

Economic Effects of Free Trade Zones based on Panel Data and Synthetic Control Methods

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Abstract: - To analyze the impact of the establishment of FTZs on economic growth, the study quantitatively evaluates the economic effects of FTZs through the synthetic control method, taking Fujian FTZs as the unit of policy intervention, and combining the panel data with the placebo test method. The mechanism of economic growth effect of the establishment of FTZ is analyzed through the mechanism of mediating effect. The results show that the estimation results of the research method are better and more robust. The difference between the true and composite values of the control variable is relatively small, with the true and composite values of openness being 15.9226 and 15.4561, respectively, with a difference of 0.4665. In 2015, the difference in GDP between Fujian Province and synthetic Fujian Province reached 0.1, and the difference has significantly increased thereafter. After adding control variables, the trend of this difference over the years is consistent with that before adding control variables, i.e., the establishment of FTZ in Fujian Province can significantly promote economic growth. There is a 1/26 probability that other provinces and cities can obtain the same policy effect as Fujian Province. Compared to other synthesized results, the maximum root mean square error ratio in Fujian Province is 6.0, which is 2.8 higher than that in Jiangsu Province, indicating the maximum processing effect. Among them, the root-mean-square error ratios of Shandong Province and Chongqing Municipality are 2.2 and 2.3, respectively, while the root-mean-square error ratio of Fujian Province is 6.0. The research method can effectively analyze the economic effects of FTZ in Fujian Province and deepen the comprehensive understanding of the economic effects of FTZ.

Key-Words: - Free trade zone; Economic effects; Panel data; Synthetic control method; Economic growth; Fujian Province; Robustness check

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1 Introduction

In the increasingly complex world economic environment, countries are looking for new ways of economic growth, trying to find a power engine that can sustainably promote high-quality economic development, [1], [2], [3]. Against this background, China has established pilot free trade zones (FTZs) based on its national and international conditions. As a strategic development plateau, FTZs can not only provide convenient conditions for the development of foreign-funded industrial enterprises in the region but also give full play to their overall effectiveness and become an endogenous force and driving engine for economic growth, [4], [5], [6]. Under the circumstances that the industrial chain and supply chain are gradually anti-globalization, China's FTZ while playing the role of innovation and other platforms and comprehensive effects, should also pay attention to the internal construction, and promote the informationization

and modernization of economic development. Fujian FTZ, as one of China's FTZs, has carried out financial reform and other related attempts. Among them, it is of great practical significance to analyze the economic effects of Fujian FTZ. The synthetic control method, as a policy effect evaluation method, can reduce the error caused by subjective choice. In this regard, the study takes Fujian FTZ as the research object and chooses the synthetic control method to understand the economic effects of Fujian FTZ policies. The study is divided into four parts. The first part is a literature review, which introduces the research of scholars at home and abroad on the FTZ and the synthetic control method. The second part analyzes the impact of Fujian FTZ on the regional economy through the synthetic control method, conducts a placebo test, and conducts a mediation effect test. The third part conducts empirical analysis and mechanism tests. The fourth part summarizes the research methods and so on,

and proposes the future research direction based on the research deficiencies.

2 Related work

FTA, as the high ground of the current policy, analyzing its impact on economic growth has more important practical significance. In the analysis of FTAs, many scholars have carried out relevant discussions. Eteria takes Georgia and Moldova's FTA agreement with the European Union as the object of study, and to understand the relationship between it and the corresponding trade performance, the relationship is explored based on relevant data analysis. The results show that during the agreement period, the relevant trade shows positive development, but the performance in export is flat, [7]. [8], take the China-ASEAN FTA as the research object, to explore the situation of its trade creation effect, firstly, we carry out the selection of samples and construct the trade gravity model. After empirical analysis, it is found that the increase in GDP of trading countries has a positive effect on trade flows, [8]. [9], take COMESA FTA as the research object, and to analyze the relationship between NTBs and it, they carry out a case study design to explore the relationship. From the results of the correlation analysis, it can be seen that the elimination of this barrier is facilitated by the provision of bilateral agreements. [10], take the Chinese FTA as the object of research, to study the relationship between it and economic growth, choose the double-difference-in-differences model (DID), and carry out the correlation analysis. From the results of the study, it can be seen that there is a positive correlation between FTZs and economic growth. [11], take FTZs as the research object, and through analyzing the relevant panel data, they found that the policy of FTZs is conducive to the reduction of income disparity among provinces, and this effect is more obvious in the provinces with relatively low incomes.

