The threshold effect of financial pressure on the interaction between technological progress and foreign direct investment under the new normal of economy

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Abstract: *The Chinese "pressure type" finance under the new normal of economy has a significant impact on local technological progress and FDI. Based on the panel data of 30 provincial levels in China from 2011 to 2020, this paper empirically examines the action mechanism and transmission mechanism of financial pressure on technological progress and FDI. The results show that there is a two-way Granger causality relationship between patent ownership, government investment in science and technology and investment of science and technology personnel and foreign direct investment in technological progress, and the technology market transaction leads to the Granger causality of actual use of FDI. The further threshold effect test shows that there is a single two-way threshold effect between technology market trading and foreign direct investment, there is no threshold effect between patent ownership and foreign direct investment, but there is a single threshold effect between government S&T investment and S&T personnel investment on foreign direct investment. Based on the above conclusions, the paper puts forward the suggestions that the local government should play a hard role in both technological progress and FDI introduction, and strengthen the guiding role of regional finance in technological progress and the attracting role of FDI.*

Keywords: *Financial pressure, Technological progress, Foreign direct investment, Dynamic threshold effect*

1. Introduction

Under the new normal of economic development, in order to implement the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements, accelerate the implementation of the innovation-driven development strategy, accelerate the transformation and application of scientific and technological achievements, and guide social forces and local governments to increase investment in the transformation of scientific and technological achievements, the central government has established a national Guidance fund for the transformation of scientific and technological achievements.On the one hand, it shows the country's determination to promote economic development through technological innovation, and on the other hand, it shows the feasibility of regulating technological progress through fiscal means.Chinese provincial governments have to face the challenges of industrial structure upgrading, transformation of economic development driving force and excessive consumption of resources. The traditional development mode of expanding production scale and increasing input of production factors cannot alleviate the problem of transformation of economic development driving force. The key to realize the transformation of economic development driving force is to accelerate technological innovation and introduce high-quality foreign investment.

In terms of its impact on regional technological progress, the impact of technological progress on green total factor productivity has a double threshold effect based on financial pressure[1], and financial pressure has both incentive and inhibition effects on technological innovation, with regional differences in its impact on technological innovation[2]. Although there are many researches on foreign direct investment and technological progress[3][4][5][6], especially the study on the threshold effect of foreign direct investment on China's technological progress, found that the inflow of foreign direct investment has a positive promoting effect on China's technological progress, among which the technology spillover effect affecting technological progress is relatively significant and has a significant nonlinear double threshold effect[7].

In addition, the share of fiscal revenue in GDP (the narrow macro tax burden) has declined for five consecutive years, but land sales and social security income have risen rapidly. The macro tax burden, as measured by the ratio of fiscal revenue to GDP, peaked in 2015, falling from 22.1 per cent in 2015 to 18 per cent in 2020, equivalent to the 2006-2007 level. In 2020, the gap between government revenue and expenditure reached a record high of 6.3 trillion yuan, and the actual deficit to GDP ratio after taking into account special and special government bonds was 10.8%. In recent years, financial problems have become more of a systemic problem holding back economic growth. The research on financial pressure includes many aspects, from the investigation of local political performance[8] to the supply of local public services[9], especially in the stage of attaching importance to high-quality economic development, environmental regulation[10][11], Environmental Pollution[12][13][14], environmental governance[15], green Total Factor Productivity[1] and other studies on green economy have made many achievements. However, the research on the relationship between financial pressure, technological progress and foreign direct investment and the threshold effect has no obvious results.

There is a significant two-way causal relationship between technological progress and FDI inflow, and there is no long-term stable development relationship[16], which means that technological progress and FDI will influence each other in the short term. Does financial stress have a significant effect on this causal relationship? Based on the above problems, this paper uses the provincial panel data of 30 provinces and municipalities in China, excluding Xizang and Hong Kong, Macao and Taiwan Special Zones, and uses Granger causality to test the two-way causal relationship between technological progress and FDI in China in recent years. Then, under the analysis of the dynamic panel threshold model, The results show that financial pressure affects technological progress and foreign direct investment. The research results of this paper have important theoretical and practical significance for a clear understanding of China's foreign direct investment under financial pressure to cope with the impact of technological progress in various aspects, the role of the trend, to accelerate the realization of high-quality economic development.

2. Literature Review

Many scholars have given explanations for the definition of financial pressure from different perspectives. Financial pressure refers to a country's fiscal revenue and expenditure pressure accumulated over a long period of time[17]. It is a relatively long-term concept. It is the product of long-term imbalance of fiscal expenditure and fiscal revenue, and eventually turns into a huge gap between the possible and the need of finance[18]. Fiscal pressure, full name fiscal revenue and expenditure pressure, is a kind of financial tension faced by the first-level government in a certain period of increasing fiscal expenditure, and fiscal revenue is relatively limited[19], the most direct manifestation of which is a persistent fiscal deficit, and the scale of the fiscal deficit is proportional to the degree of fiscal pressure: dynamically, it is manifested as a sustained expenditure growth rate faster than the fiscal revenue growth rate.

