CSCanada
Canadian Social Science
Vol. 20, No. 2, 2024, pp. 87-97
DOI:10.3968/13389

ISSN 1712-8056[Print]
ISSN 1923-6697[Online]
www.cscanada.net
www.cscanada.org

A Study on the Spatial Effect of FDI on Regional Economic Growth: Empirical Test Based on the Dynamic Space Panel Model

ZHANG JinYi[a]; ZHANG ShiJun[b],*

[a] Bachelor, North China University of Technology, Beijing, China.
[b] Doctor, Wenzhou Business College, School of Finance and Trade, Wenzhou, China.
*Corresponding author.

Supported by the Key Topics of Zhejiang Provincial Education Science Plan for 2021 (2021SB094), this research focuses on the Model of Advanced Teaching in Macroeconomics Based on OBE Results.

Received 8 February 2024; accepted 12 April2024
Published online 26 April 2024

Abstract

The panel data of 30 provinces (autonomous regions and municipalities directly under the Central Government) from 1998 to 2017 are adopted, and the data are from China Science and Technology Statistical Yearbook and China Statistical Yearbook. Based on the dynamic space panel measurement model, the space spillover effect of FDI (foreign direct investment) on domestic economic growth is studied. The results show that FDI not only promotes the economic growth of the province, but also has a spatial spillover effect on the neighboring provinces. In addition, both the static and dynamic spatial panel models show that there is a significant positive spatial correlation between foreign direct investment and the provinces, and there is a spatial dependence between the neighboring provinces. This provides a preliminary theoretical basis for the rational utilization of foreign direct investment, optimize the spatial distribution of foreign investment and promote regional economic growth.

Key words: Export; Investment; Consumption; Economic growth; Dynamic panel model

Zhang, J. Y., & Zhang, S. J. (2024). A Study on the Spatial Effect of FDI on Regional Economic Growth: Empirical Test Based on the Dynamic Space Panel Model. *Canadian Social Science, 20*(2), 87-97. Available from: http://www.cscanada.net/index.php/css/article/view/13389
DOI: http://dx.doi.org/10.3968/13389

1. INTRODUCTION

In recent decades, China's economy has been developing at a fast and steady speed, but in the process of development will also face many severe tests. As a major economic country, China has more than 30 provinces, and the regional economic development between provinces is uneven. Among them, the unbalanced regional development and the increasing gap between the rich and the poor are the difficult problems we are facing at present. China's regions with rapid economic growth have significant advantages in FDI and have been in the ranks of rapid economic development. However, the provinces with relatively slow economic development lack to attract favorable foreign investment, and their economic development is limited, resulting in problems such as uncoordinated regional economic development and uncoordinated regional allocation among the provinces. As we all know, FDI can not only drive the regional economic development of provinces, but also promote the coordinated allocation of resources and labor force growth of provinces. Foreign direct investment is highly concentrated in coastal cities or open cities, while inland and remote cities have a relatively weak ability to attract foreign investment. In order to solve the problem of unbalanced development, in the final analysis, we still need to rely on development, and development is the absolute truth. But previous research on the factors affecting foreign direct investment do a lot of discussion, basically can affect the regional economic development, but this analysis is based on one-dimensional time factors, but ignored the role of geographical space and the linkage between adjacent areas, that is to say, the relevant conclusion policy is based on single dimensional time variable this factor, we still need to analyze problems from the Angle of spatial variables (gathered), consider the externality of spatial effect (spillover effect), and make our research more deeply.

At present, China's development has reached the stage of high-speed to high-quality development, more need to rely on the introduction of foreign capital, to obtain more capital investment, in order to create more economic wealth. Introduction of foreign direct investment, promote regional economic development, increased labor productivity, innovation driving force, production mode, etc., a series of economic effect, already confirm, our country region is not independent development, but the growth of economic community, the communication between neighboring provinces, linkage effect is more and more obvious, so, the space between provincial and provincial analysis of the relationship between foreign direct investment and economic growth is indispensable.

Therefore, this paper adopts the 1998-2017 period except Hainan of China more than 30 provinces (autonomous regions and municipalities directly under the central government) panel data (because the space weight matrix is adjacent relationship, Hainan no adjacent provinces, cannot use space weight matrix), build space static, dynamic model, test the space effect of the provincial economy, to explore with the help of foreign direct investment to solve the imbalance of our economic development to provide a favorable solution.

2. LITERATURE REVIEW

2.1 Review of domestic and foreign literature

Chinese researchers have postponed the current mainstream research ideas, and the academic circle began to pay more and more attention to the economic growth and spatial correlation of regional parts. We study the spatial economic measurement model for regional problems based to the development of spatial econometric economics.

Based on the spatial correlation of FDI is affected by the regional distribution. Li Guoping and Chen Xiaoling (2007) selected the data of 28 provinces and regions in China from 1990 to 2004, estimated the spatial panel data model into regional fixed effect and time fixed effect, and investigated the influence of the spatial connection of foreign direct investment in the regional distribution of foreign direct investment in China. Through the study, the distribution of real FDI is better by the spatial panel data model, and strengthen the ability of neighboring regions to attract more foreign direct investment. He Xingqiang (2008) in the research results: by the domestic cities of foreign investment spatial location distribution test, space effect between provinces and provincial FDI will increase with the increase of adjacent provinces, adjacent to the surrounding the economy of the provincial FDI, surrounding provincial FDI unpredictable factors will affect the city FDI inflow.