[12], analyzed the economic effects of the Spanish government choosing the synthetic control method and improving it, and after a comparative analysis, it was found that the results of the improved synthetic control method were more accurate. [13], used the police department in a business district of a city in New Jersey as a study to explore its effects on crime. The construction of relevant control groups was carried out through the synthetic control method. The results show that, unlike the synthetic control area, the relevant crimes in the target area appear to be significantly

improved. [14], face the problem of effective formulation of market policies, take the carbon trading policy as the research object, analyze its implementation, study the factors affecting carbon emissions, and explore the implementation of the pilot policy through the synthetic control method. After analysis, under the role of carbon trading policy, it can promote carbon emission reduction. To study the impact of the new coronary pneumonia interventions on the epidemic, [15], chose the synthetic control method and analyzed it, and the introduction of an epidemiological house room model was carried out based on analyzing and observing the data. By comparing the results of the relevant assessments, it was found that earlier implementation of interventions favored the control of the epidemic, while mild interventions, which may favor the control of the epidemic at an early stage, had less social damage.

To summarize, in the FTZ research, most of the research methods are case studies and so on, which have multiple treatment groups and do not apply to the research of policy evaluation with only one treatment group, whereas the synthetic control method meets this requirement and can be used in the policy evaluation with only one treatment group. Therefore, the study adopts the synthetic control method in the exploration of the relationship between the construction of the FTZ and the economic dynamics of the Fujian region. Compared to previous studies, the study's method is apt and can be applied to policy evaluation with only one treatment group.

3 Application of Synthetic Control Method in the Analysis Of Economic Effects of FTZs

To understand the situation of economic effects of Fujian FTZ, the study chooses the synthetic control method and placebo test method to quantitatively assess the economic effects of Fujian FTZ. The mechanism of economic growth effect of the establishment of Fujian FTZ is analyzed through the mechanism of mediation effect.

3.1 Application of Synthetic Controls and Placebo Tests in the Analysis of the Economic Effects of FTAs

The establishment of the FTZ is conducive to the market-oriented operation of China's economy and promotes the coordination of internal economic

development strategies and external strategies, [16], [17].

