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THE IMPACT OF STOCK MARKET DEVELOPMENT AND CREDIT MARKET DEVELOPMENT ON TECHNOLOGICAL INNOVATION: AN EMPIRICAL STUDY BASED ON CROSS-COUNTRY PANEL DATA

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ABSTRACT

Technological innovation is crucial to economic growth and social transformation. In the process of technological innovation, financial capital is indispensable. Accordingly, a country's stock market and credit market are extremely important in giving impetus to technological innovation. Thus, we construct a panel data model with interactive fixed effects to study the impact of stock market development and credit market development on technological innovation in countries at different levels of economic development. Results indicate that, whether for developed or developing and emerging market countries, the development of the stock market has a significant positive influence on national technological innovation (NTI), and the impact of the development of the credit market on innovation of different types of countries is quite different. In addition, foreign direct investment (FDI) inflow can increase the positive impact of stock market development on NTI, but this impact is not significant for the sample of developed countries.

Contribution/Originality: This study comparatively investigates the impact of stock market development and credit market development on national technological innovation in countries at different levels of economic development, and the moderating effect of FDI on the stock market's impact on technological innovation has also been considered.

1. INTRODUCTION

Technological innovation is the key driving force of economic growth, and support from the financial system is an indispensable element in the process of technological innovation. For example, the use of savings, project evaluation, and risk management provided by financial intermediaries are crucial to technological innovation, reducing adverse selection and moral issues caused by information asymmetry (Freeman & John, 2018; Hsu, Tian, & Xu, 2014; King & Levine, 1993). Using 32 developed and developing countries as the research sample, the impact of financial development on technological innovation was empirically studied, and the results showed that in countries with more developed stock markets there is a higher degree of dependence on external financing and more technology-intensive industries. In addition, this study also found that credit market development hinders innovation in the above industries, and it is believed that the different effects of stock and credit markets on innovation may be due to the different payment structures of financial capital providers (Hsu et al., 2014). The impact of financing risk on innovation and entrepreneurship has also been studied by researchers, and the study showed that the prosperity of financial markets is important for the commercialization of new and radical technologies. This viewpoint is

supported by Nanda & Rhodes-Kropf (2017) which found that, in a specific industry, region or period, the degree of commercialization of new ideas depends to a large extent on the status of the financial market, and the most innovative companies are often the most vulnerable to financial risks. Therefore, innovative companies, or companies in the early stages of technology adoption, may need a "hot" financing environment to help them complete initial financing and facilitate technology diffusion (Nanda & Rhodes-Kropf, 2017). A financial system that can effectively finance technological innovation plays a vital role in promoting the innovative output of a country, and the development level of the stock market and credit market are important measurement indicators of the function of the financial system. Therefore, it is worthwhile exploring the relationship between the development of the stock market and the credit market with technological innovation. Existing studies seldom distinguish samples of developed countries from samples of developing and emerging market countries when analyzing this problem, making it difficult to observe the differences in the impacts of stock market and credit market development on technological innovation in countries at different economic development levels. In this research, we distinguish samples from developed countries and developing and emerging market countries and conduct in-depth research on the impact of stock market and credit market development on technological innovation. We also consider the moderating effect of FDI. The rest of this paper is structured as follows: the second section details the research samples, variables and data; the third section explains the econometric model constructed in this paper; the fourth section comprises the analysis results; and the final section contains the conclusions.

2. RESEARCH SAMPLES, VARIABLES AND DATA

2.1. Research Samples

In order to explore the impact of stock market development and credit market development on technological innovation at the national level, considering data availability and sample size, 47 countries were selected, including 22 developed countries and 25 developing and emerging market countries. The sample countries are listed in Table 1 .

Table 1. Research samples.