The FDI can be seen as a combination of capital stock and related technologies to promote economic growth through different channels. Balasubramanyam (1996) believes that according to the endogenous growth theory, the impact of domestic economy of scale growth on FDI is affected by the spillover effect of foreign enterprises on the technological progress of domestic capital. Based on the state space model and Kalman filter, HHM and Kang Shilong (2006) studied the impact of FDI on China's economic growth, indicating that FDI promotes the development of China's economy, but is lower than the contribution of domestic investment to economic growth.

Chen Haibo (2006) empirical research based on space panel data shows that the traditional factors attracting FDI still exist. Chen Haibo and Zhang Yue (2014) selected the statistical data of 13 cities in Jiangsu from 2004 to 2012, used Matlab software to establish the space panel model, and studied the spatial effect of FDI on regional economic growth in Jiangsu province. The results show that foreign direct investment in the region will not only promote the local economy, namely direct effect; and drive the economic development of neighboring cities, namely indirect effect. In addition, the contribution of domestic capital to the economy is greater than that of foreign capital, and the spillover intensity is also higher than that of foreign capital. There is a strong spatial dependence between the regions, and the economic interaction effect is obvious.

2.2 Literature review

In conclusion, At present, there are only a few discussions on the economic effects of FDI in various provinces in China, However, these studies have the following limitations: First, on the basis of foreign investment, Considering only the degree of economic development of each province, No interaction and spatial spillover effects between neighboring provinces were involved, No corresponding measurement data is given to analyze the indirect effect of FDI on neighboring provinces; Second, in terms of the model method adopted, Most of the studies are based on common panel data models, However, the influence of static, dynamic and spatial correlation on the results, Also does not consider the possible collinearity problem between multiple explanatory variables, All of these may cause some deviation of the model results from the real situation. Due to the focus of focus and literature selection, the empirical analysis of the results between scholars may be different or even opposite, even on the research means, most of the scholars is the traditional economics, we should complement each other from the traditional method, also need to consider the spatial correlation, the cause of the analysis of the results.

Therefore, in the empirical study, in this paper, select the variables and process the data and comprehensively analyze the literature, the space panel model will be used to reflect the FDI interaction between provinces, whether neighboring provinces are complementary or competitive, whether the economic influence on other provinces is related (space overflow). Firstly, select

spatial econometrics for the study; secondly, construct the static space panel model; then, use multiple data to establish a spatial error self-regression fixed effect model; then, construct the dynamic space panel model; construct the space panel measurement model by considering the spatial correlation; finally, the corresponding policy enlightenment is given according to the analysis conclusion of the full text.

3. DATA AND METHODS

3.1 Data source and preprocessing

Through the China statistical yearbook and China energy statistical yearbook, select 1999-2017 time data, including the actual use of foreign capital amount (one hundred million yuan), foreign investment enterprise total investment (one hundred million yuan), GDP (one hundred million yuan), the whole society fixed assets investment (one hundred million yuan), post and telecommunications business (one hundred million yuan), total retail sales of social consumer goods (one hundred million yuan), total industrial output (one hundred million yuan), ordinary institutions in school (ten thousand), research and experimental development (R & D) funds (one hundred million yuan), total labor productivity (yuan / person), exports (yuan). Before the empirical test, the data are treated with invariant price, uniform dimension, and log taking.

3.2 Variable design

Interpreted variable (GDP): economic growth, expressed by the GDP flow of the province. In the process of study, the log is taken to reflect the corresponding economic development level of each province.

Interpretive variable (FDI): total foreign investment, expressed by the attracted foreign investment in the year (FDI). The actual utilization of foreign direct investment in the provinces, and then take the logarithmic form of FDI. Foreign direct investment is one of the main forms of modern capital internationalization. Through the injection of domestic funds, the investment in enterprises operated outside the country where the investor belongs can make the economy of the invested enterprises develop more rapidly.

Controlled variable:

The whole society investment in fixed assets (INV): is the three carriages of economic growth, is the main means of social fixed assets reproduction, it reflects the relationship between investment in fixed assets, it has a significant effect on economic growth, and economic growth has a strong correlation between, so to control the whole society investment in fixed assets variables, only the influence of FDI on GDP.

Post and telecommunications business volume (TEL): on behalf of the provincial level of infrastructure, for regional economic development of post and telecommunications business volume is an essential part, mainly through the postal, telegraph, telephone and other forms to meet the individual and the needs of all kinds of information sharing and communication, infrastructure the more perfect economic growth, both have correlation, the improvement of communication ability can reduce the enterprise transaction costs, is beneficial to attract FDI flows. Therefore, it is necessary to control the total volume of post and telecommunications business and clarify the impact of FDI on the economy.

Total retail sales of social consumer goods (SALE): on behalf of the urban and rural residents and social collective total consumption in the economic industry, reflects the residents through commodity circulation channels of consumer goods, by changing the total social consumer goods, and change the national economy, the corresponding impact on GDP, so to control the total retail sales of social consumer goods, emphatically FDI impact on the economy.

Industrial output value (IND-V): (industrial output-industrial cost = industrial added value), industrial added value belongs to the second industry output value, in the higher proportion of the third industry, economic scale level and market environment conditions compared with the first and second industry is relatively good, to attract FDI inflow, so to control variables, avoid the explanatory variables FDI.

Ordinary institutions of higher learning in school (EDU): is a certain number, certain quality, the students, with the number of college students, is representing the region of human capital abundance, college students can not change the production of the number of labor (domestic labor should be determined by the total population), but can increase the comprehensive quality of labor, so as to improve production, and determine the development of GDP.

