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# The Spillover Effect of Foreign Direct Investment on Regional Growth in Iran: Spatial Econometric Analysis

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**Abstract:**
According to the economic literature, foreign direct investment (FDI) has the main role in the economic growth of countries. Therefore, the main goal of present study is to examine the direct and indirect (spatial) effect of FDI on growth of GDP in different provinces of Iran. For this purpose, the spatial econometric model in the context of panel dataa of 30 provinces of Iran during 2010-2018 has been used. The spatial weight matrix (W), is considered based on the contiguity of the regions. The results of model showed that FDI had a positive direct and spillover effects on growth of regions. Also, government spending in the different provinces, increase of financial credits and human capital had a direct positive effect on economic growth of the region's economy. The spillover effects of two variables, FDI and financial development, was significant. Meanwhile, the spatial (indirect) effect of FDI was positive, but the indirect (spillover) effect of financial development was negative.

## 1. Introduction

Foreign direct investment (FDI) is has the important role in the economic growth, especially in developing countries like Iran. In these countries the capital is not sufficient due to deficit of domestic savings in both the public and the private sectors. The mobility and international movement of capital has increased significantly in recent decades, so that in developing countries, FDI has formed a large part of the investment of these countries (Razin & Sadka, 2003, Sarker & Khan, 2020). Today, due to the various reasons including lack of domestic resources, these countries try to attract capital from other developed countries to increase domestic investment. On the other hand, investors in order to earn more profit and use cheaper inputs and labors, as well as use economies of scale, tend

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to invest in regions and countries with comparative advantages and low production costs (Mensah and Mensah, 2021). In developing countries, the amount of savings is low, and as a result, there are not enough resources for investment. On the other hand, these countries are facing a lack of financial resources for investment. Therefore, to provide capital and development of investment are looking to attract FDI from other countries (Alam et al., 2022).

Studying the factors that affect the economic growth in developing countries is necessary from several aspects. One of its aspects is that these countries need higher economic growth than developed countries in order to provide relative welfare in the country. Another aspect of the importance of attracting FDI in these countries is that this type of investment can also provide the basis for the entry of technology and knowledge. Therefore, it can provide the basis for higher economic growth (compared to domestic investment). The study of the effect of FDI on economic growth in Iran, as a country with low economic growth and lack of investment resources, is much more than other countries. The effect of FDI on the economic growth of different countries and its region was different. In other words, this effect was different from each other according to the potential of countries in absorbing technology and also their level of innovation (Borensztein, et al, 1998).

Another important issue related to attracting FDI is its effect in different regions of a country. The effectiveness of FDI in different regions of a country will be different from each other based on the structure of regions. Identifying factors affecting economic growth in the country's provinces can help economic and regional planners in setting economic development programs to remove the regional imbalances and economic growth gaps between regions through the allocation of resources. With an increase in investment (FDI) in a region that region and its neighboring regions can also benefit from positive externalities. In such a way that if FDI increases in a region of the country, economic activities within that region are affected and then the prosperity of economic activities in that area spilled over to other neighboring regions and neighboring areas can benefit from the positive results of FDI. Understanding the direct and spillover effect of FDI on output growth is necessary especially for policy making at regional and also national level. So, the main question is that does foreign direct investment in different provinces cause economic growth in these provinces? Also, has FDI spillover effects on regional economics and caused economic growth in neighboring provinces?

Based on these two questions, the aim of this paper is investigation of the effect of FDI on output growth in different provinces in Iran, emphasizing the existence of spatial effects in the period from 2010 to 2018 using the spatial econometric model. There are many studies on the effects of FDI and output growth at the national and regional levels, but the spillover and spatial effects of FDI on output growth was ignored in these studies. Therefore, the contribution of present study

is to consider the spatial effect of FDI between regions on output growth in different regions in Iran.
This study includes five sections. In the second part, the research literature are examined. In the third part of study, the methodology and data are considered. In the fourth part, the results are presented. Finally, in the last part, conclusion are presented.

