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Demonstration Technology Application and Analysis on the Scientific and Technological Progress

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Abstract

This paper takes Tianjin for example and analyzes the development tend of scientific and technological progress in Tianjin. From five aspects as 'environment of scientific and technological progress', 'input of scientific and technological activities', 'output of scientific and technological activities', 'high-tech industrialization', 'science and technology for economic and social development', the paper analysis the correlation between GDP and scientific and technological progress. Research finding shows that these five indicators are all positive correlated with the GDP, and especially 'environment of scientific and technological progress', 'input of scientific and technological activities', and 'science and technology for economic and social development', which are significantly positive correlation of GDP. The extent to which these five indicators impact the GDP from strong to weak is 'input of scientific and technological activities', 'science and technology for economic and social development', 'environment of scientific and technological progress', 'high-tech industrialization', and 'output of scientific and technological activities'. The 'input of scientific and technological activities' index (2011) in Tianjin scores only 70 which ranks fourth among the five indexes, however its impact on GDP is most significant. So it would be best for Tianjin to increase the human and financial input in 'scientific and technological activities' to promote the growth of GDP in future.

***Keywords**: GDP, scientific and technological progress, innovation, Input of science and technology, Economic development*

1. Introduction

With the development of society, the traditional extensive growth mode is gradually transforming into intensive growth mode. More and more Scholars begin to analyze the scientific and technological progress and economic development in the background of the whole society not only in pursuit of the economic development, environmental optimization and the all-round progress in other social undertakings but also to achieve social harmony as well as the sustainable development. Accordingly, the research group on China's statistically monitoring and comprehensively evaluating the scientific and technological progress has concentrated on the scientific and technological progress for years and established a scientific system to monitor the scientific and technological progress nationwide. Based on data from the research group above, this paper studies the scientific and technological progress in Tianjin in depth so as to know more information about Tianjin and whether the environment of scientific and technological progress and the input and output of scientific and technological activities has been improved or not nowadays.

2. Theory Review

Classical economists emphasized not only the physical capital and labor which mainly promote economic growth but also the importance of labor division. Adam Smith's *The Wealth of Nations* maintained that the technological progress such as the improvement of labor productivity and workers' skilled techniques are the result of labor division [1].

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Table 1. Statistical Monitoring Indicator System of Scientific and Technological Progress.

First-level indicator	Second-level indicator	Third-level indicator
Environment of scientific and technological progress	Scientific and technological human resources	Quantity of professional and technical personnel per ten thousand people
		average years of schooling
	Material condition of research	The expenses of newly increased apparatus per R&D staff(ten thousand yuan /person)
		The proportion of newly increased fixed assets of the scientific research service in the newly increased fixed assets of the whole society (%)
		The quantity of patent applications per ten thousand employed people
	Consciousness of science and technology	The proportionality coefficient between average wage in scientific research service and average wage in the whole society (%)
		The cost of digesting and absorbing technical achievement per ten thousand people (ten thousand yuan /ten thousand people)
Input of scientific and technological activities	Human input in scientific and technological activity	The quantity of R&D scientists and engineers per ten thousand people(person/ten thousand people)
		The proportion of enterprise's R&D scientists and engineers in the social R&D scientists and engineers (%)
	Financial input in scientific and technological activity	The proportion of R&D expenses in GDP（%)
		The proportion of Local Financial Allotment for scientific and technological Work in local financial Expenditure（%)
		The proportion of enterprise's R&D expenses in sales revenue（%)
		The proportion of enterprise 's expenses of digesting and absorbing the technical achievement in the expenses of the technology import（%)
Output of scientific and technological activities	Level of output in scientific and technical activity	The quantity of scientific and technological paper per ten thousand R&D people(piece/ten thousand people)
		The proportion of people who wins the State Science&Technology Awards in ten thousand people
		The quantity of patent per ten thousand employed people
	Marketization of technological achievements	The volume of transaction of technical achievement per ten thousand people
		The patent royalties and license fees transferred to foreign enterprises by ten thousand R&D people.(ten thousand dollars /ten thousand people)
High-tech industrialization	Level of high-tech industrialization	The proportion of added value of high-tech industry in the industrial added value高(%)
		The proportion of export value of high-tech products in the export value of goods（%)
		The proportion of new products' sales income in products' sales income（%)
		The proportion of technical service income of high and new tech development zone in the total income (%)
	Benefit of high-tech industrialization	The labor productivity of high-tech industrial employed people (ten thousand yuan/ person)
		High-tech industrial value added rate (%)
		The proportion of high-tech industrial growth in economic growth(%)
		The profit and tax rate of income in high and new tech development zone(%)
Science and technology for economic and social development	Transformation of economic growth mode	Labor productivity of employed people (ten thousand yuan /person)
		The proportion of invest in newly increased GDP (a hundred million yuan/a hundred million yuan)
		The productivity of comprehensive energy consumption(yuan/a kilogram of standard coal)
	Environmental improvemen	air quality index（%)
		Index of environmental pollution control（%)
	Informatization of social life	The ownership of color TV per hundred residents
		The quantity of internet users per ten thousand people
		The quantity of fixed-line telephone and mobile phone users

