

EMPIRICAL ANALYSIS OF THE CONTRIBUTION OF TECHNOLOGY PROGRESS TO THE INDUSTRIAL ECONOMY IN WUHAN IN CHINA

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Abstract On the basis of analyzing the relative researches about the technology progress at home and abroad, the paper makes a comprehensive analysis of the inputs of funds and manpower in science and technology in Wuhan in the light of the statistic data of Wuhan from 2000 to 2007 and also does a correlative study of the inputs and the industrial economic increase by way of the method of production function. The results show us that the technology progress has a remarkable promoting to the industrial economic increase in Wuhan. Based on the study, the paper proposes policy suggestions to further promote the technology progress in Wuhan and puts forward the points of view that the technology progress is the bottle neck of the industrial economic increase of Wuhan.

Key words Technology progress, Industrial economy, Empirical analysis

1 Introduction

Since 2000, the economy in Wuhan has greatly developed. Its GDP increased from 120.7 billion yuan in 2000 to 314 billion yuan in 2007, with a rate of 16.1%. The industrial output increased from 142.2 billion yuan in 2000 to 401 billion yuan in 2007, with an average rate of 16.1, of which the output of the industry with a scale has realized a rise of 5 times. The industrial contribution rate to the economy in Wuhan has risen from 20% to 35.05%. In the meanwhile, the industrial technology progress has been becoming an important factor pushing the increase of the industrial economy in Wuhan. Therefore, it is meaningful to master the correlations between the technology progress and the industrial economy increase so as to stimulate the industrial economy and the social progress.

For a long period, the economists have been engaged in qualitative and quantitative studies in economy increase and its determinants. The initial research can be dated back to the times of Adams. Smith and David. Ricardo. In the second half of the 19th century, the rise of New Classical Economics around the marginal analysis promoted the development of the increase study. The technology innovation put forward by J.A. Schumpeter makes the innovation economy better explain the phenomenon of the economy development and introduces the innovation into research as a key element promoting the economy development. All this has highlighted the main role of innovation, but has always been regarding the technology progress as the extraneous variable and not solved the problems of the economy factors determining the technology progress. In 1957, Solo et al proposed that the increase of the productivity comes from the technology progress and that the technology innovation is the intraneous variable of the economy rise. In the middle of the 80s of the 20th century, P. Romer and Lucas et al established the theory of the intraneous increase, which makes directly the technology progress intraneous in the way that the knowledge accumulation is represented by the accumulative input in production in the hypothesis that the aggregate technology progress comes from the investment to the physical capital. The theory also thinks that the technology progress exists in the system of the economy increase and invention and innovation transform and tend to the intraneous strength of the economic system, that's to say, the intraneous technology progress produce by knowledge and human capital accumulation.

Scholars of the Chinese Social Science Institute, the National Statistic Bureau and the universities and colleges, etc. have made a study of the technology progress, of which professor Zhou Fang et al studied the technology progress through the increase function of input and output, Shi Qingqi et al through the calculation of the contribution rate of the technology progress and Jiang Zhaohua proposed CSH model in light of the labour value theory of Marx.

NOW, with the development of the regional economy, the study of the technology progress is urgent so as to serve of the local economy.

The paper makes a research that the technology progress contributes to the rise of Wuhan industrial economy by way of the production function combined with the situation of Wuhan.

Step 1. Calculate the technology progress rate (%). The rate reflects comprehensive quota of the technology progress speed in a certain period. The formula is : $a = y - ak - \beta l$, of which "a" represents a yearly average increase rate of the technology progress; "y", a yearly average increase speed of output; "k", a yearly average increase speed of the capital; "l", a yearly average increase speed of the labour force; "α", the output elastic

coefficient of the capital(if the other conditions unchanged, a rise of 1% of the capital, α % of the output will be increased. Generally, $\alpha = 0.3$ for the industry firm);" β ",output elastic coefficient of labour(if the other conditions unchanged, a rise of 1% of the labour, a rise of β % for the output)

Besides, a yearly average increase speed of output, capital and labour will be calculated according to the average method. Take the output for example, its formula is: $y = (\sqrt[t]{y_t/y_0} - 1) \times 100\%$, of which Y_t is the output of the year t in the report period and Y_0 for the output of the base period.

