Whither Chinese Growth? A Sectoral Growth Accounting Approach

Robert Dekle and Guillaume Vandenbroucke

Department of Economics

University of Southern California

June 2006

We thank Xiawen Zhang for exceptional research assistance.

I. Introduction.

How long can Chinese rapid economic growth continue? This is a central—if not the most central—question in China, Asia, and in the world economy. China has been growing consistently at 8 to 10 percent of GDP per year over the last decades. Straight extrapolation and journalistic accounts suggest that at current growth rates, China will surpass Japan to become the world's second largest economy by 2020; and will surpass the United States to become the world's largest economy by 2050.

The business and popular press is especially optimistic about future Chinese growth rates. Fishman (2005) points out that since at least 300 million more peasants from the farms will join the manufacturing labor force in the next decade or so, the accumulation of labor in the manufacturing sector can continue for at least a few more decades. Fishman also suggests that since current household saving top well over 30 percent of GDP, when combined with the inflow of foreign capital, the current level of physical investment can also be sustained. Moreover, foreign direct investment into China remains insatiable, and the 100 billion dollars or so of foreign capital pouring into China every year should continue. Education levels and research and development capacity in China is also increasing at a brisk rate. Thus, according to Fishman and much of the business and popular press, China's current high growth rate can be sustained for at least several more decades.

In this paper, we provide an accounting for Chinese economic growth from 1978 to 2003. We decompose Chinese growth in GDP and in GDP per labor from 1978 to 2003 into the contributions arising from the agricultural, public, and private sectors; and the contribution arising from the reallocations of labor among these three sectors. Since

sectoral labor productivities differ, the reallocation of labor from a low productivity sector to a higher productivity sector will result in an increase in overall labor productivity. For example, output per labor in agriculture is much lower than that in nonagriculture. The reallocation of labor from agriculture to nonagriculture should result in an increase in overall labor productivity.

Our growth accounting exercise shows that the greatest contributor to overall labor productivity growth is the growth in Total Factor Productivity, particularly that in the private sector. The next greatest contributor is the reallocation of labor from the low labor productivity agricultural sector to the higher labor productivity nonagricultural sector.

Using our growth accounting framework, we project the growth rate of the Chinese economy from now until 2040. Using our framework, we project aggregate labor productivity to grow from now until 2020 at an average rate of 5.5 percent per year; and from 2020 to 2040 (again) on average at 5.5 percent per year. This 5.5 percent growth in overall labor productivity is only slightly lower than the 5.7 percent growth in labor productivity achieved between 1978 and 2003. Since the Chinese aggregate labor force is projected to grow on average at 0.3 percent per year between now and 2040; aggregate GDP for China is expected to grow at about 5.8 percent per year between now and 2040.

This paper is organized as follows. In the next Section, we describe the Chinese data, and how we adjust the data. To perform our sectoral growth accounting exercise, we must measure the growth in sectoral labor, human capital, physical capital, and the levels of sectoral land, capital, and labor shares. In Section 3, we perform our sectoral growth

accounting exercise. In Section 4, we use our sectoral growth accounting framework to project future Chinese economic growth. Section 5 concludes.

II. Data.

All data cited in this Section, unless otherwise noted, are from the annual issues of the Chinese Statistical Yearbook (CSY), issued by the State Statistical Bureau (SSB). Views among Chinese economy specialists differ as to the reliability of Chinese official economic statistics. Young (2003) and Rawski (2004) argue that GDP (output) growth is systematically overstated by the official statistics, while investment is understated. Chow (1993), on the other hand, argues that Chinese official statistics are on the whole reliable. It is beyond the scope of this paper to judge these arguments regarding the accuracy of Chinese official statistics. In general, we accept the Chinese official statistics, making adjustments only in cases when the deficiencies of the commonly used measures (such as in GDP and in investment) are well known.

For our purposes, the main challenge is to classify the Chinese data into our three sectors of interest: the agricultural sector, the nonagricultural public sector, and the nonagricultural private sector. The agricultural sector is defined as the primary industry, which includes forestry, livestock, and fishing. The nonagricultural sector is defined as the sum of the secondary and tertiary industries. In the nonagricultural public sector, we include State-owned enterprises, Collective and Cooperative units, and Township and Village enterprises (TVEs). The nonagricultural private sector includes all other types of firms, including Private enterprises, Self-employed workers, and firms with foreign investment.

Unlike in capitalist economies, in China, there are conceptual difficulties in classifying firms into the public and private sectors. In particular, Township and Village enterprises---the largest employer in China since the early 1990s (about 135 million workers)--are owned and operated by local governments. Much has been made about how these TVEs owned by local governments actually operate like private corporations. Although China's local governments may try to operate a miniature state-run economy, ultimately each local producer is subjected to competition from thousands of other villages. In this competitive environment, each local government faces a relatively hard budget constraint; and has to make its own enterprise economically successful (Naughton, 2005). On the other hand, local governments do serve as guarantors of TVE borrowing. If that is the case, then capital allocation decisions by TVEs are not determined entirely by the market. In fact, continued government interference, and corruption are described as disadvantages of local government ownership. These disadvantages of local government ownership seem to have worsened since the mid-1990s, as employment and profitability in the TVEs have declined (Naughton, 2005). While acknowledging that the TVEs may be subject to some market forces, we classify TVEs as belonging to the public sector, since ultimately, the (local) government decides how much labor and capital that these firms employ.

In fact, even in firms with corporate forms that we classify as belonging to the private sector--such as limited liability and shareholding corporations--the government owns significant equity stakes. When a State-owned enterprise is privatized, the privatized enterprise often takes the form of a limited liability or shareholding corporation. The corporate boards of these firms are dominated by government officials.

Thus, the government may exercise significant legal control over the investment and employment decisions of even these privatized enterprises (OECD, 2005).[1]

II.1 Employment by Sector

Total employment in State-owned enterprises, Collective and Cooperative units, TVEs, Private and other firms, and the Self-employed are given in the CSY. The CSY also gives the number of employees in each of these sectors that work in agriculture, so we can net out agricultural employment from total employment; and calculate the number of nonagricultural workers in public and private enterprises.[2]

Figure 1 depicts the shares of employment since 1978. Particularly noteworthy is the decline in the relative share of agricultural employment from 70 percent of all workers in 1978 to less than 50 percent of all workers in 2003.[3] The share of workers in

[1] Although China bans the direct involvement or participation of government officials in any commercial activities, in reality many government officials and their relatives invest in private enterprises. Also, because of the lack of strong legal protection of private property, private enterprises often have to seek this protection from local government officials. With this protection, private enterprise can more easily obtain loans from banks. Naturally, this means that there is some meddling in the affairs of private enterprises by government officials (Asian Development Bank, 2003).