Research and experiment development funds (R & D): R & D funds investment strength, namely the scientific development expenditure and GDP (GDP), is a country in the degree of scientific research, research and experimental development funds significantly promote the economic development, by increasing R & D investment, and cultivate more conducive to the national talent, to activate the role of the enterprise, the core competitiveness is innovation, efficient, sustainable, FDI will be more inclined to innovation, sustainable ability is strong region. So to control the R & D variable.

Full labor productivity (LAB): refers to reflect a region all workers in a certain period of time to create labor results of labor ratio of labor consumption, measure the input-output efficiency of labor factors, rapid economic growth in our country thanks to the improvement of labor productivity, but for now the pattern of economic growth is unsustainable, but the labor productivity will affect the

national economy, therefore, to control the variables of labor productivity, avoid affecting the variables of FDI.

Export volume (EXP): In China's import and export trade work, domestic export can improve China's balance of payments, stimulate domestic economic growth, solve the pressure of employment, so increasing China's domestic export volume can promote economic growth, increase foreign exchange reserves, so to control the variable of export volume.

In order to reduce the variance, each data is taken logarithmically and is recorded separately. Lngdp, Lnfdi, Lninv, Lntel, Lnsale, Lnind-v, Lnr & d, Lnlab, Lnexp, the data are from China Statistical Yearbook and China Energy Statistical Yearbook. Tais from 1998-2017, among which Hainan is eliminated because it is not adjacent to provinces.

3.3 Model selection

In the 1970s and 1980s, a branch of econometrics was spatial econometrics, whose basic content was to consider the spatial effects of economic variables in econometrics models, and to carry out a series of econometric model methods, including model setting, estimation, test and prediction. Spatial dependence breaks the basic assumption of mutual independence in most traditional classical statistics and econometrics, and is the inheritance and development of traditional methods. Current spatial econometrics does not emphasize divergence while ignoring individual interactions in space, namely spatial correlation, as in traditional panel data models. The econometric model of spatial panel data describes the spatial correlation of individuals through the dependent variables, which partly makes up for the deficiency of the traditional panel data model in describing the real economy. This space panel model can be divided into static space panel and dynamic space panel.

There are mainly four categories of static space panel data model in space panel model: fixed effect model, random effect model, fixed coefficient model and random coefficient model. Fixed effects models and random effects models are the most applied. Elhorst (2003) presents two kinds of fixed-effect models, random-effects models, fixed coefficient models and random coefficient models, and spatial autocorrelation and spatial error autocorrelation, including eight models. In this paper, we use the most commonly used spatial autoregressive effect model, the spatial error model, and the spatial Dubin model. The spatial autoregressive fixed effects model was set up as follows, mainly applicable to the spatial correlation of explanatory variables in the subregions, and discussing whether there are spillover effects or diffusion phenomena in the regions.

$$\mathrm{Y}t = \lambda W\mathrm{Y}t + \mathrm{X}t\beta + \mu + \varepsilon$$

hypothesis, $\mathrm{E}[\varepsilon t] = 0'\ \mathrm{E}[\varepsilon t\varepsilon t'] = \sigma^2\mathrm{I}_N$

The log-likelihood function can be written as a $\ln L = -\frac{NT}{2}\ln\left(2\pi\sigma^2\right) + T\sum_{i=1}^{N}\ln(1-\lambda w_t) - \frac{1}{2\sigma^2}\sum_{t=1}^{T}e_t'e_t$

among $e_t = (1-\lambda W)\left(Y_t - \overline{Y}\right) - \left(X_t - \overline{X}\right)\beta$

Lee and Yu (2010) established a general model of spatial static fixed effects, which considers both the spatial autoregressive and error terms of the dependent variables. The spatial autoregressive fixed effect model and the spatial error autoregressive fixed effect model can be obtained. Model settings are as follows:

$$Y_t = \mu_N + \lambda W_N Y_t + \gamma W_N Y_{t-1} + X_t\beta + U_t$$

$$U_t = \rho M_N U_t + \varepsilon_t$$

$$\varepsilon_t \sim iid\left(0, \sigma_0^2 I_N\right)$$

$$y_t = X_t\beta + \mu + \mathrm{B}^{-1}\varphi_t$$

$\mathrm{B} = I - \lambda W$ Among them, the other variables are set the same as the previous spatial fixed influence model, and the model can be further written as

$$y = X\beta + \nu\ ;\ \ ;\ \ ;\ \ y = \left[y1,..., y_T'\right]'\ X = \left[X_1',..., X_T'\right]'\ \nu = \left[t_T \otimes I_N\right]\mu + \left[I_T \otimes B^{-1}\right]\varphi$$

The log-likelihood function of this model is:

$$\ln L = -\frac{NT}{2}\ln\left(2\pi\sigma^2\right) - \frac{1}{2}\sum_{t=1}^{T}\ln\left[1 + T\theta^2(1-\lambda w_t)^{-2}\right] + T\sum_{t=1}^{N}\ln(1-\lambda w_t) - \frac{1}{2\sigma^2}\sum_{t=1}^{T}\tilde{e}'\tilde{e}_t$$

Through the first order condition of the log-likelihood function and using the iterative method, the log-likelihood function of the log-likelihood function is:

$$\ln L = -\frac{NT}{2}\ln\left(2\pi\sigma^2\right) + \frac{N}{2}\ln\theta^2 + T\sum_{i=1}^{N}\ln\left(1-\lambda w_i\right) - \frac{1}{2\sigma^2}\sum_{t=1}^{T}\tilde{e}'\tilde{e}_t$$

Three common setting forms of dynamic space panel:

