Approach to Impact of Human Capital and Foreign Trade on Regional Economy Based on Threshold Estimation

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Abstract. In the period of world economic integration and China's economic reform, this paper takes R&D input intensity and FDI spillover as the threshold of human resources and foreign trade for economic growth to establish the threshold regression model to empirically analyze the relation between human resources, foreign trade and economic growth based on 2004-2015 Provincial Panel Data in China. Studies have shown that the contribution of human resources for economic growth by a significant effect of the threshold of R&D. With the increase of R&D input intensity, the relationship between high-quality human resources and economic development was a significant positive correlation. And with the improvement of the level of FDI spillover, the effects of foreign trade on economic growth become weakened. The research provides scientific basis and references for human resources management foreign trade policy establishment, ensuring the steady and healthy development of economy.

1. Introduction

The gap in talent distribution and openness to the world have led to different economic levels in different regions. The status and value of human resource and the innovation are increasingly playing significant roles in promoting technological progress and industrial upgrading in different countries [1]. As the core of science and technology-based human resource, R&D has a significant influence on constructing a regional innovation system, building regional industrial clusters and adjusting regional industrial strategies [2]. How to improve the competence of high-tech personnel capital and how to achieve a balanced distribution of high-tech talents remain focused crux within the academia and the business circle. Foreign trade, as the engine of economic growth, plays a decisive role in regional economic growth and industry transformation and upgrading. Based on foreign trade and the main form of international technology transfer, FDI spillover can make up for the defects of domestic enterprises, such as lack of innovation and low technology level, and enhance the competitiveness. However, some China foreign-funded enterprises are trying to squeeze out domestic enterprises by means of market squeezing and technology blocking strategy, to prevent the excessive spillover of advanced knowledge and technologies. Therefore, the driving effect of foreign trade on regional economic growth is significantly different, depending on whether the human capital of various regions can acquire advanced technologies from foreign trade FDI spillover to realize technological progress, combined with the increase of R&D input. Based on literature on human capital R&D input and
foreign trade FDI spillover on regional economic growth, this study innovatively demonstrated the threshold effect of technology supply on economic growth with R&D input intensity and FDI spillover as main mode respectively, which provides useful reference for promoting regional economic growth.

Economic growth may mainly benefits from the optimal allocation of human capital, which mainly depends on the improvement of education, creation of an open cultural environment and the introduction of advanced technologies [3, 4]. The human capital can play an indirect role in endogenous economic growth mainly through technological innovation and imitation [5]. Different types of human capital have different impacts on economic development, and high-tech talents are especially crucial to the innovation-driven economy [5, 6]. In addition, trade structure affects the international transfer of knowledge, and influences regional economy through technological progress and capital accumulation, with different stage effects [7]. The spillover of technology in the process of international trade has always been an important factor for the increase of total factor productivity in various countries [8, 9]. FDI spillover mechanism includes linkage effect, competitive effect, technology transfer and diffusion effect, and may lead to domestic enterprises’ more dependence on foreign technologies and less ability of independent R&D [10, 11].

There are few studies on the relationship between human capital input and FDI spillover effects. Although a large number of literature studies showed that human capital and foreign trade have a great impact on economic growth, there was some bias when considering the influence of human capital and foreign trade on economic growth without sufficient technology supply, and they even lacked research of specific function mechanism. This paper, according to the unique background of China, adopted panel threshold regression model of Hansen (1999), and introduced R&D input and FDI spillover as technology supply channel factors [12]. It innovatively demonstrated a more complex function mechanism between human capital, foreign trade and economic growth, so as to further supplement relevant researches, providing useful reference theories for our country to make and perfect economic policy under the current economic situation.

2. Models and methods
The impacts of human capital and foreign trade on economic growth might show a non-linear relationship, considering fixed assets investment, research and development input, foreign direct investment, government intervention and population dependency ratio. The non-linear single threshold model of human capital and economic growth can be built, taking R&D as threshold variable.