Step 2: calculate the contribution of the technology progress to the increase rate of the output. EA、EK、EL stands for the contribution of technology progress, capital and labour respectively. They are presented as follows:

$$EA = a/y \times 100\%$$

$$EK = \alpha k/y \times 100\%$$

$$EL = \beta l/y \times 100\%$$

Step 3. Choosing quota

In this paper, the industrial increase value is chosen to reflect the rise of the industrial economy in Wuhan. Considering the price, we will calculate the rise rate of the industrial increase value based on the comparable price. "y" stands for the chain rise speed of GDP; the industrial employment of the enterprises above scale at the end of the year stands for the input of labour,"l"for the chain rise speed of the employment; the elastic coefficient of labour output β is the proportion between the employment and the industrial increase value; the investment volume of the fixed assets of the industrial enterprises above scale stand for the total capital input, "k" is the chain rise speed of the fixed asset investment(all the quota of capital should be conversed into the comparable price from the current price)

2 Situation of the Scientific and Technological Input of Wuhan Industry

2.1 Financial input

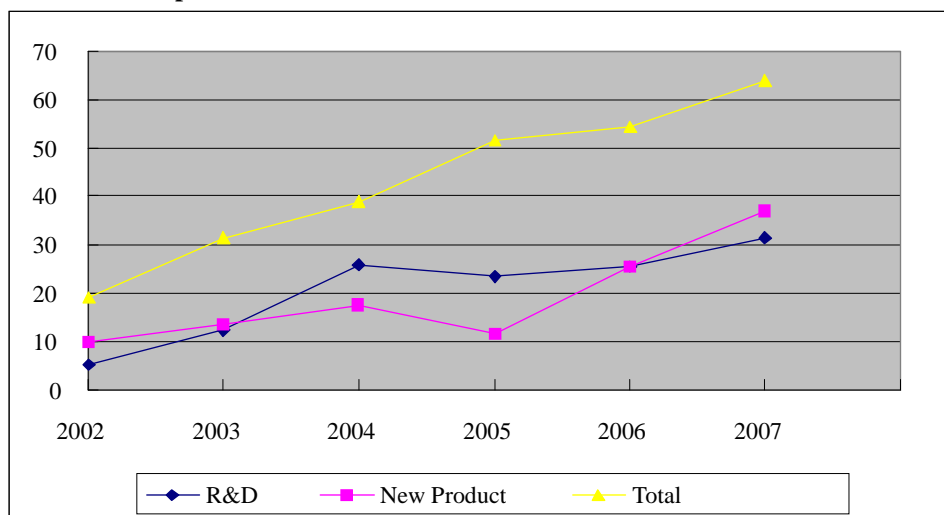


Figure 1 Input of the Industrial Science and Technology of the Scaled Enterprises in Wuhan from 2002 to 2007

Sources : Statistic Yearly Book of Science and Technology in Wuhan compiled by Wuhan Science and Technology Bureau unit:100 million yuan

In recent years, the scientific and technological input in finance of the industrial enterprises above scale in Wuhan has been increasing gradually with a fluctuation in the mid-way. The total funds of the science and technology increased by 6.4 billion yuan in 2007 from 2 billion yuan in 2002 with a rise of nearly 230% , higher than the rate of GDP in the same period. Particularly , the expenditure of the R&D, it rises from 535 million yuan in 2002 to 3.2 billion yuan in 2007, increasing by nearly 490%, remarkably higher than that of the development of the new product in the same period. However, in 2005, this two value dropped a little.

In the input of the high-tech industry, its input in Wuhan has been intensified recently. In 2007,the total funds raised for the scientific and technological activities, the total expenditure of the funds are respectively 5.8 billion yuan and 5.6 billion yuan with a rise of 31.32% and 33.49% , accounting for 48.01% and 46.06% of the total funds raised for the scientific and technological activities and the total expenditure of the funds . In the meanwhile, the R&D and the development of the new product are paid more attention and in 2007, the inputs of R&D and the development of the new product are respectively 822 million yuan and 3.44billion yuan with an increase of 50.43%and 86.69%.

3.2 Input of human resources

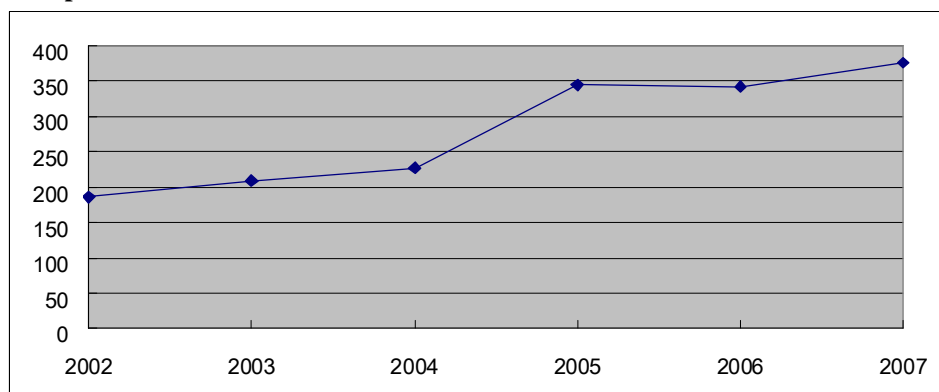


Figure 2 Persons of the Industrial Science and Technology of the Scaled Enterprises in Wuhan from 2002 to 2007

