Industrial and Aggregate Measures of Productivity Growth in China, 1982-2000

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Abstract

We estimate both the industrial and aggregate measures of the TFP growth for China over the post-reform period 1982-2000, based on a time-series input-output table and detail micro-level household survey data set on labor inputs. We find that a modest growth of aggregate TFP at 2.5% for the period 1982-2000. Except a very high TFP growth about 9% in early 80s, the aggregate TFP was modest at 2.6-3.3% for the period 1984-1994, but only -0.3% in 1994-2000. Therefore, our study suggests TFP's role was declining after the successful economic reform in China. Except the period of 1982-1984, the accumulation of capital inputs was the main contributor to the high GDP growth in China, and even accounted for more than 80% of GDP growth in 1994-2000. Besides, through our decomposition of the aggregate TFP growth, we find the efficiency gain in the reallocation of capital inputs were also deteriorating in the 90s, the efficiency gain in the reallocation of labor was very little. Our industrial TFP results also suggest many individual sectors were also showing negative TFP growth in late 90s.

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I. **Introduction**

It is widely agreed that the Chinese economy has grown rapidly since the reforms that were begun in 1978. However, there is much disagreement about the exact magnitude and characteristics of that growth. Was it predominantly due to accumulation of factors of production, or was it mostly due to productivity growth? What was the role of reallocation of factors across sectors? These questions are difficult to answer given the quality and quantity of data available. The answers to them, however, are important in understanding the effects of past economic policies and hence to devise future policies.

The primary purpose of this paper is to present some estimates of growth and productivity change by sectors based on currently available data. We also introduce more newly developed data here, this includes a time series of input-output tables and data from a survey of the labor force. A second aim is to discuss the various approximations and assumptions that are necessary to construct time series of data at the sectoral level for the whole economy. As with many papers in this literature we shall discuss in detail the data issues relating to proper deflators and sectoral classification. Our goal is to lay the groundwork for a systematic and clear framework for sectoral productivity analysis of China, i.e. to sketch out a comprehensive approach, and to point out the missing elements for further research to produce better estimates of growth and productivity change.

In our paper, we divide our sample periods into four main periods based on the structure break along China's economic reform. (1) 1982-84, growth mainly attributed to the efficiency gain from the agriculture sector reforms after China's economic reform since 1978, when China launched "household registration system" in rural areas. In 1984, all most all the peasants are in the registration systems. However, the reforms of SOE are quite lagged behind the agriculture reform. (2) 1984-1988, growth mainly attributed to the successful industrial sector reforms. The two-tier economic structure came into being with both plan economy and market economy, and any commodity had legally carried two prices with one planned price set by the central government, and a market price which reflects the market condition upon demand and supply and not regulated by the government. In addition, in this stage Chinese government launched "contract responsibility system" and adopted "open door policy", as well as developed additional fourteen coastal cities as "coastal open cities" to attract foreign investment and

technology transfer etc. (3) 1988-1994, Chinese government adopted a new doctrine so called “socialist market economy”; many “development zones” were established. (4) 1994-2000, the role of SOE had been weakened, and private ownerships had been elevated as “important component of the economy”. In addition, China is gradually reducing its tariffs to be ready for integration into the world economy. Therefore, based on the structure break and policy changes in the past years, we calculated sectoral TFP for the four sub-periods described above.

Our preferred approach to estimating productivity growth is to use gross output data rather than using only value added. To do this for the whole economy requires us to construct a time series of input-output matrices. This IO approach forces the analysis to be consistent across the whole economy, a revision of the output deflator of one sector changes the output and productivity growth of that sector but this necessarily implies that the inputs into some other sectors or final demand are also changed. For example, the service sectors are poorly measured in all countries and especially so in China. Services are also inputs into the manufacturing sector, our IO approach forces us to explicitly confront this issue. The productivity estimates for manufacturing is thus not as reliable as one might think.

If we scale these IO tables to official GDP and use official investment and labor data we find that total factor productivity growth in some sectors (at the 2-digit level) are negative. The major contributor is the agriculture sector which is large and showed high (2-5%) TFP growth.

While we are going to focus on sectoral estimates we will also discuss the aggregate economy. We use three aggregation approaches in this paper: direct Domar-weighted aggregation, aggregate production function, and aggregate production possibility frontier. The first approach was used extensively in the literature, while the latter two approaches are different from most authors. We decompose aggregate TFP growth into sectoral TFP growth and reallocation effects. Our estimate for aggregate TFP growth is in the 1.9-2.5% range for the whole period. For example, using the estimates from the aggregate production function approach, the 1.9% TFP growth is made up of 2.70% sectoral TFP growth, -0.62% reallocation of value added, -0.17% reallocation of capital, and -0.02% reallocation of labor.

This paper is organized as follows. We start with an overview of the relative literatures on the TFP estimations for China's economic growth in sector II. Next in sector III we present a methodology framework on both industrial level and aggregate growth accounting. Sector IV discusses the construction of output and input indices for sector. Sector V and VI present the results of industrial level, aggregate TFP and reallocation effects. Section VII concludes.

II. **Literature Review**

There are a number of productivity studies of China at the aggregate level, or using value added for broad (1-digit) industries. Very few literatures are focusing on the 2-digits industrial level TFP calculation and decompose the sources of economic growth and reallocation effects. For the aggregate level studies, currently there is not much debate on whether the TFP growth plays an important role in the post-reform growth. But debates are more concerning with the magnitude of the TFP, and whether the future trend of TFP growth is increasing or slowing down.

Chow (1993), using official data prior to 1980 that only included the material sectors (i.e. not including the data on service sectors that were estimated later), concluded that there was essentially no technical progress in the 1952-80 period. Chow and Li (2002) follow the similar methodology by estimating the Cobb-Douglas production function, but update the analysis to the more recent year 1998. They find a positive TFP growth of 3.03% in the post-reform period, together with 5.1% growth in capital input and 1.2% growth in labor input, could be used to explain the 9.4% exponential rate of overall GDP growth from 1978 to 1998. They also simulate an increasing trend of TFP till 2010.

Borensztein and Ostry (1996) get the similar result. They estimate the TFP growth was negative at about -0.7% average rate during 1953-1978, but the TFP rose to an average 3.8% per year during 1979-1994. Fan, Zhang and Robinson (1999) share a similar optimistic view of the future economic growth in China. They divide the Chinese economy in four sectors: agriculture, urban industrial, urban services, and rural enterprises for 1978-95 and find out TFP growth contributed 4.2 percentage points to the aggregate annual GDP growth. Hu and Khan (1997) also suggest that the TFP growth is accelerating due to the deepening of economic reforms. They calculate TFP growth rate

was 5.8% for the period 1990-1994, and find that TFP growth surpassed the growth in capital stock in the sample period.

However, many other literatures keep skepticism about the optimal TFP growth. Woo (1998) estimates the GDP growth from 1979-1993 using producer price indices, and decomposed it into factor growth, reallocation and TFP growth. He uses value added but dividing the economy into primary, secondary and tertiary sectors. In this paper, he did not try to obtain real value added by double deflation but merely revise the deflation of nominal value added using the produce price indices. In addition, for labor input Woo used number of workers, without adjusting for the composition of workers. The result is that for the period 1979-93 he revised the official growth rate from 9.3% per annum to 8.0% which he decomposed to capital accumulation (4.9%), labor force growth (1.4%), reallocation effect (0.6%) and TFP growth (1.1%). He also divides this period into two subperiods, and shows that TFP growth rate ranges from 2.76 to 3.76% per year for the period 1979-84, but only -0.11-1.58% per year for the period 1984-93. Thus he concludes that the TFP growth is not only low but also declining at the post-reform period.

Young (2003) shares the similar skeptical view of the TFP growth in the post-reform period, and discusses the problems with the official estimates of real GDP and makes estimates using alternative deflators[1]. He uses the Jorgenson et al. (1987) approach of using income earned by specific category as indicator for the labor productivity, and incorporates the labor quality into the productivity analysis. He estimated that for the non-agricultural sector total factor productivity growth was only 1.4% per year using his deflators compared to 3.0% using official numbers for 1978-98. He, however, also points out that ignoring agriculture makes this a misleading estimate, that sector is large (a quarter of GDP in this period) but with rather poor data on inputs (labor, land and capital). He comments that China's post-reform productivity performance of nonagricultural economy is respectable but not outstanding, and concludes that the efficiency gains lie mainly in the agriculture sector.

Ren (1997) is focused primarily on measurements of real GDP rather than productivity measurements, but the data issues raised there are very relevant to our

[1] He notes that using alternative deflator brings down the growth of output per capita from 7.8% to 6.1% for the aggregate and 6.1% to 3.6% for the nonagricultural sector.

discussions here. Ren re-estimated GDP growth using alternative deflators and suggest that his figure of 6.0% growth rate during 1986:94 is more realistic than the official 9.8%. In a more recent paper, Ren and Sun (2005) constructed a time series input-output from 1981-2000, and calculated the TFP growth of all the 2-digit level sectors, then calculated the Domar-weighted aggregate to the national level for 4 periods post Chinese economic reform: firstly a fast TFP growth from 1981-1984, after that a steady TFP growth at 3.14% and 3.83% for 1984-1988 and 1988-1994 respectively, and finally a very slow TFP growth at only 0.52% from 1994-2000. Like Young (2003), Wang and Yao (2001) also take into account the labor quality in TFP calculations. But they use the number of schooling years as indicative of labor quality. Their TFP results range from -0.87 to -0.38 for pre-reform period, and 1.92 to 2.98 for post-reform period, the differences are due to various labor income shares. Therefore, the TFP estimates in both Ren and Sun (2005), and Wang and Yao (2001) are somewhere between the very low estimates of 1.1 – 1.4% of Woo and Young, and very high estimates of 4-5% of Hu and Khan.

There are also a number of other studies use detailed Census, or survey, data rather than economy wide aggregates, these include Jefferson, Rawski and Zheng (1996, 2000), Groves, Hong, McMillan and Naughton (1994) , and Woo, Hai, Jin and Fan (1994). These studies seem to agree that collective owned enterprises showed much higher TFP growth than state owned ones, but gave very different estimates of the actual performance of the state owned enterprises, ranging from positive to negative.[2] While our analysis at the 2-digit level cannot be compared to these more detailed studies we should note that our results do show both positive and negative productivity growth.

III. Methodology Framework

We now summarize our methodology on both industrial and aggregate accounting to account for the various factors that contribute to growth – factor accumulation, changes in composition of factors, reallocation of factors across sectors and productivity change. Each sector of the economy is described by a production function which uses primary factors and intermediate inputs to produce gross output. This output is used for final demand and intermediate demand, and GDP is the aggregate of final demand, and is also the aggregate of sectoral value added. Much of this is described in detail in our

[2] Some of these differences are discussed in Woo (1998), which also surveyed other papers.

accounting of U.S. economic growth in Jorgenson, Ho and Stiroh (2005), and Jorgenson, Gollop and Fraumeni (1987). (See also Jorgenson and Stiroh 2000, and Gu and Ho 2000). Readers familiar with this may skip directly to the results in Sections V and VI.

1. Industrial Growth Accounting

The economy is divided into 33 sectors producing 33 different commodities. Gross output of sector *j* in period *t* is assumed to be produced with a Hicks-neutral production function using various types of capital, labor and intermediate commodities.

(1) $$Y_{jt} = A_{jt} f(K_{1jt},..K_{kjt},L_{1jt},..L_{ljt},Z_{1jt},..Z_{njt})$$

The index of productivity is represented by A_{jt}. We assume that the function is separable in such a way that the various types of capital, labor and intermediate inputs may be aggregated into indices K_{jt}, L_{jt}, and Z_{jt} respectively, so we may write the production function as:

(2) $$Y_{jt} = A_{jt} f(K_{jt},L_{jt},Z_{jt})$$

The index of capital input is aggregated from three types of assets, structures, equipment and auto vehicles. The labor input is an aggregate of the number of workers cross classified by sex, age, and educational attainment. The material input index is aggregated over the 33 separate commodities. These intermediate goods are produced by the 33 sectors plus imports. The construction of these input aggregates is described in section IV below.