## 2. Research Literature

### 2.1. Theoretical Literature

There are a lot of literature points that emphasize on the positive effect of FDI on output growth of host countries. Based on this literature, attracting FDI is one of the ways to increase investment in the host country. FDI can increase economic growth of the countries through the increase of capital formation on the one hand, as well as knowledge and technology spillovers on the other hand. According to Rostow (1956), the neoclassical growth theory introduce the foreign direct investment as the main factor of growth in different countries. Based on the Rostow (1956), FDI can establish the technology and capital. Based on the endogenous growth model, FDI generate the technological transfer between the developed and developing country. FDI also increases and strengthens domestic investment. In this way, the attraction of FDI in one region will increase the companies producing related goods and services in that region. (De Mello, 1999).
Based on the Borensztein et al. (1998) the positive effects of FDI on output growth are created not only through capital accumulation, but also due to the diffusion of technology, efficiency and productivity are increased, and this causes economic growth. The lower the technological difference between the two countries, the higher the degree of replacement of the new technology imported by FDI with the existing technology, and the new technology in the country will replace the previous technology at a faster rate and will have a greater effect on output growth. Yao (2006) believe that the higher the education activities in the host country, the faster and more technology transfer will be done. Therefore, the level of technology transfer is positively related to the level of educational investment of the host countries. Also, if the amount of specialized human resources increases along with FDI, then FDI will have a double effect on output growth. In other word, in addition to the transfer of technology with FDI, training of human resources will increase and the human capital in these countries, and further economic growth will be created (Tiwari and Mutascu, 2011).
According to Borensztein et al. (1998), FDI lead to increase in productivity of labor force through capital accumulation and technology transfer. Increasing labor productivity will further increase economic growth. The higher the increase in productivity due to the attraction of FDI, the higher growth in economic activity. This increase in productivity is more in countries that have skilled labor

force and have developed economic infrastructures. Therefore, Countries that only rely on their cheap and low-skilled labor force and natural resources in attracting FDI, cannot direct it to industries that have higher value-added and cannot achieve high economic growth. In addition, FDI has an effect on other macroeconomic variables such as exports, employment of skilled and unskilled labor, savings and consumption, each of these variables caused to economic growth.

Based on above, can be said that the positive effects of attracting FDI on developing the economic activities in the host country depend on the many variables of that country, including level of technology, level of human capital and skills of the workforce, existing infrastructure and many other variables. In addition, when we investigate the effect of foreign domestic investment on economic activities at regional level, the relationships between different regions will be very important in the analysis. Because different regions of a country are dependent on each other. So, the growth of one region will depend on the growth of other regions. Therefore, the attraction of FDI in one region and development of economic activities in that region, can cause spillover of economic growth to other related regions (Romer, 1986, Grossman and Helpman, 1993).

**2.2. Empirical Literature**

Several studies have been conducted on the impact of foreign direct investment on economic activities in different countries.

Omer and Yao (2011) examined the long-term effect of FDI on economic growth in Malaysia during 1970-2008. The result of this study states that FDI promote the long-term economic growth in Malaysia. Ahmad (2012) examined the spillover of FDI inflow on the output growth in Malaysia during 1999-2008. The result of this study indicated that the inflow of FDI had a negative effect on productivity of production factors. Shahbaz and Rahman (2012) in their study in Pakistan concluded the positive effect of FDI on the EG in the long term. Ostadi et al. (2012) investigated the effect of FDI on the EG in Iran and concluded that FDI caused to EG in Iran. Khalili and Salimi (2013) studied the effect of FDI and financial development on EG of 16 Asian countries during 1980-2008 and concluded that financial development increased the effect of FDI on EG. Sghaier and Abida (2013), investigated the effect of FDI on EG in countries of North African. The findings of the study confirmed the positive effect of FDI on EG. In their study, Alizadeh et al. (2013) studied the effect of FDI on EG during 1998-2010 in D8 member countries and concluded that FDI has a positive effect on EG. Nakhaei et al. (2014) surveyed the impact of FDI on economic freedom and EG in 84 selected countries during 2000-2012. The result of this study showed that EF increase the effect of FDI on EG. Edrees (2015) surveyed the relationship of FDI and EG in the countries of sub-Saharan African with two groups of countries including the low income countries and middle income countries during 1992-2012. The results showed that the effect of FDI on EG in low-income