Another classical economist David Ricardo believed that the aggregate social product was the outcome of a combination of land, capital and labor and the inputs of labor and capital were main factors which determined the economic growth. Based on the "Cobb-Douglas

production function", American economist Solow deduced a new economic growth model: $Y=AL\alpha K\beta$ in the late 1950s, where Y denotes total output, A denotes the level of technology, L denotes labor, K denotes capital, α denotes the contribution of capital in total output, and β denotes the contribution of labor in total output. This model is under some assumptions such as the capital and labor are substitutive for each other, the market is perfect competitive, the technology is exogenous and so on. The Solow Residual Value which is also the Contribution Rate of Scientific and Technological Progress can be solved from the equation: $\alpha+\beta=1$. The model indicates that economic growth depends not only on the capital growth rate, the labor growth rate and the weight of the correlation between capital&labor and income growth, but on the level of technical innovation. Then an Austrian-American economist called Fritz Machlup firstly put forward the conception of "knowledge industry" in 1962. Paul M. Romer's publication "Increasing Returns and Long Run Growth" in 1986 propsed the endogenous growth theory and he believed that knowledge and the technological research and development are source of economic growth [2, 3].

These theories above indicate that scientific and technological progress will have a great effect on the economic development. Although Solow's improved Cobb-Douglas Production Function has a wide range of applications, it still has some defect because of the assumptions. Therefore, this paper analyses the actual data of the scientific and technological progress and economic deveopment in order to reveal the relationship between economic development and the different dimensions of scientific and technological progress and help the decision-making of government [4].

3. Research Methodologies and Contents

3.1. Indicators and Data

Scientific and technological progress is the reflection of scientific and technological strength, technological competitiveness, R&D ability and innovation ability. For this reason, Ministry of Science and Technology established a comprehensive index of scientific and technological progress to reflect the overall level of China's scientific and technological progress. This index is comprehensively weighted by five first-level indicators which are 'environment of scientific and technological progress', 'input of scientific and technological activities', 'output of scientific and technological activities', 'high-tech industrialization' and 'science and technology for economic and social development'. These five first-level indicators are comprehensively weighted by their respective twelve second-level indicators. And accordingly these twelve second-level indicators are comprehensively weighted by their third-level indicators.

Table 2. Scientific and Technological Progress Index and GDP in Tianjin, 2004-2011

Year	The environment of scientific and technological progress index	The input of scientific and technological activities index	The output of scientific and technological activities index	The high-tech industrialization Index	The science and technology for economic and social development index	GDP
2011	76.51	70	66.57	70.45	82.05	11190.99
2010	75.34	68.48	64.81	69.98	82.58	7068.56
2009	77.12	70.98	64.43	64.13	82.87	6354.53
2008	75.23	70.1	65.34	68.67	82.96	6354.38
2007	74.74	65.19	63.72	68.63	80.08	5014.47
2006	71.86	58.86	58.15	58.82	76.44	4337.73
2005	68.53	54	73.63	71.21	70.94	3663.86
2004	57.9	52.25	54.3	55.14	64.91	2931.88

Source: "National Science and Technology Progress Statistical Monitoring Report" and "Tianjin Statistical Yearbook"

This paper takes Tianjin for example and analyzes some indexes of scientific and technological progress and some data of GDP which can be found in “National Science and Technology Progress Statistical Monitoring Report” and “Tianjin Statistical Yearbook” [5, 6].

3.2. Analysis on the Basic Situation of Scientific and Technological Progress in Tianjin

Based on the statistical data in Table 2, the development trend of these scientific and technological progress indexes (2004-2005) in Tianjin can be seen from the Figure 1 below.