[2] Brandt, Hsieh, and Zhu (BHZ, 2005) suggest that the number of agricultural workers reported in the CSY is upward biased, because the CSY assumes that all rural workers are employed in agriculture, when in fact, some rural workers are self-employed or employed in rural industry. BHZ subtract from the total number of agricultural workers, the number of rural workers involved in self-employment and in private enterprises. BHZ's procedure, however, may understate the number of agricultural workers, to the extent that many rural workers have dual jobs, in both agriculture and nonagriculture. Because of the inherent difficulty in classifying rural workers, here we take "as is" the CSY classification of agricultural and nonagricultural workers.

[3] In late 2005, the output of the service sector was revised upwards, reflecting the growth in law and consulting firms, retail stores, health clubs, and the like. Most of this output is believed to be generated by private firms, especially individual proprietors. Our estimates of employment do not capture this latest revision in the growth of the nonagricultural sector (Manchester Guardian, 2005).

private industry has increased from a negligible level in the mid-1980s to approach about 25 percent of all workers in 2003. The share of workers in public industry, while increasing until the mid-1990s, declined sharply since the late 1990s, as State enterprises and TVEs were privatized.

II.2 Prices and GDP by Sector

We follow Young's (2003) methodology by deflating the nominal GDPs reported in the CSY not by their GDP deflators, but by other survey based price indices, reported in the CSY. We deflate primary sector nominal GDP by the general price index of farm products. We deflate secondary sector nominal GDP by the ex-factory industrial price index. We deflate tertiary sector nominal GDP by the service price index.

Figure 2 depicts the ratio of the general price index of farm products ("agricultural prices") to the industrial price index ("industry prices"). For "industry prices," we take the weighted average of the ex-factory industrial price index and the service price index, where the weights are the nonagricultural GDP shares of the secondary and tertiary sectors. The ratio of agricultural prices to industry prices increased until the late 1980s, and then declined by about 60 percent from then on to return to the 1978 level.

China's agricultural prices have been gradually liberalized from government control since the early 1980s. In the early 1980s, to increase incentives to farmers, China's leaders sharply increased the procurement prices of agricultural goods (McMillan, Whalley, and Zhu, 1989; Huang, Otsuka, and Rozelle, 2004). Since then, the government has periodically intervened through procurement plans at least until the early 1990s. Thus, only from about the early 1990s are Chinese agricultural prices largely

determined by the market. We can see from Figure 2 that the ratio of agricultural to industry prices has generally declined from 1990, when agricultural prices became more market determined.

On the other hand, Brandt, Hsieh, and Zhu (2005) argue that the decline in the relative price of agriculture since 1990 is overstated in the data as depicted in Figure 2. This is because the service price index used to construct the price index for nonagricultural or industry prices is likely to overestimate the actual price increases in the services sector, owing to rapid structural shifts in the Chinese economy from personal to business services. The authors construct an alternative price index for services, and show that by using this new service price index, the ratio of agricultural to industry prices from 1990 is essentially flat. Given the inherent data problems in measuring the change in service prices in China, we are agnostic about the whether the ratio of agricultural prices to industry prices is falling or relatively flat from the 1990s.

The CSY does not break down GDP, a value added measure, into the public and private sectors for our entire sample period.[4] However, it breaks down nonagricultural gross output into the State-owned, Collective, Cooperative, TVE, and the Private sectors; so that nonagricultural gross output can be allocated to each of these sectors. We make the assumption that the share of intermediate inputs is the same in all sectors; so that the

[4] In late 2005, Chinese growth rates from 1995 to 2004 were revised upwards because of the increased estimated output in some private sector tertiary (service) industries, such as in law and advertising (Manchester Guardian, 2005). Our data do not reflect these recent upward revisions in the shares of the service sector.

ratio of net to gross outputs are the same.[5] We then simply allocate total nonagricultural GDP to the public and private sectors; according to the allocation of gross outputs.

Figure 3 depicts the growth in total output, and its breakdown from 1978 to 2003. While growing strongly since 1978, total output growth stalled in the late 1980s. In 1989, total output fell by over 5 percent. Young (2003) correlates the late 1980s slowdown in total output growth to the student uprisings in Tiananmen Square. Total output growth has been especially strong since 1999, growing at over 9 percent, even according to our lower revised growth rates (compared to the official growth rates). Particularly noteworthy is the sharp increase in the share of the output of private industry since the mid-1990s.

Figure 4 depicts the trends in labor productivity. The data on private industry labor productivity are rather volatile, jumping in 1986, and fluctuating sharply between 1990 and 1997. This may be a result of poor sectoral output data; or that in earlier years, the share of private industry was small in China, so that the privatization of some huge State enterprises may have lead to large changes in average private industry labor productivity. We thus put more credence on the long-run trends in Chinese labor productivity, than on the year-to-year fluctuations.

Average aggregate labor productivity (output per labor) in our revised data grew at 5.7 percent per annum between 1978 to 2003. Average agricultural labor productivity grew at 4.5 percent per year, from 300 yuan per worker in 1978 to 1100 yuan per worker in 2003. Average nonagricultural (industry) labor productivity grew at 4.1 percent, from

[5] This is not a bad assumption; especially after 2000, where we have data on GDPs for both State-owned and Private firms. In 2002, the ratios of GDP to gross output were about 0.70 in both sectors.

2200 yuan per worker in 1978 to 5900 yuan per worker in 2003, with annual public and private industry labor productivity growing at 2.6 percent and 7.5 percent, respectively.

We can determine the contribution of agricultural and nonagricultural labor productivity to the growth in aggregate GDP per worker by performing a simple accounting exercise. Of the 5.7 percent per annum growth in aggregate GDP per worker productivity, the contribution of agricultural labor productivity growth was 0.8 percent, and the contribution of nonagricultural labor productivity growth was 3.4 percent.[6] The remainder--1.5 percent--was the contribution of the reallocation of labor, from the low labor productivity agricultural sector to the high labor productivity nonagricultural sector.