There are also various direct and indirect links between the fiscal pressure of local governments and foreign direct investment under the new normal economy. The impact of fiscal pressures on OFDI will have a threshold effect. Specifically, the ease of FDI introduction increases with the increase of government financial pressure, and FDI shows an inverted "U" shape that rises first and then decreases with the increase of environmental regulation intensity, when the local fiscal pressure is between [0.809, 2.349], environmental regulation has the greatest pulling effect on the introduction of foreign investment. When the intensity of local environmental regulation is between [0.019, 0.035], the fiscal pressure of local governments has the greatest pulling effect on the introduction of foreign investment[10]. After the introduction of strategic competition between local governments, under the fiscal decentralization system, the location selection of FDI is significantly affected, among which the increase of fiscal decentralization level in the jurisdiction is conducive to enhancing the local investment attraction capacity, while the increase in the fiscal decentralization level of neighboring jurisdictions obviously hinders the inflow of local FDI, and the active expansion of fiscal expenditure and the funding gap have become the main driving forces for the competition for FDI in various regions[20].

The technological spillover effect of FDI has a clear threshold effect with regional technological progress, and foreign direct investment (FDI) has a stifling effect on technological innovation when it is low, and promotes technological innovation when FDI is high. When the logarithmic value of FDI exceeds the threshold value of 6, the increase of FDI has a significant role in promoting technological innovation[21]. It is further found that the inflow of FDI has a positive effect on China's technological

progress, among which the technological spillover effect affecting technological progress is more significant, while the market competition effect is not. The market competition effect and technological spillover effect of FDI have non-linear double threshold characteristics. When the FDI market share remains within a certain range, its positive market competition effect can be revealed; However, if the market share of FDI exceeds the maximum threshold, it may have adverse effects such as "market grabbing effect", hindering its role in promoting independent R&D and innovation, and the technology gap between domestic and foreign capital is too large or too small is not conducive to the technology spillover of foreign capital and the technology absorption of the host country[7].

In summary, although most of the existing research literature has noted the fact that FDI affects China's technological progress through international technological spillover effects, few literature has rigorously and deeply analyzed the characteristics of FDI's technological progress under financial pressure. In view of this, this paper attempts to use China's provincial panel data from 2011 to 2020, uses the method of dynamic generalized moment estimation to investigate the impact of China's interprovincial technological progress on foreign direct investment, and further adopts the dynamic panel threshold model to test the threshold effect characteristics of technological progress and foreign direct investment under the dynamic change of financial pressure.

3. Analysis of theoretical mechanisms

3.1 Analysis of the theoretical mechanism of technological progress of FDI

Drawing on the analysis of the bias theory of high-quality FDI by Li Jincheng and Wang Linhui[22], and referring to Acemoglu[23] to propose a biased technological progress model to analyze the formation mechanism of FDI to promote technological progress, among which "price effect" and "market scale effect" are important triggers for the formation of technological progress. The process of "price effect" is that factor scarcity will lead to a generally higher market price of the factor-intensive product, and manufacturers will tend to develop or introduce production technology in this sector in order to maximize the market profit obtained, so that the technological progress of the sector increases the productivity of scarce factors. When the factors of production are relatively abundant, the factor structure determines that the production of abundant factor-intensive products will have a large-scale market in the region, and similarly, manufacturers in order to obtain more market profits will cause manufacturers to choose to develop or introduce technologies that enrich factor production efficiency, which is the "market scale effect".

Based on the above theory of technological progress, the theoretical mechanism of FDI on technological progress is analyzed. First of all, through the analysis of the formation mechanism of technological progress, it is found that the direction of technological progress will be changed by changing the factor structure, and generally speaking, capital-biased technological progress can obtain greater profit margins, so most of the capital-biased technological innovation in the field of high-end technology. On the one hand, as far as FDI inflows are concerned, it will expand the scale of capital factors in China's region, gradually weaken the relative scarcity of capital, and then weaken the degree of improvement of capital production efficiency by technological progress, so that the capital bias of technological progress will be reduced. On the other hand, foreign investment in the construction of factories attracts a large number of redundant labor, reduces the labor supply of regional enterprises, and thus leads to technological progress in the regional labor bias.

Second, FDI has a crowding out effect on capital in China. FDI can play a significant role in promoting the high-quality development of the regional economy, and achieve it by reducing inefficiency and accelerating scientific and technological progress[24], so in order to compete for more FDI, local governments will not only indirectly provide preferential loan interest rates for foreign capital through financial market intervention, but also directly subsidize foreign-funded enterprises through fiscal means. This will inevitably crowd out a large number of domestic enterprises' financing scale, and the squeeze out of domestic capital will aggravate the scarcity of capital, leading to further research and development or introduction of capital-biased technologies by domestic enterprises.

