

Study on the Relationship between Human Resource and Technology Innovation

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Abstract—This article analyses the relationship between human resource and technology innovation in Jiangsu, Zhejiang and Shanghai areas, using stationary test and co-integration analysis. Result of study has found that the correlation between the two is positive no matter in the long or short term, and R&D's sources of funding are important engine of technical innovation in China. Besides, results show that human capital to promote technological innovation capacity has an important role, while attention to reducing regional imbalances in the distribution of human capital.

Keywords-human resource; technology innovation; stationary test; co-integration analysis

I. INTRODUCTION

Since the reform and opening up, after more than 30 years of development, China's economy gradually enter in the relatively stable economic growth. Yangtze River Delta economic circle, as the country's largest economic zone, its economy equivalent 25% to national GDP, and annual growth rates well above the national average. Zhejiang and Shanghai is China's economic center, as well as participate in international competition and economic growth in southern China, has a very important strategic position.

Human resource is the carrier of knowledge of technology innovation. Human capital refers to the specific human capabilities with a long investment cycle which from primary school, secondary school, college and universities to continue to invest in the future^[1]. Therefore, input, accumulation of human resource, inadequate levels of stock and will, to a large extent affect the sustainability of the technological innovation capability^[2,3].

Study Group on Science and technology development strategy in China is currently completed, "Report on regional innovation ability in China in 2012", in the ranking of regional innovation capacity in 2012, Shanghai, Jiangsu and Zhejiang are respectively in 1, 4 and 6th. Investment in science and technology is the necessary conditions and a prerequisite to improve the capability of regional science and technology innovation. According to the national statistical offices and ministries of science and technology results, in 2011, technology investment in China reached 868.7 billion, as shown in table 1, Shanghai's expenditures on R&D account for 6.88% of the nations, Jiangsu Province 12.27 percent, Zhejiang Province 6.89 percent, Zhejiang and Shanghai areas accounted for 26.04%, much higher than the 16.53% of the Beijing-Tianjin-Hebei region. Thus, there is a

larger input of human resource in Zhejiang and Shanghai areas, to some extent, led to the improvement of regional innovation ability.

TABLE I. THE PROPORTION OF THE R&D FUNDING SPENDING IN ZHEJIANG AND SHANGHAI AREAS

Year	Shanghai	Zhejiang	Jiangsu	Zhejiang and Shanghai	Beijing-Tianjin-Hebei
2006	8.62%	7.46%	11.52%	27.6%	20.14%
2007	8.29%	7.59%	11.60%	27.48%	19.14%
2008	7.70%	7.47%	12.58%	27.75%	17.66%
2010	6.82%	7.00%	12.15%	25.97%	17.09%
2011	6.88%	6.89%	12.27%	26.04%	16.53%

II. MODEL BUILDING

A. Selection of Indicators

According to this article needs, research on role of human resource on technology innovate, the primary issue is how to measuring technology innovation. We use R&D financial and patent indicators to scale the ability of technology innovation. From the point of view of innovation of science and technology outputs, indicators are used to reflect the region's technology innovation capability of new products. At home and abroad, the most common indicator is the number of patents^[4-7].

B. Human Capital Stock Calculations

The most widely used method of measurement is the length of education enjoyed. The equation is

$$HR = \frac{\sum P_i E_i}{P} \quad (1)$$

In the equation, HR means the human capital stock; i ($i=1,2,3,\dots$) stands for the level of education in what stage; P_i is the population of the i stage; E_i is the length of year to receiving an education; P represents the total number of people who age 6 and above.

In this article, we define the people's education degree in Zhejiang and Shanghai areas into 5 levels, which are illiteracy semi-illiterate, primary school, middle school, junior college and above. And schooling is defined as illiterate or semiliterate 0; 6 for primary school; junior high school for 9 years; high school for 12 years; university or above 16 years. The table 2 is the situation of being education in Zhejiang and Shanghai areas^[8].

TABLE II. THE SITUATION OF BEING EDUCATION IN ZHEJIANG AND SHANGHAI AREAS FROM 2000 TO 2009

Year	Areas		
	Jiangsu	Shanghai	Zhejiang
2000	9.08	8.99	7.74
2001	10.26	8.86	7.75
2002	10.26	9.15	8.03
2003	10.35	9.24	8.38
2004	10.56	9.64	8.38
2005	10.69	9.51	8.17
2006	10.95	9.73	8.13
2007	11.09	9.81	8.17
2008	10.97	9.88	8.36
2009	11.04	9.92	8.45

C. Establishment of Basic Models

This article adopts the following model to reflecting the relationship between human resource and technology innovation.

$$INN=b_0+b_1\ln RD_{it}+b_2\ln HR_{it}+\Sigma it \quad (2)$$

INN express innovation capacity, with the number of domestic patent applications authorized measure; RD on behalf of R&D funds; HR represent human resources stock; i and t respectively on behalf of the i region and t year; b0, b1 and b2 represent constant term, R&D investment and the impact of human resource on technological innovation capacity; Σit means the random interference. The following using the time series and cross section data to estimate equation (1), use of the software is Eview3.1.