Sources : Statistic Yearly Book of Science and Technology in Wuhan compiled by Wuhan Science and Technology

Bureau unit:100 persons

In human resources, the scientific and technological personnel of the industrial enterprises above scale in Wuhan have been increasing basically from 18481 in 2002 to 37575 in 2007 with a rate of 103% and a yearly increase of almost 3200. In 2007, the scientific and technological personnel of the industrial enterprises above scale occupied 53.28% of the total in Wuhan and became the manpower of the scientific and technological activities there. The input of the scientific and technological personnel of the industrial enterprises above scale in Wuhan increased by 50.48% in 2005 and also the industrial increase value was raised greatly. So a strong correlation between them existed.

3 Empirical Analysis of the Contribution to the Industrial Economy Increase on Technology Progress

3.1 Definition of α and β

Make a calculation on the base of the industrial increase value, employment at the end of the year and the investment of the fixed assets of the enterprises above scale in Wuhan from 2000 to 2007(see Table 1) and we can get $\alpha=0.6$, $\beta=0.4$. Namely, when the investment of the fixed assets increased by 1%, the industrial increase value can be raised to 0.6%; when the employment raised by 1%, the industrial increase value can be raised to 0.4%.

Table 1 Industrial Increase Value ,Employment at the End of the Year and the Investment of the Fixed Assets of the Enterprises Above Scale in Wuhan from 2000 to 2007

year	Industrial Increase Value of Scaled Enterprises(100 million yuan)	Industrial Fixed Asset Input of Scaled Enterprises(100 million yuan) (1978=100)	Employment of the Industrial Firms at the End of the Year of Scaled Enterprises(10 thousand persons)
2000	288.31	12.49	53.35
2001	329.8	17.09	51.21
2002	365.04	20.89	53.1
2003	427.89	26.90	47.53
2004	538.89	57.65	47.27
2005	734.53	79.93	48.6
2006	880.53	95.25	49.32
2007	1055.18	112.22	50.66

Sources : Statistic Yearly Book of Wuhan from 2000 to 2008

3.2 Calculation of the increase rate "a" of technology progress

According to the formula $a=y-\alpha \cdot k-\beta \cdot l$, we can get the values of y , k , l , $\alpha \cdot K$, $\beta \cdot L$ and a from 2000 to 2007

Table 2 Calculation of y , k , l , $\alpha*K$, $\beta*L$, a

Year	Industrial Increase Rate $y(\%)$	Fixed Asset Increase Rate $k(\%)$	Employment Increase Rate $l(\%)$	$\alpha*K$	$\beta*L$	Technology Progress Increase Rate $a(\%)$
2000	7.05	30.14	-0.24	18.09	-0.10	-10.94
2001	14.39	36.78	-4.01	22.07	-1.60	-6.07
2002	10.69	22.23	3.69	13.34	1.48	-4.13
2003	17.22	28.80	-10.49	17.28	-4.20	4.13
2004	25.94	114.27	-0.55	68.56	-0.22	-42.40
2005	36.30	38.65	2.81	23.19	1.13	11.99
2006	19.88	19.17	1.48	11.50	0.59	7.78
2007	19.83	17.82	2.72	10.69	1.09	8.06

3.3 Calculation of contribution rate ea of the technology progress

According to Table 2 and the relative formula said , we can get the contributions of capital, labour force and technology progress (see Table 3) .

Table 3 Calculation of Ea , Ek , El from 2000 to 2007

Year	Capital Contribution Ek %	Labour Contribution El %	Technology Progress Contribution Ea %
2000	256.54	-1.36	-155.17
2001	153.35	-11.15	-42.20
2002	124.82	13.82	-38.64
2003	100.38	-24.37	23.99
2004	264.29	-0.84	-163.45
2005	63.87	3.10	33.03
2006	57.87	2.98	39.15
2007	53.89	5.48	40.63

3.4 Analysis of the contribution of the industrial economic increase in Wuhan on technology progress

Seen from the above calculation, the industrial economy increase in Wuhan is promoted mainly by investment and the contribution to the industrial economy increase by labour forces and technology progress is not evident, but the contribution by technology progress was rising gradually from -155.17% in 2000 to 40.63% in 2007. The contribution of the capital was dropping from 256.54% in 2000 to 53.89% in 2007. We think that the results were caused by the actual situation of the industry in Wuhan. For a long period, heavy industry has been the emphasis of the industry in Wuhan(in recent years, the output of the heavy industry has continuously occupied over 75% of the total industrial output in Wuhan) that belongs to the funds-intensified, so the investment plays an important driving role. With the acceleration of the industrialization in Wuhan, its industry is now entering into the mid-post period of the industrialization in which the heavy industry begins to be in need. This directly led to a gradual decrease of the contribution rate of the industrial increase value of the enterprises above scale in Wuhan in investment from 2005 to 2007.At the same time, the contribution rate of the technology progress to the industrial increase value has been raised step by step and reached 40% or so (see Table 3) .