Finally, FDI will have a technology spillover effect on domestic firms[25][26]. On the one hand, FDI enterprises will carry out some technology transfer through domestic branches, so that the direction of domestic technological progress is in line with international standards, that is, capital bias. On the other hand, domestic local enterprises will also imitate the advanced technology of foreign capital through the "learning by doing" of the market, so as to promote the technological progress of local enterprises is

also biased towards capital.

In summary, FDI will bias technological progress towards capital through changes in factor structure, capital crowding out effects and technological spillover effects, and changes in factor structure will also lead to labor bias for technological progress. But ultimately, the introduction of FDI will promote technological progress in the region.

Hypothesis 1: FDI inflows promote technological progress in the region.

3.2 Theoretical mechanisms by which technological progress promotes the introduction of FDI

In the same way that FDI promotes regional technological progress, regional technological progress in turn attracts FDI inflows through the same path. The inflow of FDI in regions affected by technological progress is mainly carried out from the following three aspects, namely, labor factors, capital factors and technology itself.

First of all, in terms of labor factors, labor-biased technological progress will increase the labor productivity of region-related industries, increase the abundance of regional labor supply, release a large number of redundant labor, and force local governments to increase the introduction of foreign capital and open factories to absorb excess labor.

Second, capital-biased technological progress will increase regional capital production efficiency, thereby increasing the relative scarcity of regional capital, and then it is necessary to expand the scale of regional capital and attract a large amount of FDI inflows. On the other hand, enterprises with capital bias towards technological progress will be more likely to obtain financing by policy tilt, while domestic enterprises without technological advantages will be subject to strong financing constraints, and domestic capital will be squeezed out by FDI and technologically advantageous enterprises, which will aggravate capital scarcity, which will lead domestic enterprises to further choose capital-biased technological progress research.

Finally, because OFDI also has a reverse technology spillover effect[27], FDI invests in order to seek technology introduction or cooperation, and conducts technological exchanges and transfers in the form of capital injection, so there is also an incentive for high-end technology to attract foreign investment. Similarly, in order to control the outflow of technology, regional governments mostly restrict local investment in FDI and strictly screen FDI for this purpose. This way of attracting foreign investment in this technology is more purposeful and not universal.

To sum up, the impact of technological progress on FDI introduction lies in the change of factor structure, the capital crowding out effect of high and new technologies, and the reverse technology spillover effect of OFDI, and the final result is that technological progress promotes regional FDI inflows.

Hypothesis 2: Technological advances promote the introduction of FDI in the region.

3.3 Threshold effect impact mechanism of fiscal pressure

After analyzing the above pathways, we find that the threshold effect mechanism of fiscal pressure on the relationship between technological progress and FDI inflow is basically reflected in two aspects: direct effect and indirect effect.

There are two ways to directly apply the threshold of fiscal pressure: first, government investment in science and technology directly promotes local technological progress; The second is to subsidize the introduction of FDI and related policy preferences through fiscal means. The former can fully develop high-precision technology that is most suitable for local industrial characteristics with the support of government funds, policies and manpower, so as to quickly develop the market with industrial technology advantages, form industrial scale effects, and aggravate the scarcity of local capital, so the government needs to expand the scale of regional capital to support the expansion of industrial scale, thereby increasing FDI inflows. The implementation of the latter directly leads to the aggravation of regional fiscal pressure, so the degree of fiscal pressure in a place is directly related to the subsidies and policy preferences that FDI can enjoy. Specifically, the greater the fiscal pressure on the region, the smaller the government investment in science and technology in the region, the smaller the technological progress may be made, the smaller the scarce capital that needs to be compensated, and the less FDI needs to be introduced; Similarly, the greater the regional fiscal pressure, the smaller the intensity of FDI subsidies and related preferential policies, and the less attractive it will be to FDI.

There are also two ways to play an indirect threshold of fiscal pressure: factor regulation and outlook expectations[28]. Here this paper borrows the four major functions of finance to explain, namely, resource allocation function, income distribution function, economic stability function and economic development function. In addition to the basic role of the market mechanism, the allocation of economic and social resources also requires the government mechanism to deal with some exogenous problems, including correcting the excessive or insufficient amount of goods, capital and labor services provided by the market, supplementing the insufficient services provided by the market, and making structural adjustments to factors such as labor, capital and technology. In addition, the revenue distribution function of the fiscal sector can create a unified labour market and facilitate the rational movement of people between urban and rural areas and between regions. Specifically, the greater the regional fiscal pressure, the weaker the income distribution function and resource allocation function of the labor force, thereby suppressing the intensity of the interaction between technological progress and FDI. For the expected indirect effects of fiscal pressure, the three important means of regional fiscal stability and economic development include achieving full employment, stabilizing the price level, and balancing regional revenues and expenditures. When the fiscal pressure is too high, it is impossible to stabilize social security expenditure in terms of fiscal expenditure to achieve full employment, nor can it immediately change fiscal revenue policy to alleviate economic fluctuations and stabilize the price level, let alone stabilize government taxation to balance regional revenue and expenditure. In this way, economic instability caused by excessive fiscal pressure can give unpromising expectations for technological research and FDI introduction, thereby suppressing the intensity of the interaction between technological progress and FDI.

