

# *The Impact of Guangdong's Foreign Direct Investment on Innovative Development Based on Panel Data Analyses*

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**Abstract:** Foreign Direct Investment (FDI), as one of the highest forms of transnational capital flows, can take a significant role in the process of economic development. The utilization of FDI to promote innovative development has therefore become more of an important topic. With the intention of uncovering whether or not and how the FDI can still have an impact on innovative development today, the paper studies the impact of Guangdong's FDI on its innovative development by using data from 2010 to 2022 provided by the Guangdong Statistical Yearbook, statistical yearbooks of all Guangdong cities, Foshan Market Supervisory Authority official website, etc., performing a panel data analyses and revealing a statistically significant positive relation between the scale of FDI and innovative development, and a negative relationship between FDI's export capacity, the indicator of the proportion of foreign investment in the manufacturing sector to total investment and innovative development. Hence, while emphasizing the scale of FDI, the government should also focus on enhancing the competitiveness of high-tech industries and promoting the transformation and upgrading of industrial structures.

**Keywords:** Foreign direct investment, innovative development, FDI quality.

## 1. Introduction

The global economic landscape has undergone significant transformation in the previous decades, with FDI playing a significant role in shaping international trade and economic growth. As the world's second-largest economy, China is now undergoing the new development stage, implementing the new development philosophy, and moving faster to foster a new development pattern that places a strong emphasis on innovative development.

This paper analyzes the case of Guangdong Province, a prominent economic region in China, by utilizing the data spanning from 2010 to 2022 provided by the Guangdong Statistical Yearbook, statistical yearbooks of all Guangdong cities, the official website of the Foshan Market Supervisory Authority, and the official website of China Intellectual Property Administration, and performing panel data analyses. Guangdong province, as one of the first to make efforts to attract FDI, has leveraged its advantages in geographic location, government support, and land and labor abundance to attract numerous foreign enterprises and capital, has therefore witnessed remarkable strides in research and development, technology, and intellectual property creation ever since the reform and opening up, and is now in active response to the government's call to place innovation at the core position of development. However, over the past decades, the impact of FDI on Chinese economic

development has been on decline, whether or not the FDI can still meet the need for high-quality development in the relatively more developed regions like Guangdong Province in China is yet to be questioned [1].

Previous analyses mainly focus on the impact of FDI on general economic growth and development, or aspects like the efficacy of economic development, economic structure, and sustainable development, and little was done to analyze the relationship between FDI and innovative development. Therefore, this paper examines the impact of different characteristics of FDI on innovative development in a specific province, focusing on three aspects: actual scale, capability to export, and proportion of foreign investment in the manufacturing sector to total investment. Through the analyses, this paper aims to elucidate the relationship between OFDI and Guangdong's innovative development and endeavors to provide valuable insights that can guide policymakers and businesses within Guangdong Province as they navigate the complexities of innovative development and international investment. It is discovered that the actual scale of FDI has a positive impact on innovative development, while FDI's capability to export an indicator of the proportion of foreign investment in the manufacturing sector to total investment hurt innovative development. Furthermore, the results indicate that though attracting FDI is still beneficial, the restructuring of the economy and the enhancement of competitiveness of key industries has become increasingly important. The research findings hold the potential to serve as a reference point for other provinces and regions in China with similar economic structures, offering them a blueprint for understanding the impact of OFDI on their economic landscape and innovative development.

## 2. The Impact of Guangdong's Foreign Direct Investment on Innovative Development Based on Multiple Regression Analyses

### 2.1. Data Source and Variable Construction

The paper utilizes data provided by the Guangdong Statistical Yearbook, statistical yearbooks of all Guangdong cities, the official website of the Foshan Market Supervisory Authority, and the official website of China Intellectual Property Administration, and applies panel data of 21 Guangdong cities in the 2010 to 2022 period.

