Study on the Flow and Determinants of Foreign Direct Investment in Guangdong Province - Based on Fixed effects Panel Model

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Abstract—Guangdong Province, as the main force of reform and opening up, was one of the first regions in China to use foreign investment. This paper takes 21 prefecture-level cities in Guangdong Province as an example to analyze the flow of foreign direct investment and the distribution of industries. The stationary of the data is tested by LLC test and IPS test, and then the cointegration test reveals the existence of a long-run equilibrium relationship between the variables. The F-test and Hausman test, on the other hand, indicate that a fixed effects model should be used for model construction. The regression results found that the flow direction of foreign direct investment in Guangdong Province exhibits a highly uneven distribution under the combined effect of various factors, among which, the level of economic development and industrial structure have a positive driving effect, while infrastructure construction, industrial agglomeration, and labor price have a negative change in foreign direct investment.

Keywords-Hausman test; cointegration test; panel model; foreign direct investment; flow distribution

1 INTRODUCTION

The study of the unbalanced regional flow of Foreign Direct Investment (FDI) has become a reality with the acceleration of China's marketization. Since the reform and opening-up, Guangdong, as one of the most economically developed coastal provinces, is the prime development area with the highest concentration of international capital in China by virtue of its superior geographical location and preferential investment policies. Guangdong actively attracts FDI to make up for the lack of capital in its development, promotes sustained and rapid

ICEMME 2022, November 18-20, Nanjing, People's Republic of China

DOI 10.4108/eai.18-11-2022.2326882

economic growth, optimization and upgrading of industrial structure as well as technological progress, solves a large number of labor force employment problems, and provides strong support for Guangdong's economic development.

However, while the total amount of FDI in Guangdong is increasing, there is also a structural problem of FDI region. In 2019, for example, the proportion of FDI in each economic region to the province's total, the foreign direct investment absorbed in Guangdong Province is basically distributed in the Pearl River Delta region, reaching 96%, with the eastern flank accounting for 1%, the western flank accounting for 1% and the northern ecological zone accounting for 2%. The core area of the Pearl River Delta is much larger than the sum of FDI in the other three regions, accounting for almost all of the volume of FDI. It can be seen that the locational flow of FDI is uneven. In the context of promoting the revitalization and development of east and northwest Guangdong, using Guangdong FDI as the research object and studying the various factors affecting the regional flow of FDI is conducive to improving the imbalance of regional development and narrowing the regional gap. This can also promote the coordinated development of the regional economy and continuously inject new vitality into the open economy.

2 LITERATURE REVIEW

In the study of the flow of FDI, Hu et al. (2018)[1] found that the total amount of FDI utilized in China is increasing in fluctuations, from the concentration of individual regions tends to be decentralized and balanced across regions, while strengthening the degree of economic agglomeration in cities across the country and taking advantage of regional advantages according to local conditions can attract FDI inflows. Xiao Yi (2019)[2] quantifies the model using a correlation analysis index and finds that the imbalance of FDI in different regions of China has now improved, mainly in the form of a shift from the eastern to the central and western regions. Xiao, Gang (2015)[3] and Zhang, Zijian (2019)[4] found that FDI in different regions of China began to develop in a balanced direction.

Regarding the study on the factors influencing the uneven FDI flow, Mao (2020)[5], based on the highly unbalanced regional development of FDI in Yunnan Province, found that market size, industrial agglomeration, and labor price have significant effects on Yunnan Province, and transportation infrastructure and economic openness have insignificant effects on location distribution. Using a panel data model on the factors affecting FDI flows, Ma Yadan (2017)[6] found that several factors such as market size, government policies, infrastructure construction and costs interact with each other to lead to uneven FDI development in China. Wu and Yao (2018) [7] studied the degree of variation in attracting FDI in different regions of China and conclude that human capital, infrastructure, and science and technology innovation can effectively attract FDI. According to Xue, Yuan (2019)[8], in general, the number of employed people, wage level and FDI in a region are complementary and the three influence each other. Guo Liping (2020)[9] found through his study that the strength and degree of influence of regional openness, labor cost, market capacity, concentration and infrastructure on their flow varies widely, with infrastructure playing the strongest role.