Hypothesis 3: Fiscal pressures have a significant threshold effect on technological progress and FDI inflows; When fiscal pressures are low, there is a positive boost between technological progress and FDI inflows; When fiscal pressures are high, there is a significant negative effect on technological progress and FDI inflows.

4. Empirical model building

4.1 Data sources

In this paper, the balanced panel data of 31 provinces, municipalities directly under the central government and autonomous regions in China from 2011~2020 {excluding Tibet, Hong Kong, Macao and Taiwan} are used, with a total of 300 observations. All data are derived from provincial statistical yearbooks, national statistical offices, etc.

The explanatory variable in this paper is the Amount of Foreign Capital Actually Used (AFCAU). Only the actual use of foreign capital can truly reflect the level of foreign capital utilization in China, and foreign capital is a catalyst to accelerate China's economic development. Therefore, this paper selects the actual amount of foreign capital used as another measure of FDI.

The core explanatory variable in this paper is Technology Improved (TI). This paper will measure technological progress from four aspects: technology trading, patent ownership, government investment in science and technology, and investment in scientific researchers. Technology trading is from the sub-high-tech diffusion to measure the overall technological progress of the region, high-end technology can only be more safely and effectively diffused after market transactions, so as to convert into the driving force of economic development, this paper uses regional technology market transaction volume (TMTV) as a measurement index of technology transactions. Patent Ownership (POS) measures the overall level of technology ownership in the region, and measures technological progress from the outcome side, and this paper uses the number of patents per 10,000 people as its measurement index. Government Technology Investment (GTI) is a bridge between government financial inclination and government technical support, in addition to bringing some funds for technological innovation, the most important thing is to reflect the government's policy orientation for technological innovation, this paper uses the proportion of fiscal expenditure for technology investment to measure government science and technology investment. Input of researchers (IR) measures the talent indicators of regional scientific research, the fundamental executor of scientific research activities is engaged in scientific research talents, so the proportion of scientific researchers can largely reflect the level of regional scientific research, this paper uses the number of researchers per 10,000 people to measure the investment of researchers.

The threshold variable for this article is Regional Financial Pressure (RFP). Fiscal pressure

measures the degree of imbalance between regional fiscal revenue and expenditure, and most scholars use the difference between fiscal expenditure and fiscal revenue and the ratio of fiscal revenue to measure fiscal pressure, and this method will also be adopted as a proxy indicator.

According to previous research, a series of control variables that may affect the introduction of FDI are introduced into the model, including economic development level, degree of openness, marketization level index, industrial structure, and infrastructure level. (1) The Level of Economic Development (LED), generally speaking, the higher the level of economic development of a place, the closer the communication with the outside world, the more demand for foreign investment, and the easier it is to attract foreign investment, after removing the influence of price factors, this article refers to the practice of most scholars, and selects per capita GDP to measure the economic development level of a place. (2) Open, local governments to attract foreign investment will inevitably contact with the outside world, the closer the contact with the outside world, the easier, so the higher the degree of openness of a place, the more conducive to the introduction of foreign investment, this paper selects the common practice of scholars, that is, the proportion of total imports and exports of each region to GDP. (3) Industrial structure (InduStru), each link of the industrial structure requires a large amount of capital participation, foreign direct investment will promote the upgrading of the regional industrial structure, while promoting the development of the tertiary industry, improve the quality of the secondary industry, this paper uses the ratio of the output value of the tertiary industry to the output value of the secondary industry to measure. (4) Marketization Level (MZL), market mechanism can effectively and rationally allocate social resources, from the perspective of social resource allocation, state-owned economically developed areas will inevitably inhibit its market-oriented development, thus not conducive to the introduction of regional foreign investment, this paper selects the market-oriented level index presented in the "China Province Marketization Index Report (2021)" to measure. (5) Infrastructure Level (IFL), once the region has a more complete public infrastructure, it will have a positive external impact on the operating costs of the enterprise, and then it is easy to attract foreign investment, this paper refers to the research results of Fan Gang and others, according to the transportation capacity, the regional highway mileage is uniformly converted into a standard secondary road, while the railway mileage is multiplied by 14.7 converted into a standard road course, and then calculate the standard road mileage per 10,000 people as a measure.

