The Change of the Capital Input of China

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Abstract:

Capital and labor are the most important factors to the economic growth. China, as which owns abundant workforce resource, the labor-intensive industry still occupies a dominate position .Comparing with the developed countries, the capital stock of China is low, but in the last decade, the investment had a rapid growth, so the capital stock also has increased a lot. But what about the capital efficiency, has it been improved. And, is there some change for the capital cost of the economic growth. This article firstly estimates the capital stock of each sectors of China, using Perpetual Inventory Methods. And then, On the basis of the input-output model, the paper uses the input-output tables of China to analyze how the capital productivity changed, and estimates the contribution of the each factor which causes to this situation.

Key words: capital-output ratio, input output table, capital stock, investment；

Introduction：

As the development of industrialization and urbanization, China has become the economy which holds the fastest growing rate in the world. Especially in the latest decade, China has played a more and more important role in the whole world. In 2007, the real GDP growth rate of China reaches to 13%, the GDP occupying the forth place in the world economy. In 2008, the GDP of China following the Unite States and Japan stood in the third place of the whole world economy. Facing to the international financial crisis occurred in 2008, China was the first country who recovered from the recession. With the deep development of the globalization and intergradations, China's economy not only related with the interests of China, but also that of the whole world. As we all know, the input factors are significant to development of the economy, so the topic about the input factors of China has absorbed a lot of researchers' attention.

Generally speaking, input factors include capital input、 labor input and natural resource input. As for China, capital is the scarcest resource, and it is not exaggerated to say capital is the bottleneck of the economy growth. So the efficiency of the capital utility is very important to China's economy. The research on it is meaningful and necessary.

Although comparing with developed countries, the capital stock of China is low, the scale of investment develops rapidly. According to the related study, as shown in figure 1, China's capital stock was only 10.7% of the whole world, 50.36% of EU-15 countries and 53.42% of United States in 2003. However with the rapid development of investment, China's capital stock level has been greatly improved. As the figure 2 shows, total fixed asset investment developed fast, the average growth rate up to 16.8% in last decade, and the growth rate of Gross Fixed Capital Formation was 15.56%, after removing the influence of price. While the real growth rate of GDP

was 9.5%. It is witnessed that capital developed much faster than economic growth. In the meantime, the proportion of fixed capital formation in GDP has also increased a lot, form 35% in the early 90's to 43.7% in 2008. As the historical data shows, China's investment rate has increased with fluctuation, and it declines after a high value, and then increased gradually. The period was less than 10 years. As shown in figure 3, in the latest round, the increase stage began in 1997, and it still has kept the trend until now. As early as 1997, China's investment rate has occupied the first place in the world. According to the Word Bank data, China's investment rate is nearly as twice as the world average level, which is 22%. In short term, the rapid development of investment indeed drives economy to increase, but in long term, the effect of capital depends on its efficiency. Paul Krugman, who predicted the East Asian financial crisis, pointed out that the most profound causes of it were the inefficiency of investment.

