Productivity Growth of Chinese Economy by Industry

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1 Introduction

It is considered that the "Southern tour lecture" of Deng Xiaoping in 1992 has set a new stage for China's "Reform and Open" policy which started in 1978. Since then, especially in the 1990s, the GDP is growing very fast at the average annual rate of 10.5%[1].

However, the views of researchers are greatly divided over the forecast of "Socialist market economy" of China. One of such views forecasts a rather optimistic scenario of China's economy presuming in a naïve way that the recent trend of China's economy will last. Though it sounds a little too journalistic, *The Economist*, Britain journal, forecasts China's GDP (in the purchasing power parity base) will catch up with the United States' in 2010. And according to the annual reports of the World Bank, it is already supposed to have caught up with Japan at the year 1990. On the other hand, there are opposite views that point out various disturbing factors that exist in China. Some point out such problems in China's economic system as insufficient economic legislation, week financial system, and complicated tax system. Those indispensable systems for modern nation are not still well organized[2]. There are other problems including that economic policies change frequently[3] or that the economic policies decided at the central government are not necessarily working effectively at a local level. Some experts consider that the energy problem and food shortages that may occur with China's economic development might be a serious disturbing factor for world economy. Moreover, as typically stated in Krugman's paper "The Myth of the Asia's Miracle", some researchers forecast that the economic expansion of the Asian region will sooner or later be blocked. Their guess is that the increase of China's DGP growth is made by increase in inputs or rise of education level of labor as it used to be so in the Soviet Union, and that those things cannot last for a long time or can continue for only a short while.

As we see from the past experiences of Japan, the industrial structure has been upgraded mainly through the introduction of foreign technology from Western countries since the modern economic development has started in the beginning of 20th century. And it is generally recognized that Japanese economy has almost caught up with the western countries

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as to technology in 1970's, and now has come to the period of stable growth after that of high growth. It is known that the effect of technological progress has greatly contributed to the expansion of GDP during the high growth period, as to be mentioned later in this essay. If the high growth of China is to follow the same process, it is doubtful that the improvement of production efficiency has not really been accompanied with the high growth so far, as Krugman said.

Being a nation of planned economy, China has kept its economic data comparatively well among the developing countries. However, it is not sufficient to meet the international standard, for example, data on industry base are not easily available. As for researches on the growth of productivity by industry in China, we cannot find except Izumi et al(1999), though there are some research at macro level such as World Bank (1997), Shen~~Chin~~ (1999), and Ezaki and Sun (1999), etc. As an “Input Output Table on the fixed price base” has been first published by State Statistical Bureau[4], we will in this short essay take this opportunity to estimate the productivity growth by industry while reviewing the past discussions which comes round in the productivity of China. We will reconsider the engine of the economic growth of China, and make a forecast of Chinese economy accordingly.

The close examination of presumption, that is, to which extent the foreign capital contribute to the improvement of productivity, or what inter-industrial or inter-regional structures of the improvement of productivity are also should be discussed here, but we will reserve it for a further study.

First the relation between economic growth and technological progress is discussed in the following section 2; then the concept of "productivity growth" is closely discussed in the section 3. In section 4 and 5, the experiences of the U.S. and Japan are reviewed respectively, and the discussion of World Bank and of Krugman is summarized. And, the productivity growth rate by industry in China is estimated in section 6.

2 Economic Growth and Technological Progress

The history of the theory of economic development is long and can be traced back to the dispute between philosophy of “laissez faire”, where the economic development is assumed to be a natural law, represented by Adam Smith in Britain, and that of the infant industry protection theory by List of Germany in the beginning of the 19th century. After the “Economics” experienced the Marginal Revolution in the latter half of the 19th century, the center of economics moved to the theoretical economics[5] that stresses the adjustment function of markets, while the theory of economic development was losing its power.

However, when the Great Depression after the First World War attacked the world, classical market-oriented model of economics could not find a remedy to escape from the recession. Then Keynes developed a new theory, in which financial policy is important saying that unemployment could be decreased by governmental intervention to create demand for the goods market. Such Keynesian policy has become the prop of the economic policy

afterwards.

When the age of colonial system had come to end in middle of the 20th century, economics had been imposed a new problem of economic development of the developing countries (former colonies) and the theory of economic development came to attract economists' attention again. In the growth theory of Cambridge school (Harrod & Dormer theory) which follows the Keynesian, the balance between the natural rate of growth (equals the rate of working population increase + the rate of technological progress) and the warranted rate of growth (full capacity growth rate of capital, savings rate/capital coefficient)is needed. Economy is to grow faster if technological progress rate and the savings rate are high: The natural rate of growth does not necessarily correspond to the warranted rate of growth, and it is recognized that economic growth is originally unstable. As such is the standpoint, the macro-control by government is approved in the Harrod & Dormer theory.

On the other hand, neo-classical school that follows the classical theory also completed the dynamic growth theory (Tobin & Solow theory, neo-classical theory). The neo-classical theory considered that the combination of capital, labor, and output changes according to the relative price and is not fixed as Cambridge school presumes. In a word, though the demand for capital goods increases in the state of capital scarcity, since in the course of capital accumulation the marginal productivity of capital decreases while the capital price increase, the increase of the demand for capital is to stop before long, relatively low-priced labor will be substituted. And, the state of labor shortage is opposite to that. Consequently the neo-classical growth theory concludes that the relative price changes in the market so that the natural rate of growth and warranted rate of growth may balance, and the balanced growth will be realize in the long run.

Though views differ on the point economic growth being stable or not, both schools put importance to the improvement of productive efficiency, that is, technological progress in the economic growth. Moreover they also seem to share the common recognition that importing an advanced technology through introducing the foreign capital or other means can promote the economic development of developing countries[6]. Then, the factor of growth had become a controversial issue where arguments included to which extent the contribution of labor, capital equipment and technological progress, which were the factors to bring economic growth, explained the economic growth respectively, and how the technological progress rate was presumed.

3 Definition of Productivity Growth Rate

Though there is common recognition that growth of productivity is important for economic growth as described in the foregoing section, it is not same for the definition and the measurement method. Some of the definition and method of measurement for productivity growth rate are shown here.

First of all, let's begin with a method called “residual method”. This method obtains at first the aggregated input of production factors whose weights are the corresponding production elasticities, and then measures the growth of productivity as a difference of the growth rate of the output and the aggregated input.

The research of Solow (1962) and Denison (1967) were conducted by this method. The production function used in the rest error method is presumed here as follows:

(1) $Y = A \cdot F(x_1, \cdots, x_n)$,

Where, the amount of the output is stated as Y, the amount of i[th] input as $X_i, (i = 1, \cdots, n)$, and the parameter of efficiency as A. The production function shown by Equation (1) differentiated by time can be shown in the form of the rate of change as follows:

(2) $$\frac{dY/dt}{Y} = \frac{dA/dt}{A} + \sum_i \left(\frac{\partial F / \partial X_i}{F / X_i} \cdot \frac{dX_i / dt}{X_i} \right).$$

In Equation (2), it is shown that the rate-of-change of output (left side) equals to the sum of rate-of-change of efficiency (right side the first term) and the weighted average of the rate-of-change of the each input whose weight is its production elasticity (right side the second term). Supposing that the rate-of-change to be stated as a variable with dot (.) and that production elasticity to be as $\alpha_i, (i = 1, \cdots, n)$, equation (2) can also be written as follows. In the following equation, productivity growth rate is expressed by $\dot{A}$.