II.3 Capital and Land by Sector

Total gross fixed capital formation (GFCF) is obtained from the CSY. The published Chinese national accounts do not provide information on the sectoral distribution of GFCF, but the provincial accounts do. For the period 1978-95, Hsueh and Li (1999) report the sectoral distribution of GFCF in 26 provinces (all provinces other than Jianxi, Guangdong, Hainan, and Tibet), accounting for an average of 78 percent of the annual value of national GFCF. For the remaining period 1996-2003, we obtain the distributional gross fixed capital formation data from the individual Provincial Statistical Yearbooks, and aggregate across the provinces. We use the sectoral distribution reported in Hsueh and Li (1999) and in the Provincial Statistical Yearbooks to allocate overall

[6]The contribution of the primary and nonprimary sectors are measured by the growth of labor productivity in each sector, weighted by their respective shares of GDP.

national gross capital formation between the agricultural and nonagricultural sectors of the economy.

The CSY provides additional data on fixed investment by ownership (State, TVEs, Collective, private, etc.) in the nonagricultural sector. This additional data is compiled from enterprise surveys; and its magnitude is about 10 percent higher than the national income account gross fixed capital formation data, from at least the late 1990s. The coverage of fixed investment in these enterprise surveys seems quite comprehensive, and includes investment in capital construction, research and development, real estate development, and in other areas. We assume that the discrepancy between the fixed investment data and the national income accounts gross capital formation data are identical across sectors; and use the sectoral distribution in the data on fixed investment to allocate nonagricultural gross capital formation between the public and private sectors of the nonagricultural economy.

To obtain our real investment figures, we must deflate our nominal investment figures. Between 1978 and 1998, we deflate our measures of nominal sectoral investment with Young's (2003, Figure 5) alternative deflator for gross fixed capital formation. Between 1999 and 2003, we construct our own alternative deflator, following the method of Young (2003). With our measures of real sectoral investment from 1978 to 2003 in hand, we can calculate the capital stock using the perpetual inventory method and a 5 percent depreciation rate (as in Young (2003)). We obtain the starting stock of capital at the end of 1978 from Chow (1993).

Figure 5 depicts the capital-output ratios for the economy, and by sector. The capital-output ratio for the entire economy has remained constant at about 4 since 1978.

That capital deepening has not occurred for China in the post-reform period is well known (Young, 2003). The capital-output ratio of public industry has risen since the mid-1990s, reflecting the low productivity of capital in State enterprises and in the TVEs in recent years. In contrast, the capital-output ratio of private industry is falling, reflecting the higher efficiency of capital in private industry.

Finally, while we assume that labor and capital are the only two inputs in the nonagricultural sector, we allow land inputs in the agricultural sector. We measure total land inputs by the total sown area of farm crops in China (as in McMillan, Whalley, and Zhu, 1989). These data are available in the CSY. The total sown area of farm crops has remained essentially fixed, growing at an annualized rate of 0.06 percent between 1978 and 2003.

II.4 Growth in Human Capital by Sector

A proper measure of the growth of labor input should account for differences in the human capital of the workforce. For example, suppose that overall labor services are a constant returns to scale function of N types of labor:

$$L = H(L_1, L_2, \ldots L_N)$$

Differentiating, the growth of overall labor services is a weighted average of the growth of each type of differentiated labor:

$$\frac{dL}{L} = \sum_i \frac{H_i L_i}{L} \frac{dL_i}{L_i}$$

where the human capital weight H_i is revealed by the wage of worker of type i. The difference between $\frac{dL_i}{L_i}$, and the growth of overall labor undifferentiated by type can be taken as the contribution of "human capital."

While the CSY provides a reasonable measure of the overall growth of the labor force, and its sectoral distribution, it does not contain any information about the characteristics of workers, such as sector, age, and education needed in the calculation of L_i. To adjust for the changing characteristics of workers, we must use Chinese census and survey data. We obtain the number of workers by sector, age and education from the 1987 Tabulation of China's 1% Population Sample Survey and the 2000 Population Census of China. (Published Chinese census data prior to 1987 do not provide education levels broken down by age.) We classify workers into 11 age, 4 education, and 2 sector (agriculture, nonagriculture) categories to obtain a total of 88 characteristics. By taking the annualized growth rate in the number of workers of characteristic i between 1987 and 2000, we can obtain the growth rate of workers of characteristic i, $\frac{dL_i}{L_i}$.

These growth rates must weighted by H_i, or by wages. Predicted wages of workers of characteristic i are obtained in the usual way from estimated Mincer equations for Chinese workers. We calculate the growth in human capital separately for the agricultural and nonagricultural sectors. For nonagricultural workers, we use the Mincer equation estimated by Young using Chinese household level data (2003, Table 17). Reliable estimates of Mincer equations for Chinese agricultural workers do not exist. This is because Chinese farms are generally operated by families--not paid workers--who subsist by keeping a portion of agricultural proceeds, according to the household

responsibility system (Huang, Otsuka, and Rozelle, 2004). Thus, for the predicted wages of those employed in the Chinese agricultural sector, we use Mincer equations estimated for employees in Chinese rural industry, on the assumption that on the margin, the wages of employees in rural industry should capture the marginal revenue product of Chinese agricultural workers. For these employees in rural industry, we use the Mincer equation estimated by Zhang, Huang, and Rozelle (2002). The estimated returns to education for employees in Chinese rural industry are considerably lower than the returns to education for the general sample of Chinese nonagricultural workers.

We subtract from our calculated $\frac{dL_i}{L_i}$ for the agricultural and nonagricultural sectors, the growth in the overall labor forces in these sectors between 1987 and 2000, to arrive at annualized growth rates of human capital of 1.4 percent in nonagriculture, and 1.1 percent in agriculture. Given the lack of appropriate Chinese census data spanning other periods, we assume that these growth rates hold on average for the entire period 1978 to 2003. Since we do not have the characteristics of workers by type of nonagricultural industry, we assume identical growth rates of human capital for both the public and private sectors of Chinese industry.

II.5 Factor Income Shares by Sector

In China, the ratio of compensation by employees to GDP can be estimated using data from the Provincial Statistical Yearbooks or from the input-output tables. Young (2003, Table 21) finds that on average between 1978 and 1995, the labor share of output for the nonagricultural sector was 0.46 using both the provincial or the input-output data. There is clearly an upward trend in the labor share; in the provincial data, it rose from

0.42 in 1978 to 0.53 in 1995. We obtained the Provincial Statistical Yearbooks from 1996 to 2003, and calculated nonagricultural labor shares across Chinese provinces for each year. Between 1996 and 2003, the labor share averaged 0.54. Thus, for the entire period, 1978 to 2003, the nonagricultural labor share averaged 0.46. We assume identical labor shares for the public and private Chinese nonagricultural industries.

