Research on the Impact of International Technology Spillover on Regional Economic Resilience

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Abstract— *International technology spillovers have a profound impact on China's regional economic resilience. Developing countries use international technology spillovers, including technology spillovers from import trade, foreign direct investment and foreign direct investment, to promote their own economic development and enhance economic resilience through demonstration, competition, imitation and sharing mechanisms. This paper will use the entropy method to measure China's regional economic resilience, and empirically explore the impact of international technology spillovers on regional economic resilience through various channels. The results show that international technology spillovers in all channels have a significant role in promoting regional economic resilience, and the spillover effect of import channel is the largest. Accordingly, this paper provides suggestions for regions to build resilient economic paths with self-adaptation and self-reinforcement in the context of double circulation.*

Keywords— Regional Economic Resilience; International Technology Spillover.

I. INTRODUCTION

The world is undergoing profound changes unseen in a century. The international political and economic situation is complex and volatile, with rising anti-globalization and unilateralism, frequent trade frictions, and uncertainties and risks hitting all economies. When faced with various uncertainties and risks, such as the financial crisis and the epidemic, economies showed different resilience and recovery. Some economies may suffer from shocks of uncertainty and fall flat, requiring a long period of recovery, while others recover quickly from shocks.

China's strong resilience and resilience in the face of uncertainties such as the COVID-19 pandemic have attracted the world's attention. This strong resilience is the key to China's economic miracle by defusing major risks. Therefore, in the face of the dual environment of changing internal economic momentum and external uncertainties, we should pay attention to not only the speed of economic development, but also the resilience of economic development. International technology spillover is an important source of knowledge for innovation activities in developing countries, and it has a profound impact on our economic resilience. From the perspective of international technology spillover, this paper explores the impact of technology spillover on regional economic resilience and puts forward suggestions to further improve regional economic resilience.

II. BUILDING THE THEORETICAL MODEL

The study of this paper starts from the measurement of regional economic resilience, calculates the regional economic resilience of Chinese provinces through the entropy method, then calculates the international technology spillovers under the import and two-way investment channels by using the sustainable inventory method, and then uses the fixed effect model to conduct an empirical study to explore the impact of international technology spillovers on regional economic resilience.

A. Variable Measurement

The explained variable of this paper is regional economic resilience. Provincial regional economic resilience is calculated by the entropy value method, reflecting the performance of regional economic resilience in each province during 2003-2019. The value ranges from 0 to 1, and the higher the value, the stronger the provincial economic resilience.

The measurement of economic resilience mainly includes the measurement of unit indicator and multi-dimensional indicator. The measurement of single indicator of some methods is not suitable for our national situation . This paper refers to the measurement index system of economic resilience proposed by previous scholars. Starting from the concept of economic resilience, 14 variables are selected from the four targets of resistance, resilience, adaptability and creativity, and the entropy method is used to measure the regional economic resilience of 31 Chinese provinces from 2003 to 2019.

The core explanatory variable of this paper is international technology spillover, which mainly includes the technology spillover of import, foreign direct investment and foreign direct investment. Based on the methods of Zhang Shijun and Deng Feng, this paper calculates international technology spillovers . Firstly, the research and development capital stock of each country is calculated. This paper selects the top 21 major countries and regions according to the rankings of China's investment flow and stock in developed countries in the Statistical Bulletin of China's Foreign Direct Investment, and calculates the research and development capital stock of each country (region) based on the year 2003. Is the R & D capital stock of country (region) j in year t. Is the ratio of each country's R&D expenditure to the GDP of the year. Is the annual R&D expenditure of each country. Using the annual inflation rate of each country or region measured by CPI to calculate the consumer price deflator DCPI in 2003 as the base period, then the ratio of the current year's R&D expenditure to DCPI can be used to calculate the country's R&D expenditure in 2003 as the base period. The average growth rate of expenditure g is calculated using the R&D expenditure in 2003 as the base period. Then calculate the R & D capital stock of each country (region) in the base period of 2003, the

depreciation rate is 10%. Finally, use the sustainable inventory method to calculate the R & D capital stock of each country (region) in each year, the formula is:

$$S^{RD}_{jt} = (1-\delta)S^{RD}_{j(t-1)} + RDC_{jt} \qquad (1)$$

As to control variables, this paper chooses 4 classic control variables, namely Level of macro-control, Level of foreign trade, Informationalized level and Level of human capital

Thus, the R&D capital stock of each country (region) based on 2003 can be calculated, and then the international technology spillovers under the three overflow channels can be calculated. Table 1 presents the explanations for the indexes above.