Developed Countries	Developing & Emerging Market Countries
Austria	Algeria
Belgium	Argentina
France	Bangladesh
Germany	Brazil
Greece	Chile
Hong Kong	China
Israel	Costa Rica
Japan	Croatia
South Korea	Hungary
Luxembourg	India
Malta	Indonesia
Netherlands	Iran
New Zealand	Kazakhstan
Norway	Malaysia
Portugal	Mauritius
Singapore	Mexico
Slovak Republic	Panama
Slovenia	Peru
Spain	Philippines
Switzerland	Poland
United Kingdom	Romania
United States	South Africa
	Sri Lanka
	Thailand
	Turkey

2.2. Variables and Data

Dependent variable: The level of national technological innovation (NTI) is the dependent variable. When measuring the level of technological innovation in a country, the number of patent applications are widely used in previous studies (Hsu et al., 2014; Moshirian, Tian, Zhang, & Zhang, 2021; Tan, Tian, Zhang, & Zhao, 2020). We also follow this method and take the number of patent applications as a proxy variable for the level of national technological innovation. At the same time, the number of patent applications in each sample country is logarithmically normalized, as per the majority of previous studies.

Independent variables: The stock market development level and the credit market level are the core independent variables of this paper. Referring to the research of Hsu et al. (2014), the ratio of the total stock market capitalization to GDP of each sample country is used as a proxy variable for the stock market development, and the ratio of private sector credit to GDP is used as the proxy variable for the credit market development.

Control variables: Considering the main process of technological innovation and the possible influencing factors, and referring to the research of Hsu et al. (2014); Yang, Shao, Li, & Yang (2020); Cheung & Ping (2004); Griliches (1979) and other scholars, we selected R&D labor input, R&D expenditure, human capital level, and foreign direct investment as control variables.

The definitions, calculation methods and data sources of all variables are shown in Table 2.

Time interval selection and data preprocessing: Considering the availability of data, the research time interval of this paper is from 1996 to 2018. In order to prevent any inconsistency of the measurement model estimation caused by the two-way causality, the core independent variables and control variables are treated as a lag of a year. That is, the time interval of the dependent variable is from 1996 to 2017 and the time period of the core independent variables and control variables is from 1997 to 2018. In order to eliminate the dimensional influence, logarithmic normalization is carried out for R&D labor input, Z-score normalization for FDI, and mean imputation for missing data.

Table 2. Main variables and data sources.

Variable			Definition	Source
Dependent variable	National technological innovation	NTI	Natural logarithm of patent filings	World Bank
Core independent variables	Stock market development	Stock	Total stock market capitalization/GDP	Financial Structure Database
	Credit market development	Credit	Private sector credit/GDP	Financial Structure Database
Control variables	R&D labor input	R&DL	R&D personnel per million people	World Bank
	R&D expenditure (%)	R&DEx	R&D spending/GDP	World Bank
	Human capital	HC	Human Capital Index	Penn World Table
	Foreign direct investment	FDI	Balance of payments (BPM6) and net inflow of direct investments to sample countries	International Monetary Fund

2.3. Descriptive Statistical Analysis

Table 3 contains the descriptive statistical results of the panel data, and Tables 4, 5 and 6 contain the statistical characteristics of all sample countries, developed countries, and developing and emerging market countries, respectively. It can be found that, from 1996 to 2018, the indicators of the sample countries have the following characteristics:

First, the mean of patent applications in developed countries is much higher than that in developing and emerging market countries. From 1996 to 2018, the mean of patent applications per country in all sample countries was 898 per year, 1936 in developed countries, and 453 in developing and emerging market countries, indicating that

developed countries' technological innovation levels are much higher than those of developing and emerging market countries. At the same time, according to Table 3, the within-group standard deviation of patent applications (0.5261) is much lower than the between-group standard deviation (2.4916), which means that in different samples there are larger differences in the number of patent applications than in one sample.

Second, the stock market development level of developed countries is much higher than that of developing and emerging market countries. From 1996 to 2017, the mean of stock market capitalization to GDP in all sample countries was 0.42, that of developed countries was 0.6854, while that of developing and emerging market countries was only 0.1674, indicating that stock markets in developed countries have a higher ability to absorb funds than developing and emerging market countries. In addition, the maximum value of the stock market in developed countries as a percentage of GDP reached 8.2232, which means the stock market value is 8.2232 times the GDP of that year, and the sample country corresponding to this value is Hong Kong, which shows that the Hong Kong stock market has a strong ability to absorb funds. The maximum value of the proportion of GDP is 2.4917. The sample country corresponding to this observation is China, indicating that the amount of funds absorbed by the stock market in China is already 2.4917 times the GDP, which can also reflect the Chinese stock market's ability to attract investors.