countries is negative and in middle-income countries is positive. Pegkas (2015) investigated the effectiveness of FDI on EG in European countries. The results indicate that FDI has a positive effect on EG. Zhou et al. (2016) investigated the effect of FDI on EG in Southeast Asian countries during 1980-2010 and concluded that FDI had a positive and significant effect on the EG. Osano and koine (2016) surveyed the role of FDI on technology transfer and EG of Kenya, 2001-2014. Taguchi and Wang (2017) showed the positive impact of FDI on EG in Chinese provinces. Gunby et al. (2017) investigated the effect of FDI on EG in different economic sectors in China and concluded that FDI had a positive and significant effect on China's EG. Qalambaz et al. (2017) surveyed the effectiveness of FDI on EG in Iran and different countries during 1996-2015 using the panel threshold model and found that FDI increases economic growth only in the first regime. Imamvardi and Bolandqamat (2018) surveyed the effectiveness of FDI on EG in selected OPEC countries and OECD during 1995-2014 and concluded that FDI caused to a decrease in EG. Quoc and Thi (2018) investigated the effectiveness of FDI on EG in Vietnam. They concluded that FDI has a positive impact on EG. Osei & Kim (2020) examined the effectiveness of FDI on EG in 62 middle income and also high income countries and concluded that FDI causes economic development. Arain et al et al. (2021) surveyed the effectiveness of FDI on EG in Pakistan and showed that FDI has a positive impact on EG in this country.

## 3. Methodology and data

To estimate the econometric models by spatial method, in the first step, spatial correlation of the data should be tested. In this study, spatial dependence in data is examined using Moran's I statistic. This statistic is measured based on equation (1).

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x}).(x_j - \bar{x})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \qquad (1)$$

In this Eq., $x_i$ and $x_j$ are the value of X in region i and region j. $\bar{x}$ is average values in all regions. $W_{ij}$ is the elements of the spatial matrix describe the spatial dependence among regions (Lesage, 2009).

There are two general methods usually used to create and prepare the spatial matrix ($w_{ij}$). One method is based on proximity (contiguity) and the other is defined based on the distance of places and regions. In the contiguity method, the spatial effects are limited only to neighboring areas (areas that geographically have border points). Elements corresponding to non-adjacent points in the spatial matrix are considered zero and other elements related to adjacent areas are considered one. In the matrix based on the distance, all the places are considered to be neighbors. Therefore, it is the distance factor (closeness) that determines the

intensity of the effect of the points on each other. Accordingly, observations that are closer to each other should reflect higher spatial dependence than those that are far apart (Elhurst, 2014). In this study, the proximity method (zero and one) is used to build and prepare the spatial matrix.

After examining the presence of spatial effects between data, the type of spatial dependence should be determined in the next step. Spatial econometrics have presented different models to investigate the effects of different spatial interactions among variables. The spatial Autoregressive model (SAR), Spatial Durbin Model (SDM) and also the spatial error model (SEM) are three models that used in many studies (Elhurst, 2014). The general form of this model is shown in Eq. (2).

$$y_{it} = \delta \sum_{j=1}^{n} w_{ij}.y_{jt} + x_{it}.\beta + \mu_i + \xi_t + \varepsilon_{it} \quad (2)$$

In this equation, i is the index of different spatial units and t represents time. Yit, is the dependent variable, $\delta \sum_{j=1}^{n} w_{ij}.y_{jt}$ specifies the term of internal interactions between the dependent variable. Wij is the matrix with n×n dimensions that show the spatial dependence of different units. δ is the autoregressive coefficients of spatial terms, μ represents spatial effects, ξ is temporal specific effects, and $\varepsilon_{it}$ is the disturbance term of the equation.

Another mode of the spatial model (the second model) is the spatial error model (SEM). This model is used when spatial dependence is created between the variables through the omitted variables (whose effect is within the disturbance term). The form of this model can be written as below.

$$\begin{aligned} y_{it} &= x_{it}\beta + \mu_i + \xi_t + u_{it} \\ u_{it} &= \lambda \sum_{j=1}^{n} w_{ij}.u_{jt} + \varepsilon_{it} \end{aligned} \quad (3)$$

In this Eq. the term $\sum_{j=1}^{n} w_{ij}.u_{jt}$ shows the interaction effects between the disturbance parts of different units. λ also shows the coefficient of spatial correlation in residuals.

The third spatial model is SDM. This model is created when there are endogenous and also exogenous dependences. This model can be written as follows.

$$y_{it} = \delta \sum_{j=1}^{n} w_{ij}.y_{jt} + x_{it}.+\delta \sum_{j=1}^{n} w_{ij}.x_{jt}\theta + \mu_i + \xi_t + \varepsilon_{it} \quad (4)$$

In this Eq., the $\sum_{j=1}^{n} w_{ij}.x_{jt}$, shows the exogenous spatial effects between the independent variables, that is, the component of the interregional lag between the independent variables.