The results of each scholar's research vary according to the different foothold and the location selection factors considered. For example, Jiyong Chen and Wei Peng (2009)[10] studied the relationship between knowledge spillover and FDI growth on the basis of enterprise learning ability and regional innovation theory, and the results revealed that the learning ability of knowledge spillover and regional innovation ability are important factors affecting the uneven growth of FDI in regional distribution. By summarizing the relevant literature on the factors influencing FDI, it is found that the factors that have received attention from scholars mainly include agglomeration effect (YB Zhang and X Bian, 2012; Wu, Feng, 2002)[11-12], infrastructure level (Xu, Rodan and Tan, Weihong, 2003)[13], market system (Huang, Renjie, 2008)[14], economic growth (Yang, Zheng and Jiang, Ying, 2014)[15], market size (Kim, Sangwook and Park, Young 2006)[16], policy preferences (Yaling Zhao and Xin Qi, 2013)[17], etc. Most of the studies on the factors influencing FDI are consistent with the international production trade-off theory, i.e., the "triple advantage model", i.e., ownership advantage, location advantage, and internalization advantage.

Although there have been many studies on the factors influencing the location distribution of FDI in eastern provinces of China, there is a lack of research on the distribution and determinants of FDI flow in Guangdong cities. In addition, the individual influencing factors change over time. Therefore, this paper will study the current situation of regional and industrial flows of FDI and their determinants from the actual situation of Guangdong, in order to enrich the relevant theoretical research.

3 THE FLOW AND DISTRIBUTION OF FDI IN GUANGDONG PROVINCE

3.1 Practical Use of FDI

The actual amount of foreign investment used in Guangdong Province has shown four stages of overall development since 1985-2019. Firstly, from 1985 to 1990, the overall growth of FDI in this phase was slow; the second phase was from 1995 to 2003, showing a rapid upward trend, from $10.18 billion in 1995 to $15.578 billion in 2003. Secondly, from 2004 to 2015, the FDI in this phase grew substantially and steadily and rapidly, from $10.012 billion in 2004 to $26.875 billion in 2015, more than tripling; the fourth stage is from 2016 to 2019, when FDI began to decline, falling back to $23.349 billion in 2016 and declining year by year thereafter, but rebounding in 2019. This indicates that the actual use of FDI in Guangdong Province, however, has shown a downward trend in recent years, indicating that the ability of Guangdong Province to attract foreign investment has begun to decline.

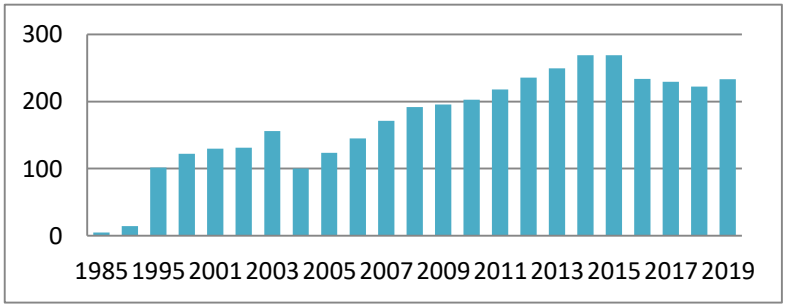

Figure 1 Actual Use of FDI in Guangdong Province (per billion USD)

3.2 Distribution of FDI

As shown in Figure 2, from the distribution of industry flows of different industries in Guangdong in 2019, service industry and manufacturing industry are the main distribution industries of FDI in Guangdong. This is due to the fact that in 2019, the four major regions in Guangdong Province continue to optimize the industrial structure, and continue to promote the service industry as the first driver of economic growth, industry for the "service-industrial-primary" structure.

From the specific data for analysis, it can be learned that in 2019, foreign direct investment in leasing and business services in Guangdong Province is 42.024 billion yuan, accounting for the largest proportion of 28%; the second largest industry is manufacturing, 38.309 billion yuan, accounting for 25%; in third place is the real estate industry, 26.546 billion yuan, accounting for 17%. Among them, industrial sectors and tertiary sectors such as wholesale and retail trade, accommodation and catering, social services, etc., together accounted for up to 60% of the total. In addition, the primary sector as well as construction, finance, transportation, scientific research and technical services also have the distribution of foreign direct investment.