\[
\text{LNGOWTH}_{it} = \varphi + \rho_1 \text{CAP}_{it} + \rho_2 \text{FT}_{it} + \rho_3 \text{FDI}_{it} + \rho_4 \text{GOV}_{it} + \rho_5 \text{PFE}_{it} + \alpha_1 \text{HR}_{it} I(R&D \leq \gamma) + \alpha_2 \text{HR}_{it} I(R&D > \gamma) + \delta_i + \theta_t + \epsilon_{it}
\]

where \(i\) and \(t\) represent region and time respectively, \(\text{LNGOWTH}_{it}\) means economic growth of region \(i\) in the year of \(t\), \(\text{CAP}\) means fixed assets input, \(\text{FT}\) means foreign trade; \(\text{FDI}\) means foreign direct investment; \(\text{GOV}\) is government intervention; \(\text{PFE}\) is population dependency ratio; \(\text{HR}\) is human resources. \(R&D\) is threshold variable, representing \(R&D\) input of region \(i\) in the \(t\) year, \(\gamma\) is specific threshold value, \(\varphi\) is intercept term estimated by the model, \(\rho\) is regression coefficient of each variable, \(\delta_i\) is the specific effect of individual, \(\theta_t\) is the specific effect of time, \(\epsilon_{it}\) is the random interference term.

This paper uses panel data of 30 provincial economies in China Mainland from 2004 to 2015. Data are from China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Population and Employment Statistical Yearbook.

3. Results and discussion
This paper examined the impacts of human capital and foreign trade on economic growth, with R&D and FDI as the threshold respectively. Both single-threshold and double-threshold models passed the test at 5% significance level, while the triple-threshold model failed. Under single threshold, threshold value is 0.005, below which, the regression coefficient of human capital to economic growth is 55.59
at the significant level of 1%, indicating that human capital plays a strong role in promoting economic growth. While above that threshold value, the regression coefficient is 52.59, also significant at the level of 1%, indicating that human capital still has certain positive effect on economic growth. Under double-threshold model, when R&D input level is below 0.010 and above 0.058, indicating that human capital has a great influence on economic growth; when the value is between 0.010 and 0.058, the impact on economic growth weakens. Besides, FDI, fixed assets input and government intervention promote regional economic growth, while population dependency ratio has a significant inhibitory effect on regional economic growth. Second, the authenticity of the estimated value of threshold(s) was verified. As threshold variable, R&D value in single-threshold model is 0.005, its confidence interval is [0.005 0.016] under the confidence level of 95%, and LM result of single-threshold model is at the 5% significance. R&D input has a threshold effect on regional economic growth. The single-threshold model show that the threshold values are 0.010 and 0.058, the corresponding confidence intervals are [0.008 0.013] and [0.006 0.058] respectively, and LM result is also at the 5% significance, indicating that the influence of R&D input on economic growth has more than one threshold. The triple-threshold effect is not significant, thus it is no need to verify the authenticity of its threshold estimates. The estimated values of independent R&D input in double-threshold model are 0.010 and 0.058 respectively, equal to the true values (table 1).

| Table 1. Regression results taking R&D as a threshold variable. |
|---------------------------------------------------------------|
| **Single threshold double threshold**                         |
| **Single threshold double threshold**                         |
| FDI               2.19***                                             |
| CAP               1.11***                                             |
| FT                0.22                                                |
| GOV               4.49***                                             |
| PFE               -3.99***                                            |
| HR(R&D<=0.005)     55.59***                                            |
| HR(R&D>0.005)     52.59***                                            |
| **HR(R&D<=0.01)**  70.51***                                            |
| HR(R&D>0.06)      74.86***                                            |
| **HR(0.010<R&D<0.06)** 58.43***                                    |
| **Note:** *** , **, and * indicates the 1%, 5%, and 10% significance, respectively.** |

The single threshold passed the test at 5% significance, and double-threshold model passed the test at 1% significance, while the triple-threshold model failed (table 2). There are two FDI spillover thresholds in the relationship between foreign trade and economic growth. Under single threshold, threshold value is 0.009, below which, the regression coefficient of foreign trade to economic growth is 2.006 at the significance of 1%, indicating that foreign trade plays a strong role in promoting economic growth. While above threshold value, the regression coefficient is 0.502, also significant at the level of 1%, but the promotion effect of foreign trade on economic growth becomes weak. Under double-threshold model, when FDI spillover is lower than 0.007, the relationship between foreign trade and economic growth is positively correlated at 1% significance level, indicating that a lower degree of FDI spillover is conducive to foreign trade and regional economic development. When FDI spillover is between 0.007 - 0.038, foreign trade’s role in promoting economic growth becomes weak; when the threshold value is above 0.038, the influence of foreign trade on regional economic development weakens further. Second, the estimated values of double-threshold model are 0.007 and 0.038. The estimated threshold values of 0.007 and 0.038 are within the 95% confidence intervals [0.006 0.010] and [0.0310.038] respectively, and LM result of double-threshold model is significant at 5% significance level. The effect of triple-threshold model is not significant.