Descriptive statistics for all explanatory, core explanatory variables, and control variables are shown in Table 1.

Table 1: Descriptive statistics of variables

variable	index	Unit	mean	standard deviation
FDI	The amount of foreign capital actually used by each province	Million dollars	836108	791708.5
RFP	The difference between fiscal expenditure and fiscal revenue is the ratio of fiscal revenue	%	1.350004	1.030694
LED	GDP per capita	RMB	53702.99	26961.43
Open	Regional total imports and exports as a proportion of GDP	%	2737.727	2883.688
InduStru	The ratio of the output value of the tertiary industry to the secondary industry	%	1.324732	0.7298589
IFL	Standard road miles per 10,000 people	km per 10,000 people	47.88597	32.10076
MZL	Market-oriented level index	1	6.686556	1.914259
TI	Technology Trading: The total turnover of the technology market(TMTV)	100 million RMB	1.557281	2.715411
	Patent ownership: number of patents per 10,000 people(POS)	pieces per 10,000 people	4.365358	5.793796
	Government science and technology investment: the proportion of fiscal science and technology expenditure(GTI)	%	2.093441	1.464228
	Investment in scientific and technological personnel: the number of scientific and technological personnel per 10,000 people(IR)	People per million	16.43781	15.06643

Source: compiled from the relevant data in the statistical yearbooks of each province, the population and employment statistical yearbook of each province, the transportation statistical yearbook of each province, the Guopingjia Statistics Bureau and the market-oriented level index report.

4.2 Metrological model building

This paper further examines whether there is a nonlinear fiscal pressure threshold effect on the relationship between local fiscal pressure and foreign direct investment, that is, when regional fiscal pressure is lower or higher than a certain threshold, whether there is a significant difference in the impact of technological progress on foreign direct investment. Most previous studies have used group tests or introduced cross-term for investigation, but because continuous variables are used as sample grouping indicators, the grouping value of financial pressure is usually selected based on subjective judgment. It is difficult to obtain an accurate "fiscal pressure" threshold. This paper introduces a threshold regression model to solve the problem, which has the advantage of automatically identifying the sample panel data and estimating the specific threshold number and threshold value, and performing the significance test of the threshold effect compared with the group test or the introduction of crossover terms. Hansen[29] first proposed a static panel threshold regression modeling measurement method based on fixed effects. Caner and Hansen[30] proposed two-stage least squares (2SLS) estimation and generalized moment estimation (GMM) estimation methods for threshold parameters for cross-sectional data containing endogenous explanatory variables and exogenous threshold variables. Finally, Kremer et al.[31] further introduce dynamic panel data on the basis of the above methods to solve the inherent endogenous problem of dynamic panels. Drawing on the method of Kremer et al.[31], this paper uses fiscal pressure as a threshold variable to construct a single threshold model of dynamic panels:

$$LnAFCAU_{it} = \beta_0 + \beta_1 LnRFP_{it} \times I(LnRFP_{it} \leq \delta) + \beta_2 RFP_{it} \times I(LnRFP_{it} > \delta) + \beta_3 LnAFCAU_{i,t-1} + \beta_4 LnTech_{it} + \gamma LnX_{it} + \mu_i + \varepsilon_{it}$$

In the formula, δ is the threshold value, $I(\cdot)$ is the threshold representation function. If the expression in parentheses is true, then $I(\cdot) = 1$, contrarily $I(\cdot) = 0$. It can be seen that for the two cases where the fiscal pressure is below the threshold($LnRFP_{it} \leq \delta$) and the fiscal pressure is above the threshold($FP_{it} > \delta$), the impact of fiscal pressure on the relationship between technological progress and foreign direct investment is β_1 and β_2, respectively. $LnAFCAU_{it}$ represents the logarithm of the actual use of foreign capital, $LnRFP_{it}$ represents the logarithm of the fiscal pressure, $LnTech_{it}$ represents the logarithm of the technological advancement factor, LnX_{it} represents the logarithm of the control variable. The threshold regression model can not only jointly estimate the fiscal stress threshold δ and the inclination [β_1 and β_2], but also perform a significance test for the threshold effect, that is, test $H_0: \beta_1 = \beta_2$. If the null hypothesis is rejected, it implies that the impact of fiscal stress on the relationship between technological progress and FDI differs significantly at different stages of fiscal stress.

Combining the basic principles of economics and finance, when the fiscal pressure is small, the capital gap required for technological progress is not urgent, but it is in a state of resistance to the technological spillover effect attached to FDI, so that technological progress has a greater restraining effect on FDI than it promotes. When the fiscal pressure is greater and exceeds a certain threshold, the capital gap required for technological progress cannot be supplemented by government fiscal expenditure, which greatly increases the demand for foreign capital for technological progress, so that technological progress promotes foreign direct investment more than inhibits. In summary, the impact of fiscal pressures on the relationship between technological progress and FDI has and only one threshold.

