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The Economic Effects of China's Pilot Free Trade Zones: A Empirical Test based on Difference in Differences

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Abstract: Free trade pilot zones have good conditions for reform in investment, trade, finance, regulation, and taxation, economic data from 18 provinces in China from 2010 to 2019 were collected. Seven provinces including Liaoning, Zhejiang, Henan, Hubei, Chongqing, Sichuan, and Shaanxi were selected as experimental groups. The double difference method (DID) was used to investigate whether the establishment of free trade zones has promoted exports and imports. The empirical results show that: The reform in the pilot free trade zone has a significant positive driving effect on the total import and export trade volume, as well as the total export trade volume. Before the implementation of the free trade pilot zone reform, there was no significant difference in the total export value between the experimental group and the control group. However, after the implementation of the reform in free trade pilot zone, there was a significant difference in the total export value between the experimental group and the control group. A certain positive spillover effect on the economic development of the province, and this effect still holds under strict and stable conditions.

Keywords: Pilot Free Trade Zone; Experiments; Economic Effects; Overflow Effect; Double Difference Method

1. Introduction

In the academic research on the impact of free trade pilot zones on regional economy, many scholars only use the proportion of some economic data of free trade zones in the province to explain their economic effects [1]. Taking Shanghai as an example, the driving force of the service industry is explained by the operating income of the service industry [2]. However, these data are too single and may also be affected by other factors. Moreover, most of them are based on a free trade zone as the research object, which is not universally applicable [3]. Therefore, by constructing mathematical models and excluding interfering factors, the impact of imports and exports in free trade zones can be studied [4]. In order to achieve the above research objectives, panel data from each province was used to collect the GDP, imports, exports, imports and exports, FDI, OFDI of the experimental sample group from 2010 to 2019 by searching for the National Statistical Yearbook, provincial statistical bulletins [5]; Collect a control group sample of 11 provinces for the years 2010-2019, including GDP, imports, exports, imports and exports, FDI, to explore whether the establishment of free trade zones has played a role in promoting exports and imports [6].

2. Literature Review

Looking at China, domestic scholars have conducted numerous statistical studies. Many literature have analyzed the development of Hainan's service industry economy from a qualitative perspective. Chen Lifen (2019) analyzed service industry indicators, the size of the service industry market, service industry taxation, the ability of the service industry to absorb employment, and the number of service industry enterprises. The exploration results show that Hainan, with the free trade zone policy as the core, has comprehensively improved and optimized the business environment, and achieved significant results in promoting the upgrading of the service industry. Liu Binglian et al. (2019) focused on factor flow and added boundary variables to fit the constraints of local administrative management and institutional barriers on factor flow. They studied the mechanism of the promotion of regional collaborative opening through the establishment of free trade zones and conducted empirical tests using counterfactual analysis. The results showed that there was a boundary effect in the Beijing

Tianjin Hebei region, with the marginal effect decreasing by an average of 0.2 to 0.3 percentage points per year. In recent years, due to the maturity and development of econometrics. Yin Hua and Gao Wei et al. (2017) used some economic indicators of the Shanghai Free Trade Zone and employed a policy effect evaluation method based on panel data to predict the economic and institutional effects generated by the Shanghai Free Trade Zone. The data results showed that the inspection of the Shanghai Free Trade Zone significantly promoted Shanghai's economic development, outbound investment level, and import and export growth; the more effective and comprehensive the implementation of the free trade zone policy, the more it can promote the economic development of Shanghai. Nie Fei (2019) used the DID model to find that the construction of free trade zones can effectively optimize the manufacturing structure, promote the upgrading of the manufacturing structure, and drive economic development overall. Zhang Jun et al. (2019) examined the economic growth effect of China's free trade zones from multiple perspectives based on a double difference spatial autoregressive model, and found that the overall economic effect of the free trade zones was significant, with a U-shaped trend of first decreasing and then increasing promotion.