The explained variable, the indicator for innovative development, is measured by the number of cities' patents granted as a percentage of China's total number of patents granted and the internal expenditure on R&D to fiscal expenditure ratio [2]. The entropy method was applied to construct the variable *score* as the explained variable.

First, the two indicators were standardized using the following equation as both are positive indicators:

$$x'_{ij} = \frac{x_{ij} - \min\{x_{1j}, x_{2j}, \dots, x_{nj}\}}{\max\{x_{1j}, x_{2j}, \dots, x_{nj}\} - \min\{x_{1j}, x_{2j}, \dots, x_{nj}\}} \quad j = 1, 2 \quad (1)$$

Then the weight of the *i*-th region under the *j*-th indicator, the entropy value of the *j*-th indicator, information entropy redundancy, and the weight of both indicators are calculated:

$$p_{ij} = \frac{x'_{ij}}{\sum_1^n x'_{ij}} \quad (2)$$

$$e_j = -k \sum_1^n p_{ij} \ln(e_{ij}) \quad (3)$$

$$d_j = 1 - e_j \quad (4)$$

$$w_j = \frac{d_j}{\sum_1^m d_j} \quad (5)$$

Where  $k = 1/\ln(n)$ .

Finally, the score for innovative development is computed:

$$score_i = \sum_1^m w_j p_{ij} \quad (6)$$

Based on the available data and the method of Bai Junhong and Lv Xiaohong [3] and Zou Jianhua and Han Yonghui [4], the paper measures the quality of FDI with *scale*, *export*, and *ind*: *scale* is defined by the actual scale of foreign investment as measured by the value of foreign investment to the number of registered enterprises ratio; *export* is the FDI's export capability as measured by the value of FDI industry exports as a percentage of the total value of export; *ind* is defined by the actual amount of foreign investment in the manufacturing sector in each city as a ratio to the total actual value of the foreign investment.

The setting of control variables is based on the method applied by Hu Xuepin [2] and Guo Xibao and Luo Zhi [5]. The paper incorporates control variables as follows: industrial structure, human resources, the domestic investment indicator as measured by the difference between the annual increment in fixed asset investment and the foreign direct investment in fixed assets as a proportion of the GDP, population growth rate, and government expenditure.

All variables and their exact method of calculation are shown in Table 1. Additionally, any indicator expressed in monetary terms and in non-proportional form, underwent GDP deflation to eliminate the impact of inflation.

Table 1: Variables and Method of Calculation

Variables	Calculation
<i>score</i>	$score_i = \sum_1^m w_j p_{ij}$
<i>scale</i>	value of foreign investment / number of registered enterprises
<i>export</i>	value of FDI industry exports / total value of export
<i>ind</i>	FDI in the manufacturing industry / total value of foreign investment
<i>structure</i>	output value of the tertiary industry/output value of the secondary industry
<i>hc</i>	number of research and development (R&D) personnel / total employment
<i>investment</i>	(annual increment in fixed asset investment - foreign direct investment in fixed assets) / GDP
<i>population</i>	(current year total population-previous year total population) / previous year population
<i>expend</i>	government expenditure / GDP

## 2.2. Model Construction

To monitor the influence of FDI quality, fixed effect models are constructed:

$$\ln(score_i) = \alpha_0 + \alpha_1 \ln(scale_{it}) + \alpha_2 structure_{it} + \alpha_3 hc_{it} + \alpha_4 investment_{it} + \alpha_5 population_{it} + \alpha_6 \ln(expend_{it}) + \varepsilon_{it} \quad (7)$$

$$score_i = \alpha_0 + \alpha_1 export_{it} + \alpha_2 structure_{it} + \alpha_3 hc_{it} + \alpha_4 investment_{it} + \alpha_5 population_{it} + \alpha_6 expend_{it} + \varepsilon_{it} \quad (8)$$

$$score_i = \alpha_0 + \alpha_1 ind_{it} + \alpha_2 structure_{it} + \alpha_3 hc_{it} + \alpha_4 investment_{it} + \alpha_5 population_{it} + \alpha_6 expend_{it} + \varepsilon_{it} \quad (9)$$