We assume that (2) is described by a translog form so the index of technology may be derived from:

(3) $$d\ln Y_{jt} = \bar{v}_{Kjt} d\ln K_{jt} + \bar{v}_{Ljt} d\ln L_{jt} + \bar{v}_{Zjt} d\ln Z_{jt} + d\ln A_{jt}$$

where $d\ln Y_{jt} = \ln Y_{jt} - \ln Y_{jt-1}$, and the $\bar{v}$'s are the two-period average share of the subscripted input in nominal gross output :

(4) $$\bar{v}_{Kjt} = \tfrac{1}{2}(v_{Kjt} + v_{Kjt-1}) \quad \text{etc.}$$

$$v_{Kjt} = \frac{P_{Kjt}K_{jt}}{P_{Yjt}Y_{jt}}$$

$$v_{Ljt} = \frac{P_{Ljt}L_{jt}}{P_{Yjt}Y_{jt}}$$

$$v_{Zjt} = \frac{P_{Zjt} Z_{jt}}{P_{Yjt} Y_{jt}}$$

The *P*'s denote the prices, P_{Yjt} is the output price to the producer (ex-factory price less taxes), P_{Kjt} is the rental price of capital, and P_{Ljt} is the price of labor input. The value of capital input is calculated such that the value of total inputs equals to the value of ouput:

(5) $$P_{Yjt} Y_{jt} = P_{Kjt} K_{jt} + P_{Ljt} L_{jt} + P_{Zjt} Z_{jt}$$

We shall use the output price to calculate the productivity indices. Official GDP is evaluated at purchasers' price, or industry price, P_{Ijt}. The difference between the two valuations is the net taxes on production, *NT* :

(6) $$P_{Ijt} Y_{jt} = P_{Yjt} Y_{jt} + NT_{jt}$$

The real value added of sector j, V_{jt}, is defined implicitly from (3) above as output less an index of intermediate inputs :

(7) $$d \ln Y_{jt} = \bar{v}_{Vjt} d \ln V_{jt} + \bar{v}_{Zjt} d \ln Z_{jt}$$

The following identity is implied:

(8) $$\bar{v}_{Vjt} d \ln V_{jt} = \bar{v}_{Kjt} d \ln K_{jt} + \bar{v}_{Ljt} d \ln L_{jt} + d \ln A_{jt}$$

where $v_{Vjt} = \frac{P_{Kjt} K_{jt} + P_{Ljt} L_{jt}}{P_{Yjt} Y_{jt}}$

is the share of value added in gross output. The price of value added is then given by the sum of values divided by the quantity index:

(9) $$P_{Vjt} V_{jt} = P_{Kjt} K_{jt} + P_{Ljt} L_{jt}$$

2. Aggregate Growth Accounting

The above describes the accounting for each sector. We now turn to the aggregation over all the sectors to derive national output. Here we present three alternative methodologies used to construct economy-wide estimates of output growth: aggregate production function, aggregate production possibility frontier, and direct aggregation across industries.

1) Direct Aggregation Across Industries

The first approach to measure the sources of growth for the aggregate Chinese economy is the direct Domar-weighted aggregate across industries, which is developed

by Jorgenson, Gollop, and Fraumeni (1987). Here we assume that the value-added function exists in each industry, without impose additional assumptions on the cross-industry restrictions on equal value-added functions, mobility of inputs across industries and equal prices for the market equilibrium.

The Domar-weighted TFP is defined as follows:

$$(10) \qquad d\ln A_t^{DW} = \sum_j D_{jt} d\ln A_{jt} = \sum_j \frac{\overline{w}_{jt}}{\overline{v}_{Vjt}} d\ln A_{jt}$$

where $D_{jt} = \frac{\overline{w}_{jt}}{\overline{v}_{Vjt}} = \frac{\overline{P}_{Yjt}\overline{Y}_{jt}}{\sum_i \overline{P}_{Vit}\overline{V}_{it}}$ is the Domar weight, and equation defines aggregate TFP is the "Domar-weighted" average of industry TFP growth, which originated by Domar (1961). This approach captures the ratio of two proportions in determining the aggregate TFP growth, the numerator w_{jt} is the proportion of each industry's value-added in aggregate value-added, and the denominator v_{Vjt} is the proportion of each industry's value-added in its gross output. The Domar-weighted sum of industry TFP is a measure of shift in aggregate production possibility frontier (Hulten, 1978).

2) Aggregate Production Function

A second approach is the aggregate production function approach. Now one must assume that there is perfect substitution among sectors, each specific type of capital and labor receive the same price in all industries, and the existence of identical value-added functions across industries, which implies that identical price of value-added functions exist across all the industries.

$$(11) \qquad P_V^{PF} = P_{V,j}$$

where P_V^{PF} is the aggregate price of value-added for the aggregate production function, and $P_{V,j}$ is the sectoral price of value-added in the individual sector. Thus the total real value added (at factor cost) is calculated as the simple sum of sectoral value added:

$$(12) \qquad V_t^{PF} = \mathring{a}_j V_{jt}$$

This aggregate output is written as a Hicks neutral function of the inputs of capital, labor and land (T):

(13) $V_t^{PF} = A_t \cdot f(K_t, L_t, T_t)$

where K_t is an index representing the aggregate of the various capital asset types, where each asset type *k* is the national sum of the asset in all sectors. We use the Divisia method to derive the input aggregate:

(14) $d \ln K_t = \sum_k \overline{v}_{Kkt} d \ln K_{kt}$, k=structures, equipments, auto vehicles

$K_{kt} = \sum_j K_{jkt}$

Similarly, L_t represents the aggregate of various types of labor:

(15) $d \ln L_t = \sum_l \overline{v}_{Llt} d \ln L_{lt}$, *l*=cross classification of sex, age, education

$L_{lt} = \sum_j L_{jlt}$

Due to the lack of data on land valuation and rents, in this paper we make no distinction about the types of land, which is captured into the capital input. This means that we might be overestimating the return to capital in the mining and real estate sectors with our assumption of zero land input. This also means that the return to aggregate capital must be interpreted to include return to this ignored land input.

From (12) we get the aggregate real value added, and we assume that (13) may be written in the translog form. The index of aggregate production technology, A_t^{PF}, may thus be derived from :

(16) $d \ln A_t^{PF} = d \ln V_t^{PF} - \overline{v}_{Kt} d \ln K_t - \overline{v}_{Lt} d \ln L_t$

where $v_{Kt} = \dfrac{P_{Kt} K_t}{P_{Kt} K_t + P_{Lt} L_t} = \dfrac{\sum_j P_{Kjt} K_{jt}}{\sum_j (P_{Kjt} K_{jt} + P_{Ljt} L_{jt})}$.

The denominator of the value shares is simply nominal GDP at factor cost, i.e. before indirect taxes.

The relation between the aggregate TFP and industrial direct Domar-aggregated TFP is described in Jorgenson, Ho and Stiroh (2005) and Jorgenson and Stiroh (2000). From eq. (8) we have:

(17) $$d\ln A_{jt} = \overline{v}_{Vjt} d\ln V_{jt} - \overline{v}_{Kjt} d\ln K_{jt} - \overline{v}_{Ljt} d\ln L_{jt}$$

Multiplying by the Domar weights and summing over all sectors:

(18) $$\sum_t \frac{\overline{w}_{jt}}{\overline{v}_{Vjt}} d\ln A_{jt} = \sum_j \overline{w}_{jt} \ln V_{jt} - \sum_j \overline{w}_{jt} \frac{\overline{v}_{Kjt}}{\overline{v}_{Vjt}} d\ln K_{jt} - \sum_j \overline{w}_{jt} \frac{\overline{v}_{Ljt}}{\overline{v}_{Vjt}} d\ln L_{jt}$$

where $w_{jt} = \dfrac{P_{Vjt} V_{jt}}{\sum_i P_{Vit} V_{it}}$

is the value share of sector j's value added in total GDP at factor cost. Combining eq. (16) with (18) we get the decomposition of aggregate productivity change:

(19)
$$\begin{aligned} d\ln A_t^{PF} = & \left(\sum_j \frac{\overline{w}_{jt}}{\overline{v}_{Vjt}} d\ln A_{jt} \right) \\ & + \left(d\ln V_t^{PF} - \sum_j \overline{w}_{jt} \ln V_{jt} \right) \\ & + \left(\sum_j \overline{w}_{jt} \frac{\overline{v}_{Kjt}}{\overline{v}_{Vjt}} d\ln K_{jt} - \overline{v}_{Kt} d\ln K_t \right) \\ & + \left(\sum_j \overline{w}_{jt} \frac{\overline{v}_{Ljt}}{\overline{v}_{Vjt}} d\ln L_{jt} - \overline{v}_{Lt} d\ln L_t \right) \end{aligned}$$

(20) $$d\ln A_t^{PF} = \sum_j D_{jt} d\ln A_{jt} + R_t^{VA} + R_t^K + R_t^L$$

where the first term in parentheses in (19) is the sum of Domar-weighted sectoral productivity change. The second term is the reallocation of value added across sectors and is represented by R_t^{VA}, the third and fourth terms are the reallocation of capital and labor, represented by R_t^K and R_t^L respectively.

3) Aggregate Production Possibility Frontier

A more favorable aggregation approach with less restrictive assumptions is the aggregate production possibility frontier (Jorgenson, 1966; Jorgenson and Stiroh, 2000; Jorgenson, 2001, Jorgenson, Ho and Stiroh, 2005). In the aggregate production function approach, we impose a very stringent assumption that requires all industries face the

same value-added functions and same price of value added. Here, we relax the assumption of the existence of an aggregate production function, and assume that value-added is not perfectly substitute across industries, thus each sector has its own value-added price and simple sum of the value-added is not appropriate as in (12).

Now we define the aggregate value-added as a Divisia index of individual value added in the aggregate production possibility frontier approach:

$$d\ln V = \sum_j \bar{w}_j d\ln V_j \tag{21}$$

where V is the aggregate value-added and V_j is the industrial value-added, and $\bar{w}_j$ is the average share of industry value-added in aggregate value-added:

$$\bar{w}_j = \tfrac{1}{2}(w_{jt} + w_{jt-1}) \qquad w_j = \frac{P_{V,j}V_j}{\sum_j P_{V,j}V_j}$$

In the factor market, we still keep the assumption of capital and labor mobility and market equilibrium, where each type of heterogeneous capital and labor receives the same price, so we can simple aggregate each type of capital and labor and obtain an aggregate index as equation (14) and (15) above.

Now we define TFP growth from the aggregate production possibility frontier in the same manner as equation (16) above, though we use $d\ln A_t$ rather than $d\ln A_t^{PF}$ in the equation.

$$d\ln A_t = d\ln V_t - \bar{v}_{Kt} d\ln K_t - \bar{v}_{Lt} d\ln L_t \tag{22}$$

Similarly we also get the decomposition of the aggregate productivity change as follows:

$$\begin{aligned} d\ln A_t = & \left(\sum_j \frac{\bar{w}_{jt}}{\bar{v}_{Vjt}} d\ln A_{jt} \right) \\ & + \left(d\ln V_t - \sum_j \bar{w}_{jt} \ln V_{jt} \right) \\ & + \left(\sum_j \bar{w}_{jt} \frac{\bar{v}_{Kjt}}{\bar{v}_{Vjt}} d\ln K_{jt} - \bar{v}_{Kt} d\ln K_t \right) \\ & + \left(\sum_j \bar{w}_{jt} \frac{\bar{v}_{Ljt}}{\bar{v}_{Vjt}} d\ln L_{jt} - \bar{v}_{Lt} d\ln L_t \right) \end{aligned} \tag{23}$$

Note since we relax the assumption that the price of value-added is the same in all industries as in the aggregate production function, thus leads to different growth rates for aggregate value-added. In this approach, since we have captures the reallocation of value-added in the aggregate TFP, thus the reallocation of value added is zero.

IV. Constructing output and input indices for sectors

We now describe the construction of the sectoral inputs and outputs as defined in (1) and (2) above. This is based on a time series of input-output "Use" or "Activity" tables which consist of the inter-industry section (dimensioned 33 commodities by 33 industries), the value added section, and the final demand section. The IO tables were constructed by Ren Ruoen in the Beihang University based on the raw data from the National Bureau of Statistics (NBS). The detail information and estimation procedures are explained in more detail in Ren and Sun (2005).

Column j of the Use matrix gives us the value of each intermediate input, $U_{ij} = P_i^Z Z_{ij}$, $i = 1,...n = 33$, and the value of capital input ($P_{Kj} K_j$), and labor input ($P_{Lj} L_j$). The net taxes are included in the capital inputs. The column sum gives us the value of gross output as described in (5) and (6) above:

$$(24) \qquad P_{Ijt} Y_{jt} = P_{Kjt} K_{jt} + P_{Ljt} L_{jt} + \sum_i P_{it}^Z Z_{ijt}$$

In Table 1, the values for gross output, capital input, labor input, energy aggregate input, and non-energy material aggregate input, capita stock and employment are given for 2000. The sum of the capital and labor value added columns equals GDP for s2000.

(a) Output and Intermediate input.

Our industry system is based on production functions where the industry gross output is a function of capital, labor, intermediate inputs which are divided by energy aggregate input and non-energy material aggregate input, and technology, which is indexed by time, *t*. The key building block for these gross output, capital, labor value-added inputs and intermediate inputs, is a time series of input output tables. The time series China input-output tables from 1981-2000 were constructed in a collaborative way including professional staffs from the National Bureau of Statistics of China (Xu Xianchun, Qi Shuchang, Liu Liping, Dong Lihua, Zhao Tonglu) and researchers from the BeiHang University (Li Xiaoqin, Ma Xiangqian, Ren Ruoen).