5. Empirical analysis and discussion

5.1 Technological Advances and the Granger Causal Test of FDI

Because this paper uses short panel data, it does not perform the unit root test and directly performs the Granger causal test. Stata was used to examine the Granger relationship between the actual use of FDI and various indicators of technological progress. As shown in Table 2, the null hypothesis is rejected between technological progress and actual use FDI, except that actual use FDI did not lead to technology market transactions, which is significant at the 1% level, and the test p-value for actual use FDI does not lead to technology market transactions is also at the level of 0.229, so on the whole, the Granger causal relationship between technological progress and actual use FDI cannot be denied.

Table 2: Grainger causal test results for technological progress and FDI

Null hypothesis	Wald statistics	Z-statistic	p-value
Patent ownership did not lead to the actual use of FDI	2.5677	6.0717	0.0000
The actual use of FDI did not result in patent ownership	2.5282	5.9185	0.0000
Technology market transactions did not result in the actual use of FDI	2.0091	3.9084	0.0001
The actual use of FDI did not result in a technology market transaction	1.3107	1.2033	0.2289
Government investment in science and technology has not resulted in the actual use of FDI	3.5702	9.9544	0.0000
The actual use of FDI has not resulted in government investment in science and technology	2.6758	6.4902	0.0000
Scientific and technical investment has not led to the actual use of FDI	2.9143	7.4141	0.0000
The actual use of FDI did not lead to investment in scientific and technological personnel	2.8232	7.0610	0.0000

5.2 The Nonlinear Relationship between the Impact of Regional Fiscal Pressure on Technological Progress and Foreign Direct Investment: An Analysis of Dynamic Threshold Effect

Table 3: Threshold estimation and threshold effect significance test of dynamic panel

The variable being explained	Core explanatory variables	Number of thresholds	Threshold	95% confidence interval	P-value	Critical value		
						1%	5%	10%
LnAFCAU	LnTMTV	1	1.031	[1.0218,1.0844]	0.06	53.39	40.46	27.42
		2	-1.956	[-2.079,-1.955]	0.55	52.53	34.03	27.36
LnAFCAU	LnPOS	1	1.092	[1.0844,1.0995]	0.17	56.93	29.45	25.34
		2	0.235	[0.1906,0.2395]	0.48	45.93	30.44	24.79
LnAFCAU	LnGTI	1	1.316	[1.294,1.325]	0.02	41.01	29.37	24.37
		2	1.01	[0.965,1.022]	0.27	45.48	33.10	28.14
LnAFCAU	LnIR	1	-0.339	[-0.364,-0.324]	0.01	52.74	30.77	25.59
		2	1.031	[1.022,1.0844]	0.19	36.55	26.99	22.75
LnTMTV	LnAFCAU	1	0.5706	[0.5351,0.5839]	0.01	40.519	26.959	22.929
		2	0.8955	[-0.1410,0.9249]	0.26	36.808	27.504	23.452
LnPOS	LnAFCAU	1	0.6469	[0.5805,0.6485]	0.73	36.495	27.672	24.332
LnGTI	LnAFCAU	1	1.3246	[0.9280,1.4710]	0.62	48.012	32.168	26.884
LnIR	LnAFCAU	1	0.8955	[0.8521,0.9249]	0.43	41.807	35.300	31.572

The four proxy variables of actual use of FDI and technological progress were taken as the explanatory variables and core explanatory variables, and the regional fiscal pressure was used as the threshold variable, and the threshold value estimation and threshold effect significance test results of the eight sets of dynamic panels in Table 3 were obtained. It can be found that there is a single threshold effect on the actual use of FDI in technology market transactions, government science and technology investment and scientific and technological personnel investment in technological progress, among which the threshold values of technology market transactions and government science and technology investment are relatively close, 1.031 and 1.316, respectively, and both are approximately significant at the 5% level. The threshold value of scientific and technological personnel investment is negative, that is, -0.339 and significant at the level of 1%, which indicates that the role of scientific and technological personnel investment in the actual use of FDI is more sensitive to financial pressure, and it has entered a turning point relatively quickly. The threshold effect of the actual use of FDI on technology market transactions is also significant at the 1% level, with a threshold of 0.5706. Similarly, the threshold effect of patent ownership in technological progress on the actual use of FDI is not significant, and the same practical use of FDI does not have a threshold effect on patent ownership, government investment in science and technology and investment in scientific and technological personnel in technological progress.

In summary, a total of four of the eight combinations have a single threshold effect, in which there

is a two-way single threshold effect between technology market transactions and actual use FDI, while patent ownership and actual use FDI do not have a threshold effect at all. The impact of government science and technology investment and scientific and technological personnel investment on the actual use of FDI will be directly affected by government finance, thus having a very significant threshold effect.