The subscripts  $i$  and  $t$  represent the city code and the year, respectively;  $score$  refers to the cities' scoring for innovative development;  $scale$  refers to the actual scale of FDI; export refers to FDI's capability to export;  $ind$  is the indicator of the proportion of foreign investment in the manufacturing sector to total investment;  $structure$  refers to industrial structure;  $hc$  refers to human resources;  $investment$  refers to the domestic investment in fixed assets;  $population$  refers to the population growth rate;  $expend$  measures the local government expenditure. and  $\varepsilon_{it}$  represents the residual.

### 3. Results

#### 3.1. The Correlation Test and Test for Multicollinearity

The correlation test is performed to find to what degree every two variables correlate. The Pearson test result in Table 2 shows that most variables are not highly correlated, with some exceptions of moderate correlation, so the VIF test was performed to see if there is multicollinearity.

Table 2: Correlation Test

	<i>score</i>	<i>scale</i>	<i>export</i>	<i>ind</i>	<i>structure</i>	<i>hc</i>	<i>investment</i>	<i>population</i>	<i>expend</i>
<i>score</i>	1.0000								
<i>scale</i>	0.0560	1.0000							
<i>export</i>	0.1037	-0.2011	1.0000						
<i>ind</i>	0.5491	0.1139	0.3857	1.0000					
<i>structure</i>	-0.0534	0.4634	-0.1537	0.0518	1.0000				
<i>hc</i>	0.4451	0.3949	-0.0822	0.4341	0.6340	1.0000			
<i>investment</i>	-0.5480	-0.1431	0.0496	-0.3627	-0.1396	-0.3983	1.0000		
<i>population</i>	0.2632	0.0227	0.0715	0.3005	0.0811	0.2388	-0.2562	1.0000	
<i>expend</i>	-0.5561	-0.1488	0.1002	-0.4277	0.2788	-0.1722	0.4665	-0.1934	1.0000

Table 3: Test for Multicollinearity

Variables	(1)		(2)		(3)	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
<i>scale</i>	1.45	0.68834				
<i>export</i>			1.07	0.9319		
<i>ind</i>					1.55	0.6444
<i>structure</i>	2.74	0.3656	2.38	0.4206	2.33	0.4290
<i>hc</i>	2.28	0.4379	2.30	0.4354	2.60	0.3843
<i>investment</i>	1.52	0.6566	1.51	0.6621	1.51	0.6603
<i>population</i>	1.11	0.8974	1.12	0.8942	1.14	0.8780
<i>expend</i>	1.89	0.5291	1.76	0.5666	1.79	0.5578

The results of the VIF test on all three models are as shown in Table 4. It can be inferred from Table 3 that as all variance inflation factors (VIF) are well under 10, multicollinearity is not considered a problem.

### 3.2. Fixed Effect Model Regression Analysis

The paper analyzes the scoring for innovative development of 21 Guangdong cities from 2010 to 2022, among which Shenzhen, Foshan, Zhongshan, Dongguan, and Guangzhou rank in the top five. These cities are all located in the economically developed Pearl River Delta region, boasting geographical advantages, abundant human capital, and additional policy support.

The results of fixed effect model regression are shown in Table 2. Models 1, 2, and 3 represent equations (7), (8), (9) respectively. Model 1 analyzes the impact of FDI's actual scale on innovative development. The result indicates a statistically significant positive relationship between the two indicators. With increasing return to scale the larger the actual scale of FDI, the higher the possibility there is to achieve economies of scale, thereby reducing average costs and stimulating innovative development. The impact of direct and indirect effect of FDI on total factor productivity has been proven in previous studies [6]. Furthermore, large-scale FDI is typically associated with more resources, including funds, technology, and management expertise, providing more R&D and innovation inputs, and may also trigger knowledge spillover effects, prompting local businesses to raise their innovation levels. Therefore, a larger actual scale of FDI helps promote innovative development.

