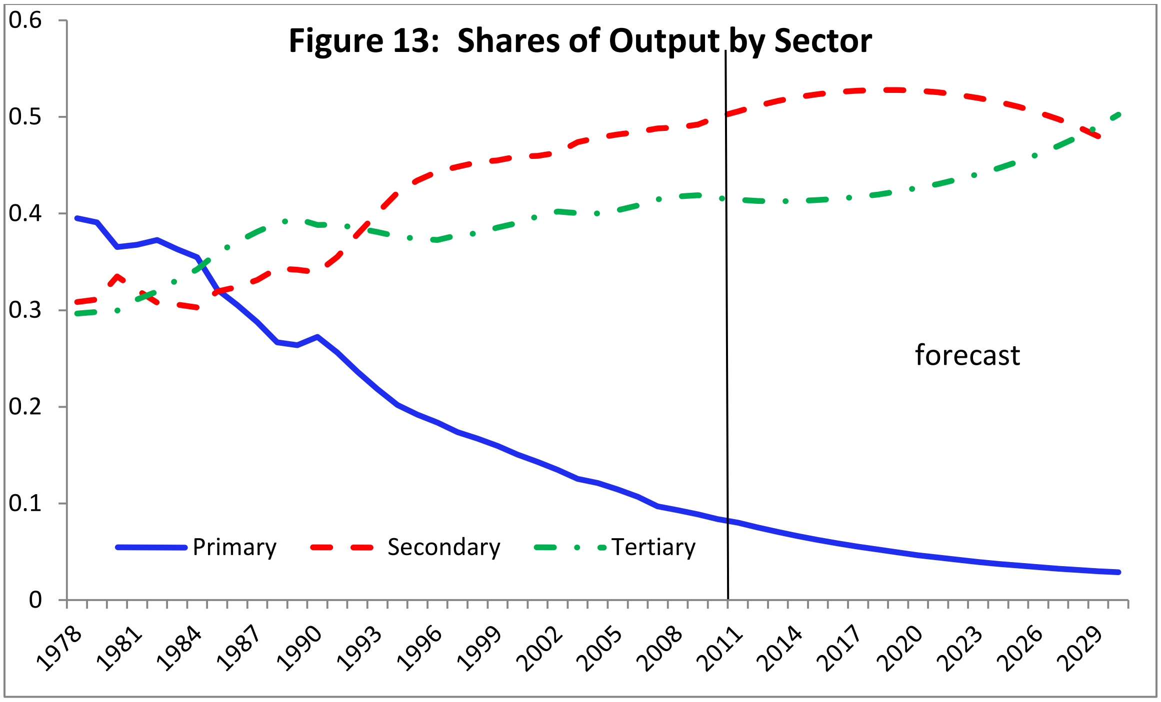
Figure 13: Shares of Output by Sector
0.6
0.5
0.4
0.3
0.2
0.1
0
forecast
Primary
Secondary
Tertiary
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029