I) The SAR model with lagged de p endent variable (theta=lambda=p si=0)

y_it = tau*y_it-1 + rho*W*y_it + beta*X_it + a_i + gamma_i + u_it

II) the SAR model with time and s p ace lagged de p endent variable (theta=lambda=tau=0)

y_it = p si*W*y_it-1 + rho*W*y_it + beta*X_it + a_i + gamma_i + u_it

III) the full dynamic SAR model (theta=lambda=0)

y_it=tau*y_it-1 + p ai*W*y_it-1 + rho*W*y_it + beta*X_it + a_i + u_it

3.4 The spatial weight matrix

The measure of spatial correlation in the model is mainly reflected by introducing the spatial weight matrix W. In this paper, we use adjacency to express the connection, the specific description is that if region i and region j adjacent, set Wij = 0. Typical adjacent mode: type: rook adjacent; bishop adjacent; queen adjacent, hierarchy: first order adjacent; second order adjacency; higher order adjacency. The concept of "regional continuity" is often used for adjacencies between regions, i. e., regions i and j are considered to have adjacencies if they have the same edges, and the elements in the spatial weight matrix WW = 1; otherwise WW = 0. Another case corresponding to this is "bishop consistency", which means that regions i and j are considered adjacent if they have the same vertices but no common edges. We adopted the queen, which combines the two cases of root and bishop.

4. EMPIRICAL TESTING AND RESULT ANALYSIS

4.1 Root test of the unit of panel data (ADF)

When modeling time series data, the sequence must be a stationary sequence, whether it may bring regression problems, so this paper needs the unit root test of variables. The DF tests and the ADF tests are the test methods of the unit root. The ADF test method expands the DF test method, which can eliminate the autocorrelation of random disturbance terms, which is also the unit root test method used this time. If the P-value is greater than the confidence level a (1%, 5%, 10%), proving that the original sequence has a unit root at that confidence level, the sequence needs to be differential transformed to ensure the stability of the sequence, and the test results are shown in the table. The lag order lag (0) of Lnindv, Lnedu, Lnr _ d, Lnexp stationary indicates that the original variable is stationary, However, the original variables of GDP, FDI, INV, TEL, SALE, and LAB are all non-stationary sequences, But after they all pass the first, second, third and fifth orders, All have passed the stability test, This shows that the fixed asset investment variable of the whole society is the first order single whole I (I) sequence first order stable, The variables of GDP and total labor productivity are second-order stable, The total retail sales of social consumer goods for the third order of stable, The total business of posts and telecommunications is the fifth order stable. Panel data also has a time trend, time trend data often has a unit root, unstable data regression is not accurate.

Table 1
Stabilarity Test for Variables (ADF)

Variable	Lag order	Standard	Smoothness
Lngdp	lag(2)	ADF-fisher	steady
Lnfdi	lag(1)	ADF-fisher	steady
Lninv	lag(1)	ADF-fisher	steady
Lntel	lag(5)	ADF-fisher	steady
Lnsale	lag(3)	ADF-fisher	steady
Lnind_v	lags(0)	ADF-fisher	steady
Lnedu	lags(0)	ADF-fisher	steady
Lnr_d	lags(0）	ADF-fisher	steady
Lnedu	lags(0)	ADF-fisher	steady
Lnlab	lags(2)	ADF-fisher	steady
Lnexp	lags(0)	ADF-fisher	steady

4.2 Ordinary panel regression

Before estimating the spatial panel model, we first need to carry out the corresponding parameter statistics and inspection of the ordinary panel model, and then determine the existence of spatial correlation, and distinguish the random effect and the specific data of fixed effects, so as to provide a favorable basis for the establishment of the spatial panel model. The ordinary panel regression is the expression of the economic growth of the province, but it is irrelevant to the neighboring province. It is the estimated result of the model. From the panel data in the table below, ordinary panel regression has been passed by autocorrelation and overidentification tests, so the results are ideal for the adjusted random effects goodness of fit R^2Is 0.9933, fixed effect goodness of fit R^2It is 0.9925, so the statistic is similar in both

random and fixed effects, indicating that the model fits well, explaining the economic growth to 99.25%, the value is very high, and the other 0.75% is influenced by other factors. For the fixed-effects model, although the within-group transformation could eliminate the effect of μ I, the introduction of new explanatory variables was associated with the random error term, and the estimator would be biased and inconsistent. The same problem exists in the estimators of the random-effect model. After estimating the random effects and the fixed effects, We need to perform a Hausman-test, To further determine whether the model employed a random effect or a fixed effect, First, by running a random effect, A Houseman test was then performed, The null hypothesis is to support the random effects, The P-value of the Hausman test was 0.00, In addition, for the measurement analysis of economic growth based on provincial regions, The fixed-effects model is clearly a better choice, Together with model testing supporting the use of fixed effects, Thus we employed a fixed-effect, Random effects served as a robustness test, The F statistic of 31.92 and its P-value (both 0) indicates that the overall model is significant.