By applying different restrictions on the SDM, other spatial models (SAR or SEM) can obtained (Elhurst, 2014). Based on the results of the SDM model, null

hypothesis $H_0 : \theta = 0$ and $H_0 : \theta + \delta.\beta = 0$ test is used. The usual statistics for this test are likelihood ratio (LR) and Wald. Based on these two types of tests, if the hypothesis $H_0 : \theta = 0$ is rejected, the SDM model is more suitable than the SAR model. This test is based on the simple Wald test. On the other hand, if the hypothesis $H_0 : \theta + \delta.\beta = 0$ is rejected, the SDM model cannot be simplified to the SEM model and the SDM model is more suitable. (Elhurst, 2014).

The general form of the regression used to investigate the impact of FDI on EG (without considering spatial effects) showed in Eq. (5).

$$LGDP_{it} = \beta_0 + \beta_1.LFDI_{it} + \beta_2.LHC_{it} + \beta_3.LGE + \beta_4.LCR_{it} + u_{it} \quad (5)$$

In this Eq., the GDP is gross domestic product in region i at time t, HC is the human capital, the GE is the government expenditure and finally the CR is the bank credits in region i at time t.

Data of FDI as well as the GDP of the provinces were extracted from the economic and financial data bank of the Ministry of Economy and Finance. The data of the total credits granted by the banks and the government expenditure were collected from the Central Bank of the Islamic Republic of Iran and the statistical yearbooks of the Statistical Center of Iran, respectively.

In this research, the average years of education has been used as a proxy for the human capital in different provinces, and the statistics related to the average years of education have been extracted from the statistical yearbook of the provinces. Since there was no separate data for Alborz province, it is considered with Tehran province.

## 4. Results

### 4.1. Data analysis

The average FDI attracted in the provinces is shown in Fig. 1. The highest amount of FDI was in Bushehr, Khuzestan and Tehran provinces, respectively. The average amount of FDI in Bushehr during the studied period was equal to 366.8 million dollars. This case was equal to 289.9 million dollars and 178.2 million dollars for Khuzestan and Tehran provinces, respectively.

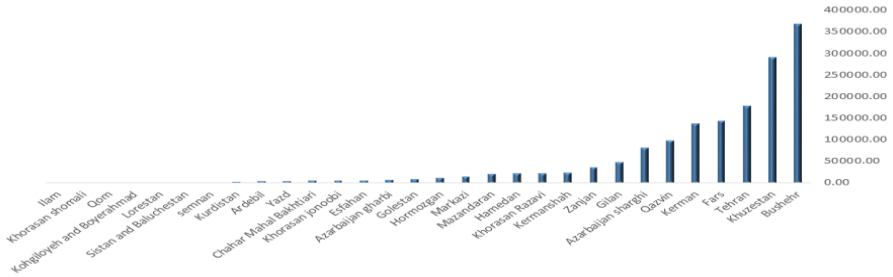



**Figure 1: Average FDI attracted in the provinces during study period**

Source: Research calculations

The lowest amount of FDI belongs to the provinces of Ilam, North Khorasan and Qom. The amount of FDI attracted in these provinces was equal to 0.6 million dollars, 0.1 million dollars and zero, respectively.

### 4.2. Estimation of the model

Since the data examined in this study includes 9 years (2011-2019), it is necessary to perform the stationary test before estimating the model. There are two groups of stationary tests in panel data. The first group of tests is called first generation unit root test, and the basic assumption of these tests is that there is no dependence between cross sections in the panel data. The second group of tests are called second generation tests, which should be used in case of dependence between cross section data. Pesaran (2004) test is one of the second generation stationary test. If the independence of the cross sections is confirmed, the first generation unit root tests can be used. Otherwise, second-generation tests such as generalized ADF for cross sections (CADF) should be used to check the stationery of the data.

Based on the above, the first step in econometrics of panel data is to recognize independence of cross-section data. In this study, the CD test of Pesaran is used. In this test, the null hypothesis is independence of different sections. Table (1) shows the results of the dependence in regions.