Using the provincial data assembled by Hsueh and Li (1999) between 1978 and 1995; and the Provincial Statistical Yearbooks from 1996 to 2003, we find that the average labor share in agriculture was 0.76 for the period 1978 to 2003. This is higher than the 0.53 found by Hayami and Ruttan (1985), using Chinese data in the pre-reform (1978) period; but similar to the 0.70 labor share used in McMillan, Whalley, and Zhu (1989). Hayami and Ruttan (1985) find that the capital share is twice as high as the land share. Chow (1993) estimates a production function for the Chinese agricultural sector using data from 1952 to 1988 and finds that the labor, capital, and land shares are 0.40, 0.25, and 0.35, respectively. Both Hayami and Ruttan (1985) and Chow (1993) include data from the pre-reform (1978) period. It is hard to interpret factor shares based on a period when the economy was centrally planned. Because of the lack of reliable data, here we assume identical capital and land shares in agriculture, 0.12. Changing the capital and land shares to 0.16 and 0.08 only negligibly affects our estimates of agricultural total factor productivity growth.

III. Sectoral Growth Accounting of Chinese Output per Labor, 1978-2003

The growth in total output can be broken down into the growth of labor supply; and the growth in aggregate labor productivity (output per labor). The growth in aggregate labor productivity—in turn—can be explained by the following expression:

$$\dot{y} = \dot{y}_A\left(\frac{Y_A}{Y}\right) + \left(\frac{Y_B}{Y}\right)\left[\left(\dot{y}_{pub} * \frac{Y_{pub}}{Y_B}\right) + \left(\dot{y}_{priv} * \frac{Y_{priv}}{Y_B}\right) + \left(\frac{y_{pub} - y_{priv}}{y_B}\right) * dl_{pub}\right] + \left(\frac{y_A - y_B}{y}\right) * dl_A$$

(EQ. 1)

The expression says that the growth in aggregate output per labor can be decomposed into the contribution of agricultural labor productivity (y_A), of public (nonagricultural) sector labor productivity (y_{pub}), of private (nonagricultural) sector labor productivity (y_{priv}), the reallocation of labor from low productivity agriculture to high productivity nonagriculture $\left(\frac{y_A - y_B}{y}\right) * dl_A$; and of the reallocation of labor from the public to the private sector $\left(\frac{y_{pub} - y_{priv}}{y_B}\right) * dl_{pub}$. The contributions of each sector are measured by the growth of labor productivity in each sector, weighted by their respective shares of output, for example, $\frac{Y_A}{Y}, \frac{Y_{pub}}{Y}$.

Table 1 shows that between 1978 and 2003, of the 8.4 percent growth in aggregate output, the growth in labor productivity contributed 5.7 percent. Of this 5.7 percent, the growth in agricultural labor productivity contributed 0.8 percent; the growth in public sector labor productivity contributed 1.6 percent; and the growth in private sector labor productivity contributed 1.7 percent. The role of the reallocation of labor from agriculture to the two nonagricultural sector contributed 1.5 percent. The role of the reallocation of labor from the public to the private sector was negligible.

The growth in output per labor in each sector i can be further decomposed into the change in the capital-labor ratio $(\dot{k}_i)$, the change in human capital $(\dot{h}_i)$, the change in the land-labor ratio (for agriculture) $(\dot{t}_i)$, and the growth in total factor productivity (TFP):

$$\dot{y}_i = \alpha_i \dot{k}_i + \beta_i \dot{h}_i + (1 - \alpha_i - \beta_i)\dot{t} + T\dot{F}P, \qquad \text{(EQ.2)}$$

where α_i and β_i are the capital and the labor factor income shares in production (from II.5).

Table 1 also shows the results of this last decomposition exercise. Of the 0.8 percent contribution in agricultural productivity, the growth in agricultural Total Factor Productivity (TFP) contributed the majority, 0.6 percent. This period was marked by enormous increases in agricultural productivity, owing to the introduction of the household responsibility system and administered increases in agricultural prices, which sharply raised incentives for farming. Capital deepening contributed only negligibly (0.05), while increased human capital (education) levels contributed modestly.

Of the 1.6 percent contribution in public sector labor productivity, the growth in TFP was negligible. The finding of negative or very small TFP growth in Chinese State industries is consistent with Jefferson, Rawski, and Zheng (1989) and the OECD (2005). Public sector labor productivity growth was driven mostly by increases in the capital-labor ratio, or by capital deepening. This accords with the experience of many State-owned enterprises in socialist countries, which achieved high rates of output per labor growth, primarily through one-shot increases in machinery and equipment.

Of the 1.7 percent contribution in private sector labor productivity, the growth in TFP comprised almost the entirety, 1.47 percent. The contributions of capital deepening and education were negligible. It is remarkable that private sector TFP growth has contributed more than quarter of the total increase in Chinese aggregate output per labor.

The reallocation of labor from agriculture to nonagriculture contributed 1.5 percent. Growth in labor productivity arises from this source because agricultural labor productivity is much lower than nonagricultural productivity; so that the transfer of labor from agriculture to nonagriculture results in an increase in output per labor. Agricultural labor productivity, while growing three-fold since 1978, even now (in 2003) is only about 1/6 of average nonagricultural productivity. This suggests that the scope of raising the aggregate productivity of labor by transferring low productivity agricultural workers to the higher productivity nonagricultural sector remains large.

We can add the sources of growth in output per labor across the three sectors in Table 1, to obtain the total contributions of capital deepening, education, and TFP increases to the growth in aggregate labor productivity. Capital deepening, education, and TFP increases contributed 1.42 percent, 0.67 percent, and 2.01 percent, respectively, to overall labor productivity growth. TFP growth of 2.01 is quite high, and compares quite favorably to the 1.7 percent and 2.1 percent increases in TFP experienced by South Korea and Taiwan during their high growth phases (Young, 1995). Li (2003) finds TFP growth of 3.2 percent per annum in China between 1978 and 1998. This higher estimate suggests that the use of unadjusted Chinese national accounts data—by overestimating GDP growth and underestimating investment—may result in very high TFP estimates.

