Proceedings of Business and Economic Studies, 2024, Volume 7, Issue 2
http://ojs.bbwpublisher.com/index.php/PBES
Online ISSN: 2209-265X
Print ISSN: 2209-2641

Research on the Impact of China's Foreign Trade Technology Spillover on Green Total Factor Productivity of Countries Along the "Belt and Road": Based on the Institutional Quality Threshold Effect

Li Chai[1], Longnan Ma[2]*, Lingwei Meng[1]

[1]Xinjiang University of Finance and Economics, Urumqi 830012, China
[2]Capital University of Economics and Business, Beijing 100070, China

Corresponding author: Longnan Ma, mlongnan@163.com

Abstract: China's growing trade with countries along the "Belt and Road" Initiative is accompanied by a focus on green development. Based on the panel data from 2007 to 2018, this paper establishes a threshold regression model to empirically analyze the institutional quality threshold effect of China's foreign trade technology spillover on the GTFP of countries along the "Belt and Road." The results show that China's foreign trade technology spillover has a significant institutional quality double threshold effect on the green total factor productivity of the countries along the "Belt and Road." As the institutional quality of the countries along the "Belt and Road" crosses a specific threshold value, the impact of China's foreign trade technology spillover on the green total factor productivity of the countries along the "Belt and Road" has a significant positive promoting effect, and corresponding suggestions are put forward.

Keywords: Technology spillover; Green total factor productivity; Institutional quality; Threshold effect

Online publication: April 29, 2024

1. Literature review

In recent years, trade cooperation between China and countries along the "Belt and Road" has been growing, but there is a wrong opinion that China's investment and trade with countries along the "Belt and Road" is to find "pollution refuge" [1]. As a supporter of the initiative, China has long taken green development as the focus of cooperation, and the sustainable trade and economic development between China and the countries along the "Belt and Road" has attracted much attention.

At present, scholars at home and abroad have not reached a unanimous conclusion on the impact of foreign trade on environmental pollution. Walter and Ugelow believed that foreign direct investment in Latin America would cause environmental pollution [2], while Copeland and Scott Taylor as well as Peters and Hertwich believed that trade would also cause environmental pollution [3,4]. Some scholars hold that trade and investment

may also promote the improvement of environmental protection technology in developing countries through technological progress and technology spillover effect, thus reducing the pollution level of host countries [5-7]. Therefore, trade has different effects on environmental pollution and different impacts on sustainable economic development [8-10].

Trade will have an impact on a country's economic growth or total factor productivity through technology spillover, but the impact of technology spillover must be based on the political, economic, and legal environment of the home country. For example, some scholars believe that the institutional environment will affect the absorption capacity of technology spillover [11]. The quality of the legal system has a significant positive impact on total factor productivity [12], and improving the quality of the economic system and political system will promote the improvement of enterprises' total factor productivity [13,14].

To sum up, many scholars at home and abroad have made relevant studies on the environmental impact and spillover effect of trade. However, the "Belt and Road" countries cover a wide range and cross regions, and due to their "natural" policy, economic and financial differences, technology spillover from China's foreign trade may have a non-linear impact on the green economic development of countries along the "Belt and Road". In this paper, resource and environmental factors are introduced into the construction of the Green Total Factor Productivity (GTFP) index, and the panel data from 2007 to 2018 are used to empirics analyze the heterogeneity of China's foreign trade technology spillovers on the environmental impact of the "Belt and Road" countries, which has reference significance for China's trade risk avoidance in the "Belt and Road" countries and the construction of high-quality "Belt and Road" initiative.

2. Model construction and variable description

2.1. Model construction

Domestic and foreign scholars mostly use the universally recognized Hansen's threshold regression model when applying threshold model analysis [15]. This paper draws on the research ideas of the above models and sets the panel regression model as follows:

$$gml_{it} = \alpha_1 \ln trade_{it} I(\mathrm{sq}_{it} \le \gamma_1) + \alpha_2 \ln trade_{it} I(\ln \mathrm{sq}_{it} > \gamma_2) + \beta_1 \ln rd_{it} + \beta_2 \ln ed_{it} + \beta_3 \ln ub_{it} + \varepsilon_{it} \quad (1)$$

Among them, gml_{it} represents green total factor productivity, $\ln trade_{it}$ represents China's foreign trade technology spillover, sq_{it} stands for the institutional quality of countries along the "Belt and Road," whereas rd_{it}, ed_{it}, and ub_{it} represent the R&D input, education input, and urbanization level of the "Belt and Road" countries, γ is the threshold value to be estimated, α_i and β_i (i = 1, 2, 3) are the influence coefficients, and i is the form of the threshold model that needs to be determined according to the threshold test.