**Table 1: Pesaran cross-section correlation test**

| CADF statistics | probe | results |
|---|---|---|
| 6.12 | 0.000 | Cross sections are dependent |

Source: Research calculations

Based on the table, the dependence of regions is confirmed. Therefore, second generation stationary tests should be used. Table (2) shows the results stationary test. According to the table, all variables of the study are stationary; therefore, it is possible to estimate the model using level of data.

**Table 2: CADF unit root test for research variables**

| variable | statistics | probe | result |
|---|---|---|---|
| LGDP | -2.86 | 0.000 | stationary |
| LFDI | -2.34 | 0.000 | stationary |
| LGE | -2.20 | 0.01 | Stationary |
| LHC | -2.66 | 0.000 | stationary |
| LCR | -2.16 | 0.04 | stationary |

Source: Research calculations

After checking the stationary of the data, the spatial correlation of different variables should be tested. Table (3) shows the value of the Moran statistic and its probability level. Based on the table, there is spatial dependence between the data.

**Table 3: Test for the presence of spatial effects**

| Test type | Statistics | probe | result |
|---|---|---|---|
| Moran test | 0.96 | 0.01 | Spatial dependence |

Source: Research calculations

In the next step, in order to determine which of the SDM, SEM, or SAR models can better describe the data, simple Wald and multiple Wald tests should be performed. The results of this test are shown in table (4). Based on table (4), the null hypothesis of the tests is rejected. Therefore, the appropriate model is the spatial Durbin model (SDM). In other words, both hypotheses are rejected at the 1% level. Therefore, both tests show that the SDM model suitable.

**Table 4: selecting the spatial type**

| Test type | | | |
|---|---|---|---|
| Simple Wald | Choosing between SDM and SAR models | 44.62 | 0.000 |
| multiple Wald | Choosing between SDM and SEM models | 56.21 | 0.000 |

Source: Research calculations

As mentioned (Table 4), the final appropriate model for estimating the model is the SDM. After identifying the model, in the next step, the type of effects in the panel data (fixed effects or random effects) should be determined. Table (5) shows the spatial Hausman test to distinguish between fixed effects model and random effects model.

**Table 5: Results of spatial Hausman test**

| test | statistics | probe |
|---|---|---|
| Spatial Hausman | 9.19 | 0.000 |

Source: Research calculations

Spatial Hausman statistic and the corresponding probability level show that fixed effects model is more suitable than fixed effect. Therefore, finally, a spatial Durbin model with fixed effects should be estimated. The SDM with fixed effect are shown in Table (6).

**Table 6: SDM model estimation results**

| effects | variables | Coefficient | Z statistics | probe |
|---|---|---|---|---|
| Direct Effect (X) | LFDI | 0.22 | 2.36 | 0.00 |
| | LGE | 0.48 | 2.27 | 0.005 |
| | LHC | 0.33 | 3.79 | 0.00 |
| | LCR | 0.14 | 3.63 | 0.000 |
| Indirect Effect (W*X) | W*LFDI | 0.13 | 3.28 | 0.001 |
| | W*LGE | -0.18 | -1.43 | 0.13 |
| | W*LHC | 0.32 | 1. 2 | 0.32 |
| | W*LCR | -0.08 | -3.87 | 0.000 |

Source: Research calculations

The results show that the direct effect of FDI on the production of the provinces has been positive and significant. The coefficient of this variable (0.22) shows that if FDI in one region increase one percent, the EG of the region will increase by 0.22 percent. The indirect (spillover) effect of FDI was positive on the growth of the provinces. The coefficient of this variable (0.13) shows that for one percent increase in FD in the region, the EG in the neighboring regions will increase by 0.13 percent. The reason for the positive spillover effects of FDI on regional EG can be the fact that while attracting FDI in one region, activities related to the activities created as a result of attracting FDI have been established in the neighboring areas of that region.

Government spending in a region has the positive direct effect. In this way, with one percent increase in government spending in a region, economic growth will increase by 0.48%. The indirect and spillover effects of this variable are negative, but not statistically significant. The human capital has positive and significant impact in the region. The direct coefficient of this variable shows that if human capital index in a region increase one percent, EG will increase by 33%. The indirect and spillover effects of this variable are positive, but not statistically significant. The credits granted by banks (LCR=0.14, probe=0.000) have a positive and direct effect on the economic growth of the regions. Therefore, if the credits granted by banks in one region increase one percent the economic growth in that region will increase by 0.14%. The estimated coefficients for the spatial spillover effects of this variable is negative and significant. The indirect coefficient of this variable (W*LCR=-0.08) indicate that if credits in one region increase one percent, the EG of other regions will decrease by 0.08 percent. The reason for the negative spillover effects of this variable can be because by increasing the amount of credits in one region, the credits in other regions will decrease and this will have a negative impact on the EG of other regions.