figure1 The Capital Stock of Major Economies

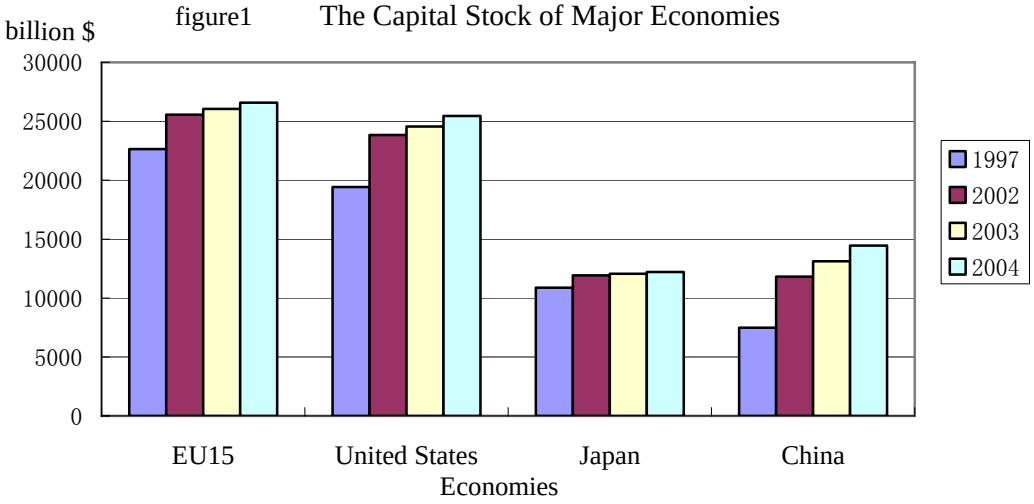


figure2 Total Investment in Fixed Assets of China

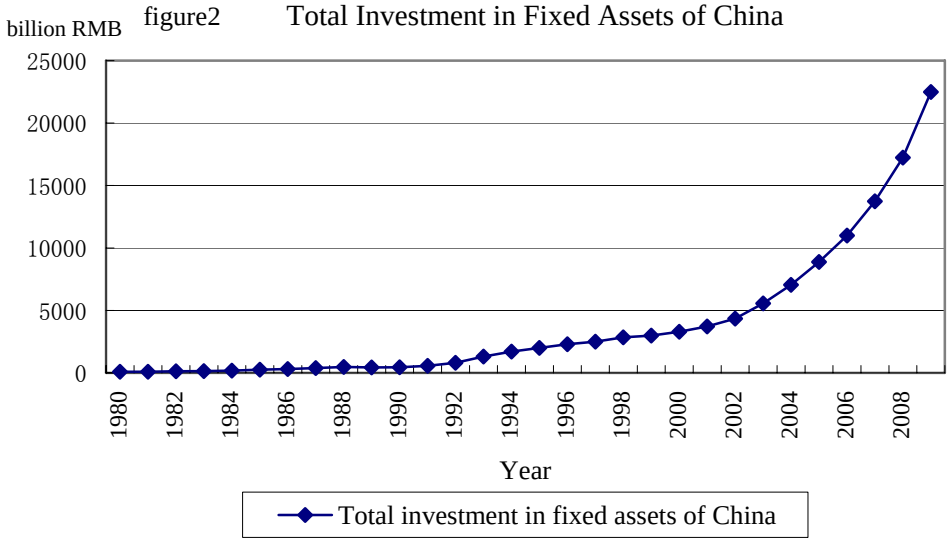
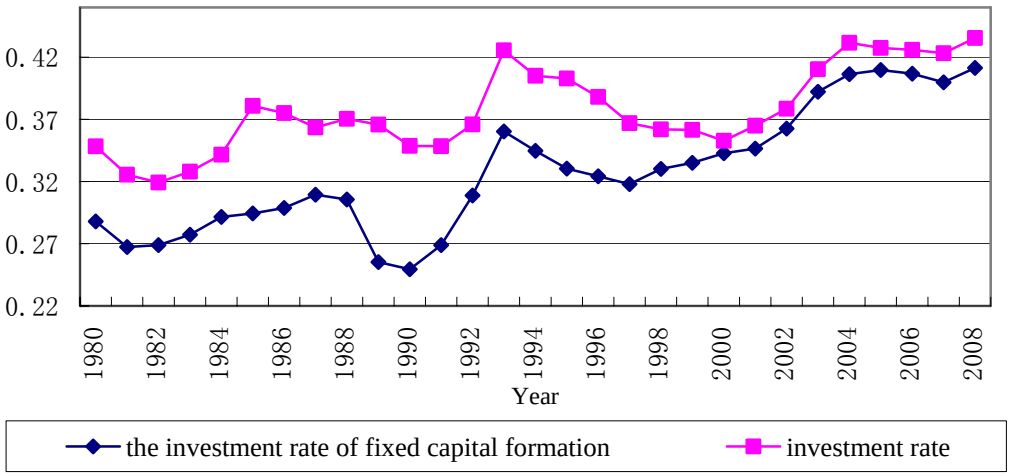


figure3 The Change of The Investment Rate of China



There are also many scholars expressed concern about the investment efficiency. Xia, Hu（2000）regarded the contribution of the capital was mainly by the increase of the quantity, not by the promotion of the capital efficiency. They used Incremental Capital-output Ratio（ICOR）to measure the efficiency of the capital, and drew the conclusion that China had a low capital efficiency. Liu (2003) believed that the capital allocation was the main reason for the low capital allocation. Zhang （2003）proposed that overstated investment and overstated competition caused to the increase of the capital-output ratio.

This article uses the input-output model to analyze the change of capital efficiency, using capital-output ratio as the indicator to measure the level of capital efficiency. And it analyzes the change of the capital efficiency on the basis of input-output model. It includes five sections: The second section introduces the Perpetual Inventory Methods, and describes the way to estimate the capital stock of China, using the limited data resource. The third section shows the theoretical basis to analyze the capital productivity, and how to use SDA to decompose the factors. The forth section gives the results of the computation and gives some explanations. Finally, the last section draws the conclusion and provides some recommendations for the economic development.

2. Capital Stock of China

2.1 Perpetual Inventory methods

Capital stock is the total physical capital existing in an economy at a moment. In this paper, the capital is fixed capital. Most of economists agree that capital stock is the suitable index to measure the capital input, and the rapid accumulation of capital is the main strength of economic growth, so there are many literatures on the capital stock research. He (1992) estimated the productive capital stock and non-productive capital stock. Huang, Ren and Liu（2002）built up Chinese capital stock time series in manufacture industry by sectors for 1980-1995 by Perpetual Inventory Approach. Xun and Wang (2007) estimated the Capital stock of 17 industries of China by input output tables. Most of the existed papers computed the sum capital stock of China, and some papers also estimated the capital stock by sectors, but the sectors are not elaborated enough. For the later research, firstly we also estimate the capital stock by sectors.

Until now, the most popular way to compute the capital stock is Perpetual Inventory Methods

(PIM) proposed by Goldsmith in 1951, and also some new methods have developed on the base of the Perpetual Inventory Methods. For example, capital lease price method proposed by Jorgenson in 1995, an optimal consistency method proposed by Albala-Bertrand J M in 2001. Now, the capital stock of the 10 OECD countries published by OECD is also computed by PIM. This method estimates the stock data by accumulating the asset which has been purchased and been defined the working life. Generally speaking, It includes following steps：

Firstly, a base year should be selected; usually the year about which there is affluent data resource, is suitable to be the base year. Then we estimate the capital stock of the base year, using the present data resource.

Secondly, estimate the investment series of the following years, and transfer the series into the data denoted by constant price.

Thirdly, compute the value of capital depreciation of each year, according to the proportion of the different assert in the total investment of the year. Then we can get the capital increment by removing the depreciation from the investment.

Finally, the data of capital stock can be received, it equals to the capital increment of this year adding to the capital stock of last year.

PIM also can be described by the formula： $K_t = I_t + (1-\delta_t)K_{t-1}$ (1)

As for one kind of asset, K_t is the asset stock of the t year, while I_t is the investment to this asset in constant price in t year, and δ_t is the Depreciation Rate of the asset in t year.

The value and the efficiency of the asset will decrease with the use time increasing .When the decreasing pattern of the asset efficiency is geometric decrease, the capital replacement equals to the capital deprecation. On this condition, the PIM model can be described in the following way:

$$K_t = I_t + (1-\delta)K_{t-1} \quad (2)$$

It means that, for the same asset, the deprecation rate is constant as the time going. According to the aforementioned knowledge, the key work to estimate the capital stock is to confirm the capital stock of the base year、 depreciation rate and the investment series.

2.2 The Data Processing

The paper also uses the PIM to estimate the capital stock of China by 37 sectors[1] form the year 1997 to 2002.

Since some investment may not become capital. We use the Gross Fixed Capital Formation as the investment series. But it's only the total number of the whole country; there is no investment data by sectors. So we try to use the allocation proportion of fixed asset investment to allocate the Gross Fixed Capital Formation to the 37 sectors.

2.2.1 Depreciation Rate

The National Bureau of Statistics of China provides the data of fixed asset investment every year, which is our basic data source. By the content of the investment, fixed asset investment can be divided into three parts: the investment to construction and installment project, the investment

[1] The corresponding relation of the 37 sectors in this paper to the benchmark sectors of China is in appendix A.

to the purchase of equipment, tools and instruments, and other investment. At first, we use some assumptions to allocate the other investment into the investment to construction and installment project, the investment to the purchase of equipment, tools and instruments. So the assets can be divided into two parts, which are construction and equipment. It is assumed that the deprecation pattern of these two kinds of fixed asset is both the geometric decrease, the deprecation rate of which are δ_1 and δ_2 separately.