Table 3. Panel descriptive statistics results.

Variable	Within/Between	Mean	Standard Deviation	Min.	Max.	Sample Structure
NTI	Overall	6.8	2.5216	0.69	14.15	N = 1034
	Between		2.4916	1.2905	12.6791	n = 47
	Within		0.5261	4.2369	8.9869	T = 22
Stock	Overall	0.42	0.7612	0	8.2232	N = 1034
	Between		0.6592	0.0035	3.751	n = 47
	Within		0.3924	-2.5192	4.8873	T = 22
Credit	Overall	0.77	0.4802	0.0414	2.1894	N = 1034
	Between		0.4552	0.1198	1.7212	n = 47
	Within		0.1637	0.2	1.3423	T = 22
R&DEx	Overall	1.16	0.9617	0.05	4.51	N = 1034
	Between		0.9308	0.1182	3.7445	n = 47
	Within		0.2766	-2.1061	2.7289	T = 22
R&DL	Overall	7.04	1.2108	3.63	8.92	N = 1034
	Between		1.1753	4.4605	8.5255	n = 47
	Within		0.3378	4.0095	9.0454	T = 22
HC	Overall	2.86	0.5186	1.57	3.97	N = 1034
	Between		0.492	1.7932	3.6477	n = 47
	Within		0.1783	1.0751	3.8496	T = 22
FDI	Overall	-0.11	1.0206	-3.0434	3.415	N = 1034
	Between		0.3698	-2.3517	0.2287	n = 47
	Within		0.9527	-2.7755	3.7499	T = 22

Note: N: number of observations; T: number of periods; n: number of research samples.

Third, the development level of credit markets in developed countries is much higher than that in developing and emerging market countries. From 1996 to 2017, the average annual ratio of private sector credit to GDP of all countries in the sample was 0.77, and the average of the developed countries was 1.0672, reflecting the average private sector credit in developed countries is much higher than GDP, and the value of this indicator for developing countries and emerging market countries is 0.5045, which is about one time lower than that of developed countries. In addition, by analyzing the standard deviations of credit development levels in Tables 4 to 6, it can be found that the difference between developed countries (0.4099) and developing and emerging market countries (0.3712) is relatively small. The standard deviation of the stock market development level of developed countries is 0.9986, which is 3.8 times that of developing and emerging market countries.

Table 4. Statistic characteristics – all samples.

Variable	Mean	Standard Deviation	Min.	25% Quantile	Median	75% Quantile	Max.
NTI	6.7955	2.5216	0.69	5.34	6.72	7.78	14.15
Stock	0.4151	0.7612	0	0.0248	0.1459	0.4856	8.2232
Credit	0.767	0.4802	0.0414	0.3358	0.7101	1.0987	2.1894
R&DEx	1.1584	0.9617	0.05	0.4	0.825	1.725	4.51
R&DL	7.0372	1.2108	3.63	5.96	7.27	8.13	8.92
HC	2.8637	0.5186	1.57	2.51	2.89	3.27	3.97
FDI	-0.1149	1.0206	-3.0434	-0.8151	-0.2226	0.4867	3.415

Fourth, developed countries invest more in R&D activities than developing and emerging market countries. From 1996 to 2017, the average ratio of R&D expenditure to GDP in the whole sample was 1.15%; the average for the sampled developed countries was 1.84%, and the average of sampled developing and emerging market countries was 0.53%. The ratio of R&D expenditure to GDP is also called R&D intensity, which is an important indicator for measuring the innovative extent in a country. Generally speaking, the R&D intensity of innovative countries should exceed 2%. Of the 47 sampled countries in this paper, 14 met this standard in some years, including Austria, Belgium, Switzerland, China, Germany, France, Israel, Japan, South Korea, the Netherlands, Norway, Singapore, Slovenia, and the United States.