2.2. Variable description and data source

2.2.1. Variable description

The DEA-ML index was used to measure the green total factor productivity of the countries along the "Belt and Road." Capital, labor, and energy were selected as input factors, GDP as expected output, and carbon emission intensity of the countries along the "Belt and Road" as non-expected output. The technology spillover of China's foreign trade is measured by a formula:

$$TRAspill_{it} = \sum_{j \ne i} \frac{TRA_{ijt}}{GDP_{jt}} \times SRD_{j,t} \quad (2)$$

TRA_{ijt}, GDP_{jt}, and SRD_{jt} represent the trade volume, GNP, and R&D capital stock of country j during the period t; The system quality along the "Belt and Road" countries adopts the data of political risk index,

economic risk index, and financial risk index in the ICRG database and establishes a comprehensive evaluation system; The proportion of R&D expenditure to GDP of the countries along the "Belt and Road" was used to measure the intensity of R&D investment of the countries along the "Belt and Road." The proportion of education expenditure to GDP of the countries along the "Belt and Road" represents the education input of the countries along the "Belt and Road"; Moreover, the proportion of urban population in countries along the "Belt and Road" was taken as a proxy variable for the urbanization level of countries along the "Belt and Road."

2.2.2. Source of data

The data of R&D input intensity, education input, urbanization level, GDP, CO_2 emission, labor force, and energy input of the "Belt and Road" countries are all derived from the WDI database of the World Bank, and the capital of the "Belt and Road" countries is derived from Payne Table (PWT). The volume of China's exports to the countries along the "Belt and Road" is from the UN COMTRADE database; The institutional quality data of the countries along the "Belt and Road" came from the ICRG database, and there were 65 countries along the "Belt and Road." Finally, based on the systematic selection of the model, indicators, and data availability, the research scope was determined to be 2007–2018, and the research object was 45 countries along the "Belt and Road," including Albania, Iraq, Qatar, Azerbaijan, Israel, Romania, Bahrain, Jordan, Russia, Bangladesh, Kazakhstan, Saudi Arabia, Belarus, Kuwait, Serbia, Brunei, Latvia, Singapore, Bulgaria, Lebanon, Slovakia, Croatia, Lithuania, Slovenia, Cyprus, Malaysia, Sri Lanka, Czech Republic, and Mongolia.

3. Empirical test and result analysis

The measurement software was used to conduct a descriptive analysis of the data of each variable from 2007 to 2018. The mean value of each variable was far greater than the standard deviation, indicating that the model had a low degree of dispersion, and each variable was in line with normal distribution without extreme outliers. Using Hansen's research idea for reference, the threshold model estimation method is used to analyze the impact of China's foreign trade technology spillover on GTFP of countries along the "Belt and Road" from the perspective of institutional quality.

3.1. Threshold effect test, model form, and threshold value determination

According to the dynamic threshold estimation method, stata software is used to test the single threshold, double threshold, and three threshold effects of the model with institutional quality as the threshold variable. The test results are shown in **Table 1**.

Table 1. Test results of the threshold effect

Threshold type	*P*-value	F_{stat}	Bootstrap	$Crit_1$	$Crit_5$	$Crit_{10}$
Single threshold	0.052	4.84	300	9.5962	11.251	16.134
Double threshold	0.030	8.08	300	11.0093	12.1574	15.274
Triple threshold	0.211	10.32	300	21.0821	26.1183	41.7333

Note: Test results were obtained by Bootstrap repeated sampling 300 times. ***, ** and * were significant at 1%, 5% and 10% levels respectively

The results of the threshold effect test in **Table 1** show that the F value of the single threshold test of institutional quality is 4.84 and the *P*-value is 0.052, which is highly significant at the 5% level; the F value of

the double threshold effect test is 8.08 and the *P*-value is 0.030, which is highly significant at the 10% level; while the P-value of the three thresholds fails the significance test. It indicates that the impact of China's foreign trade technology spillover on the green total factor production of "Belt and Road" countries has a significant institutional quality double threshold effect, so the model is set as the following formula:

$$gml_{it} = \alpha_1 \ln trade_{it} I(\mathrm{sq}_{it} \le \gamma_1) + \alpha_2 \ln trade_{it} I(\gamma_1 < \mathrm{lnsq}_{it} \le \gamma_2) + \alpha_3 \ln trade_{it} I(\mathrm{lnsq}_{it} > \eta_2) + \beta_1 gml_{it} + \beta_2 \ln rd_{it} + \beta_3 \ln ed_{it} + \beta_4 \ln ub_{it} + \varepsilon_{it} \quad (3)$$

Based on **Table 1**, the double threshold value of institutional quality is further estimated. From the threshold value estimation results, it can be seen that as a threshold variable, institutional quality has two threshold values, the first threshold value is -0.1905, and the second threshold value is -0.1899, and the corresponding estimates are smaller than their rejection domains.