In China, the scrap value rate of the fixed asset is set to be 3% to 5%. It means that the fixed asset can be counted into capital stock, until its value is less than 3% to 5% of its original value. In other words, at the end of its life, the relative efficiency of the asset is just 3%~5% of the new asset. If T represents the lifespan of the asset, and S represents the scrap value rate of the asset, the following relation holds：

$$S = (1-\delta)^T . \tag{3}$$

In China, most companies estimate their capital using straight-line depreciation method. And they don't take the capital price into consideration. So the capital stock they estimated is not accurate. But we assumed the depreciation life is correct, so we can use the related raw data estimate the average depreciation life of assets for each sector. As for manufacture industry and construction industry, we can calculate them using the following formula:

$$\text{The average depreciation life} = \frac{\left(\text{net value of fixed assets} + \text{accumulated depreciation} - \text{residual value}\right)}{\text{depreciation}}$$

When it comes to agriculture sector and service industry, we estimate the composition of the fixed assets for each sector, and estimate the average depreciation life for construction and that for instrument on the reference of depreciation period for each fixed assets. Then the depreciation rate for each sector can be estimated by using formula (3)

2.2.2 The Capital Stock for Base Year

When estimating the capital stock of the base year, we follow Xun and Wang's idea: using the input output account. Considering the data resource, we choose 1992 as the base year. There was each sector's depreciation data of fixed assets in the value added account in input output table. The depreciation of fixed assets should be the capital stock multiplies with the depreciation rate. So once the depreciation is decided, the capital stock can be received, but in current statistic data, the depreciation account does not take the change of price into consideration, so the capital stock calculated by the depreciation is not accurate. But we can use this idea to estimate the capital stock of the base year, because the error will become smaller and smaller, since the value of the fixed asset in the base year declines in the form of exponential function, as the time going.

Define K_i as the capital stock of sector i in the beginning of 1992, ϕ_i as depreciation of fixed assets of sector i, and ∂_i as the proportion of the investment to construction and equipment account for the fixed assets investment in sector i. Then we have:

$$K_i \bullet \partial_i \bullet \delta_1 + K_i \bullet (1-\partial_i) \bullet \delta_2 = \phi_i$$

$$K_i = \phi_i \Big/ [\partial_i \bullet \delta_1 + (1-\partial_i) \bullet \delta_2] \qquad (4)$$

According to the statement above, we can get the capital stock of each sector in the beginning of 1992. After the investment data of 1992 is added to the estimates, the capital stock of the base year is received.

2.2.3 Investment Series

The next task is to fix the investment series, according to the structure of the fixed assets investment; we can allocate Gross Fixed Capital Formation among main sectors. As for the secondary industry, there is original value of fixed assets for the detail sectors in China Statistical Yearbook. Original Value of Fixed Assets is the sum of the expenditure when an enterprise builds or purchases the fixed assets. It also does not take the change of the price into consideration. But the first-order differential of it represents the incremental fixed asset in some sense, so we use the first-order differential to do the further allocation. As the capital investment series of each sector have been calculated, we should divide the investment into two parts: one part is the investment to construction, the other is the investment to the purchase of equipment、tools and instruments. To do this, we adopt the proportion of the two types of investment in city fixed asset investment. Then we can get the investment series of construction and installment project, and the investment series of the purchase of equipment、tools and instruments.

The China Statistical Yearbook also provides the price index of fixed assets investment. The two investment series in constant price can be obtained after the transformation.

All the data we need is ready, the next step is using the formula (1) to calculate, and the capital stock by sectors has been estimated. The results can be seen in appendix B.

3. Capital-output Ratio

3.1 The Definition of Capital-Output Ratio

Define K_i as the capital stock of sector i, X_i as the output of sector i, then we can get direct capital-output ratio of sector i: $k_i = \frac{K_i}{X_i}$, it denotes the capital stock the sector i needs to support per output. Denote $\frac{1}{k_j} = \frac{X_j}{K_j}$ as the output per capital stock brings in sector i, it represents the direct capital productivity of sector i.

But we also should take the product chain into consideration; when the sector i produces its product, it also consumes the products of other sectors. In this way, the products produced by sector i contains not only the direct capital input of sector i, but also the indirect capital input of other sectors.

Denote that a_{ij} is the direct consume coefficient of sector i to sector j and b_{ij} is the total need coefficient of sector i to sector j. Thereby, the total capital stock per output of sector i needs can be denoted as followings:

$$k_{bj} = k_j + \sum_{i=1}^{n} a_{ij} \bullet k_i + \sum_{i=1}^{n}\sum_{m=1}^{n} a_{mi} \bullet a_{ij} \bullet k_m + ... = \sum_{i=1}^{n} k_i b_{ij}$$

So $\frac{1}{k_{bj}}$ denotes the total capital productivity of sector i. It is not only related with the capital productivity of sector i, but also keeping close relation with its consume structure and the capital productivity of the other sectors.

Denote K as the gross capital stock of the economy, then

$$K = \sum_{j=1}^{n} K_j = \sum_{j=1}^{n} k_j \bullet x_j = \sum_{j=1}^{n} k_{bj} \bullet y_j$$

Define $K_V = (k_1, k_2 \cdots k_n)$, $K_{BV} = (k_{b1}, k_{b2} \cdots k_{bn})$, $Y = (y_1, y_2 \cdots y_n)^T$

Then $K_{BV} = K_V (I - A)^{-1}$,

$$K = \sum_{j=1}^{n} k_{bj} \bullet y_j = K_V (I - A)^{-1} Y$$

Denote k_y as the capital-output ratio of the whole economy, it presents the capital stock of per GDP. $\vec{y}$ is the structure vector of final demand. Then

$$k_y = \frac{K}{\sum_{j=1}^{n} y_j} = \frac{K_V (I - A)^{-1} Y}{\sum_{j=1}^{n} y_j} = K_V (I - A)^{-1} \vec{y}$$

K_V can be further decomposed, and we illuminate it by taking the sector i as an example.

$$k_i = \frac{K_i}{X_i} = \frac{K_i}{c_i} \times \frac{c_i}{X_i}$$

c_j：The capital input in the initial input. It includes depreciation of the fixed assets and the return of the fixed capital.