Table 5. Statistic characteristics – developed countries.

Variable	Mean	Standard Deviation	Min.	25% Quantile	Median	75% Quantile	Max.
NTI	7.5683	2.6017	1.39	5.795	7.29	9.555	12.86
Stock	0.6854	0.9986	0.0003	0.0747	0.3667	0.9117	8.2232
Credit	1.0672	0.4099	0.2379	0.7848	0.9996	1.3663	2.1894
R&DEx	1.8423	0.9383	0.18	1.16	1.74	2.475	4.51
R&DL	8.0113	0.5329	5.23	7.7513	8.13	8.365	8.92
HC	3.2066	0.3791	1.58	2.9718	3.27	3.52	3.97
FDI	-0.0402	0.9167	-2.586	-0.6628	-0.1616	0.3787	3.415

Fifth, there is also a gap in the level of human capital between developed countries and developing and emerging market countries. The method for the measurement of human capital level in this paper draws on the research work of Sheng & Jing (2021). The data was taken from the Penn World Table, which was developed by the University of Groningen in the Netherlands, covering 183 countries on income, output, input, productivity and other relative data. According to the database, the average score of human capital level in developed countries is 3.2066, and the average score of human capital level in developing & emerging market countries is 2.5620.

Table 6. Statistic characteristics – developing and emerging market countries.

Variable	Mean	Standard Deviation	Min.	25% Quantile	Median	75% Quantile	Max.
NTI	6.1155	2.2403	0.69	4.8	6.29	7.22	14.15
Stock	0.1674	0.2629	0	0.0134	0.0619	0.2243	2.4917
Credit	0.5045	0.3712	0.0414	0.2278	0.3773	0.689	1.6418
R&DEx	0.5284	0.3705	0.05	0.25	0.425	0.775	2.12
R&DL	6.1054	0.9055	3.63	5.53	5.97	6.8	8.05
HC	2.562	0.4299	1.57	2.27	2.59	2.88	3.52
FDI	-0.1805	1.1006	-3.0434	-0.9239	-0.3537	0.5719	3.3885

Based on the above analysis, it can be seen that developed countries and developing and emerging market countries have a great difference on innovation input (R&D expenditure and R&D labor input), innovation output (the number of patent applications), stock market development, credit market development, and human capital.

Differences in innovation input, stock market and credit market development, and human capital levels and the ability to attract foreign direct investment may be the reasons for the differences in innovation output.

3. ECONOMETRIC MODEL

3.1. Data Stationarity Test

Considering that the construction of most panel data models assumes that the panel data is stationary, before constructing an econometric model, we tested if the panel data we constructed in this paper is stationary. Considering the data structure, we choose to use the Harris–Tzavalis (HT) method and the Im–Pesaran–Shin (IPS) method to conduct the panel data unit root tests, and Table 7 shows the results. It can be seen that at the significance level of 10%, each variable has passed the stationarity test. Among them, credit and stock are only stable under the assumption that there is no trend term, and the other variables are stationary. Therefore, we can construct a panel data model to carry out the research.

Table 7. Panel data stationarity test results.

Variable	Testing method	Includes trend items or not	P-Value	Stationary or not
NTI	HT	Yes	0	Yes
	HT	No	0.0602	Yes
Credit	IPS	Yes	0.5784	No
	IPS	No	0.0092	Yes
Stock	HT	Yes	0.9403	No
	HT	No	0.0146	Yes
R&DL	HT	Yes	0	Yes
	HT	No	0	Yes
R&DEx	HT	Yes	0	Yes
	HT	No	0	Yes
HC	HT	Yes	0	Yes
	HT	No	0	Yes
FDI	HT	Yes	0	Yes
	HT	No	0	Yes