3.2. Empirical results and analysis

The estimated results after threshold regression with institutional quality as the threshold variable are shown in **Table 2**. As can be seen from the threshold regression results, the impact of China's foreign trade technology spillover on the countries along the "Belt and Road" has a significant institutional quality threshold effect. This nonlinear relationship is not monotonically increasing or decreasing, but exists as an "inflection point," which presents significant nonlinear characteristics due to the different institutional qualities of the countries along the "Belt and Road." The higher the institutional level of the countries along the "Belt and Road," the higher the boost of foreign trade technology spillover on green total factor productivity, and the greater the promotion effect of trade technology spillover on green economic growth and sustainable development of the countries along the "Belt and Road."

Table 2. Regression results of the threshold model

Variables	Coefficient	Standard error	*t*-value	*P*-value	95% confidence interval
gtfp-lag	0.082*	0.046	1.790	0.075	[0.0081257, 0.172]
rd	0.028*	0.042	0.680	0.094	[0.1102179, 0.053]
ed	0.010***	0.019	0.520	0.005	[0.0475603, 0.028]
ub	0.006	0.005	1.080	0.283	[0.0156697, 0.005]
lnex(sq ≤ -0.1905)	0.012**	0.013	0.990	0.024	[0.0123182, 0.037]
lnex(-0.1905 < sq ≤ 0.1887)	0.014**	0.014	2.150	0.032	[0.0025528, 0.056]
lnex(sq > 0.1887)	0.029*	0.012	1.120	0.065	[0.0105604, 0.038]

Note: The test results were obtained through Bootstrap repeated sampling 300 times. ***, ** and * were significant at 1%, 5% and 10% levels respectively

Specifically, when the institutional quality of countries along the "Belt and Road" is less than or equal to the first threshold value, that is, sq ≤ -0.1905, each one percentage point increase in foreign trade technology spillovers between China and countries along the "Belt and Road" will increase the green total factor productivity of countries along the "Belt and Road" by 0.012 percentage points, and pass the significance test at 5%. When the institutional quality of countries along the "Belt and Road" is greater than the first threshold value and less than or equal to the second threshold value, that is, -0.1905 < sq ≤ 0.1887, the foreign trade technology spillovers between China and countries along the "Belt and Road" increase by one percentage point, the green total factor productivity of countries along the "Belt and Road" will increase by 0.014 percentage

points, with the significance test passing at the 5% level; When the system quality of the countries along the "Belt and Road" is greater than the second threshold value, that is, sq > 0.1887, the green total factor productivity of the countries along the "Belt and Road" increases by 0.029 percentage points for every one percentage point increase in foreign trade technology spillovers, and passes the significance test at the level of 10%.

The reason for this result may be that in countries along the "Belt and Road" with low institutional quality, the risks of economic, legal, and political systems are also larger. For example, in countries along the "Belt and Road" with high political institutional risk, there may be problems such as political mutual trust, default risk, and regional corruption; In countries with high economic system risks along the "Belt and Road," their domestic environment fluctuates greatly, and their economy and market are unstable, which affects China's export trade to them; In countries with low quality financial systems along the "Belt and Road," foreign exchange control and currency settlement in various countries lead to increased uncertainty in trade cooperation. All these risks make the countries along the "Belt and Road" unable to effectively use China's export trade, resulting in the spillover of China's foreign trade can not be fully played and absorbed.