$\frac{K_i}{c_i}$： Its reciprocal is depreciation rate and return on capital of sector i. The reciprocal represents the depreciation value and the returns of per capital stock in sector i.

$\frac{c_i}{X_i}$： Capital output coefficient of sector i. It denotes the proportion of capital input in the output.

Denote $R = (\frac{K_1}{c_1}, \frac{K_2}{c_2} ... \frac{K_n}{c_n})$, $c = diag\left(\frac{c_1}{X_1}, \frac{c_2}{X_2} \cdots \frac{c_n}{X_n}\right)$.

Then $k_y = K_V (I - A)^{-1} \vec{y} = R \bullet C \bullet (I - A)^{-1} \vec{y}$

According to the analysis, the change of the capital-output ratio can be decomposed into four parts, which are depreciation rate and return on capital, capital share of output, consume structure and final demand structure.

3.2 SDA of the Capital-output Ratio

In Economic system, One Economic variable can usually be expressed as the product of several variables which are independent with each other. Structure decomposition analysis is the method which breaks down the changes in one variable into the changes in its determinants, to measure the contribution of each independent variable to the change of the dependent variable. Many researchers have made outstanding contribution to the SDA model, and the method becomes more and more popular. As we know, a model with n independent variables can be decomposed in $n!$different ways. It is too complicated to compute all the results. There are two approaches that have been used predominantly in the literatures: two polar decomposition and mid-point weights approach, and both of them can give the close solution for the total decomposition. In this paper, we adopt two polar decomposition to analyze the capital-output ratio.

Suffix 0 denotes the variables in 0 year, while the suffix 1 denotes the variables in 1 year. So, we can get the change of the capital-output ratio from 0 year to 1 year.

$k_{y1} - k_{y0} = R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 - R_0 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0$.

The progress of the decomposition is as follows：

$$\begin{aligned} k_{y1} - k_{y0} &= R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 - R_0 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0 \\ &= R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 - R_0 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 + R_0 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 \\ &\quad - R_0 \bullet C_0 \bullet (I - A_1)^{-1} \vec{y}_1 + R_0 \bullet C_0 \bullet (I - A_1)^{-1} \vec{y}_1 - R_0 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_1 \\ &\quad + R_0 \bullet C_0 \bullet (I - A_1)^{-1} \vec{y}_1 - R_0 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_1 \\ &= \Delta R \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 + R_0 \bullet \Delta C \bullet (I - A_1)^{-1} \vec{y}_1 + R_0 \bullet \Delta (I - A)^{-1} \vec{y}_1 \\ &\quad + R_0 \bullet C_0 \bullet (I - A_0)^{-1} \Delta \vec{y} \end{aligned}$$

$$\begin{aligned} k_{y1} - k_{y0} &= R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 - R_0 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0 \\ &= R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_1 - R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_0 + R_1 \bullet C_1 \bullet (I - A_1)^{-1} \vec{y}_0 \\ &\quad - R_1 \bullet C_1 \bullet (I - A_0)^{-1} \vec{y}_0 + R_1 \bullet C_1 \bullet (I - A_0)^{-1} \vec{y}_0 - R_1 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0 \\ &\quad + R_1 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0 - R_0 \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0 \\ &= R_1 \bullet C_1 \bullet (I - A_1)^{-1} \Delta \vec{y} + R_1 \bullet C_1 \bullet \Delta (I - A)^{-1} \vec{y}_0 + R_1 \bullet \Delta C \bullet (I - A_0)^{-1} \vec{y}_0 \\ &\quad + \Delta R \bullet C_0 \bullet (I - A_0)^{-1} \vec{y}_0 \end{aligned}$$

So, the influence of the determinants to capital-output ratio can be attained.

$$
\begin{aligned}
SDAR &= \frac{1}{2}(\Delta R \bullet C_1 \bullet (I - A_1)^{-1}\vec{y}_1 + \Delta R \bullet C_0 \bullet (I - A_0)^{-1}\vec{y}_0) \\
SDAC &= \frac{1}{2}(R_0 \bullet \Delta C \bullet (I - A_1)^{-1}\vec{y}_1 + R_1 \bullet \Delta C \bullet (I - A_0)^{-1}\vec{y}_0) \\
SDAB &= \frac{1}{2}(R_0 \bullet C_0 \bullet \Delta (I - A)^{-1}\vec{y}_1 + R_1 \bullet C_1 \bullet \Delta (I - A)^{-1}\vec{y}_0) \\
SDAY &= \frac{1}{2}(R_0 \bullet C_0 \bullet (I - A_0)^{-1}\Delta\vec{y} + R_1 \bullet C_1 \bullet (I - A_1)^{-1}\Delta\vec{y})
\end{aligned}
\tag{5}
$$

4. Analysis of Capital-Output Ratio in China

4.1 Analysis of Capital Stock

According to the capital stock of each sector estimated in section 2[2], we can see the fact that the gross capital stock level was low. In 2007, the gross value of the capital stock was about 9212.46 billion RMB in constant price of 1992, 14421.04 billion RMB in 2002, increasing by 56.54%. During the period 2002 to 2007, the capital stock had increased by 1293.35 billion RMB, with a growth rate of 89.7%. These figures were closely related to the large-scale investment. The average real growth rate of fixed asset investment was 11.6% between 1997 and 2002, while it was 22.3% between 2002 and 2007. Though the promotion of the Gross Fixed Capital Formation to fixed asset investment kept falling for recent years, from 1.04 in 1997 to 0.73 in 2008, the growth rate of fixed capital formation was still as high as 11.42%

The allocation of the capital stock among sectors was also not balanced, the share of capital stock in agriculture was small, it's 4.54% in 1997, 4.16% in 2002, and 3.09% in 2007, and nevertheless, it still showed a decreasing trend. This indicates that labor was the main strength to promoting the development of agriculture in China, while the capital didn't been taken full advantage..

The secondary industry, of which output takes the largest share of the gross output, owns less than 41% of the capital stock. It was 40.71% in 1997, 34.08% in 2002, and 40.28% in 2007. Comparing with the other industries, service industry has a large capital stock; the proportion of the capital stock is 54.74%、 61.76% and 56.63% respectively in1997、 2002 and 2007, while its corresponding output share was 21.4%、30.08% and 23.49%. This suggests that capital is significance to the development of service industry.

