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Correlation Analysis Between Scientific and Technological Progress and Economic Development

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Abstract

There exists an interdependence between scientific and technological progress and economic development. The development of science and technology brings along economic development, meanwhile economic development offers powerful support for it. Based on statistical analysis of the relationship between Sci-Tech investment and economic growth in recent decade, this article explores the dependencies between them, and gives us a measurement model. The result suggests that local Sci-Tech investment is more effectively for GDP growth. Furthermore, a win-win proposal of seeking for Sci-Tech progress and economic growth is given.

Key words: Science and technology development; Independent innovation; National innovation system; Measurement model

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INTRODUCTION

China has entered the new phase of development for building a well-off society. Science and technology plays an important role of propelling Chinese social progress and economic growth. After founding New China, Sci-Tech was developing under several economic systems: first, a complete planned economy, next planned and market coexisting economy, then market-led economy. Through this long period, the guidelines, basic principles and objectives for technology development are determined gradually (ZHENG, *et al.*, 2009). In 2006, the Party decided that Sci-Tech development of guideline for our country was "independent innovation, major construction, supporting the development, and to lead the future". This guideline points out the direction of our country Sci-Tech development in the next period of time.

In order to ensure sustained economic growth, technical progress is indispensable. Modern economics theory combined qualitative method with quantitative methods for the analysis of the factors of economic growth, and regarded the science and technology as an important economy growth factor. Solow (1957), as the representative of the economists in the field, has made outstanding contributions; Robert Solow (1957) introduced the efficiency into the production, and revealed the relationship between the progress of Sci-Tech and economic growth. Lots of literatures indicate that, people pay a general attention on comparing analyzing GDP and R&D investment data. The relationship of Sci-Tech progress economic growth is hot spot not only for theoretical research, but also for practice.

Nowadays, in order to improve the international competitiveness, we have to build the national innovation system. Because its improvement and progress will bring new thinking to economic reform, provide an effective way to address the problem of the combination of Sci-Tech and economic, supply the institutional guarantee and technical foundation for technological innovation capability. As a result, this system will ultimately benefit the quality of Chinese industry and international competitiveness. Improving the level of technology and achieving the technological development with economic

growth are important parts of national innovation system (LIU, 2007). Therefore, it is particularly urgent to sort out the issues of technological development and economic growth, and to build the national innovation system.

THE MEASUREMENT MODEL OF SCI-TECH PROGRESS AND ECONOMIC DEVELOPMENT

In order to reveal the internal relation of the Sci-Tech progress and economic development, and whether the Sci-Tech production matches with the investment, we building a measurement model to explain the relation of the Sci-Tech progress and economic development, composed by GDP variables and Sci-Tech investment variables. Data from the National Bureau of Statistics Network (http://www.stats.gov.cn/), Table 1 shows time series data of Sci-Tech investment and GDP (1999-2010).

Table 1
The Science and Technology Input and GDP Time Series Data

Particular year	GDP Y (100 million yuan)	R&D X1 (100 million yuan)	The proportion of GDP	The local R&D X2 (100 million yuan)
2010	401202	7062.6	1.76	2068
2009	340506.9	5802.1	1.7	3775.7
2008	314045.4	4616	1.54	1296.6
2007	265810.3	3710.2	1.49	1070.5
2006	216314.4	3003.1	1.42	678.8
2005	184937.4	2450	1.34	527.1
2004	159878.3	1966.3	1.23	402.9
2003	135822.8	1539.6	1.31	335.6
2002	120332.7	2938	1.23	305
2001	109655.2	2589.4	2.36	258.9
2000	99214.6	896	1	237.9
1999	89677.1	678.9	0.83	188.3

Note: data from the National Bureau of Statistics Bulletin

The high correlation coefficient suggest that a measurement model between GDP and Sci-Tech investment can be established (LI, 2008). The measurement model is given by:

$$Y = 44072.425 + 51.233X_1$$
$$(2.136), (8.967) \quad (1)$$
$$R^2=0.889, \quad F=80.408$$
$$Y = 127205 + 81.733X_2$$
$$(5.23), (4.614) \quad (2)$$
$$R^2=0.692, \quad F=22.454$$

Let Y denotes the GDP, X_1 denotes R&D fund, and X_2 denotes local Sci-Tech investment. R^2 is the coefficient of determination, and F is the F-test value. Since above test result is acceptable, these equations could be used to explain the relation of Sci-Tech progress and economic growth. Further, we can see that GDP increases 8.1733 billion yuan fed by local Sci-Tech investment of 100 million; GDP increases 5.1233 billion yuan fed by R&D investment of 100 million. Therefore, local Sci-Tech investment is more effective for GDP growth.