Because China use MPS format I-O tables before 1987 and transformed gradually to SNA format till 1987. This time-series tables were constructed by the following steps: 1) Aggregate data series including total inputs, total value-added, and final uses are compiled to construct value table from 1981 to 2000. 2) Construct four current price benchmark Use tables of 1981, 1987, 1992, and 1997. Due to differences in formats, industrial classification, statistic coverage and definitions, all the tables except 1997 table were adjusted to conform to the 1997 I-O table, and scaled to the latest GDP series. Since the 1981 table is material product input and output table, so the current price Use table of 1981 was constructed using the structure of 1987 Use table and the changes of technical parameters between 1981-1987. 3) Based on the four comparable benchmark tables, the tme-series current price Use tables were constructed for the 1987-2000 using the Kuroda extrapolating approach.

The time series input-output table is summarized in two sets of tables, a "Use table" and a "Make table". Row *i* of the Use matrix gives us the intermediate use of commodity *i* by all the industries plus the purchases of *i* by final demanders (consumption, investment, government and net exports). The row sum gives us the value of domestic use of *i*, which is the domestic output of *i*. Each commodity may be made by a few industries, and each industry may make a few commodities. The structure of commodity output is given by the input-output "Make" matrix, which is dimensioned 33 industries by 33 commodities. The prices of commodities (P_i^Z, $i = 1,...n$) should be derived by aggregating the price of domestic output with the price of imports (or from surveys covering both items). However, since there is little data on import prices, here we assume they behaved in the same way as domestic prices.[3] The price of domestic commodities is derived from the prices of industry output (P_{ij}) using this Make matrix.[4]

Sectoral commodity price indices for 33 sectors from 1981-2000 were compiled based on the same approach used in the estimation of sectoral GDP at constant price, which is described in detail in OECD (2000). The industry price indices were converted from the commodity price indices using the V tables from 1981 to 2000. Thus the time

[3] Young (2003) used Hong Kong trade data to estimate an import price index for China. Expanding approximations like this could provide better estimates in the future.

[4] The details of relation between industries and commodities, and between domestic and imports, are given in Garbaccio, Ho and Jorgenson (1999).

series constant price Use tables for 1981-2000 can be derived from current price Use tables, sectoral commodity and industry price indices. The detail description is in Xu et al. (2005).

Combining the current Yuan industry output data in the IO table with these price indices we derive the quantity indices of sectoral output (Y_{jt}), as well as indices of the quantity of intermediate inputs (Z_{ijt}). To do this we assume that all purchasers pay the same price for a given commodity. This is, of course, not very accurate in the period of controlled prices and favored sectors. Adjustments for this have to wait for the construction of more detailed price indices.

Given the price and quantity of input i for each sector j from the above procedures, we define the intermediate input aggregate as a Divisia index of all the components:

$$(25) \qquad d\ln Z_{jt} = \sum_i \overline{v}_{ijt}^{Z} d\ln Z_{ijt}, \qquad v_{ijt}^{Z} = \frac{P_{it}^{Z} Z_{ijt}}{P_{Zjt} Z_{jt}}$$

where $P_{Zjt} Z_{jt} = \sum_i P_{it}^{Z} Z_{ijt}$ is the total value of intermediate inputs for sector *j* and P_{Zjt} is the price index for aggregate material input into j. These are the terms that enter into eqs. (3) and (4) in the calculation of the productivity index for *j*.

(b) Capital input.

The flow of capital services is derived by aggregating over three asset classes – structures, equipments and auto vehicles. Our method involves distinguishing between the stock of assets and the flow of services derived from them is described in detail in Jorgenson, Ho and Stiroh (2005) and Jorgenson, Gollop and Fraumeni (1987). The main sources of investment data used are from "China statistical yearbook on investment in fixed assets" and numerous years' "Chinese Statistical Yearbook". In this section, we shall merely summarize the methods here but will discuss our adaptations to the Chinese case. The detail description is in Ren and Sun (2005).

The stock of capital of type k in sector j (S_{kjt}) is accumulated from the flow of investment using the perpetual inventory method:

(26) $S_{kjt} = (1-\delta_k)S_{kjt-1} + I_{kjt}$, k=structure, equipment, auto vehicle

where I_{kjt} is the real investment in asset k, and δ_k is the geometric depreciation rate. We assume the asset life for structure is 40 years, and 16 years for equipment and 8 years for auto according to studies on estimation of capital stock in other countries. Thus the depreciation rate of equipment is 17%, structure is 8% and auto vehicle is 26% (Ren and Sun, 2005). The real investment is given by the data on value of investment divided by the price of capital goods:

(27) $I_{kjt} = VI_{kjt} / PI_{kt}$

The total stock of capital for sector j is the aggregate of the three types:

(28) $d\ln S_{jt} = \sum_k \bar{v}^S_{kjt} d\ln S_{kjt}$ $\qquad v^S_{kjt} = \dfrac{PI_{kt} S_{kjt}}{\sum_a PI_{at} S_{ajt}}$

Each of the asset types generate a flow of services in period t proportional to the stock that was in place at the end of t-1 ($K_{kjt} \propto S_{kjt-1}$), at a rental cost P_{Kkjt}. The taxation of capital income has undergone many frequent changes in the 1990s and here we shall take a highly simplified view of it to express the rental cost (i.e. a simplification of the detailed formulas for the U.S. in Jorgenson, Gollop and Fraumeni 1987). We express the rental cost of one unit of the capital stock S_{kjt-1} used in period t in sector j as:

(29) $P_{Kkjt} = [r_{jt} + (1+\pi_{kt})\delta_k]PI_{kt-1}$

where r_{jt} is the nominal rate of return in sector j, and $1+\pi_{kt} = PI_{kt} / PI_{kt-1}$ is the rate of asset inflation.

The total value of capital services is given by the capital row of the Use matrix, as expressed in eq. (24) above. The values for 2000 are given in Table 1 in the column marked "Capital Input". The rate of return is calculated such that the sum of the services over all asset types is equal to this sectoral value:

(30) $P_{Kjt} K_{jt} = \sum_k P_{Kkjt} K_{kjt} = \sum_k P_{Kkjt} S_{kjt-1}$

With this we can now give the expression for the quantity of capital services in eqs. (2) and (3) as the aggregate of all assets :

(31) $d\ln K_{jt} = \sum_k \bar{v}^K_{kjt} d\ln K_{kjt} = \sum_k \bar{v}^K_{kjt} d\ln S_{kjt-1}$,

$$v_{kjt}^{K} = \frac{P_{Kkjt} K_{kjt}}{\sum_{a} P_{Kajt} K_{ajt}}$$

That is, the weight for each asset type is the rental cost which depends on the common rate of return and an asset specific rate of depreciation. This makes our capital input index different from those that use a simple linear sum of asset types.

(c) Labor input.

The labor input used in this study is constructed by combining the value estimates from the above IO matrices and data from varies labor force. The methodology follows the research guidance of International Comparison of Productivity among Pan-Pacific Countries (Asian Countries) (ICPA) project, also very closely to the one in Jorgenson, Gollop and Fraumeni (1987), Ho and Jorgenson (1999) and Jorgenson, Ho and Stiroh (2005). We divide the work force by sex, age and educational attainment and aggregate them consistently, $L_{jt} = f(L_{1jt},..L_{ljt},..L_{70jt})$. The two sexes, three age groups and five educational classes give us a total of 30 labor categories for each sector. The groups are:

Sex
1. male
2. female

Educational Attainment
1. College or above
2. High School
3. Junior high school
4. Elementary school
5. Illiteracy and semi-illiteracy

Age groups
1. 16-34
2. 35-54
3. 55-

The data of the number of labor and breakdown of labor employment in the benchmark years are based on Population Sensuses (1982, 1990, 2000) and Sample Population Surveys (1987, 2995). The data on other years are estimated using annual Population Change surveys which have been conducted since 1990. The labor data before 1990 were collected from labor force of society series. The data on working hours are

lacking in the current Chinese statistics, thus the estimates of hours are only estimated based on the benchmark 1995 sampling population survey, by taking into account the changes in institutional arrangement for working time over the period 1982-2000. Estimation of the labor compensation matrix are estimated by reconciling two data sets. One is the three rounds of Chinese Household Income Surveys (CHIP) for 1987, 1995 and 2000, conducted mainly by Chinese Academy of Social Sciences and other collaborate institutes. The other one is using the official input-output table we can estimate the average compensation of employment by sectors from the total labor value-added divided by the total number of workers estimated from the sensuses and populations mentioned above. The detail is described in Ren and Sun (2005) and Yue et al (2005).

We begin by assuming that effective labor services for each category of labor in sector j is proportional to the hours worked by all workers in that category :

(32) $L_{ljt} = q_l^L H_{ljt}$, l=1,2,...70

The proportionality constant is represented by q to denote "quality". This is assumed to be constant over time. The total annual number of hours worked is the product of the number of workers, the average hours per week, and the average weeks per year:

(33) $H_{ljt} = N_{ljt} h_{ljt} w_{ljt}$

The number of workers for year 2000 is given in the last column of Table 1. As with the capital input in (31), we define the growth of total real labor input as a weighted average of the growth rates of all the categories:

(34) $d \ln L_{jt} = \sum_l \overline{v}_{ljt}^L d \ln L_{ljt} = \sum_l \overline{v}_{ljt}^L d \ln H_{ljt}$,

$$v_{ljt}^L = \frac{P_{Lljt} L_{ljt}}{\sum_{a=1}^{70} P_{Lajt} L_{ajt}}$$

The second equality in (34) is given by (32). The value shares are the compensation shares, where P_{Lljt} is the annual cost of a category l worker. The relative costs of the different types of workers are estimated from compensation surveys as described above. The actual value of P_{Lljt} is scaled such that the sum over all categories of workers is equal

to the total value of labor compensation in *j* as given by the Input-Output table (eq. 24) (Table 1, column marked "Labor input"):

(35) $$P_{Ljt}L_{jt} = \sum_{l} P_{Lljt}L_{ljt}$$

This labor input index, L_{jt}, is the one that enters into eqs. (3) and (4) for the sectoral productivity calculation, and P_{Ljt} is the price index of this labor input. In our labor dataset, since we lack of data for 1981, thus our TFP analysis will only focus on 1982-2000.

V. Sectoral Productivity Change

We begin by giving summary statistics of our data to provide some comparisons to other estimates. A snapshot view for one year, 2000, is given in Table 1. The largest sector by value added or gross output is Agriculture, followed by other private service, construction and electrical machinery. The smallest sector by gross output is gas utilities. The sector with the largest stock of reproducible capital is the agriculture, other private service, transportation, electric utilities and finance, insurance and real estate, while the sector with the highest employment outside of agriculture is other private service, construction and trade. The sum of capital, labor value-added is GDP, which was 9115.5 bil. *yuan* in 2000.

Table 2-6 gives the growth rates of output and inputs averaged over the whole period1982-2000 and all the sub-periods. The first column gives the annual growth rate of each sector's output for each set of real output estimates. Output growth has been rapid in all sectors of the economy. Comparing the sub-periods, before 1994 there are over 20 of 33 sectors exceeding 10% growth rates, some even grow more than 20% while after 1994 only 10 of 33 sectors sustain the high growth rate over 10%. For the whole period, Electrical machinery and communications have over 20% average annual growth rate. In addition, light industries and service industries also grew very fast during the sample period, in particular before 1994, such as apparel, paper and allied, leather, finance, insurance and real estate, and trade etc.

The growth of sectoral capital and labor input are reported in the next two columns of Table 2-6. Recall that our factor inputs are aggregate indices of the components, as given in eqs. (31) and (34). The growth rates for capital are mostly less than 10%, much lower than the growth rate of gross output. But for some sectors such as

oil and gas extraction, finance, insurance, and real estate, the growth rates for capital are very high. This is primary due to the fact that huge investments were installed for stock accumulation during these sample periods in these emerging markets. Or it could be due to the poor guesses of the initial sectoral capital stock or due to poor deflators of investment. The change in labor input is as expected, with a larger growth in labor intensive manufacturing, such as apparel, lumber and wood, leather, communications and etc, or service sectors such as trade, finance, insurance and real estate etc. The third and fourth column show the average growth rate of energy aggregate and material aggregate inputs, we can see that for most of the sectors, the growth rate of material inputs are similar to the growth rate of gross output.

For the sub-period 1994-2000, it is interesting to see that during this period, for some mining and manufacture sectors, the growth rate of labor input is negative, such as in coal mining, metal and nonmetal mining, oil and gas extraction, textile, machinery etc. This may due to the weak performance of SOEs and induced higher unemployment and laid off workers. However, in the same period the growth rate of capital input flow is still very high, in some sectors even exceeding the growth rate of sectoral gross output, such as oil and gas extraction, construction, lumber and wood, apparel paper and allied, motor vehicles, transportation equipment etc. This suggests that most of the GDP growth maybe driven by the rapid growth of capital input or over-investment in the emerging markets such as real estate, construction etc.