IV. Projections of Future Chinese Growth

We can use equations (1) and (2) to project the future growth rates of Chinese aggregate output per labor, and aggregate output (GDP) until 2040. The exogenous variables are total labor supply growth, human capital growth, changes in the sectoral capital-labor ratios, the (changes) in the sectoral employment shares, and sectoral TFP growth rates.

Macrochina, a Chinese government research institute affiliated with the State Development Committee, projects that the Chinese total labor force will grow at an average annual rate of about 0.3 percent until 2050. The Macrochina projection is more optimistic than the United Nations population projection for China, which predicts a declining working age population (falling at an annual rate of 0.4 percent until 2050). The United Nations projection assumes that China will continue with the current, general "one-child" policy, while the Macrochina projection assumes a partial discontinuation of the "one-child" policy. (There is a government proposal pending to allow all Chinese couples each of whom is a single child to have two children.) We adopt the more optimistic Macrochina (2006) projection.

In terms of purchasing power parity, China's current per capita income, at $3750, is about equal to Japan's per capita income in 1960, its closest industrialized country neighbor. In our projections, we will illustrate what would happen to China's economy if its education levels and productivity growth rates converged to Japan's current (year 2000) values in about 40 to 50 years. While the share of Chinese employees with a secondary education is high, the share of employees with a college education is much lower in China than in Japan. In 2000, the average years of education for the working age

population in Japan was 12.4, while in China, it was 10.4. Since typically, the returns to education is about 0.07 for education beyond the secondary level, for Chinese education levels to catch up to Japanese levels in about 40 years, human capital will have to grow at about 0.5 percent per year.

During 1996-2003, capital-labor ratios in agriculture, the public sector, and in the private sector grew at 2, 2, and 4 percent per annum, respectively. We assume that these growth rates of the capital-labor ratios will continue past 2040. In 2003, the employment shares of agriculture, and the public and private sectors were 0.49, 0.29, and 0.22 respectively. We assume that the share of agricultural employment will continue to shrink, to 0.36 in 2020 and 0.20 in 2040. We assume that the share of private sector employment will continue to expand, to 0.43 in 2020 and 0.70 in 2040. Consistent with the Chinese government's privatization plans, we assume that the share of public sector employment will decline to 0.21 in 2020 and 0.10 in 2040.

Over the long-run (in 40 to 50 years), we assume that Chinese total factor productivity growth rates in the agricultural and in private nonagricultural industries will gradually converge to industrialized country TFP growth rates, as typified by Japan. In China, between 1978 and 2003, TFP growth rates in agriculture; and in the public and private sectors were 3.5, 0, and 7.3. Jorgenson and Nomura (2005) estimate that annual Japanese TFP growth rates over the long-run (1960-2000) averaged 0.70 percent in agriculture; and 1.2 percent in nonagriculture. We assume that Chinese TFP growth rates in the agricultural and private sectors will gradually converge to the Japanese growth rates in these sectors (Japan does not have a sizable public sector.) For the Chinese public sector, we assume that in the long-run, TFP growth continues to be about zero. We

assume that the Chinese TFP growth rate in a given year is a weighted average of Chinese TFP growth rates in 2003 and in 2050; with weights for the 2003 value exponentially declining. Chinese TFP growth rates for the agricultural sector are projected to decline to 2.0 percent in 2020 and 1.2 percent in 2040. Chinese TFP growth rates for the private sector are projected to decline to 3.8 percent and 2.5 percent in 2020 and 2040, respectively.

Given these assumptions, we project that the average growth rate of Chinese output per labor from now until 2020 is 5.5 percent; and from 2020 to 2040 is again 5.5 percent. Adding the 0.3 percent average growth in aggregate labor supply between now and 2040, the growth in annual Chinese aggregate GDP from now until 2040 is projected to average 5.8 percent. The largest contributors to this growth are the increases in labor productivity in the private sector; and the transfer of labor from the agricultural to the nonagricultural sector. The increase in private sector labor productivity is driven mainly by total factor productivity growth in the private sector.

V. Conclusions.

In this paper, we decomposed Chinese aggregate growth from 1978 to 2003 into the contributions arising from the agricultural, public, and private sectors; and the reallocations of labor among these three sectors. Since sectoral labor productivities differ, the reallocation of labor from a low productivity sector to a higher productivity sector will result in an increase in overall labor productivity.

In addition, we decomposed the growth in labor productivity in each sector into the contributions arising from capital-deepening, increased education, and total factor

productivity (TFP) growth. This exercise showed that the greatest contributor to overall labor productivity growth is the growth in TFP, particularly in the private sector. The next greatest contributor is the reallocation of labor from the low labor productivity agricultural sector to the higher labor productivity nonagricultural sector.

Using our sectoral growth accounting framework, we project the future trends in Chinese total output, and in output per labor. We showed that TFP increases in the private sector, and the reallocation of labor from the agricultural to the nonagricultural sector, will continue to play key roles in the growth in Chinese output.

The use of our growth accounting framework to forecast the future growth of Chinese output requires some strong assumptions, particularly regarding future sectoral capital intensities, and the future reallocations of labor among the three sectors. In Dekle and Vandenbroucke (2006), we develop an explicit general equilibrium growth model, in which sectoral capital intensities and the reallocations of labor among the sectors are endogenous; and evolve in a way consistent with the rest of the economy. The forecasting exercise from the explicit model in Dekle and Vandenbroucke (2006) result in somewhat higher growth estimates for China.

References.

Asian Development Bank (2003), "People's Republic of China: The Development of Private Enterprise," mimeographed.

Brandt, L., Hsieh, C., and X. Zhu (2005), "China's Structural Transformation," mimeographed, University of California, Berkeley.

Chow, G. (1993), "Capital Formation and Economic Growth in China," *Quarterly Journal of Economics*, pp. 809-842.

Dekle, R. and G. Vandenbroucke (2006), "A Quantitative Analysis of China's Structural Transformation," mimeographed, University of Southern California.

Fan, S. and X. Zhang (2002), "Production and Productivity Growth in Chinese Agriculture: New National and Regional Measures," *Economic Development and Cultural Change*, pp. 819-838.

Fishman, T. (2005), *China Inc*., New York, Scribners.

Hayami, Y., and V. Ruttan (1985), *Agricultural Development: An International Perspective*, Baltimore, Maryland, Johns-Hopkins University Press.

Hsueh, T. and Q. Li eds. (1999), *China's National Income, 1952-1995*, Boulder, Col.: Westview, 1999.