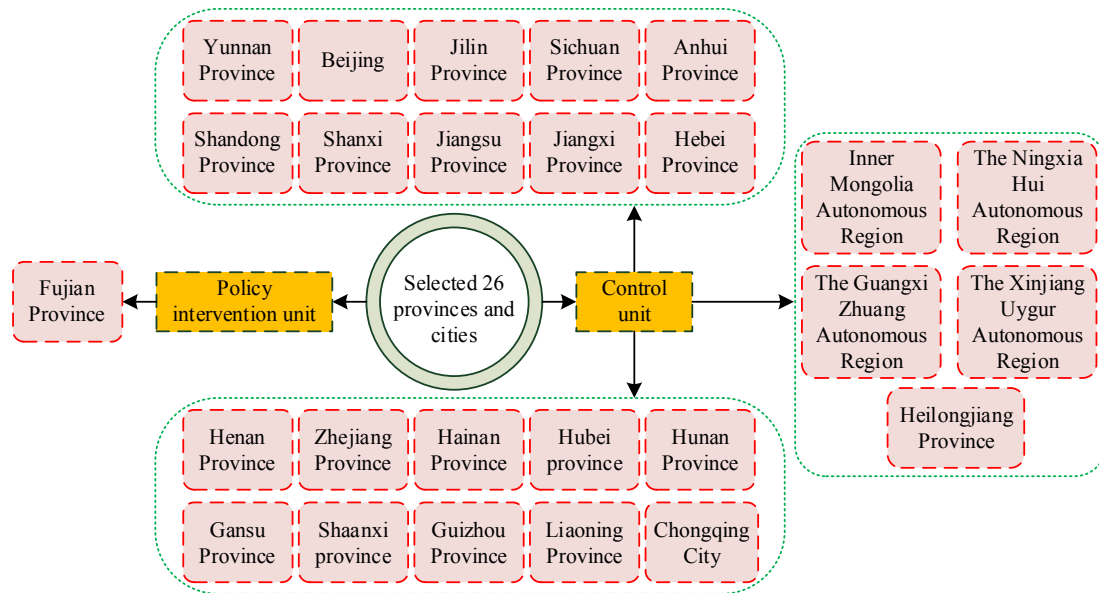


Fig. 1: 26 provinces and cities

Taking the Fujian FTZ as an example, the economic effects of the establishment of this FTZ are analyzed. In this regard, the study adopts the synthetic control method to make relevant assessments. Based on the basic principles of the method, Fujian Province is set as a policy intervention unit. Since Fujian Province is not the first region to implement the FTZ, the provinces and cities in Fujian Province that have established FTZs before are excluded from the sample, thus obtaining one policy intervention unit and 25 control units in Fujian Province. Among them, the details of these 26 provinces and cities are shown in Figure 1.

In Figure 1, there are 26 provinces and cities such as Yunnan Province and Beijing. Based on the selected 26 provinces and cities, the construction of the relevant model is carried out, and its mathematical expression is shown in Equation (1).

$$Y_{it}^1 = \alpha_{it} D_{it} + Y_{it}^N, D_{it} = \begin{cases} 1 & t > T_0 \\ 0 & \text{other} \end{cases} \quad (1)$$

In Equation (1), the policy intervention effect is denoted as α_{it} , t , T_0 for time, and the time-varying policy intervention effect is set to $(\alpha_{i_{T_0+1}}, \dots, \alpha_{it})$, N for quantity, and Y_{it} variable. To obtain α_{it} , it is necessary to estimate Y_{it}^N when $t > T_0$ denotes the outcome variable for observable policy intervention individuals as Y_{it}^1 . In the absence of a policy point in time, the corresponding individual outcome variable for the policy intervention Y_{it} can be denoted as

Y_{it}^N , in which case Y_{it}^N is unobservable. The synthetic control approach, centers on performing the construction of the counterfactual Y_{it}^N of Y_{it} . The relevant assumption is made that the normalized weight vector of potential comparison group objects is assumed to be $W = (W_2, \dots, W_{26}^*)$ such that for each W vector value there exists a potential synthetic control variable, which is denoted as $\sum_{j=2}^{26} W_j Y_{jt}$. In the meantime, there exists an optimal weight vector $W^* = (W_2^*, \dots, W_{26}^*)$ such that $\sum_{j=2}^{26} W_j Y_{jt}$ can be used as an approximate estimator of Y_{it}^N . On this basis, an estimator of α_{it} can be obtained, and the relevant mathematical expression for this estimator is shown in Equation (2).

$$\hat{\alpha}_{it} = Y_{it}^1 - \hat{Y}_{it}^1 = \sum_{j=2}^{26} W_j Y_{jt}, \quad t > T_0 \quad (2)$$

In Equation (2), the estimate of α_{it} is denoted as $\hat{\alpha}_{it}$, and the estimate of Y_{it}^1 is denoted as \hat{Y}_{it}^1 . Conduct the selection and description of variables. Based on the research subjects selected for the study, Fujian Province was set as the treatment group. For the control group, to make its conditions as identical as possible to those of Fujian Province except for the explanatory variables, the years of the provincial panel data selected for the study are from

2000 to 2018, and the provinces and cities that do not meet the requirements, such as the relatively low data, are excluded, and the data of 26 provinces (municipalities) are selected.