3.2. Econometric Model

Considering the national technological innovation (NTI) level may be affected by fixed effects from many aspects, for example, unobserved factors at the regional and national levels may affect NTI, and NTI may also be affected by time fixed effects since it changes over time. To solve the abovementioned problem, the panel fixed effects model is widely used in the construction of panel data models. By controlling the unobserved individual fixed effects and the time fixed effects, the endogeneity problem caused by omitted variables can be solved to a certain extent. However, in the assumption of the fixed effects model, the individual fixed effects only change with the individual, but does not change with time, while the time fixed effects only change with time, but do not change with the individual. In reality, unobserved influencing factors may change both with time and with individuals. For example, social culture is undoubtedly an important factor affecting the level of NTI, and it is different between different countries and changes over time. But in empirical work, it is often difficult to find a relatively accurate method to measure the influence of social culture. Based on the above background, scholars have considered introducing interactive fixed effects into econometric models to measure unobserved influencing factors that vary both with time and with individuals. The interactive fixed effects model proposed by Bai (2009) can solve such problems well, and we will use this method in the follow-up research. The benchmark regression model is set as follows:

$$NTI_{kit} = \alpha_0 + \alpha_1 Stock_{kit} + \alpha_2 Credit_{kit} + \sum_{j=1}^{4} \beta_j X_j + \delta_k + u_{it} \quad (1)$$

Where i = 1…19, t = 1…22, k = 1…5, the dependent variable NTI_{it} is country i's natural logarithm of patent application numbers in region[1] k; $Stock_{kit}$ is the independent variable, which indicates the stock market development level of country i in year t; $Credit_{kit}$ is the credit market development level of country i in year t; X_j(j = 1…4) are control variables, which indicates $R\&DEx_{kit}$, $R\&DL_{kit}$, HC_{kit}, FDI_{kit}, which denote R&D expenditure, R&D labor input, human capital level and FDI inflow, respectively; α_0, α_1, $\alpha_2$and β_j(j = 1…4) are parameters that need to be estimated; δ_k(k = 1…5) are the regional fixed effects, and u_{it} is a special error and is constructed as:

$$u_{it} = \lambda_i F_t + \varepsilon_{it} \quad (2)$$

Where F_t is an $(r \times 1)$ dimensional common factor vector that can affect NTI, λ_i is an $(r \times 1)$ dimensional factor loading vector which is capable of capturing individual-specific responses to common factors (Totty, 2017), and ε_{it} is the random error term. In order to test the robustness, the high-dimensional fixed effects model proposed by Guimaraes & Portugal (2010) will be used, and the estimated results were used as the comparison for the regression results of the panel interaction fixed effects model. To mitigate the effect of heteroscedasticity, heteroscedasticity-robust standard errors are used to estimate Equations 1 and 2.

4. RESULTS

4.1. Benchmark Regression Results

The regression results based on (1) and (2) are shown in Table 8 and show the following:

First, whether in developed countries or developing and emerging market countries, the development of the stock market has a significant positive impact on the level of NTI. That is to say, for countries at different economic development levels, the stock market is an important channel to finance technological innovation. The underlying mechanism may be as follows: the development of the stock market in a country could provide the impetus to finance technological innovation activities and, at the micro level, the stock market is an important channel for listed companies to attract external funds. They could then invest more in R&D activities and the innovative output level can be promoted despite the existence of the investors' influence on corporate decisions, which means that managers in listed companies would be pressured by stock market investors, so they tend not to invest in high-risk innovative R&D activities in order to maintain the firm's profit level and the development of the stock market could still promote the level of NTI. In other words, the net impact of stock market development on NTI is positive, which corresponds to Wies & Moorman (2015), whose research showed that in the process of the development of the stock market, the micro-mechanisms that promote and inhibit the level of innovation are intertwined, but on the whole, the development of the stock market can promote NTI. At the same time, based on the research results of this paper, it can also be seen that the development level of the stock market has a greater impact on the level of technological innovation in developing and emerging countries, which means that when other conditions remain unchanged, as the development level of the stock market in developing and emerging countries increases from the 25% quantile to the 50% quantile, the level of innovation increases by approximately 0.51% above its mean. This shows that the late-developing countries want to "catch up" or even "surpass" developed countries by improving NTI, developing the stock market, improving the trading mechanism, and building an institutional environment conducive to technological innovation.