Figure 1. Development Tend of these Indexes of Scientific and Technological Progress in Tianjin, 2004-2011

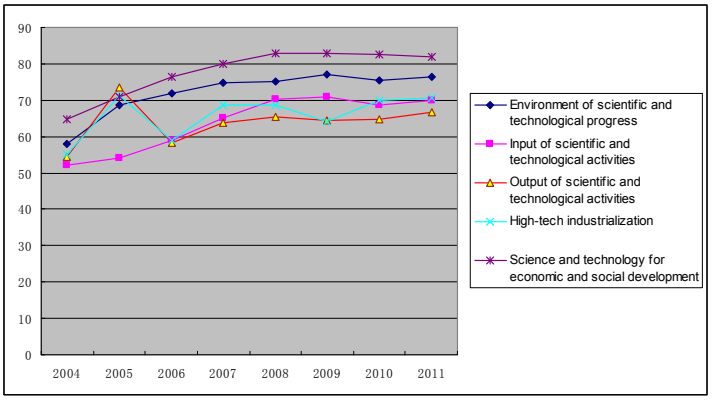

Figure 1 shows that among the five indicators, the tendency which the science and technology for economic and social development shows is the best while the input of scientific and technological activities is the worst. Tianjin has made great progress in all the five aspects from the viwpoint of development tendency. But if we analyze the scores, only the scientific and technology for economic and social development index scores more than 80 while the other four indexes score less than 80. Therefore there’s still great room for the development of scientific and technological progress in Tianjin.

3.3. Correlation Analysis between the Scientific and Technological Progress and the Economic Development in Tianjin

Based on these indexes of scientific and technological progress and the data of GDP (2004-2005), this paper separately analyzes the correlation between ‘environment of scientific and technological progress’, ‘input of scientific and technological activities’, ‘output of scientific and technological activities’, ‘high-tech industrialization’ ‘science and technology for economic and social development’ these five aspects and GDP with SPSS11.0 software. The VAR00001 below denotes the indexes of scientific and technological progress and the VAR00002 denotes the level of GDP.

3.3.1 Relationship between the Environment of Scientific and Technological Progress Index and GDP

Table 3. Comparison Table between the Environment of Scientific and Technological Progress Index and GDP in Tianjin, 2004-2011

Year	2004	2005	2006	2007	2008	2009	2010	2011
The environment of scientific and technological progress index	57.90	68.53	71.86	74.74	75.23	77.12	75.34	76.51
GDP	2931.88	3663.86	4337.73	5014.47	6354.38	6354.53	7068.56	11190.99

Analyzing the data from the comparison table between environment of scientific and technological progress index and GDP (2004-2011) in Tianjin with SPSS11.0, the result of the correlation can be seen in Table 4.

Table 4. The Pearson Correlation analysis between the environment of scientific and technological progress and GDP

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	.683
	Sig.(2-tailed)		.062
	N	8	8
VAR00002	Pearson Correlation	.683	1
	Sig.(2-tailed)	.062	
	N	8	8

Table 4 shows that the Pearson Correlation is 0.683 (greater than 0) which indicates that the environment of scientific and technological progress index is positive correlated with GDP. And the Significance is 0.062 (less than 0) which indicates that the improvement of the environment of scientific and technological progress index significantly promotes the growth of GDP.

3.3.2. Relationship between the Input of Scientific and Technological Activities Index and GDP

Analyzing the data in Table 5 with SPSS11.0, the result of the correlation between the input of scientific and technological activities index and GDP can be seen in Table 6.

Table 5. Comparison Table between the Input of Scientific and Technological Activities Index and GDP in Tianjin, 2004-2011

Year	2004	2005	2006	2007	2008	2009	2010	2011
The input of scientific and technological activities index	52.25	54.00	58.86	65.19	70.10	70.98	68.48	70.00
GDP	2931.88	3663.86	4337.73	5014.47	6354.38	6354.53	7068.56	11190.99

Table 6. The Pearson Correlation Analysis between the Input of Scientific and Technological Activities Index and GDP

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	.775*
	Sig.(2-tailed)		.024
	N	8	8
VAR00002	Pearson Correlation	.775*	1
	Sig.(2-tailed)	.024	
	N	8	8

*. Correlation is significant at the 0.05 level(2-tailed).

Table 6 shows that the Pearson Correlation is 0.775 (greater than 0) which indicates that the input of scientific and technological activities index is positive correlated with GDP. And the Significance is 0.024 (less than 0.01) which indicates that improving the input of scientific and technological activities index can also promote the growth of GDP.