We now turn to changes in total factor productivity as defined in eqn. (3). All five terms in eq. (3), averaged over the sample period and sub-periods, are reported in Table 7-11. The columns for energy, materials, capital and labor contributions are the growth rates multiplied by the value shares exactly as written in the eq. (3). The growth rates of TFP are quite varied across sectors. Many energy industries show negative TFP growth rates in our sample period, such as Oil & gas extraction, petroleum and coal product, electricity, gas utilities and etc. Finance, Insurance, and Real Estate also show large falls in productivity in our sample periods. These may due to phenomena that many projects are under the rapid-capital investment in the plant building stage, thus the gross output are lagged behind the investment, so that the calculated TFP is negative as well. We can also see that, agriculture, light manufacture industries such as apparel, lumber and wood

furniture and fixtures, paper and allied, non-elect machinery, electrical machinery, transportation equipment, instruments, communications, and trade show relatively high TFP growth during the whole period 1982-2000. Note that apparel is a major export sector in the post-reform China, it has moderate TFP growth for the whole period 1982-2000, but for late 90s the technology progress is only -2.11%. While for the 1994-2000 period, on the other hand petroleum and coal product show a very high TFP at 5.42% growth rate compared to the previous period, suggesting increasing technology efficiency in this sector. In addition, agriculture, stone, clay and glass, primary metal, electrical machinery, instruments also show very high TFP growth. Overall, comparing the different sub-periods, we find that the TFP are very high for many sectors in the 1982-1988 period, while slow down in 1988-1994, in 1994-2000 periods some sectors even show negative TFP growth, suggesting China's sectoral TFP trend is declining with time.

Turning back to the contribution of intermediate inputs, capital and labor inputs also shown in table 7-11, one can see that the slow growth of the Chinese labor force applies to all sectors, with the biggest contribution in agriculture, public service, trade and gas utilities etc. Capital contribution is highest in the Finance & Insurance, communications, oil and gas extraction, electric utilities and transportation sectors. For energy inputs, the biggest contributions are in the energy intensive sectors, such as gas utilities, electric utilities, petroleum and coal products, and oil and gas extraction sectors. For the non-energy intermediate inputs, the smallest contributions are in the agriculture sector and service sectors most notably public service, trade etc.

There are some caveats we should note about. Firstly, enterprises might break up their vertical production process into different companies, thus measurement errors might arise. For example, the nominal gross output may increase but due to the deverticalization, there could be no change in total value added or final demand. We will leave the task of adjusting for this for future work and accept the nominal values as correct.

Secondly, we find that the Oil & gas mining, electric utilities sector and other energy sectors had a large negative estimated TFP growth in our sample periods. As we noted, we do not have estimates of land input for the mining sectors and this may well play a role in producing such an implausible estimate. Another point to note is the large effect of the economic reforms during this period on prices of this sector. We should note

that before the sector deregulation, the input prices are highly subsidized, so that the price level is lower than the economy-wide price, while we assume all the sectors receive the same price based on the input-output table framework. Thus after the deregulation, the input price for those sectors will go back to the economy-wide level price. Thus we may underestimate the changes in input price. Given the fixed sectoral value term in the I-O table we would overestimate the quantity of inputs. Similarly because the deregulation issue and price difference for those highly regulated energy sectors, the growth rate of the gross output is also underestimated as well. Thus our TFP estimates would have a downward bias.

For many service sectors, such as Finance, Insurance and Real Estate, we also have implausible negative TFP growth in our sample periods. Public service and other private service sectors also show zero or negative TFP growth. These downward biases may be due to difficulty in collecting data from many small companies and town village industrial enterprises.

In our TFP calculation, we use both price based and quantity based methodologies to calculate sectoral TFP growth rate. Table 12 shows the results using both methodologies, we can see that the results are the same or quite similar for both approaches. This is also a good way to test our results.

VI. Aggregate Productivity Change and Decomposition of GDP Growth

As we have reviewed in the Introduction there are several estimates of Chinese aggregate productivity performance. Based on our industry data, we use three aggregation methodologies to build up aggregate GDP as described in Section II above. The readers should keep in mind that our preferred method for presenting aggregate estimates is the aggregate production possibility frontier method, which we will focus more on it.

Firstly, we report the contribution of each industry to value-added growth and to TFP growth for the whole sample period and all the sub-periods in table 13-17. For value-added, we report the two-period value added share $\overline{w}_j$, the growth rate $\Delta \ln V_j$ and the contribution to aggregate value-added growth ($\overline{w}_j \cdot \Delta \ln V_j$). For TFP growth, we report the Domar-weight ($D_j = \overline{w}_j / \overline{v}_{V,j}$)which is the value of gross output of j divided by GDP at factor cost, the growth of sectoral TFP $d \ln A_{jt}$, and the Domar-weighted

contribution to aggregate TFP growth (the first term on the right hand side of eq. (20), $\sum_j D_j d \ln A_{jt}$).

For the whole period 1982-2000, we can see that of the 2.70% summed growth. Agriculture is the biggest contributor with the contribution of weighted TFP growth at 0.91%, followed by electronic machinery with 0.52%, trade with 0.47%, and non-electronic machinery with 0.43%. The dampers are finance, insurance and real estate with -0.78% and oil and gas extraction with -0.30%. For each sub-period, we have similar conclusion expect for the period 1994-2000, the Domar-weighted TFP values in many sectors are much smaller, all the service sectors show negative TFP, and the aggregate Domar-weighted sum is only 0.83%. In the last period, agriculture is still the biggest contributor with 1.59%, followed by primary metal with 0.84%, electrical machinery with 0.60%, and stone, clay and glass with 0.45%. For this period, the biggest dampers are still finance, insurance, and real estate, construction, other private services, and food products.

The second aggregation method is the aggregate production function approach, which we assume an aggregate production function exists, i.e. assuming perfect substitution among sectors, and all the industries face the identical price of value-added inputs. Here we also apply eq. (16) but use our estimate of aggregate real value added based on the production function approach, not the official estimate of real GDP. Our real GDP is given by the sum of the sectoral real value added (eq. 12) and the sectoral value added is given by subtracting the intermediate input index from the output index (eqs. 3,8).

Table 18 reports the growth rate of the GDP based on the production function approach, and the decomposition of GDP growth. The first line is the growth rate of total value added, i.e. the growth rate of GDP, which is 8.3% per annum for 1982-2000. The GDP growth is very high for the period 1982-1984, then quite stable at 7-8% after 1984. The growth rate of capital input and labor input are given in lines 2 and lines 3. We can see that the growth of capital input is increasing with time, and even exceed 12% after 1994. The growth rate of labor is quite stable at the range about 3-5%. The contributions of capital, labor and TFP growth, i.e. the components of eq. 16, are given in lines 4 through 6. The contributions of the primary factors are the growth rates multiplied by the

value shares. For example for the whole period 1982-2000, of the 8.3% GDP growth, capital contributed 4.6%, labor 1.8% and aggregate TFP growth 1.9%. We find that only for the period 1982-1984, the GDP growth is driven by a very high aggregate TFP level at 7.7%, which is mainly due to the success of China's economic reform in early 80s. After that, the GDP growth is mostly driven by the capital contribution, and the aggregate TFP is comparably higher, about 2.1% during 1988-1994, but very small for the other sub-periods, only 0.79% for 1984-1988 and 0.47% for 1994-2000.

We next turn to the decomposition of this aggregate TFP growth to the components given in eq. 20. That breaks up aggregate TFP growth into the Domar weighted sum of sectoral TFP growth which is further divided into primary, secondary and tertiary industries, reallocation of value added, capital and labor. These are given in the last seven lines of Tables 18. For the whole period 1982-2000, of the 1.9% TFP growth, 2.7% is due to the sectoral TFP growth, -0.62% to reallocation of value added, -0.17% to reallocation of capital input, and -0.02% to reallocation of labor. That is, individual sectors of the economy performed well, but the sectors that expanded relatively more included the poor performers. The movement of labor contributed very little to the aggregate TFP growth, and the movement of capital has a negative contribution.

If we divide the whole economy into primary, secondary and tertiary industries, we find that the main sources of GDP growth are from the efficiency improvement in secondary industry, but the aggregate TFP was declining from 3.7% in 1982-1984 to 2.71% in 1984-1988, 1.9% in 1988-1994 and finally only 1.6% in 1994-2000. The aggregate TFP of tertiary industry also increased very fast in 1982-1984, about 2.0%. However, it decreased very fast and almost no efficiency improvement in 1988-1994 and even at a high negative number -2.5% in 1994-2000. The primary industry still sustained a stable technology improvement trend at about 0.9-1.8%, except 1984-1988.

We also noticed that the reallocation effects of capital are positive in 80s, but also declining a lot since economic reform in early 80s. After 1988, the contribution of reallocation of capital inputs even became negative. The opposite trend is the reallocation effect of value added, although they are quite negative in the 80s, but the efficiency was gradually improved in the 90s, and contribute positively in the period of 1994-2000.

Overall, the contribution of the reallocation of labor is very small from our calculation for the whole periods.

Now let's return to our preferred approach – production possibility frontier approach, which we relax our assumptions on the existence of aggregate production function, and relax all sectors face same price of value-added. Table 19 gives the growth rate in the aggregate output and decomposition using this preferred approach. Compared with table 18, since we use different approach to calculate the quantity of value added, thus the first line is different. Similarly based on equation 22 and 23, the estimated aggregate TFP is different as well. Our estimated GDP growth using the production possibility frontier method is higher than the aggregate production function method, for the whole period 1982-2000 and sub-periods 1982-1984, 1984-1988 and 1988-1994, but lower for 1994-2000 period. We found that the aggregate TFP for the whole period is 2.51%. Similar to the aggregate production function method, the aggregate TFP in 1982-1984 was very high, at about 9%. In the period of 1984-1088, quite different from the aggregate production function method result which suggests only 0.8% growth in TFP; we find a fairly significant growth at 3.3% using production possibility frontier method. Using this method, our estimated aggregate TFP in 1988-1994 is slightly higher than the aggregate production function method, and aggregate TFP in 1994-2000 is lower, only about -0.3%. Except the period 1982-1984 when we observed very high TFP growth, in other periods we find that the contribution of capital accumulation is the main factor to the aggregate TFP growth, and the reallocation of labor is almost ignorable. In our calculation, the aggregate production assumes that the price of value added is the same in all industries, while the production possibility frontier does not. In addition we define the reallocation of value-added as the difference in the growth rates of value added from the aggregate production function approach and from the aggregate production possibility frontier approach. Therefore, in table 10 the reallocation of value added is simply zero for the aggregate production possibility frontier approach.

VII. Conclusion

We have laid out a methodology to account for Chinese economic growth, both at the sectoral level and the aggregate level. Based on a time-series input-output table and detail labor input data from the micro-level surveys, we employ a consistent set of

national accounts and micro data sets, to estimate the productivity performance for China during the post-reform period.

Our estimation of the aggregate TFP growth for the post-reform period 1982-2000 is about 2.5%, which is a middle number between the current low estimates of 1.1 – 1.4% of Woo and Young, and very high estimates of 4-5% of Hu and Khan, similar to the estimates of Ren and Sun (2005), and Wang and Yao (2001). By dividing the whole period into four sub-periods 1982-1984, 1984-1988, 1988-1994 and 1994-2000, we find a pretty high TFP growth at about 9.1% in period 1982-1984, and a moderate stable period for 1984-1988 and 1988-1994, but a negative TFP growth for 1994-2000, which suggest a declining trend of future TFP growth. Thus our study support the results in Woo(1998), Young(2003), and Ren and Sun(2005), but different from Chow and Li(2002), Borensztein and Ostry(1996), Fan, Zhang and Robinson(1999), and Hu and Khan(1997). In addition different from the previous Chinese TFP literatures, we also decomposed the aggregate TFP growth into contributions from weighted Domar-weighted sectoral TFP, reallocation of value added, as well as reallocation of capital and labor inputs. Our results suggest that the main contribution comes from the Domar-weighted sectoral TFP, the reallocation of labor is almost ignorable. The efficiency improvement of the reallocation of capital is positive in the 80s, but negative in the 90s. Except the true technology progress and efficiency improvement in the 1982-1994 sub-period, in other periods the GDP growth is mainly driven by the accumulation of capital inputs, and modest growth of aggregate TFP. Especially in the late 90s, more than 80% GDP growth is driven by the capital accumulation, and the aggregate TFP is even negative.

We also examined the aggregate TFP growth for different sample periods in primary, secondary and tertiary industries, we find that the aggregate nation wide TFP is mainly contributed by the secondary industry and primary industry. Tertiary industry contributed about 20-30% in the 80s, but fairly small in early 90s and even quite negative in the late 90s.

Just as many other TFP literatures, the “well-measured” data determined the quality of our estimates. Although we are confidant that our data set has improved significantly compared to the previous studies, such as we based our studies on a time-series input-output table and derive labor data from the detail surveys, we still need to

consider many uncertainties and poor estimates of some sectors, in particular the service sectors in China. Therefore, our results at this stage are suggestive. The agriculture sector showed good productivity gains, as did many manufacturing sectors. However, many other manufacturing industries showed negative productivity growth. The deregulation reform and subsequent price difference in the energy-intensive sectors and other government regulated sectors, the TFP growth is negative which may due to these poor official data. In addition, we believe our estimates may also be afflicted by the deverticalization problem discussed above and devising methods to adjust for it would be an important improvement.