Second, different types of financial markets have different impacts on NTI, and such impacts will vary according to the level of a country's economic development. From the regression results of the full sample, the development of the stock market and the credit market both have a positive effect on NTI. However, from the results of the grouped regression, development of the stock market is not only important for developed countries, but also for the developing and emerging market countries. Development of the credit market only has a significant effect in promoting the innovation level of developed countries, and the impact on developing and emerging countries is not significant. A

[1] k = 1…5 represent the sample countries located in Europe, Asia, America, Africa and Oceania.

large number of studies have shown that debt financing is incompatible with technological innovation due to high uncertainty. The research in this paper responds to this point of view to a certain extent, that is, whether debt financing based on credit supply can promote NTI and is closely related to the level of economic development of a country. Countries' higher credit supply mechanisms might be more suitable for technologically innovative activities; therefore, it is important to explore the micro-mechanisms behind the macro-phenomenon.

In fact, innovative financing practices at the micro level can provide support for this regression result. Silicon Valley Bank, a bank which serves technology-based companies, has played a key role in supporting well-known companies such as Facebook and Twitter. Intensive innovation activities are a distinctive feature of technology-based companies in their development process. Silicon Valley Bank has broken the boundaries between equity financing and debt financing and designed a set of tools to help manage risks and support start-ups. Some innovative financing practices had already been designed, such as relaxing the requirements for collateral in order to provide loans for technology-based companies, since these companies have a high risk of failure in the growth process and often leads to a large number of bad debts. In order to control the risk of bad debts, Silicon Valley Bank added risk compensation on the basis of normal interest, which consists of handling fees and warrants. The fair value of the warrants will rise sharply if the start-ups are successful, and high returns will be obtained after exercising the warrants, thereby making up for the losses incurred by the bank due to loans provided to failed start-ups (Xu, 2020).

Table 8. Benchmark regression results.

	All Samples		Developed countries		Developing and emerging market countries	
	Model 1	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**
	IFE	HDFE	IFE	HDFE	IFE	HDFE
Dependent Variable						
NTI						
Independent Variable						
Stock	0.0729** [0.0367]	0.163*** [0.0416]	0.0590** [0.0296]	0.106*** [0.0345]	0.640*** [0.1616]	0.898*** [0.1638]
Credit	0.692*** [0.1300]	0.315*** [0.1097]	0.430*** [0.0936]	0.451*** [0.0955]	0.357 [0.2454]	-0.188 [0.2616]
R&DEx	-0.114 [0.1041]	0.024 [0.0930]	-0.0272 [0.0553]	-0.0853 [0.0598]	0.887*** [0.2344]	1.016*** [0.2832]
R&DL	0.142 [0.0927]	0.109 [0.0927]	0.206* [0.1175]	0.236** [0.1158]	-0.234* [0.1213]	-0.139 [0.1117]
HC	0.467** [0.2052]	0.17 [0.2317]	0.122 [0.1436]	0.480** [0.1946]	0.818*** [0.3018]	-0.17 [0.3737]
FDI	0.0363 [0.0240]	0.0269 [0.0290]	0.0258 [0.0161]	0.0404** [0.0188]	0.0477 [0.0366]	-0.0314 [0.0502]
Constant	4.173*** [0.8275]	5.372*** [1.0033]	5.085*** [0.9176]	3.750*** [1.0942]	4.885*** [0.8282]	7.057*** [1.0639]
Sample size	963	963	480	480	483	483
Adjusted R^2		0.9623		0.9856		0.9411
Regional fixed effects	Control	Control	Control	Control	Control	Control
Country-level fixed effects	Not control	Control	Not control	Control	Not control	Control
Time fixed effects	Not control	Control	Not control	Control	Not control	Control
Country–Time interaction fixed effects	Control	Not control	Control	Not control	Control	Not control

Note: The robust standard errors are in square brackets; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

It can be seen from the above analysis that effective innovation financing often depends on the good design of the micro mechanism. The design of the funder's income structure based on the risk characteristics of the investment target is crucial to whether it can provide continuous support effectively for innovation activities. The policy

implication of the above research conclusions is that the funding mechanism needs to be designed based on the specific characteristics of innovative activities, which is essential for sustained and effective innovative financing activities.