## 5. Concluding Remarks

In terms of policy objectives at the regional level, it is very important to investigate the influencing variables on regional growth. Therefore, the goal of present study is to investigate the effect of FDI on EG in different provinces of Iran in the period of 2011-2019 using the spatial econometric model. Based on data at the regional level, the human capital index, FDI, and the credits granted by banks and government spending have been considered as explanatory variables in the model. The results showed all explanatory variables of the model, have a positive and significant direct effect on the EG of regions. Examining the direct coefficients of the variables shows that the highest direct coefficient belongs to government expenditures in the region. Therefore, the government should pay attention to this point in its regional growth planning and budgeting. Also, it is suggested that the government should increase its expenditures, especially its capital expenditures in less developed regions. With paying

attention to the direct positive role of human capital on the EG of the regions, it can be suggested to improve the economic growth by training more human resources, especially in less developed regions. Considering the positive direct and indirect effect of FDI on regional EG, it is suggested that national and regional policy makers should adopt appropriate policies to facilitate the absorption of FDI in the country and related region. Unfortunately, according to the laws of the Department of Economic Affairs and Finance, there are many legal and administrative complications to attract FDI in the country. Therefore, it is suggested to carry out a comprehensive study to investigate the state of administrative bureaucracy in the country to attract FDI and to identify the obstacles to attract this investment and to take necessary policies to remove these obstacles. Considering that the direct effects of bank credits on the economic growth of provinces, it is suggested that banks grant more credits to increase the economic growth of regions by increasing their financial resources. Of course, careful monitoring of it, directing it towards productive activities and facilitating the conditions for granting credits can be very useful in this important matter. Since the indirect and spillover effects of the facilities granted by banks are negative and significant and the direct effects are positive, it is suggested that these credits be used more in less developed areas. Based on this, if the goal of national policymakers is to reduce inequality in different regions, regions with low production coefficients should be identified and credits should be directed to regions with low economic growth. Examining the spillover coefficients (inter-regional effects) of the variables on the EG of the regions shows that these coefficients are significant except for the coefficients related to human capital and the facilities granted by banks. This shows that the relationship between regions has an effect on their economic growth and this relationship should be considered in the modeling of regional economic growth.

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# اثر سرریز سرمایه گذاری مستقیم خارجی بر رشد منطقه ای ایران: تحلیل اقتصاد سنجی فضایی

**چکیده:**

بر اساس ادبیات اقتصادی، سرمایه‌گذاری مستقیم خارجی (FDI) نقش اصلی و اساسی را در رشد اقتصادی کشورها دارد. بنابراین، هدف اصلی پژوهش حاضر بررسی تأثیر مستقیم و غیرمستقیم (مکانی) سرمایه‌گذاری مستقیم خارجی بر رشد تولید ناخالص داخلی در استان‌های مختلف مختلف ایران است. برای این منظور از مدل اقتصادسنجی فضایی در قالب داده‌های پانل برای 30 استان ایران طی سال‌های 97-1389 استفاده شده است. ماتریس وزن فضایی (W)، بر اساس مجاورت مناطق در نظر گرفته می شود. نتایج مدل نشان داد که سرمایه‌گذاری مستقیم خارجی بر رشد مناطق تأثیر مستقیم و سرریز مثبت دارد. همچنین هزینه‌های دولت در استان‌های مختلف، افزایش اعتبارات مالی و سرمایه انسانی تأثیر مثبت مستقیمی بر رشد اقتصادی اقتصاد منطقه داشته است. اثرات سرریز دو متغیر سرمایه‌گذاری مستقیم خارجی و توسعه مالی معنی‌دار بود. در این میان، اثر فضایی (غیر مستقیم) سرمایه‌گذاری مستقیم خارجی مثبت، اما اثر غیرمستقیم (سرریز) توسعه مالی منفی بود.

**واژه های کلیدی:** سرمایه گذاری مستقیم خارجی، رشد منطقه‌ای، اقتصاد سنجی فضایی.