Table 4: The Impact of FDI Quality on Innovative Development

explanatory variable	explained variable		
	(1)	(2)	(3)
<i>scale</i>	0.0782* (0.0421)		
<i>export</i>		-2.2860** (0.9619)	
<i>ind</i>			-0.0490** (0.0190)
<i>structure</i>	0.0065 (0.0905)	-0.8539** (0.3982)	-0.6688* (0.3866)
<i>hc</i>	0.0462*** (0.0145)	0.2911*** (0.0706)	0.3005*** (0.0679)
<i>investment</i>	0.3304** (0.1568)	0.5920 (0.7069)	0.8927 (0.6740)
<i>population</i>	-0.0014 (0.0043)	-0.0538*** (0.0187)	-0.0545*** (0.0187)
<i>expend</i>	-0.7659*** (0.1284)	-0.1200*** (0.0311)	-0.1072*** (0.0302)
<i>constant</i>	2.2371*** (0.3864)	7.3151*** (1.0079)	6.2504*** (0.6141)
<i>R<sup>2</sup></i>	.9139	.9182	.9262
<i>observation</i>	273	273	273

Note: standard errors in parentheses, and \* p<0.1, \*\* p<0.05, \*\*\* p<0.01.

Model 2 analyzes the impact of FDI's capability to export which is measured by the value of FDI industry export as a percentage of the total value of export. It is shown that the capability to export does not have a statistically significant positive effect on the scoring of innovative development. This can partly be partly explained by Guangdong's structure of export and indicates the underlying challenges for Guangdong's innovative development. The capability to export suggests the

competitiveness of FDI. According to Han Yuanxi [7] and Xia Haixia and He Yuanning [8], over the past two decades, Guangdong Province's main categories of foreign trade are agricultural products, high-tech products, and machinery and electronic products. On one hand, the Guangdong consistently faces a competitive disadvantage when it comes to agricultural product exportation, with its trade competitiveness index remaining negative over the years and showing a declining trend. On the other hand, high-tech products and machinery and electronic products, though exhibiting a certain level of export competitiveness, the advantages are not significant. In addition, the high dependence on FDI for the export of these two types of products poses greater challenges to the optimization of industrial structure and innovative development in Guangdong Province [9].

Model 3 reveals a significant negative effect of the proportion of foreign investment in the manufacturing sector to total investment in innovative development. Previous research has shown that in the past two decades the relatively more developed regions in Guangdong, namely the Pearl River Delta, have been grappling with the paradox of excess capacity of production and the demand for an industrial restructuring [4]. Though in its earlier stage of development, Guangdong indeed benefited from mass FDI in its importing extensive and labor-intensive manufacturing industries, this pattern of development no longer meets the requirement for high-quality development in the new development stage. Currently, steering FDI towards high-tech industries, modern services, and the establishment of research and operation centers has become increasingly essential to the economy. Hence, it is suggested that the government also take into account whether foreign capital is invested in high-tech industries as an important indicator when evaluating the quality of foreign investment in the future.

#### 4. Conclusion

Since the reform and opening-up, FDI has had a significant impact on the speed of economic development, structural changes, and development quality in Guangdong. However, as the Guangdong economy enters a new development stage, higher demands are placed on high-quality development, especially innovative development. While the scale of FDI still does play a positive role in Guangdong's innovative development, its export capacity and proportion of foreign investment in the manufacturing sector to total investment have not shown a significant positive impact. The government and businesses may need to reconsider their tactics of using FDI to promote high-quality economic development. On the one hand, local governments can continue to attract foreign investment of considerable scale. On the other hand, the government needs to actively adjust the local economic structure and enhance the competitiveness of high-tech and electromechanical industries, as well as take into consideration the proportion of FDI in high-tech industries.

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