In ordinary panel regression fixed effect results, Lnfdi coefficient of 0.0109, significantly at 1% level, namely 1% to attract foreign investment, economic growth increased by 0.01%, it can be seen under the condition of open economy of China's economy can get more rapid growth, and the greater the FDI investment, the more capital accumulation, China's economic benefits is more, FDI has strong national economic growth, this not only can increase the host related capital stock, improve the utilization of capital. Lntel The coefficient of 0.0309, significantly at 1% level, namely the post and telecommunications business increase 1%, economic growth increased by 0.03%, in the process of provincial economic development, post and telecommunications industry is an important basic factor, the provinces through postal, telephone, and other communication technology to promote regional information exchange and sharing, therefore, postal industry is also promote the provincial economic development, promote more effective use of resources is an important factor. The coefficient of Lnsale is 0.6718, Represents ote significant at the 1% level, That means the total retail sales of consumer goods increased by 1 percentage point, Economic growth alone increased by 0.6718 percent points, The total retail sales of social consumer goods has the largest coefficient among the control variables, Since the consumption itself, namely the final consumption expenditure, is one of the "troika" of GDP, It is the basic driving force for the economic growth of a country or region, And consumption has contributed first to economic growth in recent years, Changes in consumption levels are directly and indirectly related to the economic growth of the provinces, When the economies of the provinces grow relatively fast, It will promote the growth of the consumption level effect. Within the effective economic growth rate, when the total retail sales of consumer goods increase, the economic growth rate increases.

Table 2
Results of the ordinary panel regression

Indep: Lngdp	Model 1 Stochastic effect	Model 2 Fixed effect
Lnfdi	0.0081*** (2.69)	0.0109*** (3.61)
Lninv	0.0145 (1.16)	-0.0103 (-0.71)
Lntel	0.0329*** (4.12)	0.0309*** (3.87)
Lnsale	0.6674*** (39.74)	0.6718*** (36.08)
Lnind_v	0.1409*** (11.02)	0.1489*** (9.86)
Lnedu	0.0459*** (3.49)	0.0455*** (2.93)
Lnr_d	-0.0079*** (-0.73)	0.0052 (0.41)
Lnlab	0.0755*** (5.81)	0.0889*** (5.77)
Lnexp	0.0126* (1.81)	0.0036 (0.46)
_cons	1.2258 (13.80)	1.2044*** (12.88)
obs	570	
R^2	0.9933	0.9925
F		31.92
P	0.0000	0.0000
Wald chi2	102100.18	
sigma_u	0.0526	0.0928
Sigma_e	0.0573	0.0573
rho	0.4579	0.7242

Note: * * * is significant at the 1% level, * * is significant at the 5% level, and * is significant at the 10% level. Within the () is the Z-statistic.

Lind _ v coefficient is 0.1489, said at 1% level, in the economic ability of modern China, although the influence of industrial ability on economic income is not as strong as before, because of our country's national policy, market and economic conditions, the traditional national industrial structure is close to saturation, to continuous innovation is very difficult, development ability is limited, but even if the proportion of industrial capacity of gradually weakened, it is the foundation of our modern society. Lnedu The coefficient is 0.0455, indicating that it is significant at the level of 1%, the education and economy have an inseparable connection, the investment in colleges and universities can continuously affect the national economy, colleges and universities can cultivate different professionals, and improve people's knowledge level and labor ability, thus indirectly affecting the national income level. Lnlab The coefficient is 0.0889, said at 1% level, the development of research and experiment can provide a steady stream of innovation and productivity, research and experimental development of

funds investment determines the development of science and technology and innovation, only reasonable allocation of research and experimental resources, to promote scientific and technological innovation, promote scientific and technological achievements, finally realize the rapid development of regional economy. Lningv, Lnr _ d and Lnexp variables are not significant, indicating that their impact on the national income level is relatively small or negligible, and they cannot effectively promote economic development.

4.3 Space panel regression

4.3.1 The static space panel regression

With a p-value of 0.0306 in the Hausman test, the null hypothesis was rejected where the random-effects model could not apply and a fixed-effects model should be used.

Table 3
Results of the Hausman test

	fe	re	Difference	S.E
Lnfdi	0.0098	0.0105	-0.0065	-
Lninv	-0.0146	-0.0178	0.0031	-
Lntel	0.0264	0.0267	-0.00267	-
Lnsale	0.4996	0.5614	-0.0618	-
Lnind_v	0.1256	0.1417	-0.0161	-
Lnedu	0.0157	0.0327	-0.0170	-
Lnr_d	0.0054	-0.0020	0.0075	-
Lnlab	0.1137	0.0954	0.0182	-
Lnexp	-0.0023	0.0022	-0.0045	-
chi2		10.42		
P		0.0306		

(1) There is competitiveness or complementarity in attracting foreign investment between provinces

As can be seen from the following table, for the region of the model, the results show that the provincial foreign direct investment decision process has regional and phased, compared with the traditional panel data model and space panel data model, the latter has better fit and stronger interpretation, regional fixed effect model fit of SAR, SEM and SDM model R^2Almost all reached 0.98-0.99, reflects the distribution of foreign investment in various provinces in our country do exist spatial autocorrelation, in the SDM model, under the condition of spatial fixed effect and random effect, the coefficient of each explanatory variable by 1% significant test, which shows that the GDP growth of each city has regional and cyclical characteristics. However, according to the significance of the spatial autoregressive coefficient, the fixed effect of SDM is the optimal choice. Each coefficient has passed the significance test under the conditions of adjacency, geographical distance and comparative advantage weight matrix. Due to the spatial spillover effect, the spatial effect model analysis is needed. It can be obtained from the spatial effect regression results of SDM model that W * Lnfdi is a negative number. It can be seen that after the province attracts the FDI itself, it will have a negative impact on the FDI of the neighboring province. For each FDI increased by 1%, the FDI of the neighboring province will decrease by-0.00839%. While the provincial FDI, for every 1% increase, Its own GDP will increase by 0.011%; For every 1% increase in total post and telecommunications operations, GDP will increase by 0.0019% accordingly; Every 1% increase in total retail sales of consumer goods, GDP will increase by 0.5491%; For each 1% increase in gross industrial output, GDP will increase by 0.1217%; The influence of the number of students in ordinary institutions of higher learning on GDP changes in the opposite direction, For every 1% increase in school attendance, GDP, which will decrease by 0.0592%, Probably because the level of human capital in the adjacent region has a degree of side effects on the economic growth of the region, Developed regions often develop high-end industries to increase the control of industrial development in areas with low human capital levels, From the estimated results of the Durbin model, The regression results in the spatial autoregressive dynamic model are the same as the symbolic direction and significance level of the total business volume of posts and telecommunications, total retail sales of social consumer goods, total industrial output value, and other data, There's just a difference in the coefficient size.