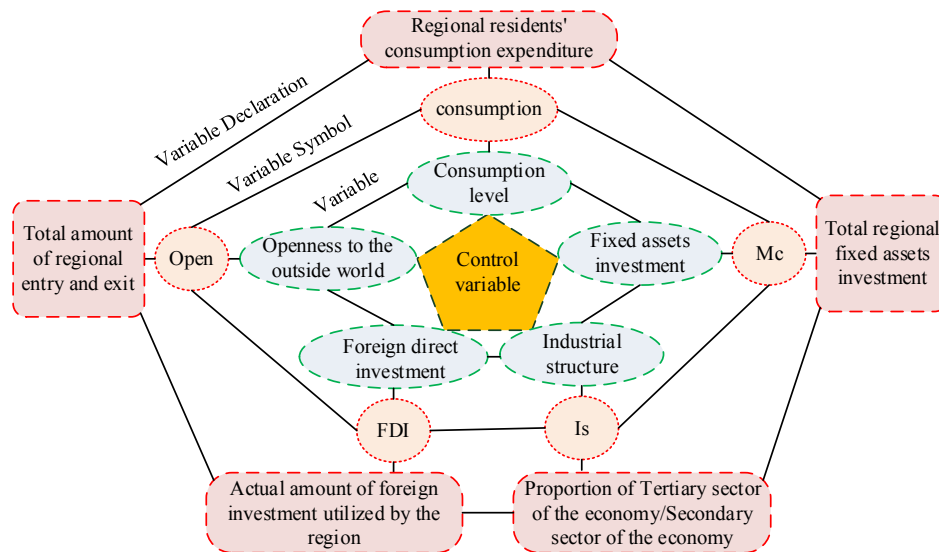


Fig. 2: Relevant explanations of control variables

The year of the start of the policy is set according to the time of the establishment of the Fujian FTZ, which is set to 2015. The explanatory variable is economic growth, and the level of economic growth is expressed through the real gross domestic product (GDP) of each province and city, taking its natural logarithm. Among the explanatory variables, the dummy variable *treat* is selected whether or not the FTZ is established, and it indicates the FTZ reform. The value of *treat* is 1 if it is established in the current year and beyond; otherwise, it is 0. The control variables and their relevant definitions are shown in Figure 2.

In Figure 2, there are five control variables, whose variable symbols are derived from the abbreviation of the variable name or a part of it, and the meanings represented by the symbols of different control variables, such as FDI for foreign direct investment, which is the amount of foreign capital utilized in the region. According to the synthetic control method, a synthetic Fujian Province is obtained, which contains the provinces (cities) of Liaoning Province, Ningxia Hui Autonomous Region, Jiangsu Province, Zhejiang Province, and Hainan Province, and the weights of the corresponding provinces (cities) are 0.621, 0.045, 0.067, 0.168 and 0.098, respectively, where the synthetic Fujian Province is the same as the real Fujian Province in other cases. The synthetic effect of synthetic Fujian Province is tested to analyze the real and synthetic values of its control variables, as

well as the economic growth of Fujian Province and synthetic Fujian Province, to explore the impact of the establishment of FTZ on economic growth. Robustness test. For economic growth, there are many factors affecting it, and there are only a few control variables selected for the study. To avoid interference with the research estimation results due to the omission of variables, the addition of control variables is carried out, adding variables such as financial market size, regional urbanization level, etc., and the reconstruction of synthetic Fujian Province is carried out through the synthetic control method. The provinces (cities) included in the synthetic Fujian Province are Jiangsu Province, Zhejiang Province, and Hainan Province, and their weights are 0.433, 0.266, and 0.301, respectively. The values of the control variables of Fujian Province and the synthetic Fujian Province are analyzed to study the changes of GDP in different years, and to judge the robustness of the estimation results of the study.