(2') $\dot{Y} = \dot{A} + \sum_i \alpha_i \cdot \dot{X}_i$ or, $\dot{A} = \dot{Y} - \sum_i \alpha_i \cdot \dot{X}_i$

As for using this expression, the problem we should solve is how to estimate the value of the production elasticity. Take Cobb=Douglas production function as an example.

(3) $Y = A \prod_i X^{\alpha_i}$,where $\sum_i \alpha_i = 1$

There are two ways to estimate the function. If Equation (3) is expressed in a linear logarithm form, it is clear that the exponent on each input is its production elasticity in this form of the function. Then the first way to estimate the production elasticity of input is to estimate statistically the coefficient parameters of the production function by directly using time series data, and then to assume the estimated value obtained to be production elasticity. The second way is an application of the marginal theory[7]. Supposing that the quantity of input is determined by the marginal theory, marginal productivity of an input equals to its real reward as is shown in the following condition. The price of output is expressed by p, the

price of i[th] input by $q_i (i = 1, \cdots, n)$.

(4) $$\frac{\partial Y}{\partial X_i} = \alpha_i \frac{Y}{X_i} = \frac{q_i}{p}$$

This condition can be rewritten in the condition that the exponent α_i of i[th] input in the production function is equal to the nominal share of the corresponding input.

(4') $$\alpha_i = \frac{q_i X_i}{pY}, (i = 1, \cdots, n)$$

Since the nominal share of each input can be calculated from ordinary national income statistics, it can be of use to estimate the parameter.

As we mentioned in the foregoing explanation of the residual method, it is necessary to note that the residual method requires a production function in some. On the other hand, there is a method where a specific production function is not assumed. In that method, such two indices as the output index and the aggregated input index are calculated, and then the difference between them is defined as the productivity index.

The researches of Kendrick (1961), Abramovits (1962), and Solow (1957) have taken such approach of index theory. This method has benefit that it requires the indices of output and aggregated input only. And such a concept might be called "Total Factor Productivity Change" or TFP change, meaning that it shows the change in overall productive efficiency and not that of the productivity of the specific input, i.e. "labor productivity" or "capital equipment productivity". If the aggregate function of inputs is regarded as a production function, it can be seen as same as the residual method and not necessarily needs to be treated separately, and a variety of estimate methods are proposed from the standpoint of the index theory in a series of discussions.

For instance, it is possible to use the fixed weight index of Laspeyres or that of Paasche and to define variable weight of Fisher by averaging them. Moreover, when the aggregate function is supposed to be a transformer log (quadratic function of the logarithm), it is known that the weight of the input corresponds to the average of nominal input share of the each input of the base and comparison year[8], which is often used in recent years.

4 Measurement of Productivity Growth Rate: Experiences of the United States and Japan

The economists we mentioned in the previous section found as a result of their proof research that technological progress accounts for most of the growth factor of American economy in postwar period, and since then it has come to be a common opinion that the role of technological progress is important for economic growth at least during the rapid growth period as we will see in this section.

However, it is necessary to note that Jorgenson and Griliches (1967) brought forward

the objection (Their research results shown on table 1). Their research covered the year 1945 to 1960, which can be called as the high growth period for the United States; it is stated that while the rate of technological progress had contributed to GDP growth considerably (it accounted for about half of 3.49%, that is, 1.60% of the growth rate of the gross domestic product) if estimated by a conventional method, however, if the method to estimate the capital and labor input and also the functional form for aggregating those inputs are revised, the contribution of productivity growth to GDP growth would become much smaller (the rate of technological progress would be 0.58% after the correction of capital input). In a word, according to their study, the productivity growth rate was an error that derived from the error in estimation. Table 1

Though it is necessary to note that there are controversies over method of the estimate of productive factor input and totaling of the input as this, the comparison of the data obtained by the same method between different periods and between economies will make some standard when trying to capture the importance of the productivity growth. Some of the preceding research on time-series comparison in Japan, and United States-Japan comparison concerning the productivity growth rate are reviewed in this section.

The estimate result of Japan Economic Research Center (1995) is shown on table 2. The capital accumulation accounted for 1.55%, which was about a half of the macro-economical growth rate of 3.30% during the prewar period, and then the contribution of productive efficiency came next holding 1.36%, which also accounted for considerable part though somewhat less in number. In the period of rapid growth during postwar days, the growth of technological progress accounted for 4.8%, which was more than the half of the GDP growth rate of 9.5%, while the effect of growth of productive factor input came up less than half. And during 1970 to 1990 after Japan has technologically to a certain extend caught up to the USA, the technological progress rate had decreased to 1.2% while the growth rate of GDP also had decreased to 4.3%. Table 2

Results from Kuroda(1992), the growth factor analysis of Japanese economy during the rapid growth, is shown on table 3. According to Kuroda, the GDP growth rate from 1965 to 1970 was the highest 11.798%; Technological progress contributed to the half, which was 5.482%, and then fixed capital contributed to rather high of 5.237%, somewhat less than technological progress. Though the previous period of 1960-65 was also at a high growth, the primary factor of the growth at this period was an accumulation of capital stock, and the technological progress did not give an important contribution to GDP growth. Table 3

The results from above-mentioned two studies have interesting findings in common. The first point is that the factor of technological progress was important as a growth factor in the period of high growth, and the second point is that the factor of capital accumulation played an important role during the time before the factor of technological progress rose. These two findings can be read that the preceding period of capital accumulation is needed for a certain duration in order that the technological progress may work as the growth engine.

Actually, we can see the similar phenomenon in Maddison's historical comparative research as the figures in Table 4 showing the result of his study (Maddison(1995)). The lower part of the table shows TFP annual growth rate of each country during the corresponding period. The most interesting is that we can find a negative TFP growth in the USA during 1829 to 1870 and in Japan during 1870 to 1930. And it seems that the TFP the growth in the UK before 1820 would be negative if we follow the UK TFP growth trend backward. This result suggests that the TFP growth in even so-called developed countries was negative or very low at least in the beginning of economic growth. Table 4

To close this section, let's take a look at the TFP growth comparison between the USA and Japan in recent years for reference. Ren (1999) estimated productivity change in Japan to compare with the US case given by Wolff (1997). As long as this Japan-U.S. TFP change comparison concerned, as we see in Table 5, it may ought to be seen that there was not a remarkable difference between the TFP growth rate between Japan and the US as generally believed to exist, though Japan surpassed a little over the US as for the average on the overall industry. Certainly, the TFP growth rate of Japan is higher in manufacturing. On the contrary, however, it is clear that the United States is higher in agriculture and in banking business. That is a proof that such Japan's globally competitive industrial sectors as steel, machinery and automobiles were eager to introduce new technologies from abroad to improve productivity, while the protected sectors like agricultures and service industries lost such an opportunity. Table 5

5 Two Views on the Economic Growth of East Asia

5-1 The East Asian Miracle (World Bank Report)

The World Bank published a report on the analysis of factors for the economic growth of East Asian nations, utilizing its database covering wide range of nations and regions including more than 110 countries. This report involves eight Asian countries (Japan, South Korea, Taiwan, Hong Kong, Malaysia, Singapore, Thailand, and Indonesia). In the report, the World Bank especially notes them as High Performance Asian Economies (HPAE), and the success of HPAE was explained with comparison to the countries of South America and Africa.