We can explain this allocation from the annual investment. More than 50% of the annual investment is to the tertiary industry, but the proportion declined from 63.64% in 1997 to 52.98% in 2007. At the same time, the proportion of investment in secondary industry was on the rise, and the average proportion was 33.55% during 1997 to 2002, while it's 42.31% during the period 2002 to 2007. One of the results was the capital stock share of the secondary industry increased in 2007. The investment in agriculture was always in weak position; the proportion of investment was 3.67% during the period 1997 to 2002, while it's 2.65% during the period 2002 to 2007.

The reason for the high capital stock in the second industry and the tertiary industry can be explained. On one hand, most of the product activities of them have a high demand on equipment or other fixed capital. On the other hand, from the respective of investment source, more than 70% of the fixed asset investment is self-financing and other funds, while the state budget funds is about 4%. So the investors always choose the sectors which have high return on investment as the

[2] The capital-stock for each sector can be seen in appendix B

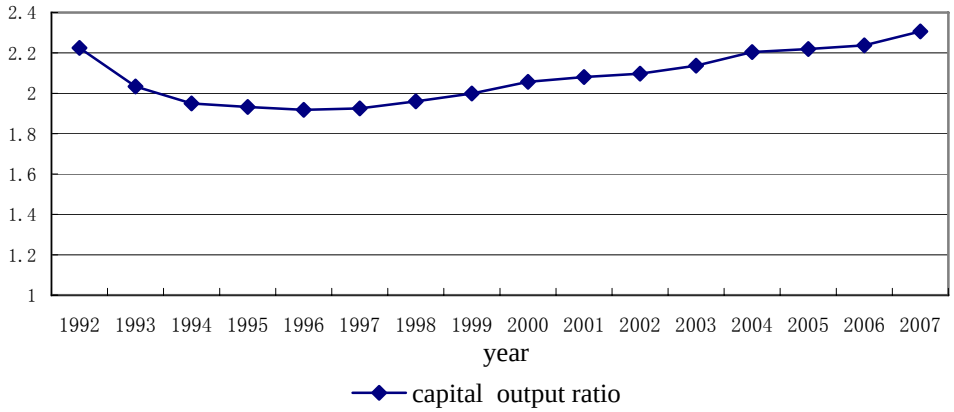
investment targets, such as financial sector、real estate、 construction and some manufactures.

4.2 Analysis of Capital-Output Ratio

The capital-output ratio reflects the relation between capital and output. It measures the value of capital unit output needs. It and ICOR are the important indictor to measure the capital efficiency. A lower capital-output ratio value means that we can obtain more output just by using less capital, and in other words, we own a high capital efficiency. Kuznes had a research about the economic of some developed countries such as USA、Germany, and he found that in long time capital-output ratio decreased slowly, while in short time it kept constant. As the investment developed rapidly, the capital stock increased rapidly. In one hand it promoted the GDP; but in the other hand, when it comes to the stage of diminishing marginal returns for capital, overstated capital was just a waste.

According to our estimation, as figure 4 shown, capital stock which supports unit of GDP has changed. The average capital-output ratio of China is 2.08. It means that 2.08 units capital is required to produce per unit GDP. But the capital efficiency has changed continuously, declining first and then keeping rising. It's 2.22 in 1992, 1.92 in 1997, 2.08 in 2002, and 2.31 in 2007, with the growth rate accelerating. This indicates that the overall capital efficiency has decreased since 1997, and capital cost of GDP has increased.

figure4 The Change of Capital Output Ratio



4.2.1 Direct capital-output ratio

Then we have the analyses for the direct capital-output ratio for each sector. At first, let's discuss the three major industries. Agriculture owns the lowest capital-output ratio, which is 0.329, followed by the secondary industries, which is 0.429. While the tertiary industry is the highest, this is 1.87. From the figures, for the agriculture sector, although mechanization level was improved constantly, its output still relied on labor input to a large extent and the capital was not used adequately, this caused that less capital was required to produce per unit of output. For the secondary industry, most sectors of this industry are capital-intensive, lots of capital stock required; however its output was also large, taking account 65.9% of the gross output, so the capital-output ratio was not high. For the tertiary industry, such as Real Estate、Transport、Management of Water Conservancy、 Environment and Public Facilities, they need adequate of construction and instrument, but the output was not high enough, only 25% of the gross output. Thus, the tertiary

industry leads a high capital-output ratio.

To analyze the reason why the capital-output ratio increased, we use SDA method to decompose the change into the change of four factors, which are depreciation rate and return on capital、capital share in initial input、value added rate、direct consume coefficients and the final demand structure.

The sectors whose capital-output ratio was larger than 1 are Mining and Washing of Coal、Extraction of Petroleum and Natural Gas、Mining and Processing of Nonmetal Ores and Other Ores、Production and Supply of Electric Power and Heat Power、Production and Distribution of Gas、 Production and Distribution of Water、Traffic, Transport and Storage, Post、Leasing and Business Services、Real Estate、Comprehensive Technical Services、Culture, Sports and Entertainment. Most of manufacture sectors are capital-intensive. They need machines and other instrument to produce the product. And the service sectors on the list also need a lot of capital stock to supply the service. We can explain this by taking Traffic sector as an example, this sector provides transport service to people, So it needs lots of traffic tools such as plane、train、boat and other infrastructure such as airport、railway. So its output need this capital to support and the capital-output ratio was high.

The sectors whose capital-output ratio was low were Textiles、Manufacture of Textile Wearing Apparel, Footwear, Caps, Leather, Fur, Feather(Down) and Its products、Processing of Timbers and Manufacture of Furniture、Manufacture of Electrical Machinery and Equipment、Manufacture of Communication Equipment、Computer and Other Electronic Equipment、Manufacture of Measuring Instrument and Machinery for Cultural Activity & Office Work construction. Most of the sectors are labor-intensive and technique-intensive. And the capital to support per unit of output was less than 0.2.

The capital-output ratio for each sector has changed with the time going. In the period of 1997 to 2002, most of the sectors owned increasing capital efficiency, except for Manufacture of Nonmetallic Mineral Products、Manufacture of Communication Equipment, Computer and Other Electronic Equipment、Construction 、Leasing and Business Services、Comprehensive Technical Services. But the increment was little, except that capital-output ratio of Comprehensive Technical Services had increased by 0.9. In this period, along with the project such as Three Gorges project going into operation, the government has increased the investment to the water conservancy and other infrastructure, causing the capital stock of Comprehensive Technical Services doubled its size. But, because of the output delay, the output just had increased by 80%.