From the above, the most common method used is qualitative analysis, which does not consider a comprehensive range of factors and can easily lead to distorted results. On the other hand, in terms of research scope, most existing literature only conducts empirical studies on the economic effects of the Shanghai Free Trade Zone, believing that the Free Trade Zone has positive economic effects. With the increase of China's opening up to the outside world, the second, third, and fourth batches of free trade zones have been established. However, few scholars have conducted research on all free trade zones. In addition, existing literature on the economic effects of free trade zones mainly analyzes the overall economic effects of individual free trade zones, and rarely focuses on discussing one aspect. This article explores whether the economic effects of free trade zones focus on whether they promote trade imports and exports.

Therefore, based on the previous analysis results, this article combines previous research results from multiple levels and perspectives to study the economic effects of the establishment of multiple free trade zones, and uses provincial panel data in China from 2010 to 2019 as support for empirical analysis. Regarding the analysis of the impact of free trade zone policies, this article will use the following methods to conduct research: (1) The difference in differences (DID) method, which involves making two differences, is a specialized econometric method used to analyze policy effects. It is not simply comparing the mean changes before and after policies, but rather analyzing them through the comparison between the experimental group and the control group. (2) The comparative analysis method has been used multiple times in this article, for example, by comparing the establishment with other non established free trade zones, and comparing the economic effects of regions without and after the establishment of trade zones. By controlling for the variable of time and replacing the control group with the experimental group, we can analyze the varying degrees of economic growth brought about by the establishment of the free trade zone.

3. Model Construction and Data Processing

3.1 Data Source and Processing

The National Bureau of Statistics of the People's Republic of China, the Industrial Database of China Economic Network, the Ministry of Commerce of the People's Republic of China, and provincial statistical bulletins, we collected provincial panel data from 18 provinces, including Liaoning, Zhejiang, Henan, Hubei, Chongqing, Sichuan, Shaanxi, Beijing, Shanxi, Inner Mongolia, and processed the data in a unified dimension (unit), taking logarithms, reserving two decimal places, and so on [7]. Seven provinces, including Liaoning, Zhejiang, and Henan, which established free trade zones in 2017, from 2010 to 2019, had not yet established free trade experimental zones as the control group. The double difference model requirements the experimental group and sample group should be subjective and random. The reason why there is no Xinjiang, Xinjiang and Xizang are located in the remote west, and their import and export trade volume will be significantly

different from the coastal provinces and border provinces that have established free trade pilot zones [8]. Therefore, Xizang and Xinjiang will be deleted from the experimental group.

3.2 Variable Design

The dependent variable: total import and export value, export value, import value. The total import and export value, export value, and import value collected through multiple channels are all unified into billions of RMB [9].

Core explanatory variables: policy variables. According to the time when the experimental group obtained national approval to establish a free trade zone, the policy variable time for the experimental group that had not yet established a free trade zone; additionally, the experimental group samples were assigned a value of 1, while the control group samples were assigned a value of 0.

Control variables:The introduction of control variables in model analysis is to prevent the experimental and control groups from being affected by other factors that may affect regional economic development.[10] Referring to existing literature in society, the introduced control variables include Gross Domestic Product (GDP), Foreign Direct Investment (FDI), Outward Foreign Direct Investment (OFDI), Total Retail Sales of Consumer Goods (sales), Fixed Assets (fixed_inv), Industrial Value Added (ind-value), Employment (workers), and Policy Variable (time).

3.3 Model Construction

Model 1:

$$trade=\alpha+\beta_1 gdp+\beta_2 fdi+\beta_3 ofdi+\beta_4 sales+\beta_5 fixed\_inv+\beta_6 ind\_value+\beta_7 labors+\beta_8 time+\beta_9 treated+\beta_{10} time*treated+\varepsilon$$

Model 2:

$$Import=\alpha+\beta_1 gdp+\beta_2 fdi+\beta_3 ofdi+\beta_4 sales+\beta_5 fixed\_inv+\beta_6 ind\_value+\beta_7 labors+\beta_8 time+\beta_9 treated+\beta_{10} time*treated+\varepsilon$$

Model 3:

$$export=\alpha+\beta_1 gdp+\beta_2 fdi+\beta_3 ofdi+\beta_4 sales+\beta_5 fixed\_inv+\beta_6 ind\_value+\beta_7 labors+\beta_8 time+\beta_9 treated+\beta_{10} time*treated+\varepsilon$$

4. Empirical Testing and Result Discussion

4.1 Estimation Method

This article adopts double difference estimation. Firstly, it can avoid endogeneity problems. Secondly, it can more accurately estimate policy effects. Thirdly, the model is simple to set up and easy to understand.