THE INTERDEPENDENT RELATIONSHIP BETWEEN THE DEVELOPMENT OF SCI-TECH AND ECONOMIC GROWTH

Science and technology are the crystallization of human knowledge, and manifested in the form of scientific results, which mainly from domestic and foreign scientific research and development activities, and used in the process of social production through technological innovation. In the production process, Sci-Tech achievements are turned into productivity by improving the equipment and labor qualities, reforming the process and management or other specific ways. The generalization of technology shows the influence on economic growth, that is, the economic benefits from technological progress.

From the following aspects, we can understand the characteristics of technology development at different periods since reform and opening. First, the difference of economic backgrounds, which starts from the beginning of the economy to the rapid development. Second,

the difference of principal contradictions, which from the disjunction of technology and economy to rapidly developing economy but hysteretic technology, then to extensive developing mode and weak capacity of independent innovation. Third, guidelines for Sci-Tech work has changed from "facing, relying on economic growth" to "innovation, industrialization," and then to "independent innovation, major construction, supporting the development, and to lead the future". Fourth, technology development objectives and tasks has changed from getting rid of the old system and adjusting the structure of scientific research to promoting and facilitating economic development and implementation of science, then to supporting and leading the social development, building an innovation-oriented country. Fifth, the status of Sci-Tech work has changed from apart from the economy to entering, then to be the core (ZHENG *et al.*, 2009). Taking a wide view of these differences and changes, it is obvious that technology development is at a historic turning point. Backtracking, we can see the extensive growth mode and the traditional strategy, pursuing growth and expansion of the quantity unilaterally. Looking forward, we have to enhance the innovation capacity and competitiveness, to form the core technology system, and achieve the new strategy of sustainable development. To fulfill these goals, we should emancipate the minds ulteriorly, based on current national situation, command by scientific development view globally, strive for an influential advantage of innovation continuously, and make efforts to advance the historical transformation on the role of Sci-Tech to social development from "promote" to "support".

Table 2
Local R&D Investment and GDP (2009)

Area	R&D equivalent (one year)	R&D funding (billion yuan)	R&D/GDP (%)	GDP ranking	GDP (billion yuan)	GDP per capita (yuan)	GDP per capita ranking
Summary	2291252	580.2107	1.70		36377.690		
Beijing	191779	66.86351	5.50	13	1186.590	72663	2
Tianjin	52039	17.84661	2.37	19	750.080	67271	3
Hebei	56509	13.48446	0.78	6	1780.746	25648	12
Shanxi	47772	8.08563	1.10	22	710.000	20925	18
Neimenggu	21676	5.20726	0.53	15	970.000	40332	7
Liaoning	80925	23.23687	1.53	7	1506.500	35051	9
Jilin	39393	8.13602	1.12	21	720.000	26373	11
Heilongjiang	54159	10.91704	1.27	16	922.410	24121	13
Shanghai	132859	42.33774	2.81	8	1490.093	80198	1
Jiangsu	273273	70.19529	2.04	2	3406.100	44670	5
Zhejiang	185069	39.88367	1.73	4	2289.000	45237	4
Anhui	59697	13.59535	1.35	14	1005.290	16431	27
Fujian	63269	13.53819	1.11	12	1190.000	33230	10
Jiangxi	33055	7.58936	0.99	20	730.000	16712	26
Shandong	164620	51.9592	1.53	3	3380.530	36089	8
Henan	92571	17.47599	0.90	5	1936.728	20691	19
Hubei	91161	21.3449	1.65	11	1283.152	22515	15
Hunan	63843	15.34995	1.18	10	1293.069	20347	21
Guangdong	283650	65.2982	1.65	1	3908.159	41360	6
Guangxi	29856	4.72028	0.61	18	817.560	17146	25
Hainan	4210	0.57806	0.35	28	164.660	19486	22
Chongqing	35005	7.94599	1.22	23	652.700	23178	14
Sichuan	85921	21.4459	1.52	9	1415.130	17412	24
Guizhou	13093	2.64134	0.68	26	388.700	9778	31
Yunnan	21110	3.72304	0.60	24	616.800	13664	29
Tibet	1332	0.14385	0.33	31	43.700	15387	28
Shaanxi	68040	18.95063	2.32	17	818.665	21842	17
Gansu	21158	3.72612	1.10	27	340.070	12984	30
Qinghai	4603	0.75938	0.70	30	100.800	18260	23
Ningxia	6920	1.04422	0.77	29	133.456	21878	16
Xinjiang	12655	2.18043	0.51	25	427.000	20381	20