The World Bank presented the following five points as factors of HPAE's success:

(1) The high growth of Total Factor Productivity: The growth of productive efficiency was faster than South American and Sub-Saharan nations.
(2) Appropriateness of the public policies: The policy authorities had enough pliability to continue good policies and to abolish bad ones.
(3) The ingenuity of the export support policies: The macro stability policy and the micro incentive policy were well combined.
(4) The expansion of economic system: The redistribution of wealth was done effectively, economic bureaucracy as a professional group was established, and the government-

private cooperation system worked well for economic management.

(5) The rapid growth of human capital: Owing to the expansion of income and the decrease in population growth rate, the enhancement of human capital (education) was achieved. The policy emphasizing on education backed it up.

Here let us introduce the empirical analysis on TFP growth done by the World Bank. The World Bank presumes an interesting macro production function whose inputs consist of the capital equipment, the labor force, and human capital (education level, concretely and estimate production elasticity of each input by regression analysis. However, the next problem here is how to estimate the production elasticity of each input. Since the TFP growth is obtained by subtracting an increase in the aggregated input from an increase in the output, the figure of production elasticity, which is used as a weight in the aggregation of input, is critically important to estimate TFP growth. The World Bank estimated two kinds of production elasticity for the calculation in the report, i.e. those sampled from (i)all countries or (ii)high income countries[9]. As is shown in Table 6a, the production elasticity of high-income countries is bigger in the capital input and smaller in the labor input[10]. Table 6a and 6b

Table 6b shows the productivity growth rate of each country calculated on the basis of production elasticity shown in Table 6a. When the production elasticity estimated with a sample of all countries, the TFP growth in all Asian HPAE nations was much larger than those in South Africa and Sub-Saharan countries. On the other hand, when the high income nations were used as weight[11], though the TFP growth turned into a big minus in Singapore(to be mentioned later) and TFP growth was rarely found in Indonesia and Malaysia, as for Hong Kong, Japan and Taiwan, the TFP growth marked considerable large figures in a absolute value standard as well as in comparison with South Africa and Sub- Saharan Africa.

5-2 The Myth of the Asia's Miracle (Krugman)

While there is such an optimistic view as the World Bank's report, there are reverse ones, the most well-known of which is Krugman's "The Myth of the Asia's Miracle" meaning the Asian growth is no threat.

Krugman's discussion can be summarized as follows: After the World War II, the economic growth of Soviet Union was greater compared with the United States, and it came to be seen that a socialism system could be more efficient than the capitalism system if focused on the aspect of growth. It seemed that the United States feared under the pressure that the Soviet Union might defeat in even economic power as they had preceded in the technological development of satellite and missile. As it went on, however, it has became clear that remarkable economic growth of the Soviet Union was possible for a certain period just because they concentrated on capital accumulation for expansion for the manufacturing sector by mobilizing all the economic resources and labor force including women and

planning of consumption and saving. In short, it turned out that the threat of Soviet Union was not a threat in fact but which has already been known as a commonsense in economics. Krugman explained that this strategy would not work for a long term since the supply of labor force is limited and qualitative improvement of the labor (increase in human resources) happened for one time only. "There is not a miracle", he says as conclusion.

According to Krugman, the economic development of Asian nations was basically the same as that of the Soviet Union, which in a word was all resource mobilization type, and the improvement of productivity (improvement of technological standard or the accumulation of knowledge) was not seen so much. Then, as for the secret that the growth of the Asian economy had continued for considerably a long term though it was just a all resource mobilization, Krugman ascribed it to "the mind that can put off satisfaction = the mind to save and invest" as conclusion. As his discussion is based on the research by Young (1992,1994) and by Kim and Lau(1994), let us review them here.

First, take a look at the research by Young. Young (1992) covered Hong Kong and Singapore, with the conclusion that the capital accumulation was a primal factor in the economic development of Singapore and the improvement of efficiency was not seen. His conclusion is shown on Table 7. As to the case of Hong Kong, the technological progress accounted for large part in the economic growth and it contributed to economic growth for more than half especially for the period of the year 1986 to 90. On the other hand seen in Singapore, the improvement of productive efficiency was hardly seen before 1985. It is worth taking note that improvement of productive efficiency was seen after 1985, though. Table 7

Now let us see the other research by Young: Young(1994) is titled "The Tyranny of Numbers", which means "You can't make objection since the figure itself is the proof". Its results are shown on Table 8. This paper focuses on the so-called Four Tigers of Asia, namely Hong Kong, Singapore, South Korea, and Taiwan, and estimates the average annual TFP growth rate during 1966-90, where the estimation of Elias(1990) as to South American countries and Christensen (1980) as to the advanced countries were quoted for the comparison. Though there is the problem that the paper does not clarify how the referenced results were estimated, Young valued them on the whole saying "the TFP growth of NIEs is not higher than that of South African nations and does not surpass what the advanced countries had experienced, either". Table 8

Then the research by Kim and Lau(1994) is shown on Table 9. Their research was a comparative study of TFP growth by estimating the production function of Asian NIEs and the advanced nations. They concluded that Korean and Taiwanese productivity has decreased slightly in a relative ratio to the United States even though they themselves admit the problems in their research that they had presumed the capital stock as a simple summation of gross investment (where depreciation was not correctly measured) and that they had not considered the human capital stock which was said to be accumulated remarkably in Asian

NIEs. Table 9

Krugman also pointed out regarding the current day Japan that it was impossible for Japan to have caught up with Europe and America without a large-scale investment almost twice the United States in the ratio against GDP. That means not TFP growth but the capital accumulation worked greatly to push up the GDP. Considering the current Japan where there was not much improvement of efficiency, he concludes the Japanese GDP per-capita might hardly exceed that of the United States.

As for China, Krugman also insists as follows without a data to back up his discussion: If the period after 1978 only was used as a sample, since the productivity was surely decreased considerably in the period of Cultural Revolution, the TFP growth would be observed as well as the input increase. if the former year of 1964 was used as a starting point, however, improvement of productivity efficiency would be as much as that of NIEs (i.e. insignificant), Krugman says.

5-3 Why opinions differ?