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Table 1. Sectoral characteristics of the economy in 2000

	Sector	Output bil. Yuan	Capital input bil. Yuan	Labor input bil. Yuan	Energy input bil. Yuan	Material input bil. Yuan	Capital Stock bil. Yuan	Employment Million
1	Agriculture	2491.6	543.7	969.2	62.0	916.7	7337.8	464.1
2	Coal mining	253.5	35.6	60.7	31.2	126.0	446.1	4.1
3	Metal & nonm. mining	335.5	60.5	63.8	36.9	174.3	162.7	2.9
4	Oil and gas extraction	578.3	271.7	68.9	145.9	91.8	923.1	0.5
5	Construction	2202.5	146.2	466.3	167.8	1422.2	264.4	19.3
6	Food products	1612.8	294.9	137.1	28.9	1151.9	309.2	8.5
7	Textile mill products	1045.4	127.4	96.4	18.9	802.7	155.5	8.7
8	Apparel	448.2	50.3	61.5	5.2	331.3	12.2	8.1
9	Lumber and wood	100.8	13.4	11.1	4.7	71.6	31.7	2.5
10	Furniture and fixtures	179.3	20.4	21.9	4.1	132.9	6.2	2.6
11	Paper and allied	306.3	31.9	43.2	19.5	211.7	75.0	1.9
12	Printing, publishing	92.2	13.1	10.6	2.2	66.3	31.1	1.5
13	Chemicals	1556.9	212.0	130.4	202.6	1011.9	801.5	5.6
14	Petroleum, coal prod	818.3	112.4	39.1	488.4	178.3	206.3	0.6
15	Leather	238.9	24.9	31.0	2.5	180.6	13.5	3.2
16	Stone, clay, glass	999.8	130.5	124.0	131.2	614.1	198.6	7.3
17	Primary metal	1277.3	138.5	132.3	178.8	827.6	691.3	3.1
18	Fabricated metal	535.6	61.5	60.3	30.2	383.6	38.3	4.8
19	Machinery, non-elect	1055.2	137.0	132.6	45.4	740.2	277.5	7.7
20	Electrical machinery	2036.9	208.5	213.3	31.9	1583.2	181.0	7.8
21	Motor vehicles	453.4	61.2	42.2	14.5	335.5	107.4	2.2
22	Transportation equip	267.8	24.1	27.1	5.8	210.8	144.5	3.3
23	Instruments	106.9	13.4	14.7	2.3	76.5	27.0	1.1
24	Rubber and plastics	565.2	64.5	49.2	20.0	431.5	43.2	3.4
25	Misc. manufacturing	421.1	58.7	55.7	13.6	293.2	160.2	5.8
26	Transportation	682.7	169.0	173.9	130.8	209.1	2879.1	16.7
27	Communications	378.6	164.0	41.6	13.2	159.9	906.1	1.9
28	Electric utilities	606.6	177.7	69.1	176.2	183.6	1760.9	4.2
29	Gas utilities	36.9	5.6	5.5	16.6	9.3	68.9	0.3
30	Trade	1238.6	283.6	346.6	41.2	567.1	589.0	48.2
31	Finance, Insur, RE	956.8	363.5	131.2	15.4	446.8	1406.2	5.9
32	Other private service	2353.7	359.0	644.1	111.3	1239.3	2928.5	45.9
33	Public service	543.0	45.7	217.2	19.3	260.8	876.5	17.0
	Total	26776.2	4424.0	4691.5	2218.5	15442.1	24060.6	720.9

Table 2. Sectoral output and inputs, 1982-2000 (growth rates % per annum)

Sector	Output 1982:2000	Capital input 1982:2000	Labor input 1982:2000	Energy input 1982:2000	Material Input 1982:2000
1 Agriculture	6.91	3.02	2.23	6.27	7.91
2 Coal mining	7.15	5.68	0.46	5.10	11.24
3 Metal & nonm. mining	10.32	7.35	0.24	9.38	13.80
4 Oil and gas extraction	1.35	11.58	3.17	10.57	11.69
5 Construction	9.23	8.78	4.48	11.84	10.80
6 Food products	9.78	8.54	4.29	11.49	10.26
7 Textile mill products	8.87	3.69	2.52	7.67	8.58
8 Apparel	14.61	1.64	6.36	17.47	15.29
9 Lumber and wood	15.87	6.55	7.50	8.43	17.14
10 Furniture and fixtures	15.69	0.51	3.08	9.89	16.95
11 Paper and allied	18.91	6.74	2.66	15.74	18.70
12 Printing, publishing	12.91	6.31	4.09	10.30	13.24
13 Chemicals	12.28	8.13	2.63	6.94	13.63
14 Petroleum, coal prod	6.63	9.56	3.55	3.86	15.40
15 Leather	15.49	1.34	7.45	14.62	16.52
16 Stone, clay, glass	14.23	8.68	0.88	9.82	17.25
17 Primary metal	10.81	6.36	2.71	5.94	11.75
18 Fabricated metal	12.94	2.17	1.93	10.07	13.49
19 Machinery, non-elect	13.25	0.41	0.42	8.54	13.80
20 Electrical machinery	22.96	9.34	5.35	14.26	21.16
21 Motor vehicles	13.61	6.94	4.44	10.14	12.98
22 Transportation equip	14.35	4.98	4.84	4.09	14.37
23 Instruments	14.05	1.39	-0.87	8.86	15.66
24 Rubber and plastics	10.94	-2.03	4.15	10.72	12.35
25 Misc. manufacturing	10.29	8.65	1.99	12.24	11.37
26 Transportation	8.06	10.87	4.60	1.25	10.66
27 Communications	21.74	14.52	6.02	15.85	23.72
28 Electric utilities	9.38	11.24	7.34	8.38	17.69
29 Gas utilities	12.68	16.68	12.65	13.79	18.79
30 Trade	12.49	5.40	7.64	7.20	10.86
31 Finance, Insur, RE	8.49	23.89	10.47	6.50	12.86
32 Other private service	11.34	16.42	4.95	8.30	13.98
33 Public service	7.16	16.20	6.56	-3.67	7.52

Table 3. Sectoral output and inputs, 1982-1984 (growth rates % per annum)

	Sector	Output 1982-1984	Capital input 1982-1984	Labor input 1982-1984	Energy input 1982-1984	Material Input 1982-1984
1	Agriculture	8.78	4.65	2.39	5.55	8.37
2	Coal mining	9.09	-0.10	-0.68	4.02	12.68
3	Metal & nonm. mining	7.86	11.31	4.17	7.48	12.00
4	Oil and gas extraction	9.60	17.45	10.40	14.58	18.35
5	Construction	14.27	4.30	5.35	19.04	17.18
6	Food products	8.15	8.75	8.27	6.18	6.84
7	Textile mill products	4.15	10.91	7.53	-1.73	0.76
8	Apparel	19.31	-12.18	10.96	14.64	21.42
9	Lumber and wood	1.87	-4.53	24.17	0.37	4.31
10	Furniture and fixtures	6.25	-6.06	22.12	2.41	6.39
11	Paper and allied	20.67	-8.30	7.06	14.09	19.67
12	Printing, publishing	18.60	-0.56	8.92	13.60	19.99
13	Chemicals	12.62	-2.94	3.08	5.57	14.78
14	Petroleum, coal prod	11.86	1.16	12.58	9.64	13.90
15	Leather	26.64	-5.29	8.83	18.11	25.75
16	Stone, clay, glass	13.78	10.67	5.05	9.83	17.63
17	Primary metal	12.26	-0.82	5.60	9.38	14.04
18	Fabricated metal	14.49	3.15	0.52	10.93	14.65
19	Machinery, non-elect	21.31	-4.24	4.31	15.57	21.13
20	Electrical machinery	19.62	-9.10	7.79	18.77	22.26
21	Motor vehicles	16.48	-7.43	1.26	13.74	13.48
22	Transportation equip	12.43	-9.44	1.64	1.28	7.99
23	Instruments	9.79	-0.89	-3.45	9.03	12.36
24	Rubber and plastics	16.78	-17.18	9.53	7.84	18.57
25	Misc. manufacturing	11.47	13.70	-4.07	11.46	12.61
26	Transportation	10.49	-0.52	4.36	9.32	11.22
27	Communications	10.67	-7.38	0.59	8.12	13.06
28	Electric utilities	4.13	-1.18	3.01	4.21	10.18
29	Gas utilities	6.98	4.20	18.34	6.21	14.34
30	Trade	29.01	-1.00	6.35	12.64	22.41
31	Finance, Insur, RE	22.02	45.93	5.09	8.16	20.84
32	Other private service	14.07	26.10	2.59	9.49	13.27
33	Public service	9.70	36.17	1.92	-0.08	8.87

Table 4. Sectoral output and inputs, 1984-1988 (growth rates % per annum)

	Sector	Output 1984-1988	Capital input 1984-1988	Labor input 1984-1988	Energy input 1984-1988	Material Input 1984-1988
1	Agriculture	3.42	0.53	3.49	-0.25	10.70
2	Coal mining	9.16	7.68	2.88	2.65	12.04
3	Metal & nonm. mining	16.15	11.68	2.78	15.74	24.24
4	Oil and gas extraction	-6.83	16.65	6.59	-6.91	3.36
5	Construction	13.06	8.03	3.29	-6.69	12.82
6	Food products	12.76	14.19	6.54	16.07	11.41
7	Textile mill products	16.99	6.67	7.70	14.82	15.24
8	Apparel	18.83	-3.52	6.44	16.41	17.85
9	Lumber and wood	30.73	2.82	8.58	28.75	37.75
10	Furniture and fixtures	24.68	0.05	5.27	19.36	31.54
11	Paper and allied	38.12	6.21	5.60	33.43	38.68
12	Printing, publishing	25.92	8.96	7.88	15.46	27.57
13	Chemicals	15.73	9.33	5.80	7.55	17.60
14	Petroleum, coal prod	-12.65	9.79	6.88	-5.73	9.13
15	Leather	19.84	2.43	6.04	17.93	20.00
16	Stone, clay, glass	26.52	16.48	2.84	22.11	35.36
17	Primary metal	4.21	6.86	6.07	-4.96	7.63
18	Fabricated metal	16.57	0.77	0.65	10.27	18.84
19	Machinery, non-elect	21.34	0.49	3.70	10.40	22.38
20	Electrical machinery	32.35	18.18	6.29	21.25	27.91
21	Motor vehicles	13.53	1.01	4.23	6.84	11.69
22	Transportation equip	15.80	3.45	6.43	-4.22	14.14
23	Instruments	15.03	2.10	-1.82	10.24	18.79
24	Rubber and plastics	9.52	-6.22	6.45	6.54	10.69
25	Misc. manufacturing	9.34	1.31	-3.27	7.94	10.86
26	Transportation	9.89	8.15	4.77	-16.13	14.55
27	Communications	15.94	1.14	4.45	12.59	20.55
28	Electric utilities	10.45	10.63	7.52	6.93	17.74
29	Gas utilities	23.69	31.03	15.99	28.70	34.75
30	Trade	19.53	5.49	7.89	0.88	12.87
31	Finance, Insur, RE	12.53	38.54	10.92	9.83	15.86
32	Other private service	10.55	22.04	5.23	-0.32	12.99
33	Public service	7.06	14.42	7.11	-21.00	7.88

Table 5. Sectoral output and inputs, 1988-1994 (growth rates % per annum)

	Sector	Output 1988-1994	Capital input 1988-1994	Labor input 1988-1994	Energy input 1988-1994	Material input 1988-1994
1	Agriculture	6.66	1.29	2.74	5.65	8.41
2	Coal mining	5.58	5.02	4.30	9.03	12.45
3	Metal & nonm. mining	9.26	5.51	0.92	9.94	13.81
4	Oil and gas extraction	-0.79	8.12	2.40	12.97	13.42
5	Construction	5.18	3.86	0.53	4.62	6.34
6	Food products	11.07	5.44	2.38	14.96	10.75
7	Textile mill products	7.15	2.73	3.91	10.68	8.78
8	Apparel	20.26	1.16	0.75	23.98	21.27
9	Lumber and wood	16.28	0.99	-2.61	4.83	16.14
10	Furniture and fixtures	17.86	-2.75	-8.82	8.20	18.00
11	Paper and allied	13.05	5.84	2.23	11.56	10.97
12	Printing, publishing	11.09	6.38	3.68	3.62	10.13
13	Chemicals	11.89	7.10	4.88	4.92	11.76
14	Petroleum, coal prod	8.33	13.44	1.36	3.45	17.61
15	Leather	18.57	7.24	1.54	17.89	20.60
16	Stone, clay, glass	10.60	5.06	0.19	7.15	14.31
17	Primary metal	9.84	6.52	3.85	8.44	14.61
18	Fabricated metal	14.12	-0.07	1.13	9.72	14.10
19	Machinery, non-elect	8.69	-0.22	2.11	4.98	8.90
20	Electrical machinery	16.59	7.62	2.92	6.56	13.76
21	Motor vehicles	16.75	10.99	4.77	7.21	17.09
22	Transportation equip	18.43	2.59	6.18	8.03	18.73
23	Instruments	12.91	0.71	2.56	2.62	13.10
24	Rubber and plastics	11.08	-2.82	1.80	11.91	11.79
25	Misc. manufacturing	11.92	7.41	0.74	12.68	13.82
26	Transportation	7.69	6.25	2.88	2.58	12.21
27	Communications	22.81	14.71	5.06	11.55	21.06
28	Electric utilities	10.46	9.10	6.18	7.72	22.28
29	Gas utilities	9.87	16.92	7.26	7.11	18.47
30	Trade	7.79	4.00	4.75	4.34	11.22
31	Finance, Insur, RE	10.80	20.87	7.95	6.01	12.08
32	Other private service	13.12	8.89	5.66	14.27	15.33
33	Public service	7.33	6.74	7.32	-0.99	9.79