Huang, J., Otsuka, K., and S. Rozelle (2004), "The Role of Agriculture in China's Development," mimeographed, UC-Davis.

Jefferson, G., Rawski, T., and Y. Zheng (1989), "Growth Efficiency and Convergence in Chinese Industry: A Comparative Evaluation of the State and Collective Sectors," Department of Economics, University of Pittsburg Working Paper, 251.

Jorgenson, D. and K. Nomura (2005), "The Industry Origins of Japanese Economic Growth," manuscript, Harvard University.

Li, K. W., (2003), "China's Capital and Productivity Measurement Using Financial Resources," Economic Growth Center Discussion Paper 851, Department of Economics, Yale University.

Macrochina (2006), "Population Projections for China," Macrochina website.

McMillan, J., Whalley, J., and L. Zhu (1989), "The Impact of Chinese Economic Reforms on Agricultural Productivity Growth," *Journal of Political Economy*, pp. 781-807.

Naughton, B., (2005), "Township and Village Enterprises," mimeographed, University of California, San Diego.

Manchester Guardian (2005), "China to Overtake Britain after Beijing Understates Growth," December 14.

OECD (2005), *Economic Surveys: China*, Paris: OECD Publishing, September.

People's Republic of China, National Bureau of Statistics of China (1988), 1987 Tabulations of China 1 percent Population Census of China (Zhongguo 1987 nian 1 % renkou chouyang diaocha zilao). Beijing: China Statistical Publishing House.

People's Republic of "China, State Council and National Bureau of Statistics of China (2002),Tabulation on the 2000 Population Census of the People's Republic of China (Zhongguo 2000 nian renkou pucha zilioa). Beijing: China Statistical Publishing House.

People's Republic of China, National Bureau of Statistics of China (various annual issues from 1981), China Statistical Yearbook (Zhongguo tongli nianjian). Beijing: China Statistical Publishing House.

Provincial Statistical Yearbooks (1997-2004) (tongli nianjian) for 25 provinces.

Rawski, T., (2004), "China's Growth Prospects," mimeographed, University of Pittsburg.

Research Institute of Economy, Trade, and Industry (RIETI) (2004), "The Huge Debate over Privatization and Management Buyouts--Can the Drain on State-owned Assets Be Justified?", mimeographed, July.

Young, A., (1995), “The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience,” *Quarterly Journal of Economics*, pp. 641-680.

Young, A., (2003), "Gold into Base Metal: Productivity Growth in the People's Republic of China During Reform,*" Journal of Political Economy*, pp. 1220-1261.

Zhang, L., J. Huang, and S. Rozelle, (2002), "Employment, Emerging Labor Markets, and the Role of Education in Rural China," *China Economic Review*, pp. 313-328.

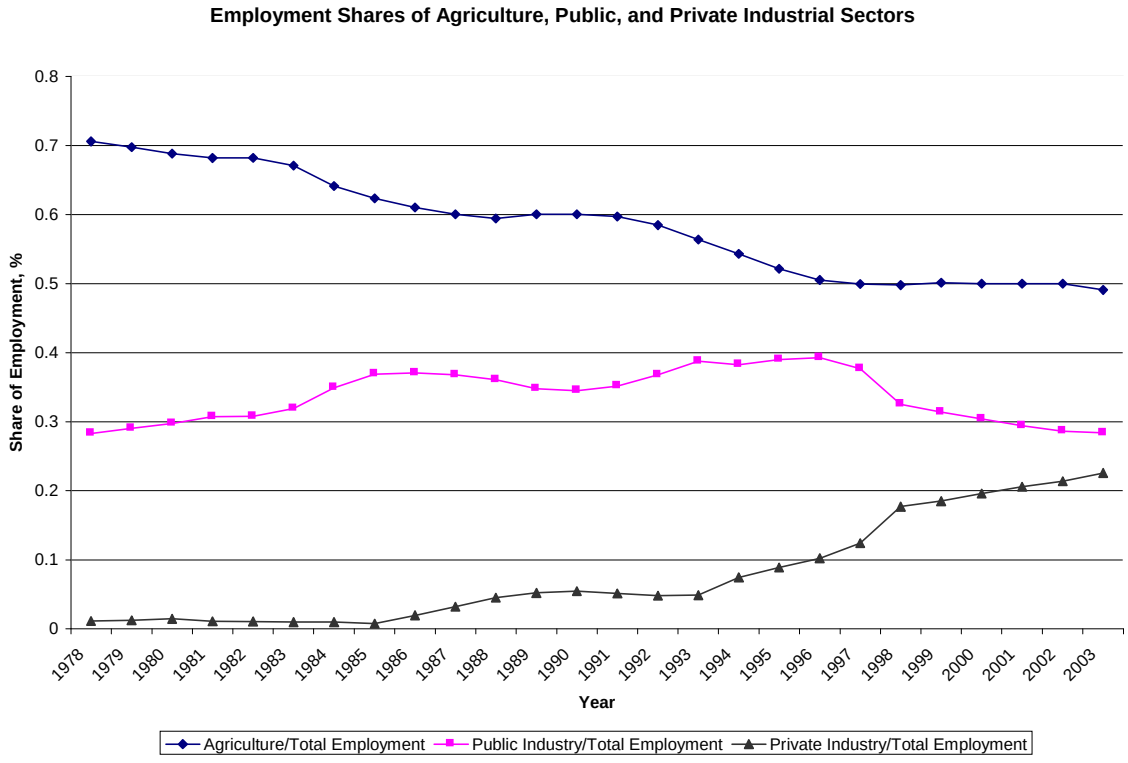

Figure 1: Employment Shares, 1978-2003.