It is necessary to keep in mind that the results differ depending on the selection of weights used (in other words, estimated value of the production elasticity), as represented in the estimate by World Bank. The fact is that one cannot place excessive trust in economic data. To declare “The Tyranny of Numbers” (The figure will not tell a lie) might be problematic. And the other problem lies in a method of estimating the capital stock. We must admit that to measure a capital stock is the most difficult step in empirical studies. For instance, it might be considerably difficult to reflect in the amount of the capital stock accurately that the computers are improving in the performance as the prices are becoming cheaper.

Now, does Krugman’s view really differ so much from the World Bank’s? It seems to me that the titles of their report, one of which reads ”The East Asian Miracles” by the World Bank and the other “The Myth of the Asia’s Miracle” by Krugman, attracted our attention and gave us the impression that their contents were opposed. The discussion of Krugman can be summarized as follows: “Though it is said that the growth of Asia is a miracle, however, the truth is that it is just as same as what the advanced countries have experienced (in the sense that they will follow the same process, i.e. take off period - high growth period - stable growth period), and that it is not necessary to be afraid that Asia will conquer the world”. On the other hand, the report of the World Bank seems to be made with the intention “to find a reason why some of the East Asian nations are in the period of high growth and that it lasts so long”. Needless to say, it is also shown in their report that the capital accumulation with the high savings rate is important as to the high growth of East Asian nations. However, the interpretations concerning the productivity growth differ. The productivity growth rate in the East Asian nations is estimated based on a certain level higher than standard leaving aside

Singapore[12]. It seems that the difference is just that World Bank gave positive evaluation, and Krugman referred to it as just same as the experience of advanced countries. Considering unavoidable error in the estimation of the productivity growth, we feel it is not constructive to discuss the figure alone and rely on it too much, just as it is expressed as "The figure will not tell a lie"

6 The Productivity Growth in China

6-1 Preceding Studies

Productivity growth in China at macro base was estimated by Ezaki (1999), the World Bank (1997) and Shen(1999).

First of all, let's take the estimated result of the World Bank shown on Table 10. In the World Bank's research, three factors, which are capital equipment, labor, and human capital stock are used as the inputs as we have already mentioned before. As for the factor of economic growth, the share of the effect of an increase of the inputs and of technological progress is about at a ratio of 7:3 as shown in the right side on Table 10, and the result had not significant difference compared with Japan, the U.S.A and South Korea. Table 10

And next, in the study by Chin he first estimates some types of production functions explained by capital and labor and the productivity growth and assumes that the production elasticity of both capital and labor were about 0.5 each. Shen~~Chin~~ evaluates this result as China's production elasticity is large in capital equipment and small in labor compared with estimate of advanced countries. This relates that the marginal productivity of capital in China is large since the level of the capital accumulation is still small in China. As we see in Table11, according to his study, the contribution of technological progress to the China's economic growth has become larger every year, and has exceeded 40% is in 1990's, while the contribution of increase in labor force and capital equipment has decreased on the contrary. Table 11

The research result by Ezaki is shown on Table 12. In his research, Ezaki adopted his original method to estimate capital stock data[13] since it is impossible to get official data regarding the capital equipment stock. Though there might be an estimate error, the result turned out roughly as same as that of Chin. Table 12

These results evaluate a role of technological progress in the economic growth of China positively, suggesting that China is promoting the improvement of productive efficiency by using technological import from foreign countries as a lever just as Japan used did. However, these estimates were done at macro level (GDP level), and the other effects that were not directly related to the productivity improvement of each enterprise, such as changes in industrial structure, were included. In the next section, we will look into the issue which industry has mainly brought such a result, and reinforce the above-mentioned hypothesis.

6-2 Estimation by Authors

In this section, we estimate productivity changes of china's such eight industries[14] as agriculture, mining, manufacturing, the electric power, construction, the transportation & communication, commerce & others. It was compiled by using four of input-Output tables in 1981, 1987, 1990, 1992, and 1995[15]at constant price of the year 1990. As already mentioned in the previous section, there are a few methods to estimate TFP growth. The function we used here to aggregate inputs was trans-log method[16] and the productivity growth is defined as difference between the production index and the input index.

Our estimation of TFP growth is based on the trans-log production function, i.e. a quadratic function of logarithm.

$$\begin{aligned} \ln Y &= \textit{quadratic } F(\ln X_i, \ln L, \ln K) \quad (i = 1, \cdots, n) \\ &= F(\ln X_i, \ln X_i \cdot \ln X_j) \quad (i, j = 1, \cdots, n, n+1, n+2) \end{aligned} \tag{5}$$

where n+1 th and n+2 th inputs are respectively labor and capital. Since the trans-log production function is a quadratic function, we can use the quadratic lemma and the growth of output from the period 0 to 1 can be defined as follows.

$$\begin{aligned} \ln Y_1 - \ln Y_0 &= \frac{1}{2}\sum_i \left(\frac{\partial \ln Y_1}{\partial \ln X_{1i}} + \frac{\partial \ln Y_0}{\partial \ln X_{0i}} \right) (\ln X_{1i} - \ln X_{0i}) \\ &= \frac{1}{2}\sum_i \left(\frac{X_{1i}}{Y_1}\frac{\partial Y_1}{\partial X_{1i}} + \frac{X_{0i}}{Y_0}\frac{\partial Y_0}{\partial X_{0i}} \right) (\ln X_{1i} - \ln X_{0i}) \end{aligned} \tag{6}$$

If we can apply the marginal theory to China, Equation (6) is to be as follows:

$$\begin{aligned} \ln Y_1 - \ln Y_0 &= \frac{1}{2}\sum_i \left(\frac{X_{1i}}{Y_1}\frac{q_{1i}}{p_1} + \frac{X_{0i}}{Y_0}\frac{q_{0i}}{p_0} \right) (\ln X_{1i} - \ln X_{0i}) \\ &= \frac{1}{2}\sum_i (w_{1i} + w_{0i})(\ln X_{1i} - \ln X_{0i}) \end{aligned} \tag{7}$$

or,

$$\ln\left(\frac{Y_1}{Y_0}\right) = \frac{1}{2}\sum_i (w_{1i} + w_{0i}) \ln\left(\frac{X_{1i}}{X_{0i}}\right), \tag{7'}$$

where symbol p and q are respectively an output and input prices, and w is a nominal input share of each input. Since $\ln(1+x) \approx x$, Equation (7) states that the growth rate of the output is the same as the weighted average of each input with the weight of corresponding nominal input share, as far as the shape of the production function is unchanged. However, the shape of production function usually changes overtime and the equality in Equation (7) does not hold in the real data. We therefore define the difference between the left hand side and the right hand side is that caused by efficiency change. To say nothing of it, if the left hand side was lager, this is because of the efficiency improvement.

Table 13 shows the estimated results. Table 13a is for 1981 to 1987, Table 13b is for 1987 to 1990, Table 13c is for 1990 to 1992, and Table 13d is for 1992 to 1995, where the figures in the table show the average annual growth rate. Table 13

Summary from the results are as follows:

(1) Before evaluating our estimated results, we want to point out the grow rate of capital input seem to be too large in almost all industries[17]. Therefore, we think that our method to estimate the real depreciation has a problem and the result we show here would be tentative.