Table 4: Nonlinear impact of total technology market turnover on actual FDI use (one of the single threshold models of dynamic panels)

variable	coefficient	Standard error	P-value
LnTMTV(LnRFP ≤ 1.031)	0.1357161**	0.0532786	0.011
LnTMTV(LnRFP > 1.031)	-0.5498234***	0.1328039	0.000
Intercept item	6.109706**	2.526034	0.016
Other control variables	control		

Variables to be explained: actual use of FDI; Core explanatory variables: Total technology market turnover

Table 4 reports the nonlinear impact of the total technology market transaction value estimated by the dynamic panel single threshold model when the explanatory variable is the actual use of FDI and the core explanatory variable is the total transaction value of the technology market. It can be observed that the impact of total technology market turnover on FDI varies significantly between different periods of fiscal stress in different regions: When the regional fiscal pressure is below threshold (LnRFP ≤ 1.031), the total transaction value of the technology market has a promoting effect on FDI (coefficient 0.1357), which is significant at the 5% level; When regional fiscal pressures are above the threshold and enter high-pressure fiscal stage (LnRFP > 1.031), an increase in total transaction value in the technology market will discourage FDI at a significant level of 1% (coefficient -0.5498). This is consistent with our theoretical analysis: technology market transactions contain the demand for technology and the demand for capital, and due to the technology spillover effect of foreign direct investment, the increase in the actual use of foreign capital will inhibit the demand for technology in the technology market and solve the demand for technology market capital. In order to solve the long-term economic development pressure, local governments are more inclined to increase the momentum of regional economic development and meet the technological needs of the technology market, thereby reducing the actual amount of foreign capital used; In areas with low fiscal pressure, more attention is paid to short-term financial pressure, so as to meet the capital needs of the technology market and increase the actual use of foreign capital.

Table 5: Nonlinear impact of government science and technology investment on foreign direct investment (Dynamic Panel Single Threshold Model No. 2)

variable	coefficient	Standard error	P-value
LnGTI(LnRFP ≤ 1.316)	0.872799***	0.1276242	0.000
LnGTI(LnRFP > 1.316)	-2.355599***	0.5640165	0.000
Intercept item	9.699667***	2.571745	0.000
Other control variables	control		

Variables to be explained: actual use of FDI; Core explanatory variables: government investment in science and technology

Table 5 reports the nonlinear impact of government R&T investment on FDI estimated by the dynamic panel single threshold model when the explanatory variable is the actual use of FDI and the core explanatory variable is government R&T. It can be observed that there are also significant differences in the impact of government technology investment on foreign direct investment during the period of regional fiscal stress: When the regional fiscal pressure is lower than the threshold (LnRFP ≤ 1.316), government science and technology investment has a promoting effect on foreign direct investment (coefficient 0.8728), which is significant at the level of 1%; When regional fiscal pressures are above threshold (LnRFP > 1.316), an increase in government investment in science and technology discourages FDI at a significant level of 1% (coefficient -2.3556). Consistent with the theoretical analysis of the technology trading market: when in areas with low fiscal pressure, the government's technology investment will face short-term capital needs, thereby increasing the actual use of foreign capital; In areas with high fiscal pressure, the higher the government's investment in science and technology, the more it will aggravate the pressure on regional finances, thereby making the economic development situation more severe in the short term, and then reducing the actual amount of foreign capital used.

Table 6: Nonlinear impact of government science and technology investment on FDI (Dynamic Panel Single Threshold Model No. 3)

variable	coefficient	Standard error	P-value
LnIR(LnRFP ≤ −0.339)	0.8960232***	0.1444538	0.000
LnIR(LnRFP > −0.339)	0.3706975***	0.1228817	0.000
Intercept item	8.509143***	2.559151	0.001
Other control variables	control		

Variables to be explained: actual use of FDI; Core explanatory variables: input from scientific and technical personnel

Table 6 reports the nonlinear impact of scientific and technological personnel investment on FDI estimated by the dynamic panel single threshold model when the explanatory variable is the actual use of FDI and the core explanatory variable is the dynamic panel single threshold model when the scientific researcher inputs. It can be expected that the investment of scientific and technological personnel can intuitively reflect the scientific research strength of the region, and also reflect the development potential of the region, and the area with large development potential will inevitably greatly attract foreign direct investment, so the investment of scientific and technological personnel will significantly promote the actual use of foreign investment. As shown in Table 7, under different financial pressures, the investment of scientific and technological personnel has promoted the actual use of foreign capital at a significant level of 1%. The catalytic coefficient (0.8960) in areas of low fiscal stress (LnRFP ≤ −0.336) was significantly greater than that (0.3707) in areas with high fiscal stress (LnRFP > −0.336).