At the same time, in order to verify the robustness of the regression results, this paper adopts the strategy of changing the control variables. According to Table 8, for different types of samples, the regression results obtained are consistent under the control of time–country interactive fixed effects, regional fixed effects and time fixed effects, and country fixed effects and regional fixed effects, indicating that the results of the benchmark regression are robust.

4.2. The Moderating Effect of FDI on the Stock Market's Impact on Technological Innovation

Considering the important role of foreign direct investment in a country's innovation level and financial development, this section introduces the interaction term between foreign direct investment and stock market development on the basis of the above benchmark regression. The estimation method and model setting used in this part are similar to the benchmark regression. Table 9 shows the regression results of the interaction term between foreign direct investment and stock market development based on the benchmark regression model.

According to Table 9, it can be found that, except for the newly introduced interaction term, the coefficients of other variables are basically the same as those in Table 8, which also reflects the robustness of the benchmark regression. The following research conclusions can be drawn: For countries with different development levels, the development of the stock market has a significant positive impact on the level of NTI, but the moderating effect of FDI on this positive impact will vary according to the country. The findings are as follows:

Table 9. Regression results of the interaction term of introducing foreign direct investment and stock market development.

	All samples		Developed countries		Developing and emerging market countries	
	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
	IFE	HDFE	IFE	HDFE	IFE	HDFE
Dependent Variable						
NTI						
Independent Variable						
Stock	0.0746** [0.0354]	0.145*** [0.0416]	0.0654** [0.0284]	0.104*** [0.0328]	0.600*** [0.1651]	0.599*** [0.1718]
FDI	0.036 [0.0278]	0.0143 [0.0338]	0.0361* [0.0199]	0.0383 [0.0244]	-0.0112 [0.0458]	-0.148** [0.0591]
Stock × FDI	0.000899 [0.0188]	0.0304 [0.0223]	-0.0171 [0.0170]	0.00291 [0.0150]	0.390*** [0.1333]	0.707*** [0.1484]
Credit	0.685*** [0.1308]	0.293*** [0.1123]	0.443*** [0.0947]	0.447*** [0.1012]	0.392 [0.2502]	-0.0519 [0.2515]
R&DEx	-0.112 [0.1041]	0.0255 [0.0930]	-0.0281 [0.0556]	-0.085 [0.0600]	0.778*** [0.2447]	0.692*** [0.2619]
R&DL	0.142 [0.0930]	0.106 [0.0927]	0.208* [0.1187]	0.236** [0.1161]	-0.204* [0.1231]	-0.075 [0.1057]
HC	0.467** [0.2060]	0.171 [0.2310]	0.109 [0.1431]	0.481** [0.1957]	0.834*** [0.3001]	-0.387 [0.3515]
Constant	4.181*** [0.8304]	5.409*** [1.0010]	5.095*** [0.9214]	3.752*** [1.0962]	4.687*** [0.8317]	7.356*** [0.9701]
Sample size	963	963	480	480	483	483
Adjusted R^2		0.9623		0.9856		0.9453
Regional fixed effects	Control	Control	Control	Control	Control	Control
Country-level fixed effects	Not control	Control	Not control	Control	Not control	Control
Time fixed effects	Not control	Control	Not control	Control	Not control	Control
Country–time interaction fixed effects	Control	Not control	Control	Not control	Control	Not control

Note: The robust standard errors are in square brackets; * p < 0.1, ** p < 0.05, *** p < 0.01.