4.2 Applicability Testing

4.2.1 Whether the error term follows a normal distribution test

The assumption of normal distribution is mainly made for statistical inference and parameter fitting. In parameter fitting, we also need to have certain assumptions about the distribution of errors. The assumption of normal distribution makes the regression curve more sensitive to extremes: because under the assumption of normal distribution, extremely large errors appear unlikely, so when extremely large errors occur, the regression line often does not exhibit a normal distribution. According to the graph after normal distribution testing, it conforms to the normal distribution and can be subjected to regression testing.

4.2.2 Normal distribution test

According to the graph after normal distribution testing, it conforms to the normal distribution and can be subjected to regression testing. As shown in Figure 1**:**

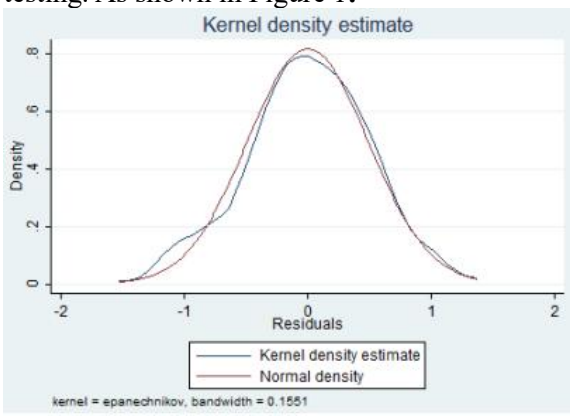

Figure 1. Normal Distribution Diagram

4.2.3 Heteroscedasticity test

Whether the mean of the error term is 0 represents that there is no significant difference in imports and exports between the experimental group and the control group before the implementation of the free trade zone policy (i.e. parallelism assumption), obtaining a double difference estimate is unbiased, as shown in Table 1. The impact of heteroscedasticity on parameter estimation mainly affects the effectiveness of parameter estimation. Generally speaking, heteroscedasticity can lead to underestimation

of true variance, thereby exaggerating the significance of parameter estimation even if the statistical measures of parameter estimation are biased, resulting in erroneous rejection of the null hypothesis that should have been accepted, so heteroscedasticity test is needed. As shown in Table 2, the P-value is 0.0005, and the null hypothesis is not accepted. There is heteroscedasticity, and robust regression will be used later to reduce heteroscedasticity.

Table 1. Mean Value Test of Error Term

Varible	Obs	Mean	Std Dev	Min	Max
el	180	-1.45e-10	.4889618	-1.373152	1.211632

Table 2: Heteroscedasticity Test

Source	chi2	df	p
Heteroskedasticity	68.69	35	0.0006
Skewness	11.36	7	0.1236
Kurtosis	0.15	1	0.7023
Total	80.20	43	0.0005

Chi2 (35) = 68.69, Prob>chi2=0.0006

4.2.4 Multicollinearity test

Although the variance inflation factor of the explanatory variable lnGDP is greater than 10, the regression coefficient is significant. Therefore, this explanatory variable is retained. As shown in Table 3, the variance inflation factors of lnsales and lnind-value are greater than 10, indicating multicollinearity. Therefore, these two explanatory variables will be removed from the subsequent regression analysis.