Table 6. Sectoral output and inputs, 1994-2000 (growth rates % per annum)

	Sector	Output 1994-2000	Capital input 1994-2000	Labor input 1994-2000	Energy input 1994-2000	Material Input 1994-2000
1	Agriculture	8.87	5.87	0.83	11.49	5.39
2	Coal mining	6.72	6.94	-4.61	3.16	9.02
3	Metal & nonm. mining	8.31	5.00	-3.45	5.23	7.41
4	Oil and gas extraction	6.21	9.69	-0.75	18.48	13.29
5	Construction	9.05	15.69	8.92	29.00	11.79
6	Food products	7.06	7.80	3.36	6.73	10.13
7	Textile mill products	6.74	0.25	-4.00	3.04	6.54
8	Apparel	4.58	10.15	10.39	12.60	5.55
9	Lumber and wood	10.22	18.28	11.34	1.17	8.66
10	Furniture and fixtures	10.66	6.27	7.18	7.75	9.69
11	Paper and allied	11.37	13.00	-0.33	8.67	12.80
12	Printing, publishing	4.17	6.78	0.36	12.43	4.56
13	Chemicals	10.25	12.06	-1.89	9.01	12.47
14	Petroleum, coal prod	16.05	8.32	0.52	8.74	17.86
15	Leather	5.80	-3.07	13.86	7.97	7.04
16	Stone, clay, glass	9.82	6.43	-1.13	4.30	8.01
17	Primary metal	15.71	8.26	-1.64	9.57	10.86
18	Fabricated metal	8.83	5.02	4.04	10.01	8.92
19	Machinery, non-elect	9.74	2.54	-4.76	8.53	10.54
20	Electrical machinery	24.19	11.33	6.33	15.80	23.69
21	Motor vehicles	9.57	11.62	5.31	14.07	9.54
22	Transportation equip	9.94	13.20	3.51	6.63	12.29
23	Instruments	15.95	2.36	-2.80	14.13	17.24
24	Rubber and plastics	9.80	6.59	3.18	13.27	11.94
25	Misc. manufacturing	8.91	13.10	8.78	14.92	8.83
26	Transportation	6.39	21.11	6.29	8.81	6.34
27	Communications	28.22	30.56	9.84	24.91	32.05
28	Electric utilities	9.32	17.94	9.82	11.40	15.57
29	Gas utilities	10.06	11.02	13.93	13.05	9.96
30	Trade	6.99	8.86	10.80	12.46	5.29
31	Finance, Insur, RE	-1.04	9.81	14.47	4.23	8.99
32	Other private service	9.18	16.99	4.83	7.69	13.54
33	Public service	6.21	20.19	6.97	4.01	4.56

Table 7. Contributions to growth in sectoral output, 1982-2000 (% per annum)

	Sector	Output	Energy	Materials	Capital	Labor	TFP
1	Agriculture	6.91	0.09	2.59	0.74	0.92	2.56
2	Coal mining	7.15	0.52	4.69	0.9	0.26	0.78
3	Metal & nonm. mining	10.32	0.75	6.17	2.21	0.04	1.15
4	Oil and gas extraction	1.35	1.62	2.82	6.73	0.14	-9.96
5	Construction	9.23	0.41	7.47	0.69	0.92	-0.25
6	Food products	9.78	0.13	7.29	1.93	0.22	0.22
7	Textile mill products	8.87	0.09	6.29	0.62	0.24	1.62
8	Apparel	14.61	0.09	10.98	0.03	0.85	2.66
9	Lumber and wood	15.87	0.63	10.99	0.97	0.93	2.35
10	Furniture and fixtures	15.69	0.22	11.68	-0.06	0.41	3.43
11	Paper and allied	18.91	0.79	12.11	0.97	0.21	4.84
12	Printing, publishing	12.91	0.14	8.77	1.1	0.51	2.4
13	Chemicals	12.28	0.74	8.09	1.68	0.18	1.59
14	Petroleum, coal prod	6.63	1.92	3.52	2.55	0.14	-1.49
15	Leather	15.49	0.1	12	0.11	1.06	2.22
16	Stone, clay, glass	14.23	1.25	8.58	2.05	0.12	2.24
17	Primary metal	10.81	0.65	7.25	1.18	0.17	1.57
18	Fabricated metal	12.94	0.37	9.16	0.32	0.21	2.88
19	Machinery, non-elect	13.25	0.27	8.76	0.01	0.08	4.14
20	Electrical machinery	22.96	0.21	15.12	1.57	0.47	5.58
21	Motor vehicles	13.61	0.2	9	1.2	0.3	2.9
22	Transportation equip	14.35	0.07	10.08	0.66	0.39	3.14
23	Instruments	14.05	0.17	9.88	0.26	-0.11	3.86
24	Rubber and plastics	10.94	0.25	8.68	-0.74	0.34	2.42
25	Misc. manufacturing	10.29	0.2	7.8	1.41	0.27	0.61
26	Transportation	8.06	0.17	2.95	3.29	1.1	0.54
27	Communications	21.74	0.54	8.2	6.83	0.95	5.23
28	Electric utilities	9.38	2.4	4.1	4.19	0.64	-1.96
29	Gas utilities	12.68	5.32	4.82	3.58	1.67	-2.71
30	Trade	12.49	0.16	4.61	1.61	1.93	4.17
31	Finance, Insur, RE	8.49	0.11	4.88	11.13	1.57	-9.21
32	Other private service	11.34	0.35	6.7	3.23	1.4	-0.34
33	Public service	7.16	-0.23	3.63	1.19	2.57	0.02

Note: The contribution of capital, labor and intermediate is their growth rates multiplied by their value shares.

Table 8. Contributions to growth in sectoral output, 1982-1984 (% per annum)

	Sector	Output	Energy	Materials	Capital	Labor	TFP
1	Agriculture	8.78	0.05	2.25	1.33	1.05	4.10
2	Coal mining	9.09	0.45	3.99	0.00	-0.25	4.90
3	Metal & nonm. mining	7.86	0.51	3.98	4.33	0.92	-1.88
4	Oil and gas extraction	9.60	1.10	4.05	11.51	0.48	-7.55
5	Construction	14.27	0.45	12.34	0.26	1.05	0.16
6	Food products	8.15	0.05	4.74	2.28	0.34	0.75
7	Textile mill products	4.15	-0.02	0.53	2.07	0.70	0.86
8	Apparel	19.31	0.04	14.64	-2.34	1.33	5.64
9	Lumber and wood	1.87	0.03	2.48	-0.99	3.04	-2.69
10	Furniture and fixtures	6.25	0.07	4.00	-1.48	2.34	1.32
11	Paper and allied	20.67	0.70	11.96	-2.10	0.64	9.48
12	Printing, publishing	18.60	0.19	12.27	-0.13	1.17	5.10
13	Chemicals	12.62	0.63	7.92	-0.85	0.19	4.72
14	Petroleum, coal prod	11.86	4.14	1.92	0.45	0.48	4.87
15	Leather	26.64	0.12	17.93	-0.82	1.27	8.15
16	Stone, clay, glass	13.78	1.52	7.02	3.26	0.72	1.26
17	Primary metal	12.26	1.39	7.54	-0.21	0.36	3.19
18	Fabricated metal	14.49	0.43	8.79	0.80	0.06	4.42
19	Machinery, non-elect	21.31	0.53	12.21	-1.07	0.59	9.05
20	Electrical machinery	19.62	0.26	14.55	-2.26	0.67	6.41
21	Motor vehicles	16.48	0.23	8.43	-2.24	0.06	9.99
22	Transportation equip	12.43	0.05	5.05	-2.36	0.12	9.56
23	Instruments	9.79	0.17	6.31	-0.28	-0.55	4.14
24	Rubber and plastics	16.78	0.14	12.12	-4.32	0.75	8.08
25	Misc. manufacturing	11.47	0.12	7.95	3.15	-0.52	0.77
26	Transportation	10.49	1.98	2.49	-0.20	0.82	5.40
27	Communications	10.67	0.37	4.95	-3.15	0.09	8.41
28	Electric utilities	4.13	1.25	1.24	-0.60	0.22	2.01
29	Gas utilities	6.98	2.09	2.51	1.65	1.74	-1.01
30	Trade	29.01	0.37	10.95	-0.28	1.16	16.82
31	Finance, Insur, RE	22.02	0.18	7.32	21.99	0.73	-8.20
32	Other private service	14.07	0.40	5.75	5.58	0.80	1.54
33	Public service	9.70	-0.05	3.90	2.29	0.80	2.75

Table 9. Contributions to growth in sectoral output, 1984-1988 (% per annum)

	Sector	Output	Energy	Materials	Capital	Labor	TFP
1	Agriculture	3.42	0.00	3.18	0.16	1.51	-1.43
2	Coal mining	9.16	0.19	4.48	1.56	1.12	1.82
3	Metal & nonm. mining	16.15	1.07	9.45	4.31	0.51	0.82
4	Oil and gas extraction	-6.83	-0.51	0.87	10.61	0.34	-18.14
5	Construction	13.06	-0.14	9.23	0.52	0.66	2.81
6	Food products	12.76	0.12	8.11	3.46	0.24	0.82
7	Textile mill products	16.99	0.14	10.91	1.15	0.76	4.03
8	Apparel	18.83	0.05	12.40	-0.74	0.70	6.43
9	Lumber and wood	30.73	2.26	22.66	0.56	1.07	4.18
10	Furniture and fixtures	24.68	0.47	20.45	0.01	0.49	3.26
11	Paper and allied	38.12	1.45	24.55	1.39	0.44	10.29
12	Printing, publishing	25.92	0.19	17.57	2.03	0.98	5.14
13	Chemicals	15.73	0.73	9.90	2.50	0.40	2.19
14	Petroleum, coal prod	-12.65	-2.51	1.65	3.63	0.28	-15.69
15	Leather	19.84	0.11	14.12	0.31	0.83	4.48
16	Stone, clay, glass	26.52	2.79	16.04	4.67	0.37	2.66
17	Primary metal	4.21	-0.70	4.43	1.68	0.40	-1.59
18	Fabricated metal	16.57	0.37	11.90	0.16	0.07	4.08
19	Machinery, non-elect	21.34	0.30	13.53	0.10	0.54	6.86
20	Electrical machinery	32.35	0.30	18.73	4.27	0.49	8.56
21	Motor vehicles	13.53	0.13	7.57	0.27	0.20	5.35
22	Transportation equip	15.80	-0.17	9.30	0.79	0.45	5.41
23	Instruments	15.03	0.20	10.56	0.59	-0.26	3.94
24	Rubber and plastics	9.52	0.10	7.17	-1.53	0.45	3.33
25	Misc. manufacturing	9.34	0.09	7.05	0.20	-0.40	2.40
26	Transportation	9.89	-2.91	3.63	2.86	1.10	5.21
27	Communications	15.94	0.53	7.43	0.47	0.78	6.73
28	Electric utilities	10.45	1.98	2.75	5.13	0.56	0.04
29	Gas utilities	23.69	10.71	7.99	8.19	1.97	-5.17
30	Trade	19.53	0.00	4.48	1.97	2.09	10.99
31	Finance, Insur, RE	12.53	0.17	5.51	19.18	1.62	-13.96
32	Other private service	10.55	-0.02	5.98	4.71	1.48	-1.59
33	Public service	7.06	-1.19	3.68	0.92	2.80	0.85

Table 10. Contributions to growth in sectoral output, 1988-1994 (% per annum)