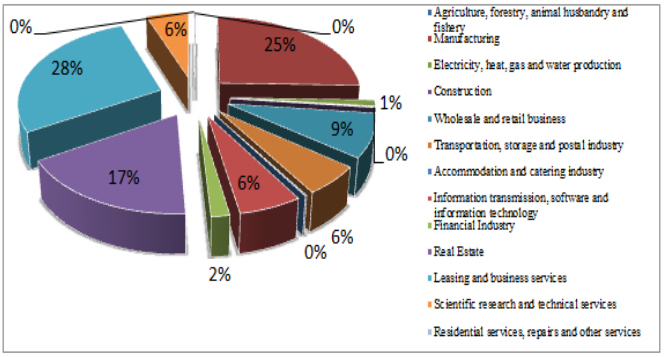

Figure 2 Distribution of FDI in Different Industries in Guangdong Province in 2019

3.3 The Flows of FDI

From the perspective of the four major economic regions in Guangdong Province, during 2018-2019, the amount of FDI received in the Pearl River Delta region within Guangdong Province far exceeds that of the other three regions, basically accounting for more than 90% of the total, with a significant disparity from the other three regions, indicating that FDI in Guangdong Province is mainly concentrated in economically developed regions. Compared with 2018, the utilization of foreign investment in the Pearl River Delta and northern Guangdong has increased in 2019, while the eastern and western flanks show a declining trend.

In recent years, influenced by many factors such as policies, costs and markets, Guangdong's ability to attract FDI inflows is weak, and the overall trend is declining. Moreover, the distribution of FDI flows in Guangdong Province is extremely uneven, mainly distributed in areas with advantages in various aspects such as developed economy, optimized industrial structure and rich talent resources.

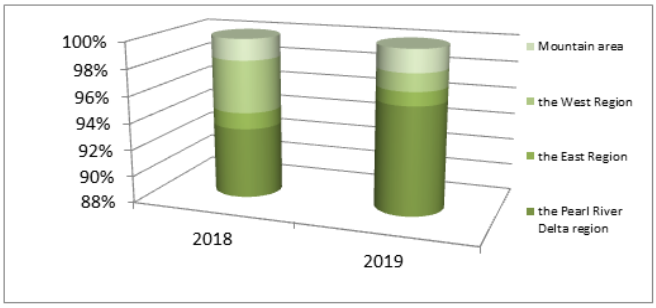

Figure 3 Proportion of FDI in Four Major Regions of Guangdong Province

4 EMPIRICAL STUDY ON THE DETERMINANTS OF FDI IN GUANGDONG PROVINCE

4.1 Variable Selection and Data Sources

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In the context of the uneven distribution of FDI in Guangdong, the determinants that specifically affect regional differences in FDI are quantified based on the differences among municipalities. According to the practical significance, the need of the model and the availability of data, the openness to the outside world, industrial structure, infrastructure construction, industrial agglomeration, economic development level and labor price of each city during 2008-2019 were selected as explanatory variables, and the actual amount of foreign direct investment used by each city was used as the explanatory variable, and the data were

obtained from China Statistical Yearbook and Guangdong Statistical Yearbook. The explanatory variables are as follows:

4.1.1 GDP

Regional economic development refers to the total final value of a region's total output in a given period, concentrating on the overall strength of a region's market size and level of economic development. The larger the GDP of a region, the larger the market size of the region and the more attractive it is to foreign direct investment.

4.1.2 Openness (OPEN)

The degree of external economic openness reflects the extent to which a country or region's market is open to the outside world. In general, the more open to the outside world, the more foreign investment will be attracted. This paper measured the economic openness of each region of Guangdong to the outside world by the proportion of total imports and exports to the regional GDP of each city.

4.1.3 Infrastructure Development (ROAD)

The construction of infrastructure is an important prerequisite for the development of enterprises and is a public service system that ensures the normal conduct of social and economic activities in a country or region, which includes highways, post and telecommunications, ports, railroads, etc. In recent years, various regions in Guangdong Province have gradually improved different aspects of transportation infrastructure construction to improve the comprehensive level of transportation security within the region. Combining with the actual situation of Guangdong Province, this paper took road as the most basic transportation mode due to the topographical conditions of different regions and measures the construction of transportation infrastructure by road density, i.e., the ratio of the number of road miles in a region to the area of the region, and this variable is positively correlated with the construction of transportation infrastructure.