(2) Even though the data we used is not necessarily reliable, there is a tendency for TFP to increase. Though the average TFP growth among the overall industry was not seen much in the period before 1990, it has actually expanded, e.g. 0.29% in 1981-87, -0.06% in 1987-90, 0.56% in 1990-92, and 3.80% in 1992-95. This trend of change was similar to the results of the above-mentioned studies at macro base.

(3) The TFP of energy and service sector is negative. It is hard to imagine that the TFP of such sectors as Electricity, Coal Products, and Petroleum Products decreases with such a large negative rate. It seems that the data sets we used have a problem.

~~(3)~~(4) As for the factors that explain output growth in China, generally speaking, the effect of increase in intermediate inputs was the most significant in every period. In this sense, Krugman's view that "Expansion of output in East Asian countries depends mostly on the expansion of inputs" was not wrong.

(5) The TFP growth of Agriculture sector was positive in every period.

(6) The growth of productivity was observed mainly in light manufacturing such as Wooden Products, Textiles & Leathers and Paper Products.

~~(6)~~(7) The growth of TFP was observed also in Machinery sector including electric machinery and automobiles. As is well known, a lot of foreign capital flows in such sectors. We dare say, therefore, China's machinery sector grew faster along with introduction of new technologies from foreign countries.

(8) In the E~~e~~lectricity, Other Services and the Transportation & Communication, the effects of the intermediate inputs and the increase of capital stock were large, and the productivity was not improved.

7 Some Concluding Remarks

In this short essay, the significance of the improvement of productivity (in other words, technological progress) in economic growth was confirmed through reviewing preceding empirical researches. However, there is also another view that no efficiency improvement is observed in Asian economic growth. Based on the information we have obtained from those researches, we tried to estimate TFP growth by industry in Chinese economy of recent ten-odd years.

We think we could confirm the following, though it is necessary to take note that there

might be errors between the data and realities:

(1) It can be said that the difference between an optimistic theory such as World Bank's and pessimism such as Krugman's lies only in whether to regard the estimated figure as large or small. The former views that Asian NIEs has improved productivity by the same degree (in a word large enough) as the advanced countries had experienced, and the latter thinks the technological progress of Asian NIEs was not so surprisingly large as expressed as "miracle" and can be guessed from the experiences of the advanced countries.
(2) In fact, when some studies concerning the productivity improvement of China by the macro base are examined, the contribution of productivity to the economic growth is not small compared with the advanced countries. And, it seems that the contribution of productivity improvement to GDP growth has been growing in recent years.
(3) Indeed, defining TFP growth in China by gross output base, the largest contribution to the increase of output is the increase of the intermediate inputs, and it might be called "total mobilization of the resources" type in a sense as Krugman says. However, the economic growth of the advanced countries experienced also more or less the same situation in the beginning of the economic growth as Maddion(1995) pointed out.
(4) When we consider the increasing tendency of the TFP growth, the economic growth of China has been promoted mainly in Light Manufacturing and Machinery sector.
(5) Though there are some exceptions such as Energy industries and the Transportation & Communication, the effect of the productivity improvement to enlarge the output is growing as a common characteristic.

When we see the growth factors of Chinese economy from the supply side, the results are summarized above. Considering the fact that the capital accumulation has been in progress and the improvement of productive efficiency seems to improve, it seems that there is not a big kink in the supply trend on the supply side. However, I would like to add that the economic growth is not decided only by the supply capacity but also the trend on the demand side that is also important.

It is known that inventory stock increase that accounts for increase in the final demand is incredibly large in China compared with the capitalism countries' standard. Therefore, the expansion of the supply may have to stop for a while since an atmosphere of the overproduction (deflation tendency) is emerging in the current economic condition.

This stagnation in the current situation might develop into the financial crisis or lead to withdrawal of the foreign capital, which happened in Thailand and South Korea, since the macro safeguard will not work easily in Chinese economic system. Again, I would like to stress that the current situation and the improvement of productive efficiency (expansion of supply capacity) have different points for argument; consequently even if the current situation of Chinese economy is not good, the argument that "The growth of Chinese economy might

have been a myth" is not to deny the conclusion of this short essay.

Neither the relation of the productivity improvement and the foreign capital nor the mutual relation among industries or inter-regional extension is referred in this essay as mentioned at the beginning. We will discuss to them in another chance for further study.

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Data Appendix

1. Input Output Tables

As main data, we used 18 sectors linked IO tables carried in Li Qiang and Xue Tiandong eds (1998) that re-evaluates ordinary current price tables to those in constant price of the year 1990.

Li Qiang and Xue Tiandong eds (1998), *Analysis of Chinese Economic Development*

by sector -with Newly Compiled 1981-95 Linked Input-Output Tables in Constant Price-, China Statistical Publishing House.

However, since these link tables unfortunately do not have rows of individual value added items, we calculated (nominal) value added items by aggregating the following current price tables into the same 18 sectors.

State Planning Commission~~of China~~ and State Statistical Bureau (1986), *Input-Output Tables of China 1981*, China Statistical Publishing House.

State Statistical Bureau ~~and Office of the National Input-Output~~(1991), *Input-Output Tables of China 1987*, China Statistical Publishing House.

———(1993), *Input-Output Tables of China 1990*, China Statistical Publishing House.

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———(1997), *Input-Output Tables of China 199*5~~2~~, ~~China Statistics Press~~ China Statistical Publishing House.

As for constant price depreciation of fixed capital by industry, we estimated them by deflating the nominal depreciations in current price tables. We assumed the deflators of depreciation to be the weighted average of deflators by sector with weight of nominal share in the fixed capital formation, or investment, though we know this method is not necessarily suitable to obtain real capital consumptions. Needless to say, output deflators by industry are defined as a ratio of the nominal total output and the real total output. However, since the current price IO table for 1981 was made up based upon MPS and it does not include the row and column of service sector as SNA type IO tables does. We, therefore, could not estimate the (both real and nominal) depreciation in 1981of service sector.

2. Labor Force

As for employed persons by sector, we used “Number of Employed Persons by Sector” in *China Statistical Yearbook*. In the case the sector classification in the Yearbook is rougher than that in input-output tables, we distributed the figure in the Yearbook, with the same proportion as personal income in input-output tables, to the corresponding sectors.

State Statistical Bureau(1991),*China Statistical Yearbook 1991*,~~China Statistics Press~~ China Statistical Publishing House.

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1 Growth rate during 1991 to 1998. China Statistics Yearbook, 1999 editions.

2 The incompleteness of the legal and the financial system is apparent in the following case: according to the interviews which a research group in Osaka University of Economics did at Dalian China in November 1999, it is virtually impossible for private companies to receive financing from commercial banks except they have enough confidence and connections with politicians and/or bureaucrat, and this situation interferes with the promotion of the private companies. The banks may not be able to afford private companies as they hold the bad debt for the state enterprises, though. Moreover, it is found that a lot of non-banks (sponsored by government-owned banks) also are holding a large sum of bad debt. According to Asahi Newspaper dated January 9, 2000, the Supreme People's Court has put out the notice that they will not accept the appeal concerning the default that the creditors of non-banks (e.g. those in Japan) may bring. Considerable amount of loans from the Japanese financial institutions seem to remain uncollected.