Table 3. Multicollinearity Test

Varible	VIF	1/VIF
Lngdp	72.87	0.013723
Lnsales	51.74	0.019326
Lnfixed	18.40	0.054357
Lnlabors	6.98	0.143296
Lnfdi	6.37	0.156928
lnofdi	3.55	0.281981
	2.92	0.342662
Mean VIF	23.26	

4.2.5 Descriptive statistics

Table 4 displays 180 observations, including some indicators of variables such as trade, import, and export, such as mean and standard deviation Difference, minimum value, maximum value.

Table 4. Descriptive Statistical Analysis Table

Varible	Obs	Mean	Std Dev	Min	Max
Trade	180	4443.85	6828.81	37.6	30838.2
Import	180	2138.72	4244.78	10.516	23517.2
Export	180	2266.99	39.5.10	20.2	23076.3
Gdp	180	19724.9	13485.8	1350.43	62351.7
Fdi	180	913.634	4788.46	.29525	48677.4
Ofdi	180	92.0204	159.818	.09342	1034.08
Sales	180	8102.07	5855.85	350.8	27343.8
Fixed_inv	180	15505.2	10591.7	1016.9	51949.2
Ind_value	180	7079.81	4926.30	326.7	22840.5
Labors	180	536.297	1597.05	294.1	6767

4.2.6 Correlation coefficient

The correlation between each explained variable is displayed, and the larger the correlation coefficient, the more significant the correlation. The correlation between trade, GDP, OFDI, sales, fixed_inv, and ind-value is significant. As shown in Table 5, the correlation coefficient between Trade and GDP is 0.5840, and the correlation is generally significant; The correlation coefficient with FDI is 0.0191, and the correlation is not very significant; The correlation coefficient with OFDI is 0.7977, indicating a highly significant correlation; The correlation coefficient with

the total social sales and retail sales of sales is 0.5796, indicating a significant correlation; The correlation coefficient with fixed assets investment is 0.2119, which is not very significant; The correlation coefficient with industrial added value is 0.4349, indicating a significant correlation; The correlation coefficient with labor force is 0.1408, and the correlation is not very significant. It can be seen that there is a strong positive correlation between Trade and GDP, OFDI, sales, and industrial added value.

Table5. Correlation Coefficient

	Trade	gdp	ofdi	sales	fixed_~v	ind_va~e	labors
Trade	**1.0000**						
gdp	**0.5840***	**1.0000**					
	0.0000						
fdi	**0.0191**	**0.1169**					
	0.7991	**0.1180**					
ofdi	**0.7977***	**0.5669***	**1.0000**				
	0.0000	**0.0000**					
sales	**0.5796***	**0.9808***	**0.5734***	**1.0000**			
	0.0000	**0.0000**	**0.0000**				
fixed_~v	**0.2119***	**0.8730***	**0.2808***	**0.8574***	**1.0000**		
	0.0043	**0.0000**	**0.0001**	**0.0000**			
ind_va~e	**0.4349***	**0.9303***	**0.4082***	**0.8981***	**0.8697***	**1.0000**	
	0.0000	**0.0000**	**0.0000**	**0.0000**	**0.0000**		
labors	**0.1408**	**0.7408***	**0.1353**	**0.6936***	**0.7735***	**0.8207***	**1.0000**
	0.0594	**0.0000**	**0.0702**	**0.0000**	**0.0000**	**0.0000**	

4.3 Estimated Results

4.3.1 Domestic Pilot on total trade

Table 6. Double Difference Estimation Result (Total Trade Volume)

lntrade	Robust					
	Coef.	Std.Err	z	P>|z|	[95% Conf. Interval]	
lngdp	**1.438136**	**.3345291**	**4.3**	**0.000**	**.7824713**	**2.093801**
lnfdi	**.0585931**	**.412909**	**1.42**	**0.156**	**-.0223356**	**.1395218**
lnofdi	**.0336343**	**.0338621**	**0.99**	**0.321**	**-.0327342**	**.1000028**
lnfixed_inv	**-.2996199**	**.1716247**	**-1.75**	**0.081**	**-.6359982**	**.0367583**
lnlabors	**-.2285147**	**.2665359**	**-1.01**	**0.314**	**-.7909154**	**.253886**
time	**-.2298905**	**.1407482**	**-1.63**	**0.102**	**-.505752**	**.0459709**
treated	**.4527998**	**.3423562**	**1.32**	**0.186**	**-.218206**	**1.123806**
did	**.2287921**	**.1325638**	**1.73**	**0.084**	**-.0310281**	**.4886123**
_cons	**-2.061204**	**1.836514**	**-1.12**	**0.262**	**-5.660707**	**1.538298**
sigma_u	**.38787958**					
sigma_e	**.23551814**					
rho	**.73062856**					
N	**180**					
Ch2(8)	**240.52**					
P	**0.0000**					