4.1.4 Industrial Structure (VALUE)

China has been promoting supply-side structural reform in recent years, deeply optimizing the industrial structure and continuously adjusting the proportional relationship between industries, so as to meet the needs of China's high-quality economic development at this stage. The more developed the secondary and tertiary industries of a region are, the more FDI they can attract to enter, and the higher their overall market conditions and technology levels will be. Therefore, the output value of industrial and tertiary industries as a share of GDP in each city of Guangdong is used to calculate and measure the industrial structure.

4.1.5 Industrial Agglomeration (INDUS)

Industrial agglomeration mainly refers to the degree of convergence of the same type of industry in the same area. The formation of industrial clusters in the region can constitute an industrial chain, bring into play the advantages of scale, reduce production costs, improve the

efficiency of collaboration, and at the same time strengthen the attractiveness of a region for foreign direct investment. In this paper, the number of industrial enterprises above the scale is used to reflect the agglomeration effect of each city in Guangdong Province, and the larger the value of the index, the more significant the agglomeration effect.

4.1.6 Prices of Labor Forces (WAGE)

The price of labor is the sum of all direct and indirect costs paid by an enterprise for the use of labor in its production, operation and labor supply activities during a certain period of time. Labor cost is an important part of many industries' cost, and FDI will mainly consider the labor cost of the region when making location selection. In this paper, we chose the average wage of urban workers in each city to measure the price of labor, which is inversely related to the movement of attracted FDI.

4.2 Test of Panel Data

4.2.1 Test for Smoothness

In order to minimize the presence of spurious regressions in the data, the panel data were first tested for smoothness. There are several alternative tests for stability, such as LLC test for the same root, Breintung test, Hadri test, and IPS test and ADF test for different roots, etc. In this paper, we selected the following two different tests for specific analysis, and when the results of these two different tests are smooth, the panel data are proved to be smooth, and then we can carry out Model construction, testing and regression.

4.2.1.1 LLC Test for the Same Root

The LLC test results yielded that since the original hypothesis of the LLC test is that the variable data are not smooth, and the variables OPEN, FDI, GDP, ROAD, VALUE, INDUS, and WAGE under the same root were tested and their p-values were less than 0.05, the model does not have a unit root and the original hypothesis was rejected, indicating that the variables are horizontal series smooth.

Table 1 LLC Test

Variables	Statistical quantities	P-value (<0.05)	Smooth or not
FDI	-4.1044	0.0000	Yes
GDP	-6.6564	0.0000	Yes
OPEN	-9.1908	0.0000	Yes
ROAD	-5.0327	0.0000	Yes
VALUE	-5.2312	0.0000	Yes
INDUS	-1.8637	0.0312	Yes
WAGE	-3.3587	0.0004	Yes

4.2.1.2 IPS Test for Different Roots

The original hypothesis of IPS test is still the existence of unit root of variables, we can find through Table 2, except for the variable OPEN, FDI, GDP, ROAD, VALUE, INDUS, and WAGE, these variables cannot reject the original hypothesis, and their p-values are all greater than 0.05, that is, FDI, GDP, ROAD, VALUE, INDUS, and WAGE have unit root and are non-stationary.

Table 2 LLC test

Variables	Statistical quantities	P-value (<0.05)	Smooth or not
FDI	-0.6421	0.2604	No
GDP	-1.5978	0.0550	No
OPEN	-3.7698	0.0001	Yes
ROAD	-1.5997	0.0548	No
VALUE	-1.4907	0.0680	No
INDUS	3.3760	0.9996	No
WAGE	2.1775	0.9853	No

Since the variables were found to be non-stationary after the IPS test, the variables were differenced to first order. The results of the IPS first-order difference test show that the p-values of these variables with first-order difference are less than 0.05, which can reject the original hypothesis, i.e., there is no unit root, and the OPEN of first-order difference is also confident in rejecting the original hypothesis, then all of the IPS first-order difference tests reject the original hypothesis, indicating that all variables are smooth in the first order.