The estimated values of FDI spillover in double-threshold model are 0.007 and 0.038 respectively, equal to the true values (table 3). There exist FDI spillover threshold effects in foreign trade’s influence on regional economy. In the east China, the talents absorbed the technology spillover of FDI, and realized the efficient integration with R&D, significantly improving technical ability of human capital and innovation ability (table 4).
Table 2. Threshold significance test and confidence interval.

| Threshold variable | Model                  | F    | 1%   | 5%   | 10%  | Threshold | 95% confidence interval |
|--------------------|------------------------|------|------|------|------|-----------|-------------------------|
| R&D                | Single threshold       | 5.97*| 9.18 | 5.83 | 4.39 | 0.005     | [0.005  0.016]           |
|                    | Double threshold       | 27.93***| 30.57 | 24.59 | 21.72 | 0.01     | [0.008  0.013]           |
|                    | Triple threshold       | -0.00| 0.00 | 0.00 | 0.00 | 0.05     | [0.007  0.051]           |
|                    |                        |      |      |      |      | 0.01     | [0.009  0.010]           |

*Note: The F value are obtained by repeatedly sampling 3000 times through bootstrap.

However, it may be difficult for employees of domestic enterprises to learn advanced technologies and management concepts from FDI enterprises. Meanwhile, the increase of FDI spillover made local companies rely too heavily on foreign companies, thus losing independent R&D ability. What’s more, domestic enterprise’s strategy of “exchanging market for technology” might make China fall into a modern trap of “more backward, more import”.

Table 3. Taking FDI as a threshold variable regression result.

| Threshold variable | Single threshold | Double threshold |
|--------------------|------------------|------------------|
| R&D                | 13.95***         | R&D              |
| CAP                | 1.191***         | CAP              |
| GOV                | 6.116**          | GOV              |
| HR                 | 45.79*           | HR               |
| FT(FDI<=0.009)     | 2.006**          | FT(FDI<=0.007)   |
| FT(FDI>0.009)      | 0.502***         | FT(0.007<FDI<=0.038) |
| **                 | **               | FT(FDI>0.038)    |

*Note: ***, **, and * indicates the 1%, 5%, and 10% significance, respectively.

Table 4. Threshold significance test and confidence interval.

| Threshold variable | Model                  | F    | 1%   | 5%   | 10%  | Threshold | 95% confidence interval |
|--------------------|------------------------|------|------|------|------|-----------|-------------------------|
| R&D                | Single threshold       | 11.49** | 12.81 | 7.22 | 5.18 | 0.009     | [0.007  0.012]           |
|                    | Double threshold       | 29.78***| 18.35 | 7.46 | 4.66 | 0.007     | [0.006  0.010]           |
|                    | Triple threshold       | 0.00  | 0.00 | 0.00 | 0.00 | 0.038     | [0.003  0.038]           |
|                    |                        |      |      |      |      | 0.013     | [0.012  0.024]           |

*Note: The F value are obtained by repeatedly sampling 3000 times through bootstrap.

4. Conclusion

Using non-linear panel threshold model, the study introduced R&D input and FDI spillover as major technology supply modes into the complex non-linear relationship between human capital and regional economy and between foreign trade and regional economy, indicating the existence of threshold characteristics of R&D input intensity and FDI spillover. Within the shortage of high-tech human capital stock in China, governments and enterprises should increase R&D input to expand the group of high-tech R&D personnel, and actively build domestic and foreign technical personnel exchange platform to promote cooperation between domestic enterprises and foreign R&D institutions. And,
more attention should be paid to FDI spillover in different stages. Different paths of technological progress should be adopted. Additionally, Enterprises should make full use of efficient and convenient information channels to broaden the vision of R&D personnel training. Governments need to standardize and adjust their policy ideas for attracting investment to better absorb the technology spillover of FDI through cooperation and exchange, and improve technological level and transformation efficiency of scientific and technological achievements. Finally, government should increase investment on R&D in backward areas, and provide tax incentives to foreign enterprises investing in backward areas. What’s more, governments can build technology and knowledge exchange platform, to enhance the knowledge sharing of high-tech talents among different regions and organizations, and gradually narrow the gap of regional economic growth.

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