TABLE 1. Definition of variables

Type of Variables	Name of Variables	Symbols of Variables	Description of Variables
Explained variable	Provincial economic Resilience	RES	R&D expenditure
Explanatory variable	International technology spillovers from import channels	LNIM	$IM_{it} = \dfrac{im_{it}}{im_t} IM_t$
	International technology spillovers of FDI channels	LNFDI	$FDI_{it} = \dfrac{fdi_{it}}{fdi_t} FDI_t$
	International technology spillovers in OFDI channels	LNOFDI	$OFDI_{it} = \dfrac{ofdi_{it}}{ofdi_t} OFDI_t$
Control variable	Level of macro-control	LNGOV	Fiscal expenditure /GDP
	Level of foreign trade	LNFIRI	Amount of foreign capital /GDP
	Informationalized level	LNINF	Total telecom business /GDP
	Level of human capital	LNHUM	Number of students enrolled in ordinary institutions of higher learning

B. Model Establishment

The explained variable studied in this paper is regional economic resilience, and the fixed effect model is adopted in the following form:

$$RES_{it} = \alpha + \beta_1 LNFDI_{it} + \gamma X_{it} + \mu_i + \varepsilon_{it} \qquad (2)$$

$$RES_{it} = \alpha + \beta_2 LNOFDI_{it} + \gamma X_{it} + \mu_t + \varepsilon_{it} \qquad (3)$$

$$RES_{it} = \alpha + \beta_3 LNIM_{it} + \gamma X_{it} + \mu_t + \varepsilon_{it} \qquad (4)$$

RES_{it} represent regional economic resilience, $LNIM_{it}, LNFDI_{it}, LNOFDI_{it}$ are the international technology spillovers to Province i in year t generated by three channels.

For the sake of data stationarity, logarithmic processing is taken. γ is control variable back coefficient matrix. μ_{it} is fixed effect model. ε_{it} is residual term.

III. THE RESULTS AND INTERPRETATION

All the above models have passed the Hausmann test, and fixed effect models can be used. In this paper, STATA16.0 software is used to conduct empirical regression. Table 2 below shows the fixed effect regression results of models (2), (3) and (4).

As shown in the empirical results in Table 2, international technology spillovers of import channels, FDI channels and OFDI channels are positively correlated with regional economic resilience at 1% level, and the control variables are basically significant at 1% level.

The impact of international technology spillover from import channels on regional economic resilience is positive. In the import channel, it is mainly the demonstration and imitation mechanism and competition mechanism that promote the technology spillover between industries.

TABLE 2. The impact of international technology spillover on regional economic resilience

	RES (2)	RES (3)	RES (4)
LNFDI	0.049***		
	(3.048)		
LNOFDI		0.316***	
		(30.331)	
LNIM			0.723***
			(3.379)
LNGOV	-0.177	0.097***	-0.991**
	(-1.004)	(3.814)	(-2.493)
LNFTRI	-0.013	-0.028***	0.012
	(-0.552)	(-4.140)	(0.409)
LNINF	-0.022***	-0.001	-0.022***
	(-3.181)	(-0.131)	(-3.250)
LNHUM	-0.106***	-0.051***	-0.106***
	(-10.998)	(-9.149)	(-11.027)
YEAR	YES	YES	YES
PROVINCE	YES	YES	YES
Constant	0.344***	0.821***	-0.170
	(7.168)	(27.212)	(-1.178)
Observations	429	429	429
R-squared	0.941	0.982	0.942

Firstly, Chinese enterprises located in the downstream supply chain import intermediate products with high technical content, which will directly improve the quality and technical level of Chinese products by putting them into production. And developed countries, due to the improvement of technology level, will expand the types and technology content of intermediate products and force downstream enterprises to raise their investment in research and development and make technological innovations; In addition, downstream enterprises can further improve their own technology by learning, absorbing and re-innovating the knowledge and technology

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contained in intermediate products. Secondly, the improvement of the technology level of enterprises within the industry can also generate inter-industry technology spillover effect through forward correlation and backward correlation, further improving the domestic technology level and enhancing the resilience of regional economy.

The spillover effect of foreign direct investment (FDI) is also obvious. During the period from 2003 to 2019, which was the golden period for high-quality foreign capital to invest in China, many FDI also played a win-win role, which greatly promoted the economic resilience and development of Chinese provinces. The technology spillover phenomenon is generated by horizontal spillovers such as demonstration and imitation mechanism, competitive extrusion mechanism and personnel flow mechanism, and vertical spillovers such as industrial association mechanism. Enterprises in the host country can digest, absorb and re-innovate the advanced technologies spillover, so as to promote the overall technological progress of the country and enhance the regional economic resilience of each region.

Foreign direct investment (OFDI) also contributes to the economic resilience of our regions. After WTO entry, China is not only receiving foreign investment, but also continuously investing abroad. In particular, after the "One Belt, One Road" policy, China has strengthened its investment in countries along the routes. These investments are of strategic significance. On the one hand, technology spillovers are generated by the foreign investment of developed countries through sharing mechanism, imitation mechanism and personnel flow mechanism. On the other hand, for developing countries, such as the Belt and Road investment, the promoting role of foreign investment in technological progress is becoming more and more prominent through resource replacement, industrial transfer and personnel flow mechanism.