First, for developing and emerging market countries, the positive impact of stock market development on the level of NTI will be positively moderated by FDI inflows, that is, the more FDI that flows into developing and emerging market countries, the greater the influence of stock market development on NTI. There are two possible mechanisms behind this phenomenon: 1) FDI can indirectly play a role in financing innovation. The inflow of FDI means the inflow of foreign capital, and FDI may indirectly flow into the stock markets of developing and emerging market countries. Therefore, it promotes the development of the stock market to a certain extent, so it can also enhance the positive impact of the development of the stock market on the level of NTI; 2) Since FDI flows into developing and emerging market countries and developed countries, it also means that foreign investors can participate in the host country's financial markets, and the invested company can learn new technical knowledge and management experience. Therefore, it is possible for FDI to promote the impact of the development of the stock market on the level of NTI through this channel.

Second, for developed countries, FDI does not play a significant role in promoting the impact of stock market development on NTI. This may be due to the fact that enterprises in developed countries act as a role to be learned and imitated, and it is difficult for FDI inflows to have technological spillover effects on them. At the same time, according to the benchmark regression results in Table 8, for developed countries, the development of the credit market has a greater positive impact on NTI than the stock market, indicating that the improvement of NTI is more dependent on the development of the credit market in developed countries. Therefore, even if FDI flows into developed countries, the moderation effect through this channel may be limited.

The strategy for robustness testing in this section is similar to the previous subsection, that is, by changing the control variables to test the robustness of the regression results and observing the stock market development level and the coefficients of the interaction terms between the stock market development level and foreign direct investment. By changing the control variables, the core regression results are consistent, indicating that the regression results are robust.

5. CONCLUSIONS

The development of economic theory and practice has made academia and the area of policymaking focus more attention on the key role of technological innovation in economic growth. At the same time, the discussion on how to promote technological innovation is increasing, and many branches of research have been derived. Among them, how to effectively finance technological innovation activities has also become an important research topic and has received increasing attention in the fields of finance and innovation research in recent years.

Based on the above background, this paper studies the impact of the development of the stock market and credit market on NTI from the macro level and the moderating effect of FDI inflows. The conclusions of this paper are set out in the following points:

First, whether it is for developed countries or developing and emerging market countries, the development of the stock market has a significant effect on promoting NTI. Considering the operation mechanism of the stock market, the positive impact of the development of the stock market on NTI might be achieved by affecting the innovation level of listed companies, such as easing their financial constraints.

However, there may be mechanisms that are not conducive to improving the innovation level of listed companies. For example, managers' decisions on R&D investment may be influenced by the enterprise stock price, or the pressure from shareholders may cause the managers to reduce investment in R&D.

This paper found that the net impact of stock market development on NTI is positive and significant, indicating that despite the existence of the "Wall Street curse" and other phenomena, listed companies will still choose to invest in innovation to a certain extent after obtaining financing, thereby increasing the company's competitive advantage in the long run.

Second, the impact of credit market development on NTI in different types of countries is quite different. In developed countries, the development of the credit market has a significant role in promoting NTI. However, the development level of the credit market in developing and emerging market countries has no significant impact on NTI. The mechanism behind this phenomenon may be that developed countries have a credit supply mechanism that is more suitable for innovative activities, and the innovative financing practice of Silicon Valley Bank also supports this view. Silicon Valley Bank breaks the boundary between equity financing and debt financing when providing credit to technology-based start-ups and designs the creditors' income structure to enable creditors to share the high income brought by the success of start-up enterprises, which could make up for the losses caused by banks investing in high-risk innovative activities that ultimately failed.

Furthermore, this paper argues that the design of investors' or creditors' income structure is extremely critical for the financial sector to provide effective support for innovation.

Third, for developing and emerging market countries, FDI inflow can increase the positive impact of stock market development on NTI, but this impact is not significant for developed countries. There may be two mechanisms behind this: one is that after FDI flows into developing and emerging market countries, they might engage in the stock market, which can increase the positive impact of stock market development on innovation by improving innovative financing channels; the other is that FDI has technological spillovers to host countries, so when FDI flows into developing and emerging market countries, it also brings technical knowledge and management experience to the invested companies, and the stock market has the function of financing innovation, so FDI will increase the impact of stock market development on NTI.

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