The capital efficiency for most of the sectors had fallen. Especially for the secondary industries, such as textile、 Processing of Timbers and Manufacture of Furniture、 Processing of Petroleum, Coking, Processing of Nuclear Fuel、Manufacture of General Purpose and Special Purpose Machinery、Textiles、Papermaking, Printing and Manufacture of Articles、Chemical Industry、Manufacture of Metal Products、Production and Distribution of Gas、Production and Distribution of Water. In recent years, due to the natural monopoly, ‘windfall effect’ has appeared in the mining industry, especially for Extraction of Petroleum and Natural Gas, and its rate of return was up to 90% for these years. The high return caused the overstated investment, making the capital efficiency declined, For the same reason, the capital efficiency of the sectors such as Real Estate、Processing of Petroleum、Coking, Processing of Nuclear Fuel、Chemistry industry、Manufacture of Metal Products all declined, over-capacity of production becoming possible.

According to the related research, capacity utilization of polysilicon、cement、chemical industry has fallen. Sale Output Rate for many sectors in manufacture industry had declined. Meanwhile, decreasing capital efficiency not only took place in the upstream sector of manufacturing industry, but also appeared in the middle and lower reaches of manufacturing industry represented by mechanical manufacturing industry. And even capital efficiency for textiles and other labor-intensive sector also declined. For some labor-intensive sectors such as textile, too much emphasis on the expansion of the size and quantity resulted in the declining of the capital efficiency.

As for agriculture, investment on it was low, and the proportion in gross fixed assets investment was less than 3%. The reason why its capital increased was that its output developed slowly from 2002 to 2007. Therefore its capital efficiency should be further improved as well. For most of service sectors, the capital-output ratio had fallen. It indicated the capital efficiency for these sectors had been improved in this period. In addition, compared with other industries, the investment on education、 health and social security usually own a long investment cycle, with a low rate of return in current. In addition, the support efforts of local government on these sectors ware limited. All of these lead to the insufficient investment in this area.

4.2.2 SDA of the capital-output ratio

To analyze the reason why the capital-output ration changed, we decompose the value into four factors resorting to SDA method. They are depreciation rate and return on capital、capital share of output、consume structure and final demand structure.

The data we use is the input output tables of 1992、1997、2002 and 2007, made by National Bureau of Statistics of China. We merge the sectors of the original tables into 37 sectors, in the mean time; we transfer the variables in constant price in order to avoid the impact of the price.

The result is as the following table shows:

Table1: The Contribution to The Change of Capital-output Ratio

Contribution / Period	The change of each factor				The contribution of each factor			
	SDAR	*SDAC*	*SDAB*	*SDAY*	$P\Delta R$	$P\Delta C$	$P\Delta B$	$P\Delta Y$
1992-1997	0.318	-0.607	0.032	0.029	32.27%	61.50%	3.25%	2.98%
1997-2002	-0.805	0.220	0.222	0.448	47.50%	12.99%	13.01%	26.42%
2002-2007	-0.2364	0.250	0.255	-0.050	29.90%	31.58%	32.37%	6.25%

$P\Delta R = \frac{|SDAR|}{|SDAR|+|SDAC|+|SDAB|+|SDAY|}$ It denotes contribution of the change of R, and $P\Delta C, P\Delta B, P\Delta Y$, represents the contribution of C, B and Y respectively.

Based on the results above, for the period 1992 to 2007, the capital output coefficient played the most important role in the decline of the capital-output ratio. In this period, China began to implement socialist market economic system, and the economy went into the exploratory stage. Various industries mushroomed. Besides, due to the low capital base, the marginal utility of new investment highlights, promoting the output increased. According to the estimation，the capital efficiency had almost been improved for all the sectors.

Although, for both the period 1997 to 2002 and 2002 to 2007, the capital-output ratio had increased, the main factors were not the same. Depreciation rate and return on capital and the final demand structure were the main factors making the capital-output difference during the period 1997 to 2002. While for the period 2002 to 2007, final demand structure had small influence, and the contribution of other three factors nearly equaled.

The reciprocal of the depreciation rate and return on capital had played a reverse role in both periods. It's estimated that the average depreciation rate was about 0.074 in 1997, while it was 0.08 in 2002, 0.74 in 2007; and the change was not obvious. But there was an apparent rise of the return on capital; it's 8.15% in 1997, while it's 9.76% in 2002 and 13.18% in 2007. In the period 1997 to 2002, the sectors such as Mining and washing of coal, mining of metal ores, and the return on capital had a fast growth; it may be related to the increase of raw material price, which made the profit margin of these sectors raised. In addition, the reform of state-owned enterprise and internal restructuring promoted the return on capital more or less. Meanwhile ,The development of the tertiary industry such as Financial intermediation、Hotels and Catering services also contributed to the rise of the return on capital.

For the period 2002 to 2007, the sectors such as Mining and processing of nonmetal ores and other ores、Extraction of Petroleum and Natural Gas、Manufacture of Nonmetallic Mineral Products、Construction、Smelting and Rolling of Metals、Financial intermediation、Wholesale and retail trades, the return on capital had increased rapidly. During this period, China was in the process of integration with the international financial market, the financial sector developed rapidly, and the service industry had also prospered. In addition, the price of the raw material price continued to rise, all of these resulted in the increase of profits in these sectors.

The rise of the return on capital increased the cost of capital lease. The capital factors became more expensive comparing with the labor factors, which makes it possible that some capital is replaced by labor. In this way, the capital-output ratio will decline. So, the increase of the return had negative effect to the increase of the capital-output ratio.

During the period 1997 to 2002, the contribution of the final demand structure was 26.42%. For the three major industries, the tertiary industry had the largest direct capital-output ratio, followed by the secondary industry. The proportion of the tertiary industry in final demand has increased from 26.63% in 1997 to 40.7% in 2002, while the proportion of the primary industry had declined from 14.89% to 9.5%. The change of proportion caused the rise of the capital-output ratio.