We can see the interdependent relationship between Sci-Tech development and economic growth from the following three aspects. Firstly, Sci-Tech progress is a key factor to advance economic developing (Solow, 1957). Knowledge plays more and more important role in economy, and the promotion is multidimensional, not only on output value, but also on productivity. The relationship can be reflected not only by economic fluctuations, but also by economic development scale. It can be presented as the relation of Sci-Tech and industrial structure, or the relation of technical structure and output structure. Secondly, Sci-Tech progress is driven by economic growth needs. With the rapid economic development, there are more and more problems, such as energy shortages, environmental pollution, international conflicts, industry competition and etc.. The settlement of these problems is to rely on the Sci-Tech progress. Better economic development is, the more urgent demand of Sci-Tech the economic system needs. New technology emerges as the times require. In order to gain superiority, enterprises have to improve technology and polish products. Thirdly, technological development depends on economy, and is subject to the economic level. Better economic development, more powerful sustainment it can offer. The supply of Sci-Tech innovation resources is determined by local economic level. Better economic level is, higher ratio the technological financial allocation and R&D funding accounts for. Then, Sci-Tech will benefit it.

Table 2 Local R&D investment and GDP (2009), the top five of GDP are Guangdong, Jiangsu, Shandong, Zhejiang, Henan. Their R&D funding are 3.49, 3.75, 2.78, 2.13, 0.93 times greater than the average respectively. The last five provinces of GDP are Gansu, Hainan, Ningxia, Qinghai, Xizang. Their R&D funding are 0.2, 0.03, 0.06, 0.04, 0.01 times greater than the average respectively. The top six of the proportion of R&D funding in GDP are Beijing, Shanghai, Tianjin, Jiangsu, Shaanxi, Zhejiang. The top six of the GDP per capita are Shanghai, Beijing, Tianjin, Zhejiang, Jiangsu, Guangdong. The coincidence rate is 83.33%. It is suggested that Sci-Tech impacts on economic development directly, and there are significant difference between regions.

In addition, there are three kinds of coefficient relation in these statistical data. First, weak correlation: because of lower level of economic development and Sci-Tech progress, the interaction between them is weak, such as western provinces. Second, strong correlation: Sci-Tech is coordinated with economic, both at higher level; technology is driven by industrial demands, however, it also influenced economic growth, such as eastern provinces and most of central provinces. Third, no relevant: because of technological advance or lag lead to slow economic growth or wasting technology resources. For example, Shaanxi Province is advanced in Sci-Tech with lower level of economic development; Neimenggu Province is opposite.

CONCLUSION

Generally, Sci-Tech progress drives rapid economic growth, whereas, great economic environment supports the technological innovation. From the perspective of the development in science and technology, the fact is indisputable that the developmental level and comprehensive strength of science and technology is improved, and the technology in key industries is improved comprehensively, and a series of key technology of developing the economic society is proved. The situation is fine as the above, but some problems that can't be ignored still exist. Secondly, shortage of innovation, especially the independent innovation of enterprise, has become the primary obstacle of economic society's development.

From a regional development perspective, there are significant differences, that is, the unbalance development from east regions to west regions. The eastern region has demonstrated a good situation that technology leads the economic growth recently, while the western is still in infancy, and there even still exits a mismatch between technology and economic growth. So in the coming period, it is essential to enhance macro-control, and support the central and western Sci-Tech development energetically. In the eastern region, it is necessary that taking advantage of market regulation and making whole effort to Sci-Tech progress, which provides powerful support for economic growth.

In order to realizing the coordinated development, the key is scientific and technological system innovation. So it is essential to speed up the technology system innovation at this stage, and at the same time it has certain foundation, especially in the eastern region, which has indispensable condition and executive ability. Next, we have to pay attention to the position of Sci-Tech and role conversion. What is more, we must build a system to support the technological innovation. Sci-Tech progress can liquidize remnant technological resources, increase the contribution rate of high-tech to economic growth, and promote the state competitiveness. The harmonious interaction of technology, economy, society, environment will serve for co-development of technological progress and economic growth.

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