It can be seen in Table 6, the coefficient of DID is significantly positive (0.2288), indicating that the implementation of policies in the free trade pilot zone has a significant (10% significance level) positive driving effect on the total import and export trade. This empirical test confirms the basic hypothesis that "establishing a free trade zone" does indeed promote the growth of foreign trade volume. On the one hand, it is because the foreign trade business of each free trade experimental zone has developed steadily; On the other hand, various pilot free trade zones actively carry out institutional innovation in stabilizing foreign trade, providing a batch of replicable and promotable experiences, such as the innovative cross-border e-commerce "multi warehouse linkage" model in Heilongjiang

Pilot Free Trade Zone. Trade

4.3.2 Domestic Pilot on Import & Export

Table 7. Double Difference Estimation Result (Import)

lnimport	Robust					
	Coef.	Std.Err	z	P>|z|	[95% Conf. Interval]	
lngdp	1.31917	.4347938	3.03	0.002	.4669901	2.17135
lnfdi	.1393994	.0752971	1.85	0.064	-.0081803	.286979
lnofdi	.015559	.0429116	0.36	0.717	-.0685462	.0996642
lnfixed_inv	-.5586729	.2409458	-2.32	0.020	-1.030918	-.0864279
lnlabors	-.0243842	.3513486	-0.07	0.945	-.7130148	.6642464
time	-.0274117	.1228948	-0.22	0.823	-.2682812	.2134578
treated	.3346426	.3400715	0.98	0.325	-.3318854	1.00117
did	.1858366	.1190974	1.56	0.119	-.04759	.4192633
_cons	-1.589635	2.054796	-0.77	0.439	-5.616962	2.437691
sigma_u	.43557701					
sigma_e	.27958647					
rho	.70821284					
N	180					
R2	0.7894					
chi2(8)	256.43					
P	0.0000					

Table 8. Double Difference Estimation Result (Export)

lnimprt	Robust					
	Coef.	Std.Err	z	P>|z|	[95% Conf. Interval]	
lngdp	1.263271	.2924327	4.32	0.000	.6901135	1.836429
lnfdi	.0583038	.1086858	0.54	0.592	-.1547165	.2713241
lnofdi	.1727351	.0800849	2.16	0.031	.0157715	.3296987
lnfixed_inv	-.3775434	.226149	-1.67	0.095	-.8207872	.0657004
lnlabors	-.1583104	.2318803	-0.68	0.495	-.6127874	.2961666
time	-.7191988	.2138438	-3.36	0.001	-1.138325	-.3000727
treated	-.7650085	.3538189	-2.16	0.031	-1.458478	-.0715334
did	1.597843	.3078178	5.19	0.000	.9945314	2.201155
_cons	-1.186714	1.170012	-1.01	0.310	-3.479896	1.106467
sigma_u	.5090015					
sigma_e	.85631883					
Rho	.26107598					
N	180					
R2	0.7894					
chi2(8)	278.32					
P	0.0000					

It can be seen in Table 7, although the coefficient of DID is positive (0.1858), it is not significant (P=0.119), indicating that the implementation of free trade pilot zone policies has no significant impact on changes in total import trade. This may be due to the time required for the implementation of new measures such as institutional innovation and market opening in free trade zones, or the lag in their effects; On the other hand, it may also be because some inland provinces are not suitable for developing an outward oriented economy and have not seen the changes brought about by the implementation of policies to establish free trade zones in the short term.