Table 7: Nonlinear impact of actual FDI use on technology market transactions (Dynamic Panel Single Threshold Model No. 4)

variable	coefficient	Standard error	P-value
LnAFCAU(LnRFP ≤ 0.5706)	0.0546639	0.0672612	0.417
LnAFCAU(LnRFP > 0.5706)	0.1177956*	0.0675658	0.082
Intercept item	-9.627611***	2.792211	0.001
Other control variables	control		

Interpreted variables: total technology market turnover; Core explanatory variables: actual use of FDI

Table 7 reports on the nonlinear effect of actual FDI use on technology market transactions, with a single threshold making its effect present in two phases, the first phase being gentler but not significant, and the second phase being a bit steeper than the first phase and significant at the 8% level. However, the overall trend is upward, that is, the actual use of FDI will always promote regional technological progress, when the fiscal pressure is lower than the threshold, the regional government has no financial pressure, and the use of FDI is not so urgent, so that its effect on promoting regional technology transactions is not great; Conversely, when the fiscal pressure is greater than the threshold, the pressure on the government's finances will force the government to make full use of FDI, thereby maximizing the technological spillover effect of FDI and increasing the transaction volume of regional technology markets.

6. Conclusions and recommendations

Since 2013, we began to explore a modern fiscal system that is compatible with national governance, and the relationship and influence mechanism between pressure fiscal management and modern economic development and urban management have begun to attract the attention of scholars, and foreign direct investment is the most important way to attract foreign investment in developing regions, and technological progress is a process with four aspects: research and development, transaction diffusion, government investment and talent. Therefore, it is of great practical significance to explore the dynamic relationship between regional fiscal pressure, technological progress and foreign direct investment, as well as the threshold effect. This paper first sorts out the Grainger causality of technological progress and actual use of FDI, and then tests the dynamic panel threshold model based on the unified panel, and comprehensively examines the relationship between regional fiscal pressure, technological progress and foreign direct investment and threshold effect.

The findings in this paper found: (1) There is a two-way Granger causal relationship between patent ownership, government science and technology investment and scientific and technological personnel investment and foreign direct investment in technological progress, while technology market transactions lead to Granger causation in the actual use of FDI; (2) There is a hump relationship

between the total transaction of technology market in technological progress and the government's investment in science and technology and the actual use of FDI, that is, the actual use of foreign capital in a region shows a trend of first rising and then declining with the increase of total technology market transaction and the increase of government science and technology investment, among which the logarithmic value of the regional fiscal pressure as a threshold variable is 1.031, which is the greatest likely to increase the promotion effect of technological progress on the actual use of foreign capital; (3) The threshold effect of actual use of FDI on technology market transactions under fiscal pressure is significant, and it is all in a positive promotion effect, and the second half of the effect is significant at the 8% level.

Based on the results of this paper, the following enlightenment is obtained:

(1) Local governments should grasp both technological progress and FDI introduction, and both hands should be firm. In the process of technological progress, government investment in science and technology is the financial and policy support for technological progress, and the most important thing is to provide an appropriate policy environment; The investment of scientific and technological personnel is the human support for technological progress and the core embodiment of regional scientific and technological strength; Patent ownership is a direct embodiment of regional technological progress and a potential force that translates into economic power; Finally, technology market transactions are mainly reflected in the mid-end technology field, which is also an important power conversion mechanism to steadily promote economic development. On the one hand, the introduction of FDI will bring a large amount of capital to promote economic development, and on the other hand, it will also bring sub-advanced technologies that are in line with international science and technology. The Grainger causal test shows that all four aspects of technological progress lead to the introduction of regional FDI, and the same introduction of regional FDI will also lead to technological progress in addition to technology market transactions. Therefore, paying attention to the high-quality progress of government science and technology investment, scientific and technological personnel investment, patent ownership and technology market transactions, and simultaneously strengthening the introduction of FDI, can promote each other and steadily enhance the economic development potential and current economic development momentum.

(2) Strengthen the guiding role of government finance in technological progress and the role of FDI in attracting FDI. From the empirical results of this paper, it can be seen that the fiscal situation of the region has a significant threshold effect on the guiding effect between technological progress and actual use of FDI, and the role of technology market transactions and government science and technology investment on actual use of FDI shows a significant inverted "U" structure with the increase of government financial pressure. In this way, keeping the fiscal pressure at an appropriate size, that is, keeping the regional fiscal pressure at a size of 1.031, can ensure that the fiscal pressure contributes to the above orientation process. Secondly, in addition to paying attention to financial support for high-end science and technology research and development, it is also necessary to pay attention to the role of finance in the introduction and diffusion of sub-high-end technologies in the market, effectively supervise and promote the process of transforming sub-high-end technologies into economic development power, and steadily promote the kinetic energy transformation of the new normal of economic development.

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