As for the total capital-output ratio of each sector, as our estimation, the sectors which have high total capital-output ratio are mainly the capital-intensive sectors in manufacturing industry and the sectors who required more capital in the tertiary industry, such as Mining、Processing of Petroleum, Coking, Processing of Nuclear Fuel、Smelting and Rolling of Metals、Manufacture of Metal Products、Production and Supply of Electric Power and Heat Power、Production and Distribution of Gas, Production and Distribution of Water、Traffic, Transport and Storage, Post、Real estate、Comprehensive Technical Services、Culture, Sports and Entertainment. For all these sectors, the total capital-output ratio was more than 2. It means more capital was required to support per unit of the final demand for these sectors. Comparing with 1997, the sectors such as Mining and Washing of Coal、Production and Supply of Electric Power and Heat Power、Production and distribution of gas、Production and Distribution of Water、Traffic, Transport and

Storage, post、Real estate and Other service, had higher proportion in final demand. It caused the increase of the capital-output ratio.

Capital output coefficient and direct consume coefficient also contributed to the improvement of the capital-output ratio, for the period 2002 to 2007, their contribution reached 31.58% and 32.28% respectively. From the perspective of the consume structure, the sectors such as Extraction of Petroleum and Natural Gas, Processing of Petroleum, Coking, Processing of Nuclear Fuel、Chemistry、Smelting and Rolling of Metals、Production and Supply of Electric Power and Heat Power、Production and Distribution of Gas, have higher proportion in the sum of the intermediate input comparing with 2002, and these sectors had the high direct capital-output ratio. As the development of technology, the consumption of the primary products had decreased, while the consumption of the capital-intensive products had increased. This caused to the increase of the capital-output ratio.

Capital output coefficient reflects the proportion the capital input occupying in output .The average level was increasing, and it's 0.116 in 1997, 0.139 in 2002 and 0.143 in 2007. For the three major industries, the value for the first industry and the secondary industry were relatively stable, about 0.028 and 0.11 respectively. While for the tertiary industry, capital output coefficient hold a significant increase. And it's 0.175 in 1997, while it's 0.216 in 2002 and 0.284 in 2007.Especially for Traffic, Transport and Storage, Post、Leasing and Business Services、 Hotels and Catering Services、Financial Intermediation、Real Estate、Services to Households and Other Services, the proportion of the capital input in the output had increased.

For further analysis, capital-output coefficients can be expressed as the product of value added rate and capital share. The value added rate is an indicator which can measure the input output efficiency of an economy. As the results show the value added rate had increased slightly from 37.88% in 1997 to 38.88% in 2002, while it fell to 32.5% in 2007. The decrease suggests the increase of the capital-output coefficient mainly depended on the rise of the capital share.

Capital share refers to the proportion of the capital input in the initial input, which represents the distribution of the National income among the various factors. As the data shows, the capital share had increased from 37.29% in 2002 to 44.2% in 2007. And it had increased by 5 percentage points for the secondary industry, while 13 percentage points for the tertiary industry. As the fall of labor's share had become a widely accepted fact, some experts pointed out that the low output proportion of the service industry, the use of the capital-intensive technology and the improvement of profitability for the state-owned enterprise were the possible explanation. In addition, the reform of the state-owned enterprise and the extent of the monopoly made the capital income of the manufacture industry increased. Furthermore, as the industrial structure had moved form agriculture to the non-agriculture industry, the capital share increased. It improved the contribution of the capital to the GDP, causing to the increase of the capital-output ratio. Associated with the increase of the capital share, the labor's share had declined, which caused a widespread concern in society. Kujis in World Bank had proposed that the consumer downturn in this period was not the result of the high household savings, but the result of the low labor's share in National income. Some researches also think it was unfavorable to the political stability. In response to this phenomenon, many economists advice that measures should be taken to improve the labor's share in national income.

Except for the factors above-mentioned, the investment rate was rising, while the consume

rate was decreasing. This fact would inevitably lead to the increase of the capital-output ratio. Investment comes from savings; the saving rate had already increased from 36% in 1996 to 51.3% in 2007 in China. Even more, it still has a trend to increase, due to the traditional consume concept and the rise of the estate price. The high savings rate would reduce the consumption and inhibit the capital efficiency to a certain extent.

5. Conclusion：

According to our calculation and analysis, it can be witnessed that the capital stock base was weak in china, and its distribution was also not balanced. It was little for the primary industry, and increase too rapidly for the secondary industry. In addition, due to the rapid development of the investment, capital stock grew fast, and it was faster than the growth of GDP. Therefore, the capital-output ratio had been increasing. This suggests that the cost of the economy development on capital had been rising and the efficiency of the capital was low.

According to the analysis of each sector, the direct capital-output ratio for many sectors had increased. Overcapacity problem even appeared in some manufacturing sectors and real estate sector. In addition, the capital-output ratio for agricultural also increased in 2007, indicating the capital efficiency should be improved. Taking the tertiary industry as a whole, the capital-output ratio was on the decline, suggesting the marginal return was in the up state. The contribution of capital to output still has potential to increase. Therefore, the allocation of the capital should be optimized to ensure the healthy operation of the economy, and the investment in the primary industry and the second industry should be increased. For the manufacture industry and some service sectors,

According to the section four, we know that the final demand structure did great contribution to the increase of the capital-output ratio during the period 1997 to 2002. As the proportion of the primary industry and the development of the capital intensive industry, the economy needs more capital input. The rise of the return on capital has eased the increase of the capital-output ratio. And its contribution has reached 31.8%. During the period 2002 to 2007, the contribution of the return on capital、capital-output coefficient and consume structure nearly equaled. Among them, the return on capital still played a reverse role in the change of the capital-output ratio. In addition, more and more capital intensive technology has been used. It also made the capital-output ratio increase. The capital share in the initial input has increased much, and the labor’s share has declined. So we should improve the labor’s share. On the one hand, the quality of the employers should be improved, at the same time, expending employment and increasing personal income are also necessary. On the other hand, the government should implement the macro-control, making the distribution of income more equitable through financial and tax policies.

The last but not the least, China’s economy relies much on investment, and the fact of high saving rate and high investment rate also help to increase the capital-output ratio. So measures should be taken to change the way of economic development, making the consumption be the main strength to promote the economy.

