Research on productivity effect of manufacturing capital accumulation——an empirical study based on data of manufacturing enterprises in Beijing, Tianjin and Hebei

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Abstract: Based on the panel data quantile regression, the horizontal and vertical comparisons reveal the marginal effect of the capital accumulation of the Beijing-Tianjin-Hebei region on the growth of total factor productivity. Combined with the heterogeneity of regions and industries, this paper provides a theoretical basis for how to effectively invest and how the government solves the mismatch of capital. The study found that although the increase in investment has a positive effect on the technological progress of enterprises, the dividend of capital investment has gradually disappeared, and the overall trend is inverted U-shaped. In terms of sub-regions, increasing investment in quality is still the main problem that Hebei Province facing in the future. Different industries also present different characteristics. A few industries have shown an increase in investment increased the growth rate of total factor productivity.

1. Introduction
Neoclassical economics believes that factor input and the improvement of total factor productivity jointly promote economic growth, while the scarcity of resources determines that factor-driven growth is difficult to sustain, and total factor productivity will play an increasingly important role. Since China entered the new normal, the government actively encourages enterprises and regions to explore new development models. In order to achieve sustainable economic growth and supply-side reform, it is necessary to clarify the following question: Changing the growth mode that depends on investment is the key to China's economic transformation. Does this transformation apply to all enterprises? Does the existence of heterogeneity in enterprises and industries affect the contribution of capital investment to the growth of total factor productivity?

Through horizontal and vertical comparisons, enterprises should increase effective investment, improve input-output relationship, and promote sustainable and healthy development of enterprises. In April 2017, the CPC Central Committee and the State Council decided to establish a national-level new district in Xiong'an New District as a major historic strategic project. Therefore, understanding the characteristics of manufacturing capital stock and total factor productivity in the Beijing-Tianjin-Hebei region is a prerequisite for effective investment and further research.

Based on the above analysis, the full text is divided into three parts. The first part is literature review, which summarizes the relationship between capital investment and total factor productivity and related literature, and briefly summarizes the quantile regression. The second part is to measure
the total factor productivity of the manufacturing industry in the Beijing-Tianjin-Hebei region using LP semi-parameter method, use capital stock to represent the amount of capital accumulation and adopts panel quantile regression to empirically analyze the characteristics of capital stock of enterprises from the perspective of the marginal effect of capital on total factor productivity. The marginal effects of different locations and time periods are further explored. The third part is the conclusions and recommendations of the article.

2. Literature review
Total Factor Productivity (TFP) is an indicator of the relationship between input and output. The measurement of total factor productivity generally refers to the measurement of the growth rate of total factor productivity. Meeusen & Broeck, Battese & Coelli improved SFA, using the measurement method to estimate the frontier of the production function, and divided the total production function into the front-end production function and the non-efficiency part. Relatively speaking, there is less literature on enterprise TFP. In order to solve the problem of an inevitable measurement technology when enterprise TFP estimation, that is, simultaneity deviation. Olley and Pakes (1996) developed a method based on the consistent semi-parametric estimation method, OP method. Levinsohn and Petrin (2003) further proposed the LP method to reduce the amount of sample loss, but this method is still used less in China.

Capital is the most important input factor in the process of economic growth. The efficiency of capital use and its mechanism of action on total factor productivity have always been the focus of research. As capital density increases, the marginal productivity of capital begins to decline, and the rate of economic growth will inevitably decline (Kim, Lau, 1996). At the same time, China’s economy has accumulated relatively excess capital too early and too quickly because of excessive competition by local governments, excessive investment has led to a large amount of capital deposited in the field of overcapacity, and weakened the ability of the economy to absorb surplus labor, thereby restricting the continued growth of economy (Zhigang Yuan, 2002).

According to China's data from 1978 to 1998, Chow and Lin (2002) found that the contribution of physical capital investment to China's economic growth was 62%. Wang and Yao (2003) found that the contribution rate of physical capital investment to China's economic growth was 47.7% between 1978 and 1999. Wang Dihai et al. (2008) found that the healthy investment rate is positively correlated with the economic growth rate. However, the current research on the relationship between capital and total factor productivity is mainly concentrated in the macroscopic field, and few studies have analyzed it based on micro data.

The quantile regression can more fully describe the relationship between the independent variable and the dependent variable. Koenker and Hallock (2001) proposed a quantile regression method for panel data, and Karlssom (2005) introduced nonlinear data into panel quantile regression. Zhu Jianping (2012) proposed a two-stage panel quantile regression method, and compared with the fixed effect transform quantile regression method proposed by Luo Youxi et al.

Capital accumulation is the dynamic process of turning profit into capital, capital stock refers to the total amount of capital in a society at a certain moment. We use capital stock to represent the amount of capital accumulation in this paper. Next, we will compare the capital stock characteristics of enterprises with different developments through the manufacturing enterprises above designated size in the Beijing-Tianjin-Hebei region, and compare the trends of different regions and different time periods.