4. Conclusions and enlightenments

In the context of the high-quality development of the "Belt and Road" initiative, based on the literature review and theoretical mechanism, using panel data of China and countries along the "Belt and Road," this paper establishes a threshold regression model and empirically analyzes the impact mechanism of China's foreign trade spillover on GTFP of countries along the "Belt and Road." Moreover, this study verifies the non-linear threshold effect caused by the heterogeneity of the institutional quality of the countries along the "Belt and Road" and draws the following conclusions and implications:

From the analysis in this paper, it is concluded that China's foreign trade technology spillover has a significant institutional quality threshold effect on the countries along the "Belt and Road." In the relationship between the foreign trade spillover effect and GTFP of the countries along the "Belt and Road," the level of institutional quality shows obvious threshold characteristics. When the countries along the "Belt and Road" cross the first and second threshold values, with the improvement of the institutional quality of the countries along the "Belt and Road," the positive promoting effect of China's foreign trade spillover effect on their GTFP increases significantly. Therefore, it is imperative to implement and expand the trade of technology products between China and other countries along the "Belt and Road" according to the regional heterogeneity. During the implementation process of the "Belt and Road" initiative, China can further expand product trade with countries along the "Belt and Road," mainly focusing on technical product cooperation and low-carbon economic cooperation. In terms of technical product cooperation, first, strengthen the trade of high-tech products with countries along the "Belt and Road," thereby enhancing the spillover effect on the countries along the "Belt and Road." The second is to improve the technical level of the "Belt and Road" itself. For example, China can jointly establish the "Belt and Road" scientific research and innovation platform with the countries along the "Belt and Road" to promote the green total factor productivity of the "Belt and Road" in a coordinated way. The third is that the countries along the "Belt and Road" can also enhance the absorption of technology spillovers from China's foreign trade through the improvement of research and development capabilities. Taking China's current "green Belt and Road" construction, environmental pollution management into account, incorporate green and low carbon into the implementation of the "Belt and Road" initiative according to the actual situation of each country to promote the sustainable economic development of countries along the "Belt and Road."

Disclosure statement

The authors declare no conflict of interest.

References

[1] Zhang Y, 2017, Study on the Environmental Effects of China's OFDI and Contracted Projects in Host Countries, thesis, Northwest University.

[2] Walter I, Ugelow JL, 1979, Environmental Policies in Developing Countries. AMBIO, 8(3): 102–109.

[3] Copeland BR, Scott Taylor M, 1994, North-South Trade and the Environment. The Quarterly Journal of Economics, 109(3): 755–787. https://doi.org/10.2307/2118421

[4] Peters GP, Hertwich EG, 2006, Pollution Embodied in Trade: The Norwegian Case. Global Environmental Change, 16(4): 379–387. https://doi.org/10.1016/j.gloenvcha.2006.03.001

[5] Li X, Lu X, 2010, International Trade, Transfer of Polluting Industries and Industrial CO_2 Emissions in China. Economic Research Journal, 45(1): 15–26.

[6] Chen D, 2020, Decline of Trade Barriers and Improvement of Environmental Pollution: New Evidence from Chinese Enterprise Pollution Data. Economic Research, 55(12): 98–114.

[7] Hu Z, Shi D, 2019, "Spillover Effect" or "Pollution Effect"? A New Perspective and Reestimation of Trade Liberalization on Industrial Sulfur Dioxide Emissions. Statistical Research, 36(12): 94–105.

[8] Cai W, 2019, Study on the Impact of International Trade on Environmental Pollution, thesis, Zhejiang University.

[9] Ma G, Tang Y, Guo D, 2019, Research on the Environmental Effects of China's Trade Mode Transformation. Issues in International Trade, 2019(4): 143–156.

[10] Huang J, 2020, Trade Liberalization of Intermediate Goods, Environmental Regulation and Industrial Pollution Emission. Macroeconomic Research, 2020(6): 144.

[11] Yi C, Li S, Zhang J, 2015, Institutional Environment, Absorptive Capacity and Reverse Technology Spillover Effects of OFDI in Emerging Economies: A Threshold Test Based on China's Provincial Panel Data. Finance and Economics Research, 2015(11): 4–19.

[12] Jin X, Ru Y, Wu H, 2008, System, Production Efficiency and Export Differences Between Regions in China. Management World, 2008(11): 65.

[13] Cao Q, Ren G, Luo Y, 2014, The Impact of Regional Institutional Environment on Enterprise Technological Innovation. Science of Finance and Economics, 2014(1): 71.

[14] Yan G, Ran Q, 2017, Supply-Side Reform, Total Factor Productivity and Institutional Innovation. Business Economics Research, 2017(5): 10–12.

[15] Hansen BE, 1999, Threshold Effects in Non-Dynamic Panels: Estimation, Testing, and Inference. Journal of Econometrics, 93(2): 345–368. https://doi.org/10.1016/S0304-4076(99)00025-1