We think that in the near future, the contribution of the technology progress to the industrial economy increase will be rising continuously. At present, the global economic crisis is spreading from the virtual economy to the substantial economy and has some bad effects on the manufacturing industry, which makes the industry economy facing great pressure. However, when the industry economy goes downward, certain favorable opportunities are coming on the conditions that the industry economy realizes the technology progress and the structure adjustment. In this way, objectively, the crisis may push the technology progress to deploy the function in the rise of the industrial economy. In the economy development, the industry lies in the mid-post period of industrialization, the industrial economy based on the heavy industry must keep on strengthening the technology progress so as to raise its competitive power.

Table 4 Classification of the Industrial Aggregate Output Value in Wuhan According to Light and Heavy Industries

		Total Industrial Output of Light and Heavy Industry			
		Light	Proportion	Heavy	Proportion(%)

		(100million yuan)	(%)	(100million yuan)	
2000	1422.37	612.56	43.07	809.81	56.93
2001	1611.76	660.38	40.97	951.38	59.03
2002	1769.92	712.19	40.24	1057.73	59.76
2003	1994.49	804.98	40.36	1189.51	59.64
2004	2402.34	968.14	40.30	1434.2	59.70
2005	2674.41	579.3	21.66	2095.11	78.34
2006	3162.06	720.84	22.80	2441.22	77.20
2007	4010.3	971.27	24.22	3039.03	75.78
2008	4338.28	944.10	22.91	3394.18	77.09

3.5 Policy suggestions

Now, the industrial economy in Wuhan is lying in the transition from technology application to technology improvement and creation. In the light of "the Quota of the Statistic Supervision of Innovative Wuhan" issued by Wuhan Statistics Bureau, from 2006 to 2007, the expenses of R&D in Wuhan occupied respectively 2.08% and 2.15% of GDP. According to the features of the technology innovation of the developed countries, in general, the technology innovation includes three stages, namely, technology application(below 1%),improvement(between 1% and 2%) and creation(above 2%).The above proportions show that the industrial technology progress in Wuhan has entered into the stage of the technology creation remarkably. In this stage, we should fully deploy the contribution of the technology progress to the industrial economy and promote the development of the newly-typed economy.

Firstly, accelerate the development of the high-tech industry and make it become the main power assuming the technology progress. The output values of the high and new technology industry from 2005 to 2007 were respectively 83.7billion yuan, 111.07 billion yuan and 138.01billion yuan, occupying36.7%,39.4%,39.1% of the industrial aggregate output of the enterprises above scale of the year. In recent years, the output of the high and new technology has been kept 40% or so in the industrial economy in Wuhan. Also, it is necessary to increase the input of research and development of the high and new technology and push it industrialized so as to realize the strategic target of "innovative Wuhan" on the base of the high-tech industry.

Secondly, establish the special project funds of science research to realize the joint action of the funds and to promote the technology progress of the industrial enterprises. Learn from Shanghai and Shenzhen, arrange unified the funds of the technology progress supporting the industrial enterprises from various governmental departments. Unite the funds from enterprises and the relative social organizations to set up special funds of the scientific and technological project. Realize the joint action of the funds among the governments, enterprises and society developing science and technology through the project, encourage the joint research and development, the cooperation and innovation of the big-mid-small firms and support enterprises, universities and research institutes to form the strategic alliance of the self-independent innovation to push the integration of industry, universities and research institutes.

Thirdly, strengthen the public service of science and technology and promote the innovation of the industry clusters. In light of the transition from "element driven" to "innovation driven", directed by the idea of "make Wuhan thrive by innovation", depending on the pillar industry and regarding the high and new technology garden and industrial bases as medium, the industry in Wuhan should greatly develop the industrial clusters, public technology service and technology innovation intermediaries to guide the accumulation of innovation factors and to accelerate the coordinative innovation of the clusters so as to upgrade the synergic innovative capacities inside the industry.

4 Conclusions

Through an authentic analysis of the increase contribution of the industrial economy in Wuhan from technology progress, the paper draws conclusions that strong correlations exist between the technology progress and the industrial economy increase in a country or in a region. As a modern industrial city, the development of the industry in Wuhan plays a key role in its economy increase. So Wuhan must attach more attention to its technology progress so that its industrial structure is fast upgraded and its industrial economy rises quickly.

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