3 For instance, as for the value added tax, the government repeatedly changed their policy whether they admit the export exemption to the foreign-affiliate firms.

4 Li Qiang and Xue Tiandong (1998).

5 The marginal revolution was developed by Marshall of Cambridge, Mengar of Wien, and Walras in Lausanne. Simply put, it tries to explain the subjective value by the scarcity. After the Keynesian revolution, Samuelson advocated the economics that runs after two hares, that is, the optimum allocation of resources (classical economics) and full employment policies (Keynesian economics) and it was called "Neo-classical synthesis". Since then the economics that incorporates the ideas of the marginal revolution has been called neo-classical economics.

6 The theory of economic development has been restored to modern ideas by Rostow(1960) and others in the cold war period of postwar days. According to Rostow, the economic development will go through the process that can be put as traditional society → take-off period → mature stage → mass consumption age. He regarded the take-off period especially important and assumed that it required as necessary condition that the rapid expansion of the productive capacity by fluidizing the capital in order for economy to take off. So it was considered that the factors such as change of income policy, the capital concentration by tax increase, increase of the export of primary commodity, introduction of foreign capital, and the establishment of monetary systems were required in order for the rapid expansion to be achieved. And, it was considered that these were often caused by exogenous factors such as a political revolution and help from foreign countries, etc.

7 In the marginal theory, when an enterprise wishes to get the maximum profit in a given price structure (where perfect competition is assumed), it only has to input the factor of production to make marginal productivity and the substance reward even. However, the sufficient condition where a profit maximum point exists is the case where both the marginal productivity of each factor and the harvest for the scale diminish successively. In fact, the linear homogeneous production function (or whose harvest is constant for the scale) does not meet this requirement. When the linear homogeneous production function like Cobb=Douglas' is used, the element such as the capital stock is assumed to be a fixed element (so that the sufficient condition of the maximum profit is met), and the demand for other elements are available from the marginal condition. Considering the remainder distributed to these elements is a reward to the capital stock,

the expression of the same form as the marginal condition is consequentially obtained from Euler's theorem as for a capital input. However, it needs to be kept in mind that the expression has no meaning as the demand function of the capital stock.

8 This index is called Translog index.

9 According to the definition of World Bank which evaluated by the gross domestic product per person in 1991, low-income nations refer to the countries with less than 635 dollars and the middle-income countries refers to the one with between 635 and 7911 dollars and the high-income nations refers to the one with more than 7911 dollars.

10 However, on the other hand, we may feel this result is not parallel with our economic common sense that the production elasticity of capital might be large in a country like developing countries where the capital stock is relatively scare.

11 Again, it is meant that the weight of capital equipment to be increased, and the weight of the input of labor to be decreased.

12 In the estimate of all of their researches, it is doubtful that there was a significant improvement of productivity in Singapore.

13 In his research, strangely enough, the technological progress rate has been given tentatively beforehand and the stock of capital equipment was then estimated as solution of the reverse function. It seems paradoxical to use the capital equipment in order to estimate the technological progress rate again.

14 The production means all of the production where the additional value and the middle input are added, and the concept of productivity corresponds to it in the estimate in this essay.

15 Therefore, the factors decomposition analysis of economic growth covers such four periods as 1981 to 1987, 1987 to 1990, 1990 to 1992 and 1992 to 1995.

16 As already mentioned, the weight for aggregation is taken from the average of the base year and the comparison year of the nominal input shares.

17 Since 1978, definition of the depreciation in China changed frequently as that the value of depreciation may increase. As a result, growth rate of the capital consumption may be overestimated in our calculation.

Table 1: Growth factor analysis of the United States by Jorgenson and Griliches

	Average Annual Growth Rate (%, 1945-1965)		
	(A) Total Output	(B) Total Input	(C) Technological Progress
Based on the old method	3.49	1.83	1.60
After the total production corrected	3.59	1.84	1.49
After Capital goods value corrected	3.59	2.12	1.41
After the correction made by operation rate	3.59	2.57	0.96
After capital input corrected	3.59	2.97	0.58
After labor input corrected	3.59	3.47	0.10

Source: Jorgenson and Griliches (1967). As it is an average of 20 years, the total of (B) and (C) do not equal to (A).

Table 2:Growth factor analysis of Japanese economy by Nihon Keizai Kenkyu Center (Annual Growth Rate (%))

	1885-1940	1955-1970	1970-1990
Growth rate of NNP	3.30	9.5	4.3
Contribution of capital	1.55	3.3	2.4
Contribution of labor	0.39	1.4	0.7
Contribution of technological progress	1.36	4.8	1.2

Source: Nihon Keizai Kenkyu Center (1995)

Table 3:TFP growth rate of Japan by Kuroda (Annual Average (%))

	60-65	65-70	70-75	75-80	80-85
Growth rate of added value labor	9.725	11.798	4.733	3.784	3.896
Contribution of labor	1.397	1.079	-0.075	1.154	0.953
Contribution of the capital	5.349	5.237	3.792	1.925	2.047
Contribution of technological progress	2.979	5.482	1.016	0.704	0.895

Source: Kuroda (1992)

Table 4 Comparative Growth Performance of the USA, UK, and Japan, 1820-1992 by Maddison

		1820-1870	1870-1913	1913-1950	1950-1973	1973-1992	1820-1992
GDP	USA	4.22	3.94	2.84	3.92	2.39	3.61
	UK	2.04	1.90	1.19	3.00	1.59	1.89
	Japan	0.31	2.34	2.24	9.25	3.76	2.77
TFP	USA	-0.15	0.33	1.59	1.72	0.18	0.63
	UK	0.15	0.31	0.81	1.48	0.69	0.57
	Japan	na	-0.31	0.36	5.08	1.04	1.38

Source Maddison(1995)

Table 5:United States-Japan comparison of TFP growth rate by Ren and Wolff (Average annual growth rate (%))

Industry	Japan (1960-90)	The United States (1958-87)	Japan-U.S. difference
Agriculture	-0.45	1.14	-1.59
Mining	2.21	-0.36	2.57
Manufacturing	0.91	0.64	0.27
Construction	0.49	-0.23	0.72
Public Utility	-0.04	-0.26	0.22
Commerce	1.31	1.04	0.27
Finance and real estate	-0.41	0.45	-0.86
Transportation	0.77	1.13	-0.36
Communication	1.53	0.22	1.31
Others	-0.63	-0.50	-0.13
Total	0.63	0.37	0.26

Source: As for Japan by Ren(1999) and the United States by Wolff (1997).