(2) Whether FDI has a positive impact on the economic growth of the province

In the SAR model, in a single fixed effect, bidirectional fixed effect and random effect, the coefficient of the explanatory variables of the model through the significant of the 1% of test, indicating that there are regional and periodic characteristics in the growth of FDI, but according to the significance of spatial autoregressive coefficient, two-way fixed effect in the SAR model is the best choice. The purpose of the model of FDI on the economic growth of neighboring provinces, the table presents the specific value of three model, a fixed effect and the estimation of random effect, for the provinces, at the same time by FDI and the surrounding provinces of FDI, the fixed effect of the 1% significance test, and the coefficient is positive, said with the growth of FDI, can promote the growth of the economic level of the provinces, which verified the FDI economic growth of the province is a positive impact on the research problem. Lnfdi The value is 0.0093 * * *, which refers to the impact of foreign capital on the economic increase of the province. The introduction of FDI in the province provides convenient conditions and introduces relevant policies, so that the FDI shows positive externalities and then increases the economic level of the province. This shows that with every 1% increase of the FDI in the province, the economic effect of the province increases by 0.0093 * * *, and the effect is significant. In addition, there is a positive correlation between the total business of posts and telecommunications, total retail sales of social consumer goods, total industrial output value,

research and experimental development (R & D) funds, labor productivity of total staff and GDP (GNP). For each 1% increase, the national income will increase by 0.032%, 0.1096%, 0.5033%, 0.1071%, 0.0094% and 010% respectively. From the coefficients of each variable and their significant level, the influence of most variables on the regional distribution of FDI is consistent with the theoretical hypothesis, and the estimated results of all models indicate that the aggregation effect of FDI is positively correlated with the stock of FDI, especially the two-way fixed effect.

(3) Whether the growth of FDI in this province has driven the economic growth of neighboring provinces

W * Lngdp reflects the correlation of space and the value of the bidirectional fixed effect in SAR is 0.0653 * * * (this is the spatial autoregressive coefficient), Significant at the 1% level, With the province's GDP, for every 1% increase, Effect on neighboring provinces increased by 0.0653%, This suggests that the role of spatial lag variables on economic development is significant, That is, the economic interaction and radiation between the provinces are significant in the spatial regression model, The GDP output level of this province has a mutual effect and a spatial spillover effect on each neighboring province, Positive spillover from areas with economic growth will spread to the surrounding areas, And play a positive role. From the fit degree R^2In view, the estimation results of the model with fixed effects (including individual fixed and two-way fixation) are far better than the ones without their fixed effects, due to the degree of fit R in the traditional model^{2}It is based on the decomposition of the residual sum of squares, which is no longer applicable to the judgment of models with spatial effect characteristics. It can be seen from the table that the fit degree R of two-way fixed effect^{2}Of 0.9850, fit of individual fixed effects R^2The value of 0.9785, indicating that the model fits quite well. Lambda A coefficient of significance, the impact of a standard deviation of the economic growth of the province, will have an impact of 0.529 standard deviation on the economic growth of neighboring provinces.

Table 4
Static spatial panel regression

Indep:Lngdp	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	SAR (spatial autoregressive model)			SEM (Spatial error model)		SDM (Spatial Dubin Model)	
	Individual fixation effect	Two-way fixation effect	stochastic effect	fixed effect	stochastic effect	fixed effect	stochastic effect
W*Lngdp	0.2189*** (9.76)	0.0653*** (1.75)	0.1532*** (6.12)				
W*Lnfdi						-0.00839 （-1.50）	-0.00997 （-1.75）
Lnfdi	0.0098*** (3.67)	0.0093*** (3.00)	0.0105*** (3.80)	0.1022 （4.6）	0.00956*** （3.73）	0.011*** (4.33)	0.0099*** （3.77）
Lninv	-0.01469 (-1.14)	0.0328** (2.52)	-0.0178 (-1.36)	0.001*** （0.08）	0.0668 （0.54）	0.0019*** （0.14）	-0.0001 （-0.01）
Lntel	0.0264*** (3.72)	0.1096* (7.26)	0.0267*** (3.64)	0.06156 （5.10）	0.0622 （5.11）	0.0505** （2.76）	0.07353 （3.87）
Lnsale	0.4996 (20.65)	0.5033 (13.98)	0.5614*** (21.65)	0.68266 （36.23）	0.6841 （37.05）	0.5491 （16.49）	0.6331 （18.89）
Lnind_v	0.1256*** (9.21)	0.1071* (7.87)	0.1417*** (10.26)	0.13415 （10.34）	0.1364 （11.29）	0.1217 （8.67）	0.1406 （10.26）
Lnedu	0.0157*** (1.11)	-0.1005*** (-5.13)	0.0328** (2.28)	-0.0059 （-0.31）	0.0022*** （0.13）	-0.0592 （-2.65）	-0.0291 （-1.28）
Lnr_d	0.0054*** (0.48)	0.0094*** (0.82)	-0.0020 (-0.18)	0.01265*** （1.05）	0.0036*** （0.31）	0.0166*** （1.42）	0.0036*** （0.30）
Lnlab	0.1137* (8.15)	0.1004* (7.23)	0.0954* (6.66)	0.79413 （6.02）	0.07199** （5.69）	0.1032 （7.38）	0.07791 （5.62）
Lnexp	-0.0023 (-0.32)	-0.0121* (-1.74)	0.0022*** (0.30)	-0.00197 （-0.27）	0.00095*** （0.13）	-0.0079 （-1.09）	-0.0052 （3.45）
Spa_lambda				0.5290	0.5258	0.4763	0.4512
obs				570			
R^2	0.9785	0.9850	0.9861	0.9924	0.9929	0.9801	0.9902
Log-likelihood	884.9759	947.5311	790.0224	889.2961	813.7384	917.2744	823.2370
sigma2_e	0.0026*** (16.87)	0.0021*** (16.91)	0.0028*** (16.02)	0.0023*** （16.36）	0.0025*** (15.90)	0.0022*** （16.41）	0.0024*** （15.49）