	Sector	Output	Energy	Materials	Capital	Labor	TFP
1	Agriculture	6.66	0.06	2.94	0.32	1.10	2.24
2	Coal mining	5.58	0.94	5.70	0.62	1.42	-3.10
3	Metal & nonm. mining	9.26	0.85	7.11	1.34	0.15	-0.20
4	Oil and gas extraction	-0.79	1.25	4.14	4.35	0.13	-10.66
5	Construction	5.18	0.05	4.20	0.32	0.13	0.48
6	Food products	11.07	0.18	7.69	1.21	0.13	1.87
7	Textile mill products	7.15	0.13	6.64	0.41	0.39	-0.42
8	Apparel	20.26	0.11	16.00	0.15	0.08	3.92
9	Lumber and wood	16.28	0.31	11.10	0.15	-0.31	5.02
10	Furniture and fixtures	17.86	0.17	13.17	-0.44	-0.81	5.77
11	Paper and allied	13.05	0.64	7.52	1.05	0.18	3.65
12	Printing, publishing	11.09	0.04	7.39	0.94	0.43	2.28
13	Chemicals	11.89	0.46	7.25	1.61	0.38	2.20
14	Petroleum, coal prod	8.33	1.27	4.51	3.55	0.05	-1.05
15	Leather	18.57	0.14	15.55	0.81	0.19	1.87
16	Stone, clay, glass	10.60	0.86	8.00	0.93	0.03	0.78
17	Primary metal	9.84	0.79	9.18	1.33	0.30	-1.75
18	Fabricated metal	14.12	0.28	10.23	-0.03	0.12	3.51
19	Machinery, non-elect	8.69	0.13	6.01	-0.05	0.29	2.31
20	Electrical machinery	16.59	0.09	10.02	1.35	0.27	4.87
21	Motor vehicles	16.75	0.09	12.19	2.37	0.26	1.84
22	Transportation equip	18.43	0.17	13.33	0.52	0.45	3.95
23	Instruments	12.91	0.03	8.56	0.13	0.40	3.78
24	Rubber and plastics	11.08	0.23	8.47	-0.57	0.15	2.79
25	Misc. manufacturing	11.92	0.15	10.02	1.03	0.08	0.65
26	Transportation	7.69	0.40	3.59	2.00	0.70	1.00
27	Communications	22.81	0.36	6.30	6.99	1.01	8.15
28	Electric utilities	10.46	2.20	5.53	3.71	0.46	-1.44
29	Gas utilities	9.87	2.82	5.65	2.88	1.04	-2.51
30	Trade	7.79	0.06	4.84	1.25	1.16	0.48
31	Finance, Insur, RE	10.80	0.10	4.68	9.12	1.30	-4.41
32	Other private service	13.12	0.60	7.14	1.83	1.67	1.89
33	Public service	7.33	-0.03	4.81	0.54	2.89	-0.89

Table 11. Contributions to growth in sectoral output, 1994-2000 (% per annum)

Sector	Output	Energy	Materials	Capital	Labor	TFP
1 Agriculture	8.87	0.19	1.97	1.35	0.32	5.04
2 Coal mining	6.72	0.36	4.04	1.05	-1.31	2.59
3 Metal & nonm. mining	8.31	0.51	3.78	0.98	-0.68	3.72
4 Oil and gas extraction	6.21	3.58	2.40	4.94	-0.10	-4.60
5 Construction	9.05	1.12	7.94	1.32	1.84	-3.16
6 Food products	7.06	0.11	7.18	1.52	0.26	-2.02
7 Textile mill products	6.74	0.05	4.79	0.00	-0.41	2.31
8 Apparel	4.58	0.11	3.80	1.22	1.57	-2.11
9 Lumber and wood	10.22	0.06	5.93	2.72	1.38	0.14
10 Furniture and fixtures	10.66	0.16	6.91	0.76	0.93	1.91
11 Paper and allied	11.37	0.52	8.45	1.62	-0.06	0.84
12 Printing, publishing	4.17	0.19	3.10	1.05	0.04	-0.21
13 Chemicals	10.25	1.06	7.77	2.06	-0.18	-0.46
14 Petroleum, coal prod	16.05	4.78	4.31	1.52	0.03	5.42
15 Leather	5.80	0.07	5.07	-0.41	2.01	-0.93
16 Stone, clay, glass	9.82	0.52	4.71	1.01	-0.15	3.74
17 Primary metal	15.71	1.18	7.10	1.15	-0.17	6.46
18 Fabricated metal	8.83	0.44	6.39	0.61	0.46	0.94
19 Machinery, non-elect	9.74	0.30	7.16	0.36	-0.61	2.53
20 Electrical machinery	24.19	0.25	18.01	1.27	0.60	4.04
21 Motor vehicles	9.57	0.36	6.95	1.81	0.49	-0.03
22 Transportation equip	9.94	0.13	9.01	1.72	0.39	-1.31
23 Instruments	15.95	0.28	11.92	0.34	-0.39	3.80
24 Rubber and plastics	9.80	0.39	8.74	0.81	0.31	-0.45
25 Misc. manufacturing	8.91	0.36	6.02	2.03	1.17	-0.69
26 Transportation	6.39	1.38	2.02	6.03	1.60	-4.65
27 Communications	28.22	0.78	11.69	14.23	1.28	0.24
28 Electric utilities	9.32	3.26	4.52	5.65	1.02	-5.14
29 Gas utilities	10.06	5.31	2.66	1.87	2.07	-1.84
30 Trade	6.99	0.31	2.34	2.37	2.87	-0.90
31 Finance, Insur, RE	-1.04	0.06	3.83	4.15	2.10	-11.18
32 Other private service	9.18	0.32	7.07	2.88	1.27	-2.36
33 Public service	6.21	0.14	2.31	1.64	2.67	-0.54

Note: The contribution of capital, labor and intermediate is their growth rates multiplied by their value shares.

Table 12. Sectoral total factor productivity growth (% per annum)

		TFP							
		Price _based	Quantity _based	Price _based	Quantity _based	Price _based	Quantity _based	Price _based	Quantity _based
		1982-84	1982-84	1984-88	1984-88	1988-94	1988-94	1994-00	1994-0
1	Agriculture	4.10	4.10	-1.42	-1.43	2.24	2.24	5.04	5.04
2	Coal mining	4.90	4.90	1.76	1.82	-3.10	-3.10	2.59	2.59
3	Metal & nonm. mining	-1.88	-1.88	0.83	0.82	-0.20	-0.20	3.73	3.72
4	Oil and gas extraction	-7.55	-7.55	-18.14	-18.14	-10.65	-10.66	-4.58	-4.60
5	Construction	0.16	0.16	2.82	2.81	0.48	0.48	-3.15	-3.16
6	Food products	0.75	0.75	0.82	0.82	1.87	1.87	-2.01	-2.02
7	Textile mill products	0.86	0.86	4.03	4.03	-0.42	-0.42	2.31	2.31
8	Apparel	5.64	5.64	6.43	6.43	3.92	3.92	-2.11	-2.11
9	Lumber and wood	-2.69	-2.69	4.18	4.18	5.02	5.02	0.14	0.14
10	Furniture and fixtures	1.32	1.32	3.26	3.26	5.77	5.77	1.91	1.91
11	Paper and allied	9.48	9.48	10.28	10.29	3.65	3.65	0.84	0.84
12	Printing, publishing	5.10	5.10	5.14	5.14	2.29	2.28	-0.21	-0.21
13	Chemicals	4.72	4.72	2.20	2.19	2.20	2.20	-0.46	-0.46
14	Petrol., coal prod	4.87	4.87	-15.69	-15.69	-1.05	-1.05	5.42	5.42
15	Leather	8.15	8.15	4.48	4.48	1.87	1.87	-0.93	-0.93
16	Stone, clay, glass	1.25	1.26	2.65	2.66	0.78	0.78	3.74	3.74
17	Primary metal	3.19	3.19	-1.59	-1.59	-1.76	-1.75	6.46	6.46
18	Fabricated metal	4.42	4.42	4.08	4.08	3.51	3.51	0.94	0.94
19	Mach., non-elect	9.05	9.05	6.86	6.86	2.31	2.31	2.53	2.53
20	Elect. machinery	6.41	6.41	8.56	8.56	4.87	4.87	4.04	4.04
21	Motor vehicles	9.99	9.99	5.35	5.35	1.84	1.84	-0.03	-0.03
22	Transport. equip	9.56	9.56	5.41	5.41	3.94	3.95	-1.32	-1.31
23	Instruments	4.14	4.14	3.92	3.94	3.78	3.78	3.80	3.80
24	Rubber and plastics	8.08	8.08	3.35	3.33	2.79	2.79	-0.45	-0.45
25	Misc. manufacturing	0.77	0.77	2.41	2.40	0.65	0.65	-0.69	-0.69
26	Transportation	5.40	5.40	5.20	5.21	1.00	1.00	-4.65	-4.65
27	Communications	8.41	8.41	6.72	6.73	8.15	8.15	0.24	0.24
28	Electric utilities	2.01	2.01	0.04	0.04	-1.44	-1.44	-5.14	-5.14
29	Gas utilities	-1.01	-1.01	-5.19	-5.17	-2.51	-2.51	-1.84	-1.84
30	Trade	16.83	16.82	10.96	10.99	0.48	0.48	-0.90	-0.90
31	Finance, Insur, RE	-8.20	-8.20	-13.96	-13.96	-4.41	-4.41	-11.18	-11.18
32	Other private service	1.54	1.54	-1.60	-1.59	1.89	1.89	-2.36	-2.36
33	Public service	2.75	2.75	0.83	0.85	-0.89	-0.89	-0.54	-0.54

Table 13. Domar-weight decomposition of productivity growth (1982-2000)

	Value-Added			Total Factor Productivity		
Sector	V-A Weight	V-A Growth	Contribution to Aggregate V-A	Domar weight	TFP growth	Weighted TFP growth
Agriculture	0.240	0.065	0.015	0.363	2.564	0.909
Coal mining	0.014	0.036	0.001	0.030	0.765	0.022
Metal & nonm. mining	0.014	0.078	0.001	0.032	1.149	0.049
Oil and gas extraction	0.019	-0.051	-0.001	0.030	-9.948	-0.301
Construction	0.058	0.051	0.003	0.206	-0.245	-0.060
Food products	0.045	0.085	0.004	0.162	0.217	0.017
Textile mill products	0.033	0.096	0.003	0.131	1.620	0.194
Apparel	0.010	0.131	0.001	0.038	2.658	0.075
Lumber and wood	0.002	0.153	0.000	0.008	2.349	0.020
Furniture and fixtures	0.004	0.138	0.001	0.013	3.430	0.047
Paper and allied	0.006	0.204	0.001	0.023	4.837	0.074
Printing, publishing	0.003	0.126	0.000	0.011	2.399	0.021
Chemicals	0.037	0.117	0.004	0.124	1.593	0.180
Petroleum, coal prod	0.013	0.100	0.001	0.042	-1.489	0.013
Leather	0.005	0.124	0.000	0.019	2.216	0.020
Stone, clay, glass	0.030	0.124	0.004	0.090	2.234	0.222
Primary metal	0.032	0.117	0.004	0.116	1.567	0.222
Fabricated metal	0.014	0.123	0.002	0.050	2.881	0.137
Machinery, non-elect	0.036	0.125	0.004	0.113	4.143	0.428
Electrical machinery	0.027	0.280	0.008	0.106	5.584	0.514
Motor vehicles	0.012	0.147	0.002	0.041	2.901	0.109
Transportation equip	0.006	0.141	0.001	0.022	3.140	0.055
Instruments	0.003	0.117	0.000	0.008	3.857	0.031
Rubber and plastics	0.013	0.076	0.001	0.049	2.422	0.106
Misc. manufacturing	0.012	0.077	0.001	0.042	0.609	0.020
Transportation	0.045	0.087	0.004	0.080	0.541	0.065
Communications	0.008	0.204	0.002	0.013	5.227	0.022
Electric utilities	0.020	0.056	0.001	0.042	-1.960	-0.106
Gas utilities	0.001	0.071	0.000	0.002	-2.718	-0.006
Trade	0.078	0.142	0.010	0.140	4.169	0.471
Finance, Insur, RE	0.051	0.055	0.003	0.086	-9.210	-0.776
Other private service	0.080	0.087	0.007	0.170	-0.339	-0.109
Public service	0.031	0.080	0.003	0.066	0.012	0.013
Aggregate weighted TFP growth	1.000		0.089	2.465		2.70

Note: The "weighted TFP growth" is the first term on the right of eq. (18), $D_{jt} d \ln A_{jt}$, where the weights are gross output divided by GDP.