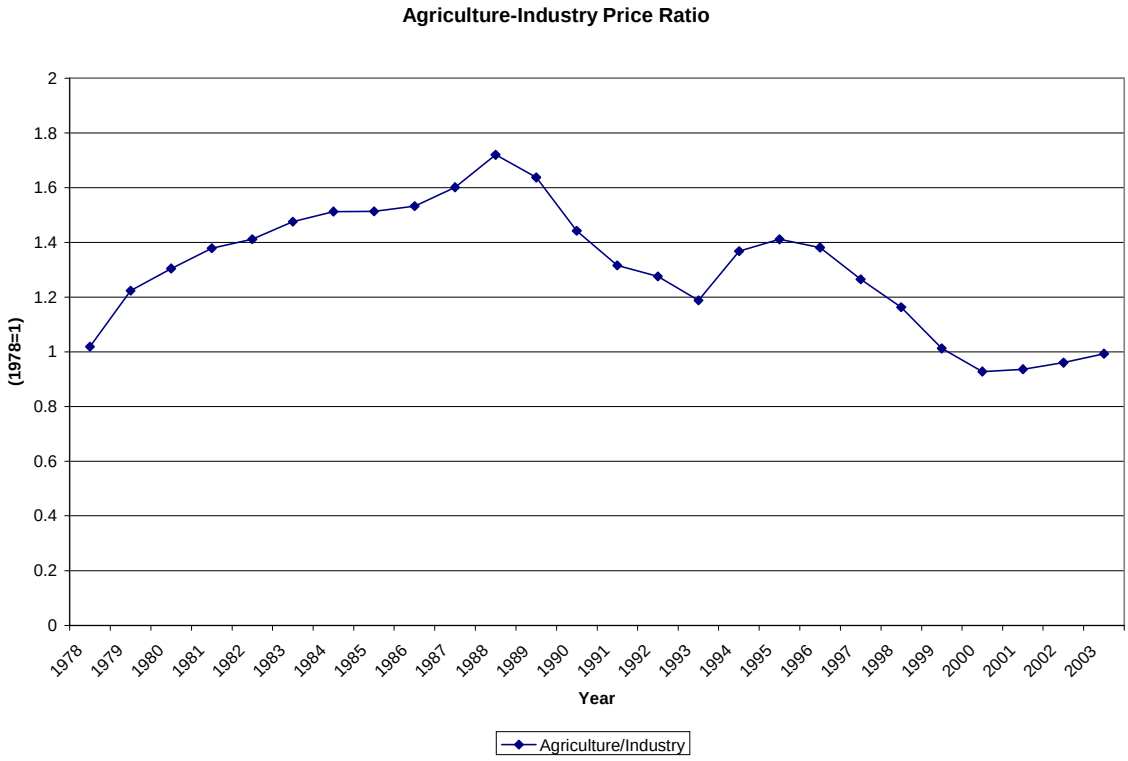

Figure 2: Prices of Agricultural Goods Relative to Industrial Goods.

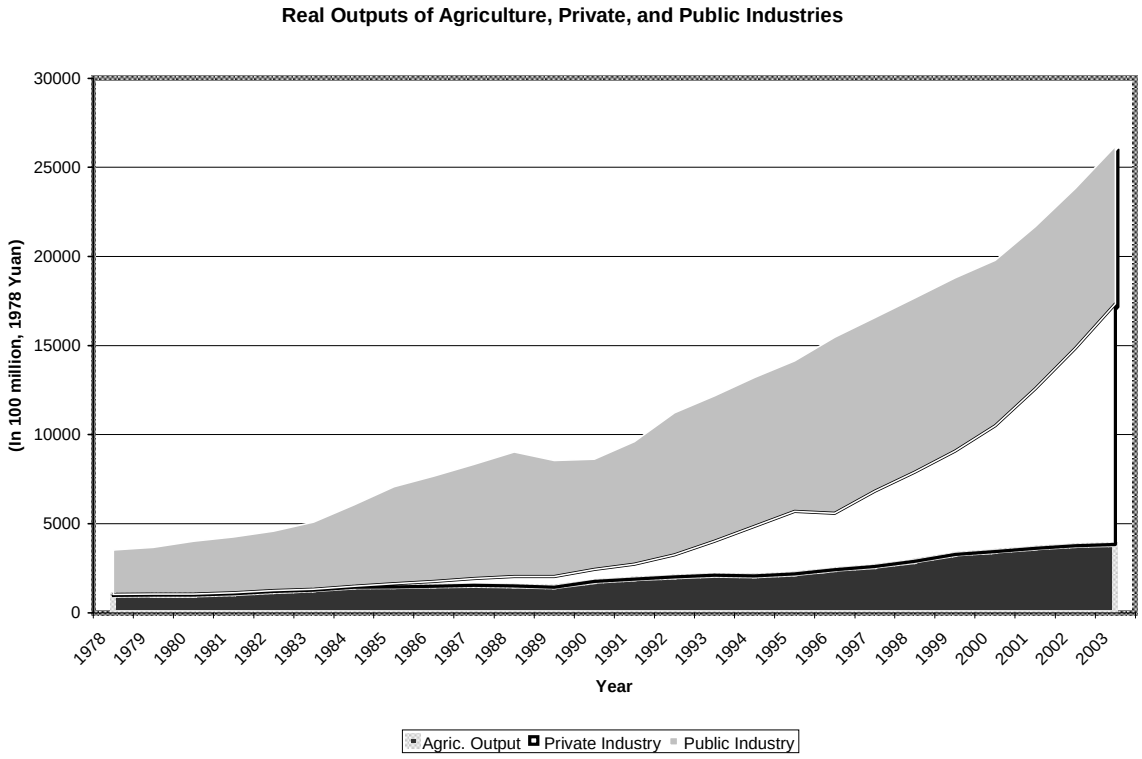

Figure 3: Real Outputs of Agriculture, Private and Public Industries, 1978-2003.