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Appendix A：

The Map for the Sectors to the Benchmark Classification

ID	Sectors	Benchmark Classified Sectors
1	Agriculture, Forestry, Animal Husbandry & Fishery	Agriculture, Forestry, Animal Husbandry & Fishery
2	Mining and Washing of Coal	Mining and Washing of Coal
3	Extraction of Petroleum and Natural Gas	Extraction of Petroleum and Natural Gas
4	Mining of Metal Ores	Metal ore mining
5	Mining and Processing of Nonmetal Ores and Other Ores	Mining and Processing of Nonmetal Ores and Other Ores
6	Manufacture of food and tobacco	Manufacture of food and tobacco
7	Manufacture of Textiles	Manufacture of Textiles
8	Manufacture of Textile Wearing Apparel, Footwear, Caps, Leather, Fur, Feather(Down) and Its products	Manufacture of Textile Wearing Apparel, Footwear, Caps, Leather, Fur, Feather(Down) and Its products
9	Processing of Timbers and Manufacture of Furniture	Processing of Timbers and Manufacture of Furniture
10	Papermaking, Printing and Manufacture of Articles	Papermaking, Printing and Manufacture of Articles
11	Processing of Petroleum, Coking, Processing of Nuclear Fuel	Processing of Petroleum, Coking, Processing of Nuclear Fuel
12	Chemical Industry	Chemical Industry
13	Manufacture of Nonmetallic Mineral Products	Manufacture of Nonmetallic Mineral Products
14	Smelting and Rolling of Metals	Smelting and Rolling of Metals
15	Manufacture of Metal Products	Manufacture of Metal Products
16	Manufacture of General Purpose and Special Purpose Machinery	Manufacture of General Purpose and Special Purpose Machinery
17	Manufacture of Transport Equipment	Manufacture of Transport Equipment
18	Manufacture of Electrical Machinery and Equipment	Manufacture of Electrical Machinery and Equipment
19	Manufacture of Communication Equipment, Computer and Other Electronic Equipment	Manufacture of Communication Equipment, Computer and Other Electronic Equipment
20	Manufacture of Measuring Instrument and Machinery for Cultural Activity & Office Work	Manufacture of Measuring Instrument and Machinery for Cultural Activity & Office Work
21	Manufacture of Artwork, Other Manufacture	Manufacture of Artwork, Other Manufacture
		Scrap and Waste
22	Production and Supply of Electric Power and Heat Power	Production and Supply of Electric Power and Heat Power

23	Production and Distribution of Gas	Production and Distribution of Gas
24	Production and Distribution of Water	Production and Distribution of Water
25	Construction	Construction
26	Traffic, Transport and Storage, Post	Traffic, Transport and Storage
		Post
27	Leasing and Business Services	Information Transmission, Computer Services and Software
		Leasing and Business Services
28	Wholesale and Retail Trades	Wholesale and Retail Trades
29	Hotels and Catering Services	Hotels and Catering Service
30	Financial Intermediation	Financial Intermediation
31	Real Estate	Real Estate
32	Services to Households and Other Services	Services to Households and Other Services
33	Comprehensive Technical Services	Comprehensive Technical Services
		Research and Experimental Development
		Management of Water Conservancy Environment and Public Facilities
34	Education	Education
35	Health, Social Security and Social Welfare	Health, Social Security and Social Welfare
36	Culture sports and Entertainment	Culture, Sports and Entertainment
37	Public Management and Social Organization	Public Management and Social Organization

Appendix B:

Fixed capital stock for each 37 sectors of China (unit: 0.1 billion RMB)

ID	Sectors	1997	2002	2007
1	Agriculture, Forestry, Animal Husbandry & Fishery	4188.71	5993.05	8449.26
2	Mining and Washing of Coal	2103.29	2040.76	3848.84
3	Extraction of Petroleum and Natural Gas	2270.33	3314.55	5005.07
4	Mining of Metal Ores	462.56	328.75	1345.12
5	Mining and Processing of Nonmetal Ores and Other Ores	1492.83	1450.50	1275.18
6	Manufacture of food and tobacco	2485.57	2506.20	6843.04
7	Manufacture of Textiles	1683.03	1508.91	3767.31
8	Manufacture of Textile Wearing Apparel, Footwear, Caps, Leather, Fur, Feather(Down) and Its products	550.62	618.63	1971.40
9	Processing of Timbers and Manufacture of Furniture	316.59	412.42	1692.00
10	Papermaking, Printing and Manufacture of Articles	1043.46	1484.31	3254.79
11	Processing of Petroleum, Coking, Processing of Nuclear Fuel	1189.93	1644.75	3090.60
12	Chemical Industry	4461.34	5761.66	13713.07

13	Manufacture of Nonmetallic Mineral Products	2071.39	1740.89	5482.87
14	Smelting and Rolling of Metals	3338.84	5038.51	11326.61
15	Manufacture of Metal Products	623.65	683.91	2539.32
16	Manufacture of General Purpose and Special Purpose Machinery	2229.26	1862.06	7152.52
17	Manufacture of Transport Equipment	1463.27	2197.59	5786.14
18	Manufacture of Electrical Machinery and Equipment	846.19	1058.59	2889.70
19	Manufacture of Communication Equipment, Computer and Other Electronic Equipment	709.24	2347.51	4760.96
20	Manufacture of Measuring Instrument and Machinery for Cultural Activity & Office Work	179.83	196.74	641.60
21	Manufacture of Artwork, Other Manufacture	333.49	274.45	986.37
22	Production and Supply of Electric Power and Heat Power	5586.28	9639.12	18048.43
23	Production and Distribution of Gas	215.43	249.57	659.44
24	Production and Distribution of Water	485.32	660.82	1237.51
25	Construction	1364.16	2128.74	2877.76
26	Traffic, Transport and Storage, Post	13872.06	24986.17	36030.47
27	Leasing and Business Services	2195.40	3525.84	5678.14
28	Wholesale and Retail Trades	4000.82	4327.31	6400.25
29	Hotels and Catering Services	1029.39	1635.03	2808.12
30	Financial Intermediation	1018.24	974.61	856.99
31	Real Estate	12348.54	22836.03	54944.17
32	Services to Households and Other Services	572.72	1226.26	1976.42
33	Comprehensive Technical Services	636.07	1011.71	1516.32
34	Education	5129.34	12809.02	21247.90
35	Health, Social Security and Social Welfare	541.32	849.43	1238.94
36	Culture sports and Entertainment	3042.10	4937.13	7288.82
37	Public Management and Social Organization	1267.84	1742.45	2450.71
	SUM	87348.45	136003.98	261082.16