3. Research design

3.1 Samples and data sources
The purpose of this paper is to study the marginal role of corporate capital stock for total factor productivity growth in the Beijing-Tianjin-Hebei region. The data used in this paper is the industrial enterprise database data from 2004 to 2013. Due to the large number of industrial enterprise database
samples and some enterprise information errors or missing, this paper filters and adjusts the enterprise samples before use.

First of all, the paper excludes the sample of enterprises with zero industrial output value or zero number of employees, and limits the total output value of fixed price, total fixed assets, management expenses, payable wages, etc., which must be positive, depreciation, paid-in capital, etc. cannot be negative. Secondly, according to the matching process similar to Brandt (2012), the matching and unmatched data were combined to obtain the unbalanced panel data from 2004 to 2013. Finally, the price index of the enterprise's industrial output value, basic input and intermediate input is deflated in the time dimension. Based on 2004, the industrial product price index, the fixed asset investment price index, the raw materials, fuel, and power purchase price indices were deflated. The capital stock is measured by the perpetual deposit method.

3.2 Measurement of total factor productivity growth
In this part, the LP method is used to obtain the level of total factor productivity at the enterprise level. In order to more clearly understand the level and characteristics of the total factor productivity growth of Beijing-Tianjin-Hebei, the results of the calculation are divided into time and region. This paper uses the proportion of total industrial output value as the weight of the enterprise, focusing on the trends of total factor productivity in different years and regions and industries. Figure 1 shows the total factor productivity from 2004 to 2013 in China.

Figure 1 shows that from 2004 to 2009, the growth rate of total factor productivity showed a steady increase. After 2009, it increased sharply to 2.48, and after 2010, there was a downward trend. Due to the financial crisis, some enterprises stopped production and exited the market in 2009. With the government’s bailout policy and the partial withdrawal of capital dividends and factor inputs, the average total factor productivity growth rate in 2009 increased significantly. After 2010, China's financial industry has become a new source of economic development. Housing prices and stock prices have risen sharply, attracting a large amount of capital investment.

The growth rates of TFP in Beijing, Tianjin and Hebei are basically consistent with the overall trend, but the technological progress and innovation of enterprises in Hebei Province lags behind that of Beijing and Tianjin. The innovation capacity of Hebei Province does not match its geographic area, population and economic aggregate. Its economic development relies heavily on resource input. Paradoxically, the mineral resources of Hebei Province are not very rich, which affects the effective allocation of resources to a certain extent, and has a crowding-out effect on high-tech industries.

4. The analysis of empirical results

4.1. Overall research
With the advancement of technology and the improvement of overall efficiency, the marginal utility of capital for total factor productivity growth is not static. Studying the investment behavior of economic entities at different stages of development, the quantile regression of panel data can study the...
relationship between the two more comprehensively at different grading levels. Table 1 and Figure 2 shows the results of the quantile regression of the entire Beijing-Tianjin-Hebei region.

| TFP Quantile | Capital stock factor | P | T   |
|--------------|----------------------|---|-----|
| 0.1          | 0.01949              | 0 | 12.7|
| 0.2          | 0.02119              | 0 | 19.46|
| 0.3          | 0.02248              | 0 | 25.66|
| 0.4          | 0.02247              | 0 | 27.59|
| 0.5          | 0.02216              | 0 | 31.1 |
| 0.6          | 0.02096              | 0 | 32.88|
| 0.7          | 0.02037              | 0 | 35.23|
| 0.8          | 0.01791              | 0 | 28.07|
| 0.9          | 0.01439              | 0 | 18.7 |

The regression results in Table 1 show that as the technological level of the enterprise increases, the marginal role of the capital stock gradually increases, and reaches a relatively stable peak between 0.3 and 0.5. For companies with faster total factor productivity growth, the role of capital in technology growth is significantly lower. For companies with a TFP of 0.9, the marginal value of capital stock is only 0.014, which is 64% of the median.

The increasing trend in Figure 2 shows that increasing investment can bring greater economic benefits and promote the growth of total factor productivity. Between 0.1 and 0.2 points, the increase in capital investment is most significant. At this time, the capital stock of enterprises does not reach the optimal ratio of capital and labor input. Increasing investment can not only achieve higher profits, but also significantly promote technological progress. However, for enterprises after the median quintile, their profit status is relatively good, and there is a certain degree of scale advantage. Although the investment increase has a positive effect on the technological progress of the enterprise, the dividend of capital investment gradually disappears.