Table 3 IPS First-order Test

Variables	Statistical quantities	P-value (<0.05)	Smooth or not
D.FDI	-5.3851	0.0000	Yes
D.GDP	-2.9438	0.0016	Yes
D.OPEN	-4.8274	0.0000	Yes
D.ROAD	-4.0527	0.0000	Yes
D.VALUE	-4.3135	0.0000	Yes
D.INDUS	-5.8495	0.0000	Yes
D.WAGE	-2.2405	0.0125	Yes

4.2.2 Co-integration Test

Pseudo-regressions may exist in non-stationary series, and conducting cointegration tests can analyze the quantitative relationships between non-stationary economic variables, so as to determine whether there is a long-term stable equilibrium relationship between the variables. The Kao test is used for the cointegration test, and the original hypothesis is that the residuals are non-stationary and there is no cointegration relationship between the variables, which can be used to analyze whether there is cointegration relationship between FDI and GDP, ROAD, VALUE, INDUS, and WAGE according to it. As shown in Table 4, the P-value is equal to 0.0003, which is less than 0.05, so the original hypothesis is rejected, indicating the existence of a long-term equilibrium relationship for all variables.

Table 4 Kao Residual Cointegration Test

ADF	**t-Statistic** **Prob.**
	-3.479999 **0.0003**
Residual variance	6.92E+08
HAC variance	6.51E+08

4.3 Model Construction

Before building the model, F-test and Hausman test were used to validate the model. Among them, the F-test is used to test whether the model has individual effects, if the test does not show the presence of individual effects, it indicates that the mixed model form should be used, if the test shows that the model has individual effects, the Hausman test is performed, if the original hypothesis of this test is rejected, it indicates that the fixed effect model form should be used, otherwise we use the random effect model form. Then the relevant validation steps and process are shown in the following table: the results of the F-test show that since the original hypothesis of the F-test is that there is no individual effect in the model, and the p-value corresponding to the statistic of the above test is less than 0.05, the original hypothesis is rejected, indicating that the model should be chosen in the form of the presence of individual effects.

Table 5 Redundant Fixed Effects Tests

Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	12.2443	(20,225)	0.0000
Cross-section Chi-square	185.5705	20	0.0000

Further analysis was performed using the Hausman test as follows: the original hypothesis of the test was the existence of a random effect form of the model, but according to the statistic of this test corresponding to a p-value less than 0.05, it means that the constructed model should exist in the form of fixed effects, so the original hypothesis was rejected.

Table 6 Hausman Test

Test cross-section random effects			
	Chi-Sq.		
Test Summary	Statistic	Chi-Sq.	Prob.
Cross-section F	111.4956	6	0.0000

A multivariate linear fixed effects model is constructed, and then the basic form of the model is as follows.

$$LnFDI_{it}=\beta_0+\beta_1*LnGDP_{it}+\beta_2*LnOPEN_{it}+\beta_3*LnROAD_{it}+\beta_4*LnVALUE_{it}+\beta_5*LnINDUS_{it}+\beta_6*LnWAGE_{it}+\varepsilon+u_{it} \quad (1)$$

Where, i=1,2, ...21, t=2008,2009, ...2019. Y represents the explanatory variable, β_0-β_n are the variable coefficients, n is the number of variables, X_{it} represents the explanatory variable, ε is the unobservable individual effect, and u_{it} is the disturbance term. To reduce the impact of data non-standardization, the variables are transformed into logarithmic form. Regressions were performed using Eviews 7.0 software and the results were as follows.

Table 7 Results of Model Regression

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-1.777742	10.53006	-0.16882	0.8661
LNGDP	1.472892	0.405603	3.631366	0.0003
LNOPEN	0.342149	0.194275	1.761158	0.0796
LNROAD	-1.293071	0.322289	-4.012143	0.0001
LNVALUE	5.213942	2.501421	2.084392	0.0383
LNINDUS	-0.511298	0.171981	-2.972996	0.0033
LNWAGE	-1.622271	0.363249	-4.466005	0.0000
Prob (F-statistic)	0.000000			

The specific model is obtained as follows.

$$LnFDI_{it}=1.777742+1.472892*LnGDP_{it}+0.342149*LnOPEN_{it}-1.293071*LnROAD_{it}+5.213942*LnVALUE_{it}-0.511298*LnINDUS_{it}-1.622271*LnWAGE_{it}+\varepsilon+u_{it} \quad (2)$$