In order to further verify whether the baseline regression results are robust, the replacement index of regional economic resilience is adopted. This paper uses Martin's measurement method for reference and uses the rate of change of GDP to represent regional economic resilience [5], replacing the explained variable in this paper for robustness test. The regression results after replacement show that the spillover of import and foreign direct investment significantly positively promotes regional economic resilience at the 1% confidence level, and the spillover of foreign direct investment positively promotes regional economic resilience at the 5% confidence level. This result is in the same direction as the result of baseline regression, indicating that international technology spillovers can significantly promote regional economic resilience, which indicates that the results of the above baseline regression are robust.

IV. THE CONCLUSIONS AND POLICY RECOMMENDATIONS

The empirical results show that the international technology spillovers under import channels, foreign direct investment channels and foreign direct investment channels have significantly improved the level of regional economic resilience of Chinese provinces, and the promoting effects of these three channels are significantly different. The spillover under import channel can best promote the development of regional economic resilience, followed by the spillover of foreign direct investment, and the last is the spillover of foreign direct investment. Therefore, through the empirical analysis above, this paper draws the following two conclusions:

First, International technology spillover has a significant positive impact on China's regional economic resilience.

Second, Import channel spillover contributes the most to our economic resilience, followed by foreign direct investment and foreign direct investment.

In order to continue to enhance the economic resilience of the country as a whole and various regions and promote better economic development, the following suggestions are put forward for the follow-up investment and trade in China:

A. Expand the scale of import and fully realize the positive effect of technology spillover from import trade

Our country is the first country in international trade, import the second country. However, there is still a certain gap between import scale and export trade, especially the small scale of high-tech products import. We can play the role of foreign exchanges on such platforms as import trade expositions, free trade zones and free trade ports, and enhance economic and trade cooperation with other countries through more preferential policies and loose trade environment. Second, improve the mix of imported products. In recent years, the proportion of Chinese imports of industrial manufactured goods and machinery products has been increased, but the proportion of high-tech imports is still low. Therefore, we should pay more attention to the quality of imported products rather than the quantity, and increase the import of products with high technology content and those with less technology. The government should introduce policies and measures to guide enterprises to import more advanced technological equipment and products in key technological fields, and give tax incentives and preferential policies to enterprises that introduce high-tech products. Finally, adjust import trading partners to trade with countries with large R&D capital stocks.

B. Strengthen cooperation between domestic and foreign-funded enterprises

In terms of utilizing FDI, because of historical development and geographical location, foreign direct investment is mainly concentrated in the east coastal area of our country, and there is a problem of unbalanced regional development in utilizing foreign capital. First, the central and western governments should introduce preferential policies to attract foreign investment, improve infrastructure and attract more foreign investment. Secondly, we should create a sound business environment and establish a fair market competition system. Our government should strengthen infrastructure construction especially in western areas, improve transportation, logistics, storage and related supporting service facilities, create an attractive business environment, guarantee fair competition between domestic and foreign enterprises, and enhance the confidence of transnational enterprises in investing in our country. Finally, we should diversify the source area of foreign direct investment and expand the scale of direct investment from developed countries.

C. Improve the level of independent innovation

Our economic development not only needs international technology spillover, but also needs our own technological progress more and more. Firstly, Chinese government should introduce relevant policies to encourage independent innovation, form a good atmosphere for independent research and development in society, continuously increase R&D investment and support, and improve our research system combining "industry, university and research". Secondly, due to the low proportion of investment in basic research, the foundation of independent innovation is not solid. The Chinese government should vigorously encourage the development of basic research, increase the investment in basic research, and make more policy resources tilt towards basic research. Second, we will introduce corresponding preferential tax policies. The government can offer tax breaks for the business activities of high-tech enterprises, scientific research institutions and key areas of emerging industries, and deduct the R&D expenses actually incurred by enterprises in their R&D activities before taxes are levied. Third, improve the intellectual property protection system and relevant laws and regulations. At present, China's awareness of intellectual property protection and related mechanisms are weak, which is not conducive to enterprises to carry out independent research and development innovation activities. Therefore, establishing a unified intellectual property protection system, raising the awareness of the whole society respecting intellectual property and increasing the illegal cost of infringement can stimulate the vitality of social innovation and urge enterprises to increase investment in independent research and development. Fourthly, scientific and technological innovation cannot be separated from the support of financial capital and other elements. The government should vigorously promote the development of the financial industry and improve its service level. Financial institutions should focus on scientific and technological innovation, innovate financial services and products, increase credit for scientific and technological enterprises, and meet the financing needs of enterprises for independent research and development. Fifth, give full play to the country's advantages in capital, human resources and technology, take the lead in setting up state key laboratories and scientific and technological innovation platforms, pool resources to overcome technical difficulties, and master key core technologies in key areas.

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