Table 14. Domar-weight decomposition of productivity growth (1982-1984)

	Value-Added			Total Factor Productivity		
Sector	V-A Weight	V-A Growth	Contribution to Aggregate V-A	Domar weight	TFP growth	Weighted TFP growth
Agriculture	0.326	0.090	0.029	0.452	4.100	1.840
Coal mining	0.019	0.081	0.002	0.033	4.900	0.160
Metal & nonm. mining	0.015	0.057	0.001	0.025	-1.881	-0.049
Oil and gas extraction	0.023	0.063	0.002	0.033	-7.547	-0.242
Construction	0.046	0.057	0.003	0.178	0.163	0.032
Food products	0.045	0.112	0.005	0.150	0.747	0.106
Textile mill products	0.040	0.128	0.005	0.143	0.861	0.137
Apparel	0.007	0.148	0.001	0.022	5.637	0.126
Lumber and wood	0.001	-0.018	0.000	0.003	-2.692	-0.009
Furniture and fixtures	0.002	0.063	0.000	0.006	1.323	0.007
Paper and allied	0.003	0.234	0.001	0.008	9.479	0.073
Printing, publishing	0.003	0.165	0.000	0.007	5.095	0.035
Chemicals	0.033	0.117	0.004	0.096	4.721	0.451
Petroleum, coal prod	0.020	0.134	0.003	0.047	4.868	0.228
Leather	0.002	0.289	0.001	0.008	8.147	0.065
Stone, clay, glass	0.019	0.118	0.002	0.043	1.255	0.054
Primary metal	0.034	0.106	0.004	0.109	3.187	0.347
Fabricated metal	0.012	0.146	0.002	0.034	4.418	0.152
Machinery, non-elect	0.030	0.221	0.007	0.078	9.050	0.705
Electrical machinery	0.016	0.145	0.002	0.047	6.407	0.306
Motor vehicles	0.012	0.222	0.003	0.035	9.990	0.345
Transportation equip	0.005	0.225	0.001	0.017	9.561	0.160
Instruments	0.003	0.071	0.000	0.007	4.139	0.027
Rubber and plastics	0.015	0.136	0.002	0.044	8.085	0.356
Misc. manufacturing	0.014	0.095	0.001	0.038	0.772	0.027
Transportation	0.046	0.106	0.005	0.081	5.399	0.437
Communications	0.002	0.093	0.000	0.004	8.408	0.034
Electric utilities	0.022	0.028	0.001	0.037	2.014	0.074
Gas utilities	0.001	0.049	0.000	0.001	-1.011	-0.001
Trade	0.040	0.366	0.016	0.086	16.815	1.527
Finance, Insur, RE	0.037	0.232	0.009	0.059	-8.203	-0.455
Other private service	0.070	0.151	0.011	0.133	1.539	0.207
Public service	0.038	0.122	0.005	0.078	2.750	0.214
Aggregate weighted TFP growth	1.000		0.125	2.138		7.48

Note: The "weighted TFP growth" is the first term on the right of eq. (18), $D_{jt} d \ln A_{jt}$, where the weights are gross output divided by GDP.

Table 15. Domar-weight decomposition of productivity growth (1984-1988)

	Value-Added			Total Factor Productivity		
Sector	V-A Weight	V-A Growth	Contribution to Aggregate V-A	Domar weight	TFP growth	Weighted TFP growth
Agriculture	0.274	0.003	0.001	0.393	-1.428	-0.550
Coal mining	0.015	0.083	0.001	0.027	1.820	0.045
Metal & nonm. mining	0.014	0.105	0.002	0.025	0.823	0.033
Oil and gas extraction	0.018	-0.104	-0.002	0.026	-18.144	-0.507
Construction	0.052	0.153	0.008	0.198	2.805	0.551
Food products	0.039	0.160	0.006	0.138	0.824	0.113
Textile mill products	0.036	0.215	0.008	0.132	4.033	0.506
Apparel	0.007	0.213	0.002	0.025	6.427	0.159
Lumber and wood	0.002	0.176	0.000	0.005	4.184	0.018
Furniture and fixtures	0.003	0.109	0.000	0.009	3.264	0.022
Paper and allied	0.005	0.372	0.002	0.016	10.286	0.132
Printing, publishing	0.004	0.228	0.001	0.010	5.141	0.042
Chemicals	0.034	0.151	0.005	0.101	2.195	0.184
Petroleum, coal prod	0.015	-0.281	-0.004	0.035	-15.690	-0.566
Leather	0.003	0.194	0.001	0.010	4.480	0.044
Stone, clay, glass	0.027	0.183	0.005	0.065	2.656	0.175
Primary metal	0.030	0.015	0.000	0.097	-1.595	-0.156
Fabricated metal	0.012	0.130	0.002	0.035	4.077	0.153
Machinery, non-elect	0.039	0.205	0.008	0.107	6.862	0.697
Electrical machinery	0.023	0.418	0.009	0.075	8.560	0.544
Motor vehicles	0.012	0.170	0.002	0.035	5.347	0.192
Transportation equip	0.005	0.210	0.001	0.015	5.415	0.084
Instruments	0.003	0.099	0.000	0.007	3.940	0.030
Rubber and plastics	0.013	0.072	0.001	0.041	3.331	0.139
Misc. manufacturing	0.012	0.065	0.001	0.034	2.401	0.081
Transportation	0.045	0.159	0.007	0.077	5.212	0.405
Communications	0.003	0.131	0.000	0.005	6.734	0.029
Electric utilities	0.018	0.103	0.002	0.032	0.041	0.005
Gas utilities	0.001	0.130	0.000	0.001	-5.166	-0.008
Trade	0.091	0.247	0.020	0.143	10.991	1.436
Finance, Insur, RE	0.048	0.108	0.005	0.076	-13.959	-1.089
Other private service	0.069	0.094	0.007	0.141	-1.595	-0.228
Public service	0.033	0.097	0.003	0.069	0.850	0.066
Aggregate weighted TFP growth	1.000		0.102	2.205		2.78

Note: The "weighted TFP growth" is the first term on the right of eq. (18), $D_{jt} d \ln A_{jt}$, where the weights are gross output divided by GDP.

Table 16. Domar-weight decomposition of productivity growth (1988-1994)

	Value-Added			Total Factor Productivity		
Sector	V-A Weight	V-A Growth	Contribution to Aggregate V-A	Domar weight	TFP growth	Weighted TFP growth
Agriculture	0.234	0.055	0.014	0.361	2.238	0.893
Coal mining	0.013	-0.030	0.000	0.030	-3.102	-0.094
Metal & nonm. mining	0.014	0.041	0.001	0.033	-0.199	0.002
Oil and gas extraction	0.015	-0.104	-0.002	0.025	-10.657	-0.279
Construction	0.056	0.032	0.003	0.192	0.478	0.174
Food products	0.044	0.120	0.005	0.160	1.865	0.307
Textile mill products	0.033	0.026	0.001	0.142	-0.424	-0.065
Apparel	0.009	0.174	0.002	0.038	3.922	0.185
Lumber and wood	0.002	0.192	0.001	0.008	5.023	0.048
Furniture and fixtures	0.003	0.186	0.001	0.013	5.768	0.087
Paper and allied	0.006	0.197	0.001	0.023	3.651	0.085
Printing, publishing	0.003	0.148	0.000	0.012	2.284	0.025
Chemicals	0.038	0.157	0.006	0.127	2.202	0.295
Petroleum, coal prod	0.011	0.114	0.001	0.037	-1.052	-0.008
Leather	0.004	0.123	0.001	0.017	1.873	0.038
Stone, clay, glass	0.032	0.058	0.002	0.097	0.780	0.080
Primary metal	0.034	-0.001	0.000	0.120	-1.754	-0.185
Fabricated metal	0.014	0.148	0.002	0.053	3.513	0.203
Machinery, non-elect	0.037	0.085	0.003	0.122	2.309	0.279
Electrical machinery	0.025	0.247	0.006	0.096	4.868	0.474
Motor vehicles	0.011	0.162	0.002	0.040	1.840	0.082
Transportation equip	0.006	0.182	0.001	0.021	3.946	0.097
Instruments	0.003	0.131	0.000	0.007	3.784	0.029
Rubber and plastics	0.013	0.106	0.001	0.047	2.791	0.132
Misc. manufacturing	0.012	0.068	0.001	0.045	0.651	0.030
Transportation	0.051	0.066	0.003	0.091	1.001	0.104
Communications	0.007	0.239	0.002	0.010	8.155	0.078
Electric utilities	0.018	0.053	0.001	0.039	-1.443	-0.069
Gas utilities	0.001	0.042	0.000	0.003	-2.509	-0.008
Trade	0.088	0.058	0.005	0.160	0.482	0.072
Finance, Insur, RE	0.057	0.102	0.006	0.095	-4.407	-0.433
Other private service	0.077	0.107	0.008	0.154	1.894	0.305
Public service	0.032	0.054	0.002	0.067	-0.891	-0.048
Aggregate weighted TFP growth	1.000		0.078	2.480		2.92

Note: The "weighted TFP growth" is the first term on the right of eq. (18), $D_{jt} d \ln A_{jt}$, where the weights are gross output divided by GDP.

Table 17. Domar-weight decomposition of productivity growth (1994-2000)

	Value-Added			Total Factor Productivity		
Sector	V-A Weight	V-A Growth	Contribution to Aggregate V-A	Domar weight	TFP growth	Weighted TFP growth
Agriculture	0.194	0.109	0.021	0.315	5.036	1.586
Coal mining	0.013	0.057	0.001	0.031	2.589	0.077
Metal & nonm. mining	0.015	0.104	0.002	0.038	3.725	0.140
Oil and gas extraction	0.022	0.001	0.000	0.036	-4.603	-0.204
Construction	0.068	0.001	0.000	0.233	-3.158	-0.733
Food products	0.050	-0.010	0.000	0.183	-2.016	-0.367
Textile mill products	0.028	0.075	0.002	0.114	2.311	0.264
Apparel	0.014	0.028	0.000	0.052	-2.111	-0.107
Lumber and wood	0.003	0.154	0.001	0.011	0.135	0.004
Furniture and fixtures	0.005	0.135	0.001	0.019	1.906	0.036
Paper and allied	0.009	0.088	0.001	0.032	0.842	0.024
Printing, publishing	0.004	0.024	0.000	0.012	-0.210	0.000
Chemicals	0.038	0.055	0.002	0.147	-0.459	-0.029
Petroleum, coal prod	0.012	0.330	0.004	0.052	5.422	0.347
Leather	0.008	0.024	0.000	0.029	-0.929	-0.028
Stone, clay, glass	0.034	0.152	0.006	0.117	3.738	0.452
Primary metal	0.029	0.306	0.010	0.127	6.457	0.840
Fabricated metal	0.015	0.084	0.001	0.062	0.942	0.054
Machinery, non-elect	0.034	0.080	0.003	0.120	2.531	0.305
Electrical machinery	0.034	0.267	0.009	0.156	4.041	0.604
Motor vehicles	0.012	0.093	0.001	0.047	-0.033	0.002
Transportation equip	0.007	0.027	0.000	0.030	-1.311	-0.042
Instruments	0.003	0.129	0.000	0.009	3.797	0.034
Rubber and plastics	0.013	0.030	0.000	0.057	-0.451	-0.025
Misc. manufacturing	0.013	0.087	0.001	0.045	-0.689	-0.032
Transportation	0.038	0.055	0.002	0.071	-4.649	-0.325
Communications	0.015	0.255	0.004	0.026	0.240	-0.042
Electric utilities	0.023	0.036	0.001	0.055	-5.136	-0.278
Gas utilities	0.001	0.067	0.000	0.003	-1.844	-0.004
Trade	0.073	0.081	0.006	0.137	-0.895	-0.125
Finance, Insur, RE	0.052	-0.086	-0.005	0.091	-11.183	-1.016
Other private service	0.094	0.041	0.004	0.217	-2.360	-0.549
Public service	0.028	0.081	0.002	0.060	-0.541	-0.030
Aggregate weighted TFP growth	1.000		0.079	2.732		0.83

Note: The "weighted TFP growth" is the first term on the right of eq. (18), $D_{jt} d \ln A_{jt}$, where the weights are gross output divided by GDP.

Table 18. Growth in Aggregate Output and its Sources (Aggregate Production Function)

	1982-2000	1982-1984	1984-1988	1988-1994	1994-2000
Value added	8.29	11.12	7.73	7.28	8.74
Capital input	8.75	3.11	8.84	6.73	12.58
Labor input	3.89	3.73	4.66	3.41	3.91
Contribution to aggregate growth (eq. 14)					
Capital	4.57	1.72	4.83	3.58	6.33
Labor	1.83	1.66	2.11	1.59	1.94
Aggr. TFP	1.90	7.74	0.79	2.11	0.47
Contribution to aggr. TFP (eq. 18)					
Weighted sectoral TFP	2.70	7.48	2.78	2.92	0.83
--- Primary Industry	0.91	1.84	-0.55	0.89	1.59
--- Secondary Industry	2.10	3.67	2.71	1.94	1.60
--- Tertiary Industry	-0.31	1.96	0.62	0.08	-2.51
Reallocation of value added	-0.62	-1.38	-2.47	-0.53	0.78
Reallocation of capital	-0.17	1.80	0.48	-0.28	-1.15
Reallocation of labor	-0.02	-0.15	0.00	0.00	0.00

Table 19. Growth in Aggregate Output and its Sources (Aggregate Production Possibility Frontier)

	1982-2000	1982-1984	1984-1988	1988-1994	1994-2000
Value added	8.91	12.50	10.2	7.81	7.96
Capital input	8.75	3.11	8.84	6.73	12.58
Labor input	3.89	3.73	4.66	3.41	3.91
Contribution to aggregate growth (eq. 14)					
Capital	4.57	1.72	4.83	3.58	6.33
Labor	1.83	1.66	2.11	1.59	1.94
Aggr. TFP	2.51	9.12	3.26	2.64	-0.31
Contribution to aggr. TFP (eq. 18)					
Weighted sectoral TFP	2.70	7.48	2.78	2.92	0.83
--- Primary Industry	0.91	1.84	-0.55	0.89	1.59
--- Secondary Industry	2.10	3.67	2.71	1.94	1.60
--- Tertiary Industry	-0.31	1.96	0.62	0.08	-2.51
Reallocation of value added	0.00	0.00	0.00	0.00	0.00
Reallocation of capital	-0.17	1.80	0.48	-0.28	-1.15
Reallocation of labor	-0.02	-0.15	0.00	0.00	0.00