Note: * * * is significant at the 1% level, * * is significant at the 5% level, and * is significant at the 10% level.

Ordinary panel data model does not consider the interaction effect of space and spillover effect, therefore, in the ordinary panel data model, foreign direct impact on economic growth is overestimated, not only due to the coefficient of foreign direct investment is overestimated, and the contribution of other variables in the economic growth model is overestimated, not considering the fact that spatial factors compared with the spatial error model, after adding spatial factors, the space dubin model is the most appropriate model.

4.3.2 Dynamic spatial panel regression

In fact, as a continuous and dynamic system activities, each province of foreign direct investment is affected by many factors, and the static space panel model can only reflect the influence of some factors, and the index is easy to measure, as for other important potential factors cannot be quantified in the static space panel model, which greatly affects the accuracy of the model. While the dynamic space panel model can effectively solve these problems.

Table 5
Results of the dynamic spatial panel regression

	Model 1	Model 2
Indep: Lngdp	**SAR**	**SDM**
	fixed effect	
W*Lngdp	0.7035 (26.17)	0.7600 (29.89)
W*Lnfdi		-0.0134** (-3.72)
Lnfdi	0.0069*** (3.85)	0.00627*** (3.82)
Lninv	-0.0034*** (-0.38)	0.01792*** (2.11)
Lntel	0.0195*** (4.14)	0.02931*** (2.46)
Lnsale	0.0134*** (0.54)	0.0806** (3.00)
Lnind_v	0.067** (6.65)	0.0456*** (4.65)
Lnedu	0.0421** (3.90)	0.0097*** (0.65)
Lnr_d	-0.0324*** (-3.79)	-0.0250*** (-2.99)
Lnlab	0.0577** (5.87)	0.0425** (4.54)
Lnexp	0.0188* (3.81)	0.00090*** (0.19)
Spa_rho	0.1340	0.4550
obs	540	
R^2	0.9941	0.9949
Log-likelihood	1059.4109	1114.8541
sigma2_e	0.00120	0.0009

Note: * * * is a 1% level of significance, * * is a 5% level of significance, and * is significant at a 10% level

(1) There is competitiveness or complementarity in attracting foreign investment between provinces

In the fixed-effect dynamic model, the effect of W * Lnf di of SDM was negatively significant (-0.0134%), Shshows that the foreign direct investment in each province has space competition effect, The neighboring provinces will hinder foreign direct investment in the province. We believe that, First, between provinces with relatively similar levels of economic development, The surrounding economic development has a weak impact on the investment in the province, Second, the investment of the province will have a significant negative impact on the investment of the neighboring provinces, That is, the increase in investment in the province will relatively reduce the investment in the neighboring provinces, The rounding provinces will affect their own FDI growth, We can draw the general conclusion that the economic and social factors of neighboring provinces have both spatial complementary and crowding out effect on foreign direct investment.

(2) Whether FDI has a positive impact on the economic growth of the province

According to the results of spatial effect regression of SAR and SDM model, the coefficient of Lnfdi is significantly positive, indicating that for each percentage increase of the FDI of this year compared with the FDI of the previous year, the GDP of this year will increase by 0.69%. This model once again verifies that FDI has a positive impact on the economy of the region, and the impact is relatively significant, so that FDI shows positive externalities and then increases the economic level of the province. This shows that with every 1% increase in FDI of the province, the economic effect of the province increases by 0.0069 * * *, and the effect is significant. In SAR, the coefficient of Lninv is significantly negative (-0.0034 * * *). The reason may be that China's industrial capacity is near saturation, and the growth of industrial capacity will not increase GDP relatively substantially, and the increase of industrial input makes the output not proportional. The coefficient of Lntel, Lnsale and Lnedu is significantly positive, indicating that the total business of posts and telecommunications, total retail sales of social consumer goods and education have a positive driving effect on the improvement of GDP in various regions. The specific coefficient is 0.0195%, 0.0134% and 0.0421%. Moreover, the coefficient of Lnr & d is significantly negative, the reason is that the investment of experiment and research has no benefit in the short term, and there is a certain loss, so the impact on regional GDP is relatively negative. As can be seen from the series of data, FDI can significantly promote the improvement of the province, and there is a positive spillover effect, and can optimize the industrial structure, improve the efficiency of enterprises, and promote the economic development of each province.