Table 6a:Estimate of production elasticity by World Bank (1960-90)

Samples	Fixed capital	Labor force	Human capital
All samples (2,093)	0.178	0.669	0.154
High income nations (460)	0.399	0.332	0.269

Table 6b:Estimate of TFP Growth by World Bank ((%) 1960-90)

Industry	All samples weight	High income nation weight
Hong Kong	3.6470	2.4113
Indonesia	1.2543	-0.7953
Japan	3.4776	1.4274
South Korea	3.1020	0.2335
Malaysia	1.0755	-1.3369
Singapore	1.1911	-3.0112
Taiwan	3.7604	1.2829
Thailand	2.4960	0.5466
South America	0.1274	-0.9819

Sub Sahara	-0.9978	-3.0140

Source: World Bank (1994);'Human capital' refers to the education standard index.

Table 7:Comparison of Hong Kong and Singapore by Young

Hong Kong	Growth rate of GDP	Labor share	Capital share	Technological progress share
1971-76	0.406	27%	36%	36%
1976-81	0.512	30%	40%	30%
1981-86	0.294	19%	55%	26%
1986-90	0.260	8%	38%	54%
Singapore	Growth rate of GDP	Labor share	Capital share	Technological progress share
1970-75	0.454	24%	122%	-47%
1975-80	0.408	28%	68%	4%
1980-85	0.300	12%	101%	-13%
1985-90	0.383	35%	33%	31%

Source: Young (1992); the growth rate of the gross domestic product shows the average annual growth rate during the period (4 or 5 years).

Table 8: Comparison of increase rate of TFP among Asia, advanced countries, and Latin America by Young (Average per year)

Developing countries	Period	Annual rate	Advanced countries	Period	Annual rate
Hong Kong	1966-91	2.3%	Canada	1947-73	1.8%
Singapore	1966-90	- 0.3%	France	1950-73	3.0%
South Korea	1966-90	1.6%	West Germany	1950-70	3.7%
Taiwan	1966-90	1.9%	Italy	1952-73	3.4%
Argentina	1940-80	1.0%	Japan	1952-73	4.1%
Brazil	1950-80	2.0%	Netherlands	1951-73	2.5%
Chile	1940-80	1.2%	Britain	1955-73	1.9%
Colombia	1940-80	0.9%	The USA	1947-73	1.4%
Mexico	1940-80	1.7%			

Source: Young (1992) As for the advanced countries quoted from Christensen et al (1980) and as for South America quoted from Elias(1990).

Table 9:Technological progress rate in each country by Kim and Lau

Country	Period	Technological progress rate
Hong Kong	1966-90	2.4%
Singapore	1964-90	1.9%
South Korea	1960-90	1.2%
Taiwan	1953-90	1.2%
France	1957-90	2.6%
West Germany	1960-90	2.2%
Japan	1957-90	2.9%
Britain	1957-90	1.5%
The USA	1948-90	1.5%

Source: Kim and Lau(1993)

Table 10: Comparison of increase rate of TFP among China, US and South Korea by World Bank

Country	Period	Average annual growth rate (%)				Factor share (%)	
		GDP	Capital equipment	Human capital	Labor force	Input	Technological change
China	1978-95	9.4	8.8	1.6	2.4	71	29
The USA	1950-92	3.2	3.2	1.1	1.6	65	35
Japan	1960-93	5.5	8.7	0.3	1.0	70	30
South Korea	1960-93	8.6	12.5	3.5	2.4	79	21

Source: World Bank (1997)

Table 11: Estimate of TFP rate of increase in China by Shen

	Growth rate of GDP	Labor share	Capital share	Technological progress share
1953-78	6.1%	23.7%	73.8%	2.5%
1979-90	9.0%	19.4%	44.4%	37.2%
1991-97	11.2%	10.3%	46.4%	43.3%

Source: Shen (1999)

Table 12: Estimate of TFP Growth in China by Ezaki and Sun

	Growth rate of GDP	Labor share	Capital share	Technological progress share
1981-85	10.8%	16%	44%	40%
1986-90	7.9%	17%	72%	11%
1991-95	12.0%	8%	41%	50%

Source: Ezaki abs Sun(1999)

Table 13a: Factor analysis of growth of production calculated by trans-log index 1981-87

1981-1987	Annual Growth Rate (%)				Contribution to Output Growth (%)				
	Output	Int. Inputs	Capital	Labor	Output	Int. Inputs	Capital	Labor	TFP
01 Agriculture	7.39	9.88	38.96	1.00	7.39	3.37	0.85	0.63	**2.54**
02 Metal Products	11.43	12.68	35.74	4.08	11.43	10.61	2.89	0.33	**-2.41**
03 Electricity	9.61	12.71	32.33	8.35	9.61	8.71	7.50	0.69	**-7.29**
04 Coal Products	7.35	10.57	36.28	3.56	7.35	5.31	6.19	1.16	**-5.31**
05 Petroleum Products	7.13	8.58	28.57	-4.97	7.13	6.82	4.64	-0.21	**-4.11**
06 Chemicals Products	14.66	13.42	37.07	10.10	14.66	11.52	2.54	0.74	**-0.14**
07 Machinery	19.47	17.79	32.84	5.78	19.47	14.37	2.03	0.75	**2.31**
08 Clay & Ceramics	14.01	14.41	50.90	12.18	14.01	10.12	4.13	2.64	**-2.88**
09 Wooden Products	10.93	15.13	17.99	-13.93	10.93	10.70	0.92	-3.37	**2.68**
12 Food Processing	13.02	11.47	39.82	6.94	13.02	10.64	0.95	0.34	**1.09**
11 Fibers	11.83	11.27	39.03	7.62	11.83	10.14	1.11	0.55	**0.04**
12 Textiles and Leathers	12.36	10.63	39.86	6.36	12.36	9.23	0.80	0.71	**1.62**
13 Paper Products	18.94	18.37	38.71	7.70	18.94	15.18	1.60	1.02	**1.15**
14 Miscellaneous Products	-0.17	-2.49	3.79	-20.86	-0.17	-2.00	0.18	-3.05	**4.70**
15 Construction	15.41	16.87	32.23	14.50	15.41	12.82	0.93	3.06	**-1.40**
16 Trans & Communication	15.25	17.98	38.53	9.91	15.25	8.31	9.53	2.88	**-5.47**
17 Trade	23.68	26.53	28.36	9.30	23.68	15.24	2.16	3.25	**3.03**
18 Other Services	12.53	14.17	---	6.14	---	---	---	---	---
Total	12.95	14.19	40.11	3.02	12.95	9.53	2.31	0.82	**0.29**

Table 13b: Factor analysis of growth of production calculated by trans-log index 1987-90