D. The Stationary Test

If the two variables are non stationary time series, there may be a false return, so we should make a stationary test. Because the original data on monotonicity of the logarithm does not change the data, as well as elimination of unequal variances, this article to log processing the raw data.

TABLE III. THE RESULT OF STATIONARY TEST

Var.	Area	ADF statistics	5% thres. limit value	Conclu.	DW statistics
LnINN	Jiangsu	-8.7600	-1.9959	stationa.	0.8147
	Shanghai	-5.8725	-1.9823	stationa.	2.0443
	Zhejiang	-5.9543	-1.9882	stationa.	1.6989
LnRD	Jiangsu	-6.1216	-1.9823	stationa.	1.7872
	Shanghai	-7.2404	-1.9823	stationa.	2.4980
	Zhejiang	-3.0698	-1.9882	stationa.	1.3811
LnHR	Jiangsu	-4.8459	-1.9882	stationa.	1.0115
	Shanghai	-3.7357	-1.9959	stationa.	1.8353
	Zhejiang	-4.4078	-1.9823	stationa.	1.8143

As can be seen, 5% smooth with the significant level of each variable, which validates their sine qua non for a co-integration relationship.

E. The Co-integration Test

First, with OLS regression get a series of residual sequence. Then, test the stationary of e. If e has a smoothness, it means that the sequence is Co-integration^[9].

Through unit root tests of model residuals, we have found the model has a smooth, Co-integration relationship exists between each variable.

F. The Error Correction Model

Unit root tests have demonstrated the Co-integration relationship between the variables, but it can't measure variable deviations from common stochastic trend of adjusting speed, we introduce the error correction model ECM.

$$DINN= b_0+b_1D\ln RD_{it}+b_2D\ln HR_{it}+ \beta_1D\ln RD(-1) + \beta_2D\ln HR(-1)+b_3E+ \Sigma it \quad (3)$$

Estimated parameters and excluding insignificant variables, using time series data to estimate (3), aimed at a long enough time to discover the relationship between human capital stock and R&D investment as well as technology innovation ability, estimated results are as follows.

Jiangsu:

$$DINN=0.0093+0.1584 D\ln RD_{1t}+8.9866D\ln HR_{1t}-0.2056\ln RD(-1)+3.4762D\ln HR(-1)+1.1138E$$

F=1.9172, DW=2.2736

Shanghai:

$$DINN= -11.6180+0.6475 D\ln RD_{2t}+3.4765D\ln HR_{2t}+0.5882\ln RD(-1)+1.2563D\ln HR(-1)+0.8288E$$

F=2.0457, DW=2.4284

Zhejiang:

$$DINN= 0.2111+0.2352 D\ln RD_{3t}+2.9992D\ln HR_{3t}+0.1907\ln RD(-1)+1.9073D\ln HR(-1)+0.6531E$$

F=2.2307, DW=1.2584

As can be seen, three provinces' coefficient of the stock of human capital is greater than0, which describes the human capital is correlated with technology innovation ability. Coefficient of Jiangsu province's stock of human resource is 8.8966, much larger than the 3.4765 in Shanghai and 2.9992 in Zhejiang province, means Jiangsu's education is more powerful.

III. CONCLUSION

A. Attach Importance to The Investment of Human Resource

High-quality human resources are the most valuable resources of scientific and technological innovation, in the society of knowledge economy, knowledge is increasingly becoming critical of local government gain a competitive advantage, the key to success or failure depends on mastering advanced expertise, and gain valuable efforts to human resource as the cutting-edge information to make decision. Increase investment in human resource, can greatly improve the overall quality and creativity of the people, which is more long-term gains from the investment in physical capital.

B. Reduce the Imbalance in Regional Distribution of Human Resource

This article through analyzing the relationship between stock of human resource and technological innovation ability in Zhejiang and Shanghai areas from 2000 to 2009, draw the

conclusion that human resource plays a large role in promoting technology innovation capability, but human capital stock is uneven in regions. Therefore, the government should invest more education spending in backward region as to reduce regional imbalances in the distribution of human resource stock.

C. *Analysis on Zhejiang and Shanghai areas*

Jiangsu Province has the advantage of a large number of high-tech small and medium-sized enterprise, a good business environment, as well as a wealthy of powerful creation capability of science and technology resources, it should increase investment in higher education and the cultivation of innovation talents to keep its predominance.

As the national economic center, Shanghai, has the advantage of good economic and technological base, a high level of education, a developed market economy, and a high insolation of production, teaching & research. These capabilities are unique which do not found in relatively backward regions. In Shanghai, besides maintaining basic education, it's important to increase investment in higher education.

As for Zhejiang Province, remains the focus on basic education still important, in addition, should further steps up efforts to promote accumulation of human capital stock and do not relax on the higher education investment.

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