(3) Whether the growth of FDI in this province has driven the economic growth of neighboring provinces

In the table above table, for the SDM model estimation results, W * Lngdp, significant effect under 10% (0.7600 *), with the GDP of the province, every 10%, the effect of the neighboring province increased 0.0653%, which shows that the spatial lag variable on the economic development is not significant, the mutual effect and space spillover effect, economic increase of the positive spillover area will spread to the surrounding areas, and play a general positive effect. Fits R of SDM under fixed effects^{2}Value of 0.9949, fit R of the fixed effect of SAR and^{2}The value is 0.9941, both of which indicate that the model fits quite well.

5. CONCLUSION AND SUGGESTION

5.1 Conclusion

In order to investigate the FDI to China provinces of economic growth, this paper exploratory use of ordinary panel and including space autoregression model (SAR) and space dubin model (SDM), the control panel model, research shows that through the dubin model to attract foreign investment between provincial competitive, namely the number of attract foreign investment and neighboring province attract foreign investment is reverse, the province to attract foreign investment increase, will cause the neighboring province attract foreign investment, its effect and surrounding provinces present significant reverse correlation. The reason may be that the foreign investment resources is limited, if investment in a province, the other provinces of foreign investment will reduce, provinces in order to attract foreign investment will launch several measures to achieve economic growth, but this on the other hand inevitably caused the reduction of foreign investment in other provinces, although all local governments hope by introducing more foreign investment to obtain a higher degree of economic growth. From the perspective of spatial autoregressive model, whether static model or dynamic model, FDI always maintains a significant positive correlation on the economic growth of the province, including most of its own variables have a positive impact on the economy of the province. In addition, the FDI of this province has a positive effect on the economic growth of neighboring provinces. In addition to attracting foreign investment to achieve the goal of economic growth, it can also play the same positive effect on the economic growth of neighboring provinces in the spatial effect, that is, promote the economic growth of neighboring provinces. The results of each models show that FDI, total post and telecommunications business, total retail sales of consumer goods, education and research significantly promote the economic growth of the province; FDI affects the economic development of the province is opposite to the amount of foreign investment in the province. In static or dynamic models, FDI affects the economy significantly than other factors.

5.2 Suggestions

Formulate differentiated regional economic introduction strategies to meet the economic needs of different regions. China's economic development is significantly affected by the regional spatial location, and there are great differences in the attraction degree and economic potential of FDI among different provinces. Various governments should take measures according to local conditions and implement relevant policies realistically, so as to promote the economic development of each province to the greatest extent.

First, in order to avoid the competition between provinces due to foreign direct investment caused by the resources of financial loss, provinces can through the relevant policies and regulations in the form of effective management and regulate the behavior and control the competition between the provinces, can strengthen cooperation between provinces or various preferential policies, to attract foreign investment maximization and avoid between provinces to attract foreign capital for disorderly, harmful and other competition.

Second, the provinces should be through effective cooperation to strengthen the coordinated development between the ability, and can optimize the various policies between the government and the allocation of resources, eliminate the unequal protection between the provinces, improve the ability to solve economic risk between provincial governments, this can increase the FDI of the province and neighboring provinces mutual economic growth, achieve mutual benefit and win-win results between provinces.

Third, after attracting foreign investment, the industrial transfer between provinces can be carried out in an orderly manner, which can not only realize the inter-provincial economic exchanges and develop the headquarters economy, but also provide opportunities for the development of other provinces, and finally achieve balanced development. The improvement of spatial structure and industrial distribution can reduce the enterprise investment cost, therefore, the Chinese government needs to adjust the provincial industry layout, give full play to the provinces of different economic development level, promote the economic development of the provincial enterprises, gather a higher level of provincial, and further promote the development of low-income provinces, to reduce the cost of enterprise investment, attract more foreign direct investment, improve efficiency, form a competitive advantage.

In short, the road of China's economic development of foreign direct investment space correlation and space spillover effect is obvious, the provinces should not only pay attention to the provincial economic growth, increase the elements of the province, economic production capacity, the coordinated development of the industry, more should pay attention to the economic development of the province, the so-called first rich drive rich, pay attention to the neighboring province to attract foreign direct investment work and the role of the elements of development path, by strengthening the direct investment and the provincial government control, out of a provincial characteristics, effect, innovation, the sustainable development of the prosperous road. Establish the national macro-control mechanism and strengthen the economic construction under the institutional environment. It is one of the important ways for sustainable economic development to coordinate and cooperate with all provinces and break the relatively independent systems and mechanisms among provinces. We should coordinate the needs of national strategies and work to jointly forge national economic prosperity and strength.

REFERENCES

Guo, Z. C. (2022). *The impact of FDI on industrial upgrading: Based on the spatial effect analysis of 34 prefecture-level cities in the HuaiHe River Basin.* SHS Web of Conferences, 148.

Haider, M. (2023). Spatial effects of trade, foreign direct investment (FDI), and natural resource rents on carbon productivity in the GCC region. *Peer J*, 11.

Lin, H., Wang, X. Y., & Bao, G. (2022). Heterogeneous Spatial Effects of FDI on CO2 Emissions in China. *Earth's Future, 10*(1).

Ryu, B., Kim, D., & Kang, H. (2014). Determinants of Korean FDI in China using the Spatial Effects. *International Commerce and Information Review, 16*(4).

Tang, D. L., Li, S. J., Yang, Y. H., & Gu, L. L. (2020). Regional Difference in Spatial Effects: A Theoretical and Empirical Study on the Environmental Effects of FDI and Corruption in China. *Discrete Dynamics in Nature and Society,* 2020.

Zhang, W., Pan, X. F., & Yang, Y. (2014). Spatial Effect Analysis of Foreign Direct Investment (FDI) on Carbon Intensity in China. *Environmental Engineering and Management Journal, 13*(5).