In addition, as shown in Table 8, the coefficient of DID is significantly positive (1.5978), and the coefficient is particularly significant (P=0.000), indicating that the implementation of free trade pilot zone policies has a significant (1% significance level) positive promotion effect on the total export trade. On the other hand, it has also

been proven that before the implementation of the free trade pilot zone policy, there was no significant difference in the total export value between the experimental group and the control group. However, after the implementation of the free trade pilot zone policy, there was a significant change in the total export value between the experimental group and the control group, which also indicates that the implementation of the free trade pilot zone policy has a significant positive promotion effect on the total export value.

4.3.4 Double difference experiment results of free trade pilot zone

In summary, the effect before and after the implementation of the policy of establishing a free trade pilot zone is yDID=ydid2-ydid1=1.739. As seen in table 9:

Table 9. DID Result

Outcome var	lnexp~t	S.Err.	| t |	P>| t |
Before				
Control	**6.640**			
Treated	**6.843**			
Diff(T-C)	**0.203**	**0.244**	**0.83**	**0.406**
After				
Control	**6.287**			
Treated	**8.228**			
Diff(T-C)	**1.941**	**0.372**	**5.22**	**0.000*****
Diff-in-Diff	**1.739**	**0.445**	**3.91**	**0.000*****

R-square: 0.15

*Meansand Standard Errorsare estimated by linear regression

Inference*p {<}0.01; **P {<}0.05; *P {<}0.1

5. Conclusion and Suggestions

By searching the National Statistical Yearbook, Provincial Statistical Yearbook, National Bureau of Statistics of the People's Republic of China, China Economic Net Industry Database, Ministry of Commerce of the People's Republic of China, and provincial statistical bulletins to collect economic data from 18 provinces in China from 2010 to 2019, with Liaoning, Zhejiang, Henan, Hubei, Chongqing, Sichuan, and Shaanxi provinces as the experimental group and Beijing, Shanxi, Inner Mongolia, Jilin, Anhui, Jiangxi, Hunan, Guizhou, Gansu, Qinghai, and Ningxia as the control group, the double difference method (DID) analysis was used to explore whether the establishment of free trade zones has played a role in promoting exports and imports. The empirical results show that: (1) the implementation of policies has a significant positive driving effect on the total import and export trade volume, as well as the total export trade volume; (2) Before the implementation of the free trade pilot zone policy, there was no significant difference in the total export value between the experimental group and the control group. However, after the implementation of the free trade pilot zone policy, there was a significant difference in the total export value between the experimental group and the control group. This also indicates that the implementation of policy has a significant positive promoting effect on the total export value; (3) The establishment of the free trade zone has a certain positive spillover effect on the economic development of the province, and this effect still holds under strict and stable conditions.

Based on the above research results, the establishment of domestic free trade pilot zones has indeed had a positive impact on regional economic development. Therefore, analyzing the reasons for the success of these provinces can provide a model and inspiration for future reforms of free trade pilot zones. Firstly, increase the implementation of the free trade zone strategy and improve the spatial radiation mechanism of the free trade zone. From the research results, the establishment of free trade zones has a significant positive promoting effect on regional economic growth. Therefore, it is necessary to further strengthen policy support for established free trade zones, increase feasibility studies for newly established free trade zones, and continuously expand and enrich the coverage and connotation structure of China's free trade zones. Secondly, optimize the spatial layout and promote differentiated development of the

free trade zone. Based on the relatively strong promotion of positive economic growth by inland free trade zones, the country should strengthen its policy tilt towards inland free trade zones to promote their higher quality development. For relatively mature coastal free trade zones, the focus should be on highlighting the quality requirements of institutional innovation and achieving improvement in development connotation and efficiency. Thirdly, each free trade zone should leverage its own strengths and unleash systemic synergies. Release market vitality and steadily promote the transformation and innovation of government functions.

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Key Topics of Zhejiang Provincial Education Science Plan for 2021 (2021SB094): Research on the Model of Advanced Teaching in Macroeconomics Based on OBE Results)

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