3.3.3. Relationship between the Output of Scientific and Technological Activities Index and GDP

Analyzing the data in Table 7 with SPSS11.0, the result of the correlation between the output of scientific and technological progress index and GDP can be seen in Table 8.

Table 7. Comparison Table between the Output of Scientific and Technological Activities Index and GDP in Tianjin, 2004-2011

Year	2004	2005	2006	2007	2008	2009	2010	2011
The output of scientific and technological activities index	54.30	73.63	58.15	63.72	65.34	64.43	64.81	66.57
GDP	2931.88	3663.86	4337.73	5014.47	6354.38	6354.53	7068.56	11190.99

Table 8. The Pearson Correlation Analysis between the Output of Scientific and Technological Activities Index and GDP

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	.308
	Sig.(2-tailed)		.458
	N	8	8
VAR00002	Pearson Correlation	.308	1
	Sig.(2-tailed)	.458	
	N	8	8

Table 8 shows that the Pearson Correlation is 0.308 (greater than 0) which indicates that the output of scientific and technological activities index is positive correlated with GDP. And the Significance is 0.458 (greater than 0.01) which indicates that improving the output of scientific and technological activities index can't significantly promote the growth of GDP.

3.3.4. Relationship between the High-Tech Industrialization Index and GDP

Analyzing the data in Table 9 with SPSS11.0, the result of the correlation between the high-tech industrialization index and GDP can be seen in Table 10.

Table 9. Comparison Table between the High-Tech Industrialization Index and GDP in Tianjin, 2004-2011

Year	2004	2005	2006	2007	2008	2009	2010	2011
The high-tech industrialization index	55.14	71.21	58.82	68.63	68.67	64.13	69.98	70.45
GDP	2931.88	3663.86	4337.73	5014.47	6354.38	6354.53	7068.56	11190.99

Table 10. The Pearson Correlation Analysis between the High-Tech Industrialization Index and GDP

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	.537
	Sig.(2-tailed)		.170
	N	8	8
VAR00002	Pearson Correlation	.537	1
	Sig.(2-tailed)	.170	
	N	8	8

Table 10 shows that the Pearson Correlation is 0.537 (greater than 0) which indicates that the high-tech industrialization index and GDP have positive correlation. And the Significance is 0.170 (greater than 0.01) which indicates that improving the high-tech industrialization index can't significantly promote the growth of GDP.

3.3.5. Relationship between the Science and Technology for Economic and Social Development Index and GDP

Analyzing the data in Table 11 with SPSS11.0, the result of the correlation between the science and technology for economic and social development index and GDP can be seen in Table 12.

Table 11. Comparison Table between the Science and Technology for Economic and Social Development Index and GDP in Tianjin, 2004-2011

Year	2004	2005	2006	2007	2008	2009	2010	2011
The science and technology for economic and social development index	64.91	70.94	76.44	80.08	82.96	82.87	82.58	82.05
GDP	2931.88	3663.86	4337.73	5014.47	6354.38	6354.53	7068.56	11190.99

Table 12. The Pearson Correlation Analysis between the Science and Technology for Economic and Social Development Index and GDP

		VAR00001	VAR00002
VAR00001	Pearson Correlation	1	.714*
	Sig.(2-tailed)		.047
	N	8	8
VAR00002	Pearson Correlation	.714*	1
	Sig.(2-tailed)	.047	
	N	8	8

*. Correlation is significant at the 0.05 level(2-tailed).

Table 12 shows that the Pearson Correlation is 0.714 (greater than 0) which indicates that the science and technology for economic and social development index is positive correlated with GDP. And the Significance is 0.047 (less than 0.01) which indicates that improving the high-tech industrialization index can significantly promote the growth of GDP.

4. Conclusion

This paper can draw a conclusion basing on the demonstration analysis between the scientific and technological progress and economic development. Firstly, 'environment of scientific and technological progress', 'input of scientific and technological activities', 'output of scientific and technological activities', 'high-tech industrialization', 'science and technology for economic and social development' these five indicators are all positive correlated with GDP. Secondly, from the viewpoint of Pearson Correlation, the extent to which these five indicators impact GDP from strong to weak is 'input of scientific and technological activities', 'science and technology for economic and social development' 'environment of scientific and technological progress' 'high-tech industrialization' and 'output of scientific and technological activities'. Lastly, the 'input of scientific and technological activities' index (2011) in Tianjin scores is only 70 which ranks fourth among the five indexes. However its impact on GDP is most significant. So it would be best for Tianjin to increase the human and financial input in scientific and technological activities to promote the growth of GDP in future.

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