The estimated parameters of economic development level and industrial structure are significantly positive, indicating that economic development level and industrial structure have a positive relationship with FDI in Guangdong; for every 1% increase in economic development level, FDI will increase by 1.47%; for every 1% increase in industrial structure, FDI will increase by 5.21%. The higher level of regional economic development and the larger market capacity have a more attractive on FDI entry. Guangzhou and Shenzhen and other

developed areas of the Pearl River Delta, the scale of FDI is much larger than that of the lagging areas in the eastern and northwestern Guangdong. The estimated parameters of infrastructure construction, industrial agglomeration, and prices for labor are significantly negative, indicating that these variables are negatively correlated with FDI in Guangdong Province; each 1% increase in infrastructure construction will decrease FDI by 1.29%; each 1% increase in industrial agglomeration will decrease FDI by 0.51%; each 1% increase in labor price will decrease FDI by 1.62%. Although the estimated parameter of external openness is positive, the effect on Guangdong FDI and its flow is not significant.

The negative effect of industrial agglomeration also indicates that the current industrial agglomeration in Guangdong Province is mainly a "geographical" concentration, and the public policy environment of industrial agglomeration with innovation still needs to be improved and enhanced. And the negative infrastructure development correlation may be a reflection of the lag, which is subject to subsequent in-depth study. The strong inverse relationship between labor prices and FDI in Guangdong cities is in line with expectations. According to the law of diminishing marginal returns of neoclassical economics, less-developed regions have lower labor costs, so profit-seeking capital should flow from developed regions to those regions. However, the reality is that there is no such status quo in Guangdong, and there is such a huge difference in the regional distribution of FDI, which is also a reflection of the Lucas paradox. The reason for this is that even though East and Northwest Guangdong have low labor costs, developed regions have other important factors, such as human capital, openness to the outside world, natural resources, urban agglomeration effects, and social capital. East and Northwest Guangdong have been constrained by low economic output, lack of human resources, and relative isolation to attract foreign investment into the region, making the FDI location flow formation imbalance.

In a word, there are many determinants affecting FDI, but they may show different correlations with FDI and exert different strengths on it as the development progresses over time. The uneven distribution of FDI inflows in various regions of Guangdong is also the result of a combination of factors, so we need to start from the actual situation and analyze the situation of different regions in a practical and specific manner.

5 CONCLUSIONS

This paper studies the distribution status and flow of FDI in Guangdong Province, and by constructing a fixed-effect panel model to study the effects of foreign economic openness, industrial agglomeration, industrial structure, infrastructure construction, economic development level, and labor prices on FDI in Guangdong Province, we can draw the following conclusions:

Firstly, FDI in Guangdong Province is characterized by regional differences, with a focus on Guangzhou and Shenzhen. In addition, the development of total FDI in Guangdong Province in terms of industry and source shows obvious differentiated features; service industry and manufacturing industry are the main industries of FDI inflow in Guangdong Province.

Secondly, from the empirical findings of the panel data, there is a significant positive relationship between the level of economic development, industrial structure and FDI inflow to

each city in Guangdong Province in the past twelve years; labor price, infrastructure construction, and industrial agglomeration has an inverse variation relationship with FDI inflow to each city in Guangdong Province. Among them, the industrial structure has the strongest role in generating FDI in Guangdong Province, followed by labor price, the level of economic development and infrastructure has a somewhat smaller role, and the industrial agglomeration has the least role.

Although the FDI in the northwest and east of Guangdong got a small increase at a later stage due to the tilt of preferential policies and under the influence of FDI diffusion effect, the effect is not significant. It is worth noting that the revitalization of northwest Guangdong is open to Hong Kong, and the Greater Bay Area should take the initiative to radiate northwest Guangdong, to introduce foreign investment for its development of northwest Guangdong. Under the support of "Double-transfer" initiative and partner assistance, foreign enterprises especially Hong Kong-funded enterprises, can transfer the processing link to the northwest of Guangdong. Accelerate the construction of overseas Chinese pilot zones, drive the use of overseas Chinese capital and overseas Chinese power. The less-developed regions should take advantage of the Revitalization Strategy of Northwest Guangdong to develop the regional economy comprehensively. Finally, lay the foundations for economic development to attract more talents by driving the improvement of various supporting conditions to attract more foreign investment, breaking the state of capital bottlenecks, technology constraints.

Acknowledgment. The research of this paper was funded by the "public management" construction project of characteristic key discipline from Guangdong Province, China in 2016 (F2017STSZD01) and Guangdong Higher Education Teaching Reform project (F2018J051).

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