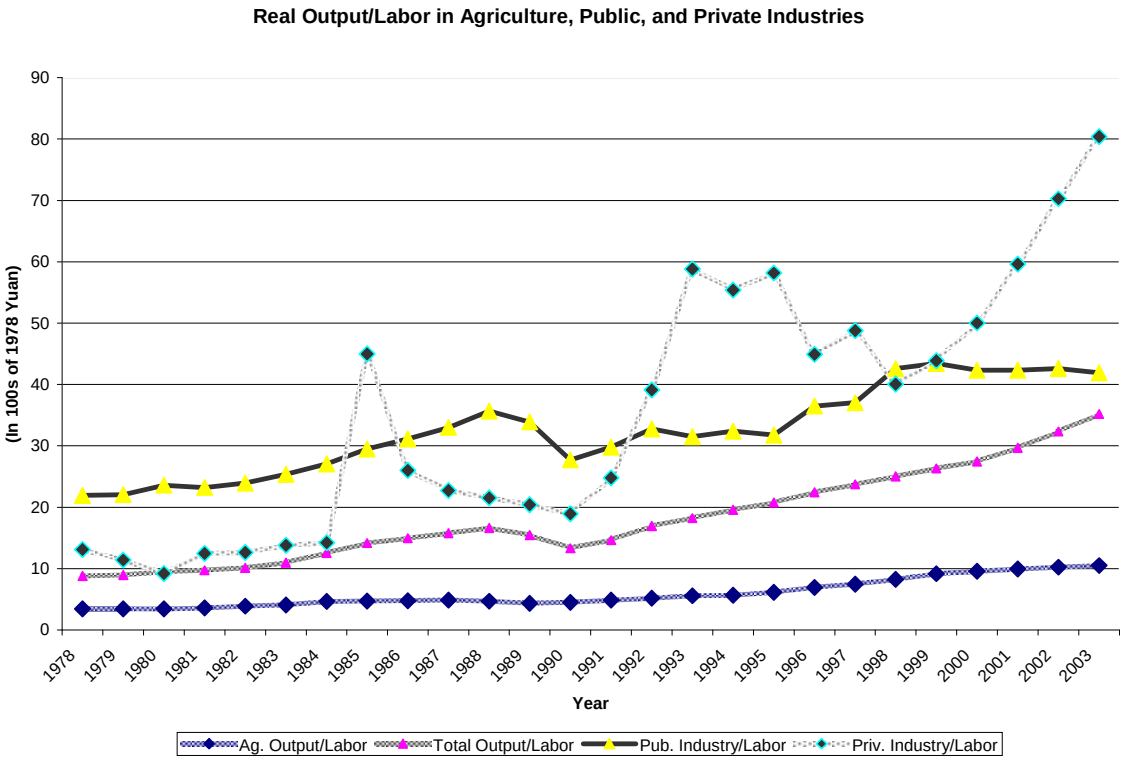

Figure 4: Real Output per Worker Ratios (Labor Productivity) by Sector, 1978-2003.

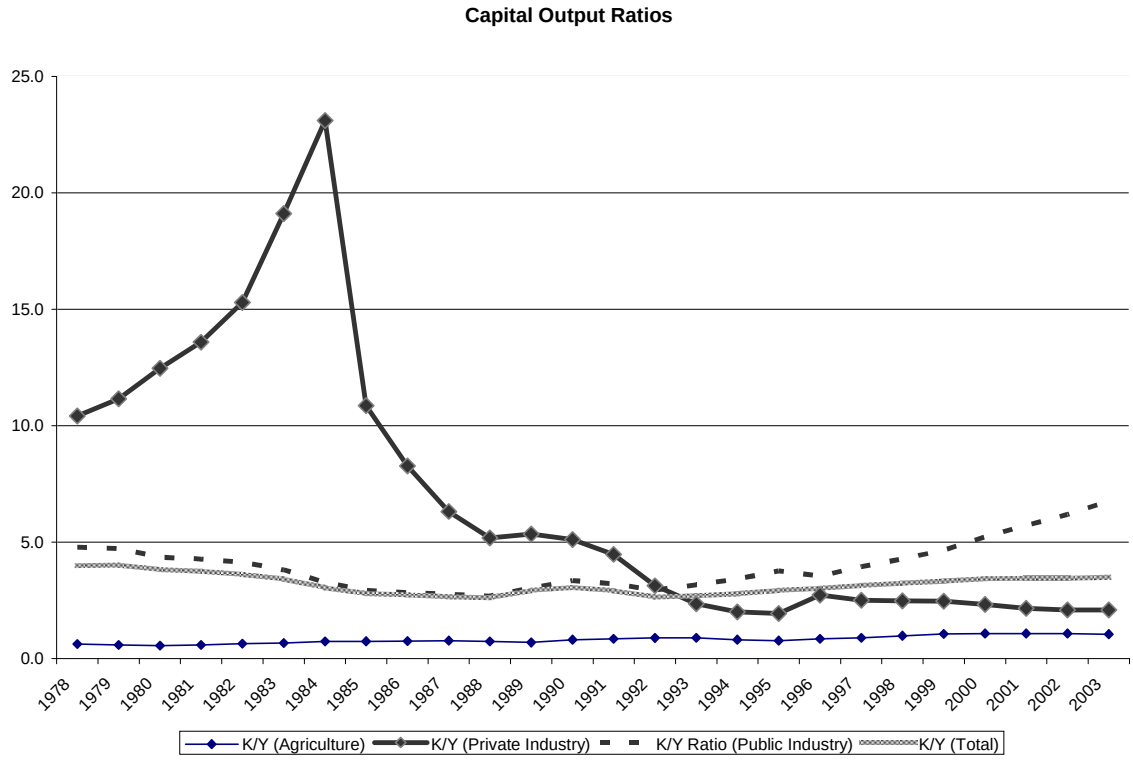

Figure 5: Capital-Output Ratios for the Economy, and by Sectors, 1978-2003.

Table 1: Chinese Sectoral Growth Accounting, 1978-2003 (growth in percent, annualized)	
Aggregate Output:	8.4
Aggregate Labor:	2.5
Output-Labor:	5.7
Contribution of Agricultural Labor Productivity Growth:	0.8
Of Which:	
Agric. Capital-Labor	0.05
Agric. Human Capital	0.14
Agric. Land-Labor	-0.08
Agric. TFP	0.6
Contribution of Public Labor Productivity Growth:	1.6
Of Which:	
Public Capital-Labor	1.27
Public Human Capital	0.38
Public TFP	- 0.06
Contribution of Private	1.7
Labor Productivity Growth:	
Of Which:	
Private Capital-Labor	0.11
Private Human Capital	0.17
Private TFP	1.47
Reallocation of Labor from	1.5
Agric. to Nonagric.	
Reallocation of Labor from	0.1
Public to Private	

Table 2: Long-Run Projections		
(in percent per annum; unless otherwise specified)		
	2020	2040
Projected Variables		
Total Output	5.8	5.8
Aggregate Output/Labor	5.5	5.5
Agric. Output/Labor	0.4	0.4
Public Output/Labor	0.6	0.6
Private Output/Labor	2.3	1.8
Labor Reallocation	2.1	2.6
Agric. to Nonagric.	1.8	2.4
Public to Private	0.3	0.2
Exogenous Variables		
Labor	0.3	0.3
Human Capital	0.5	0.5
Capital-Labor		
Agriculture	2	2
Public	2	2
Private	4	4
Employment (Share)		
Agriculture	0.36	0.20
Public	0.21	0.10
Private	0.43	0.70
TFP		
Agriculture	2.0	1.2
Public	0	0
Private	3.8	2.5