1987-1990	Annual Growth Rate (%)				Contribution to Output Growth (%)				
	Output	Int. Inputs	Capital	Labor	Output	Int. Inputs	Capital	Labor	TFP
01 Agriculture	5.07	8.91	-2.41	2.52	5.07	3.27	-0.05	1.54	**0.31**
02 Metal Products	7.22	11.92	0.20	3.19	7.22	10.30	0.01	0.22	**-3.32**
03 Electricity	7.23	17.84	11.04	1.00	7.23	13.15	2.08	0.07	**-8.08**
04 Coal Products	10.02	21.09	-5.94	3.38	10.02	11.86	-0.83	1.01	**-2.02**
05 Petroleum Products	6.75	12.06	4.47	7.43	6.75	10.03	0.60	0.25	**-4.13**
06 Chemicals Products	12.92	12.69	8.20	1.66	12.92	11.07	0.48	0.11	**1.25**
07 Machinery	12.57	10.10	4.52	-1.58	12.57	8.58	0.21	-0.16	**3.94**
08 Clay & Ceramics	17.22	18.99	12.97	4.00	17.22	14.15	1.03	0.70	**1.34**
09 Wooden Products	11.76	7.24	9.51	-4.26	11.76	6.00	0.39	-0.56	**5.93**
12 Food Processing	6.66	3.49	15.13	0.45	6.66	3.22	0.43	0.02	**2.99**
11 Fibers	6.86	7.33	11.43	0.03	6.86	6.52	0.39	0.00	**-0.05**
12 Textiles and Leathers	18.24	13.65	20.35	1.91	18.24	11.82	0.50	0.21	**5.71**
13 Paper Products	14.63	13.04	16.90	1.29	14.63	11.10	0.67	0.14	**2.72**
14 Miscellaneous Products	50.52	46.84	33.31	21.98	50.52	39.85	1.36	2.38	**6.92**
15 Construction	-1.57	-0.37	-1.74	0.56	-1.57	-0.29	-0.04	0.11	**-1.35**
16 Trans & Communication	10.31	23.13	5.64	2.53	10.31	12.63	1.02	0.69	**-4.03**
17 Trade	0.23	5.64	-1.49	3.29	0.23	3.89	-0.06	0.88	**-4.48**
18 Other Services	4.44	7.59	14.14	3.63	4.44	3.94	1.96	1.24	**-2.70**
Total	7.31	9.16	7.03	2.33	7.31	6.41	0.39	0.57	**-0.06**

Table 13c: Factor analysis of growth of production calculated by trans-log index 1990-92

1990-1992	Annual Growth Rate (%)				Contribution to Output Growth (%)				
	Output	Int. Inputs	Capital	Labor	Output	Int. Inputs	Capital	Labor	TFP
01 Agriculture	5.02	6.02	22.77	0.99	5.02	2.32	0.48	0.59	**1.63**
02 Metal Products	16.87	16.45	33.53	7.06	16.87	14.31	2.00	0.50	**0.06**
03 Electricity	15.23	14.46	47.93	20.33	15.23	10.46	9.77	1.48	**-6.48**
04 Coal Products	4.85	11.06	29.31	-8.65	4.85	6.85	3.33	-2.31	**-3.02**
05 Petroleum Products	4.72	11.84	42.63	17.48	4.72	9.72	5.96	0.68	**-11.64**
06 Chemicals Products	21.68	17.37	25.00	4.92	21.68	15.17	1.47	0.34	**4.71**
07 Machinery	29.61	26.26	23.09	7.16	29.61	22.57	0.97	0.70	**5.36**
08 Clay & Ceramics	22.00	19.85	16.10	-2.84	22.00	15.36	1.17	-0.44	**5.92**
09 Wooden Products	20.33	18.99	15.18	-13.07	20.33	16.11	0.65	-1.43	**5.01**
12 Food Processing	11.96	13.20	29.72	-2.49	11.96	12.09	1.07	-0.12	**-1.08**
11 Fibers	16.86	14.76	20.45	-2.87	16.86	13.11	0.75	-0.22	**3.21**
12 Textiles and Leathers	27.92	29.45	29.92	6.29	27.92	25.71	0.81	0.63	**0.77**
13 Paper Products	20.90	18.62	22.03	5.33	20.90	15.83	0.94	0.57	**3.56**
14 Miscellaneous Products	42.09	37.80	42.67	22.61	42.09	32.71	1.60	2.20	**5.59**
15 Construction	14.70	18.26	32.49	4.75	14.70	14.21	0.78	0.94	**-1.23**
16 Trans & Communication	13.62	13.65	29.05	3.39	13.62	8.04	4.86	0.83	**-0.10**
17 Trade	13.10	30.27	60.83	6.32	13.10	23.44	2.43	1.17	**-13.94**
18 Other Services	25.41	44.82	26.97	3.01	25.41	24.59	3.70	0.95	**-3.82**
Total	17.40	20.36	29.21	1.96	17.40	14.72	1.69	0.43	**0.56**

Table 13d: Factor analysis of growth of production calculated by trans-log index 1992-95

1992-1995	Annual Growth Rate (%)				Contribution to Output Growth (%)				
	Output	Int. Inputs	Capital	Labor	Output	Int. Inputs	Capital	Labor	TFP
01 Agriculture	12.51	22.15	16.83	-1.73	12.51	9.11	0.38	-0.98	**4.01**
02 Metal Products	22.73	23.93	30.73	17.87	22.73	20.18	1.98	1.65	**-1.09**
03 Electricity	2.00	21.52	16.89	3.12	2.00	15.07	3.58	0.27	**-16.93**
04 Coal Products	13.92	10.42	5.36	-4.79	13.92	6.37	0.60	-1.32	**8.26**
05 Petroleum Products	8.32	20.21	19.85	22.29	8.32	16.16	2.80	1.31	**-11.96**
06 Chemicals Products	29.60	28.44	20.83	5.63	29.60	24.63	1.18	0.44	**3.36**
07 Machinery	32.82	28.64	21.95	1.63	32.82	24.64	0.85	0.17	**7.17**
08 Clay & Ceramics	28.25	25.11	33.94	3.72	28.25	19.47	2.48	0.56	**5.73**
09 Wooden Products	42.09	37.04	54.07	10.56	42.09	31.62	2.66	1.02	**6.78**
12 Food Processing	25.43	17.33	20.80	3.56	25.43	15.73	0.81	0.19	**8.70**
11 Fibers	18.59	18.23	9.04	1.35	18.59	16.08	0.30	0.11	**2.09**
12 Textiles and Leathers	50.00	45.13	37.22	-3.57	50.00	40.38	0.96	-0.28	**8.95**
13 Paper Products	27.18	26.42	24.14	-7.05	27.18	22.62	1.02	-0.72	**4.26**
14 Miscellaneous Products	-25.27	-26.56	-19.60	-43.98	-25.27	-22.85	-0.85	-4.21	**2.66**
15 Construction	26.80	28.88	17.35	7.69	26.80	22.68	0.40	1.47	**2.24**
16 Trans & Communication	7.98	11.35	29.17	5.07	7.98	6.15	5.72	1.33	**-5.22**
17 Trade	5.34	1.52	14.48	10.18	5.34	1.11	0.73	2.21	**1.29**
18 Other Services	6.16	11.03	17.45	-1.67	6.16	6.01	2.14	-0.56	**-1.43**
Total	21.21	22.01	20.86	0.46	21.21	16.08	1.24	0.10	**3.80**