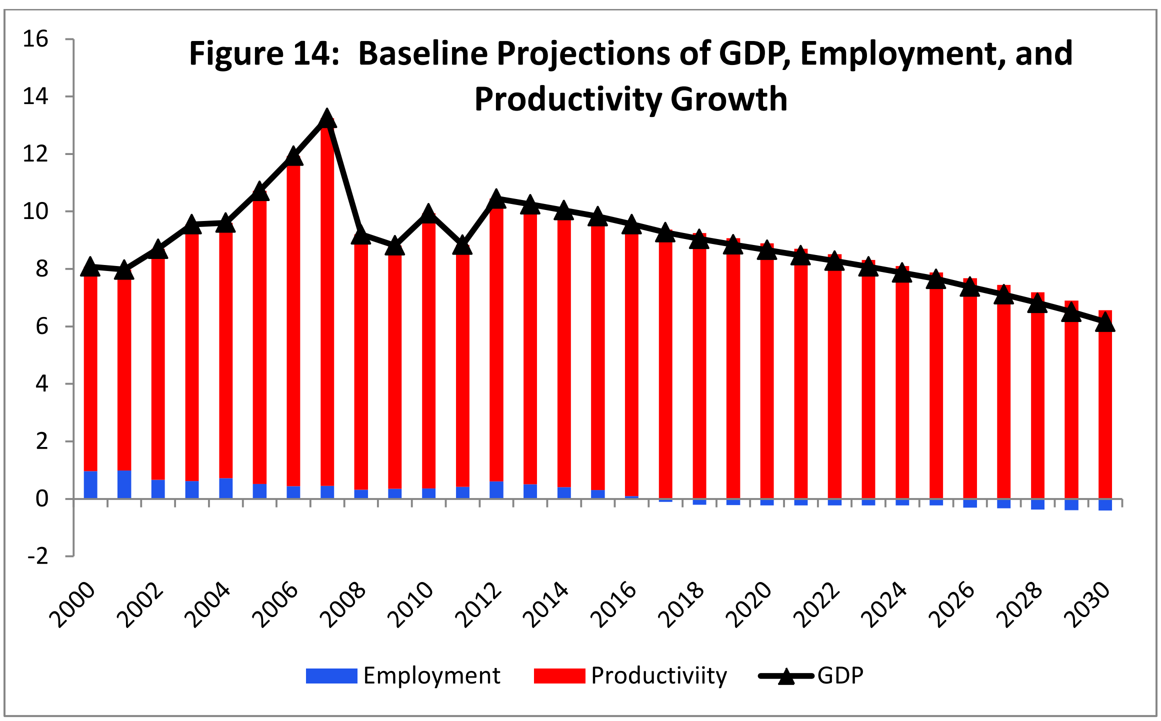
Figure 14: Baseline Projections of GDP, Employment, and Productivity Growth
16
14
12
10
8
6
4
2
0
-2
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Employment
Productiviity
GDP

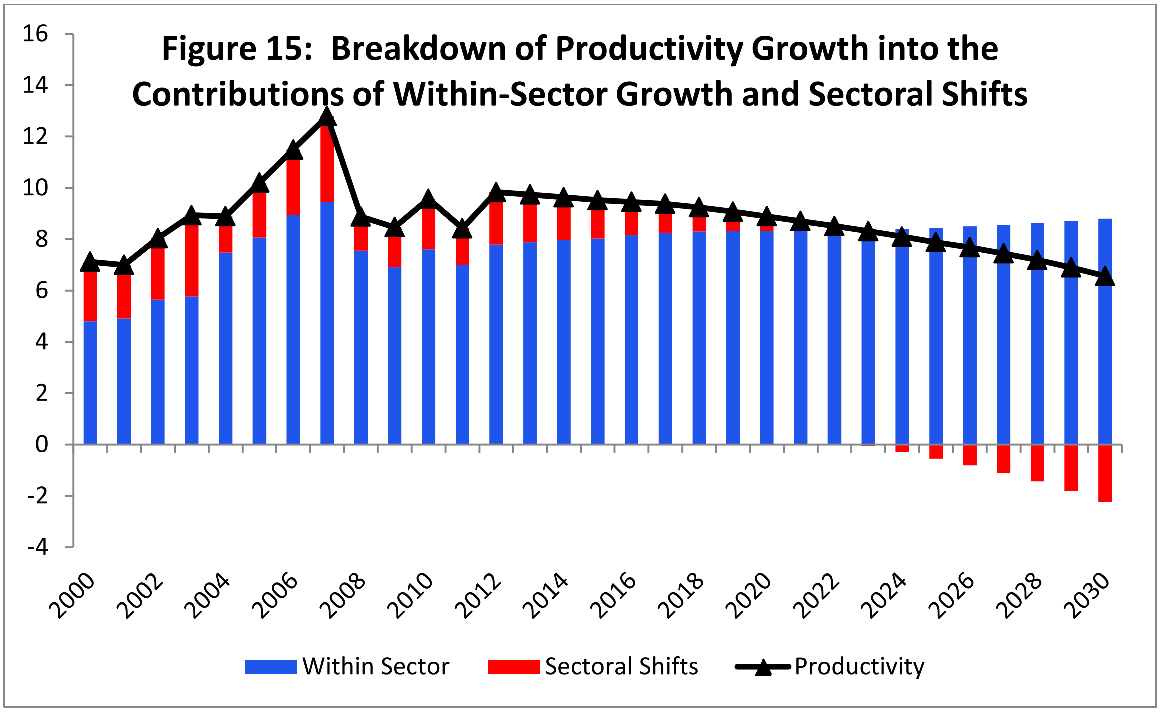
Figure 15: Breakdown of Productivity Growth into the
Contributions of Within-Sector Growth and Sectoral Shifts
16
14
12
10
8
6
4
2
0
-2
-4
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Within Sector
Sectoral Shifts
Productivity