4.2. Region-divided study

Table 2 and Figure 3 shows the results of the regression of the region-divided of Beijing, Tianjin, and Hebei. The economic development level of Beijing and Tianjin is relatively high. This promotes the development of specialized inputs and services, provides a centralized market for workers with specialized skills and enables companies to benefit from technology spillovers, further enhancing the utilization of capital by firms. Therefore, the role of the capital stocks in these two regions shows a steady rise. The capital stock factor is between 0.006 and 0.019.
By contrast, the economic development level of Hebei Province is relatively backward, and most enterprises have not reached the optimal production scale. The 0.1 to 0.4 quantile interval increases the marginal output value of unit capital input by as much as 0.032. It can be foreseen that increasing quality investment is still the main problem facing Hebei Province in the future. Hebei provincial government should make full use of the geographical advantages of the adjacent Beijing-Tianjin-Second City, and use inter-regional links to fully absorb advanced knowledge and technology spillovers, further deepen structural reforms through the absorption of coding and non-coding knowledge.

4.3. Time-phase research
After 2008, in order to cope with the impact of the world financial crisis on China's economic operation, the Chinese government has implemented stimulus investment policies including RRR cuts and interest rate cuts. Therefore, this paper divides the time period into two periods: 2004-2008, 2009-2013, Table 3 and Figure 4 shows the regression results for two periods.

| TFP Quantile | Capital stock factor(2004-2008) | T(2004-2008) | Capital stock factor(2009-2013) | T(2009-2013) | Pa |
|--------------|---------------------------------|--------------|---------------------------------|--------------|----|
| 0.1          | 0.02085                         | 9.92         | 0.01636                         | 6.91         | 0  |
| 0.2          | 0.02318                         | 10.37        | 0.018                           | 12.04        | 0  |
| 0.3          | 0.02394                         | 19.13        | 0.01961                         | 15.2         | 0  |
| 0.4          | 0.02177                         | 19.93        | 0.02136                         | 19.06        | 0  |
| 0.5          | 0.02211                         | 24.08        | 0.0206                          | 21.33        | 0  |
| 0.6          | 0.02162                         | 24.45        | 0.01868                         | 19.87        | 0  |
| 0.7          | 0.02175                         | 24.03        | 0.01771                         | 22.78        | 0  |
| 0.8          | 0.01985                         | 18.82        | 0.01589                         | 14.41        | 0  |
| 0.9          | 0.01753                         | 18.99        | 0.01246                         | 11.06        | 0  |

* represents the P value of capital stock in the two periods of 2004-2008 and 2009-2013.

In the two periods from 2004 to 2008 and 2009 to 2013, the marginal output of capital stock to total factor productivity also showed the characteristics of inverted U-shaped. From 2004 to 2008, in the interval of [0.1, 0.3], the marginal output value of capital stock increased significantly, and began to decrease after reaching the peak. It stabilized at 0.022 in [0.4, 0.7], and then decreased rapidly after 0.7 points. The overall characteristics were not much different from the previous period 2009 to 2013, and there was a rapid upward trend between 0.1 and 0.4 points, followed by a sharp decline.

4.4. Industry-divided research
By analyzing the data, we can find the regression results for the 0.25, 0.5, and 0.75 quantiles for each
industry in the manufacturing industry. Most industries show a trend of increasing first and then decreasing, which is consistent with the overall trend. In addition, with the improvement of the technical level, the role of capital stock has gradually decreased in nine industries. This part of the industry is mainly concentrated in the textile industry, shoes and hats, leather, wood processing and other light industries. Since the technology required by enterprises is relatively simple, increasing capital investment does not significantly promote the improvement of corporate technology.

In the beverage, stationery, chemical fiber and plastics industries, the role of capital stock is increasing rapidly. By introducing investment and expanding the scale of the enterprise and the management of standardization, it is possible to promote the technological level of the enterprise extremely effectively. Appropriate policy tilt can more fully play the role of this part of enterprises in promoting the improvement of regional total factor productivity.

5. Summary
First, the average growth rate of total factor productivity in China over the years was 2.42, which was higher than the average of developed countries by 2%. The relatively high growth rate indicates that there is still a certain gap between the technical level between China and developed countries. Technology introduction and spillover are still important driving forces for regional economic development. Total factor productivity increases first and then decreases.

Secondly, the growth rate of TFP in Beijing, Tianjin and Hebei is basically the same as the overall trend, but the technological progress and innovation of enterprises in Hebei Province lags behind that of Beijing and Tianjin. In order to solve the problem of uneven development in the Beijing-Tianjin-Hebei region, the geographical advantage provides the basis for Hebei Province to absorb advanced professional knowledge.

In addition, although the increase in investment volume still has a positive effect on the technological progress of enterprises, the dividend of capital investment gradually disappears, and the overall trend is inverted U-shaped. After 2009, relying on the original capital investment is obviously unable to achieve long-term growth in total factor productivity.

Finally, Increase quality investment is still the main problem Hebei Province facing in the future. Different industries also present different characteristics, according to the characteristics of different industries, different incentive mechanisms should be implemented to encourage effective free investment. By deepening the reform of investment and financing systems, the key role of investment in optimizing supply structure should be exerted.

In general, as technology advances and overall efficiency increase, the marginal utility of capital for total factor productivity growth is not static. Enterprises should use horizontal and vertical comparisons to identify their own nodes and increase effective investment.

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