Table 1: Comparison of Capital Stock Measures Billion 2000 RMB				
	Wu	Chow & Li	Perkins & Rawski	Holz*
1998	30.3	32.2	15.2	20.5
2002	44.8		22.5	29.9
2005	63.2		33.3	

Table 2: Components of Chinese Growth Average Annual percent change except as noted			
	1978-1989	1989-2000	2000-2011
GDP	9.1	9.4	9.9
Contribution to GDP Growth:			
Productivity	6.2	8.3	9.3
Within-sector	4.4	6.1	7.2
Sectoral Shifts	1.7	2.1	2.1
Employment	2.9	1.1	0.5
Working-Age Pop.	2.6	1.3	1.2
Emp./Population (%) (average change)	.3	-.2	-.6
Sectoral Productivity Growth			
Primary*	3.9	4.8	6.9
Secondary**	5.1	10.6	7.7
Tertiary***	5.0	4.5	7.5
Employment Share (average change, percentage points)			
Primary	-1.0	-.9	-1.4
Secondary	.4	.1	.6
Tertiary	.6	.8	.7
Productivity Levels (2000 yuan, average over period)			
Primary	208	344	610
Secondary	657	1796	4719
Tertiary	908	1519	3164
Rate of Increase in the Capital-Labor Ratio			
Total	4.6	8.7	11.3
Primary	2.1	6.5	11.8
Secondary	2.5	8.1	8.1
Tertiary	3.0	6.0	9.8

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

Table 3: Productivity Equation Estimates Sample Period 1979 – 2010			
	Coefficients (standard errors in parenthesis)		Equation standard error
	K/L ratio	Constant	
Primary	.47 (.111)	.021 (.009)	.027
Secondary	.48 (.194)	.049 (.014)	.039
Tertiary	.37 (.12)	.034 (.009)	.027

Table 4: Results						
	Base	**Lower Emp. Growth**	**Lower Investment**	**Lower Investment Coefficient**	**Lower Secondary Share**	**Combined**
GDP Growth						
2010	9.9	9.9	9.9	9.9	9.9	9.9
2020	8.7	8.1	8.2	5.7	8.3	4.7
2030	6.2	5.5	5.4	2.9	4.0	.9
Employment Growth						
2010	.4	.4	.4	.4	.4	.4
2020	-.2	-.9	-.2	-.2	-.2	-.9
2030	-.4	-1.1	-.4	-.4	-.4	-1.1
Productivity Growth						
2010	9.6	9.6	9.6	9.6	9.6	9.6
2020	8.9	9.0	8.4	5.9	8.6	5.6
2030	6.6	6.7	5.8	3.3	4.4	2.0
Within-Sector Contribution to Productivity Growth						
2010	7.7	7.7	7.7	7.7	7.7	7.7
2020	8.3	8.5	7.8	5.1	8.4	5.1
2030	8.8	8.9	8.0	4.2	9.8	3.8
Effect on Productivity Growth of Sectoral Shifts						
2010	1.9	1.9	1.9	1.9	1.9	1.9
2020	.6	.6	.6	.7	.2	.5
2030	-2.2	-2.3	-2.2	-1.0	-5.4	-1.7
Rate of Growth of the Capital-Labor Ratio						
2010	11.9	11.9	11.9	11.9	11.9	11.9
2020	10.3	10.6	9.1	8.6	9.1	8.0
2030	8.5	8.8	6.8	6.0	7.9	4.7

Table 5: Components of Japanese Growth (Avg. annual % 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