To avoid the variable measurement error affecting the estimation results of the study, the regional economic growth level is expressed through the per capita GDP, and the synthetic Fujian Province obtained through the synthetic control method changes, as shown in Figure 3.

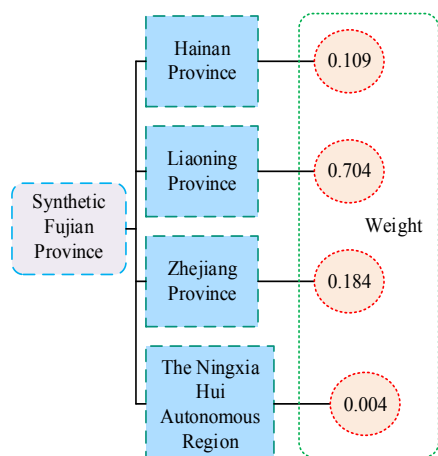


Fig. 3: Relevant explanations of control variables

In Figure 3, the provinces (cities) it contains are Liaoning Province, Ningxia Hui Autonomous Region, Zhejiang Province, and Hainan Province, and the weights of the corresponding provinces (cities) are 0.704, 0.004, 0.184, and 0.109, respectively, with Liaoning Province taking the largest weight. On this basis, the correlation values of the control variables of Fujian Province and synthetic Fujian Province are analyzed to study the changes in their GDP under different years and to judge the robustness of the estimation results of the study. Compared with the DID method, although the synthetic control method will select the control group more strictly, the estimated economic growth effect of the study cannot be fully guaranteed to be affected by the FTZ because the interregional economy is affected by more unobservable policies, so a placebo test is needed to accurately assess the estimated effect of the policies. The study takes 25 provinces (municipalities) other than Fujian Province as treatment groups respectively, and estimates them through the synthetic control method, comparing the net effect of the policies they obtained with the baseline results, and analyzing the effect of the existence of the FTZ and economic growth in Fujian Province. The results of the multiple synthetic control method are compared with the results of Fujian Province as the treatment group to analyze the effect of the establishment of FTZ in Fujian Province on economic growth. Root Mean Square Error (RMSE) was selected to improve the accuracy of the test by calculating the ratio of RMSE before and after the establishment of FTZ in each province (city) and conducting a placebo test. That is to say that setting Fujian Province as affected by the FTZ will result in a large treatment effect, and the out effect on other provinces (cities) when synthesized are all relatively small. The RMSE ratios of Fujian Province and

other provinces (cities) are calculated to analyze the robustness of the estimation results of the research method.

3.2 Analysis of the Economic Growth Effect Mechanism of the Establishment of the Fujian FTZ

After the empirical analysis of the research method, the mechanism of the impact of the establishment of Fujian FTZ on economic growth is studied. Referring to the existing research, the mechanism of the establishment of FTZ affecting economic growth is summarized, which can be divided into three kinds, namely, improving the level of technological innovation, improving industrial agglomeration, and improving the efficiency of resource allocation. Based on this, the study adopts the mediation effect model when conducting the impact mechanism research. First, the mediation effect test of the innovation drive is carried out. In the test, technological innovation is set as a mechanism variable, and in the process of testing the impact of the establishment of FTZ on economic growth through regression analysis, the first relevant econometric modeling is carried out, in which the relevant mathematical expression for testing the impact of the establishment of FTZ on economic growth is shown in Equation (3).

$$\ln gdp_{it} = \alpha_0 + \beta_1 t_treat_{it} + \beta_2 X_{it} + \varepsilon_{it} + \mu_{it} \quad (3)$$

In Equation (3), the set of economic growth is set to $\ln gdp$. The dummy variable for the establishment of FTZ is denoted as t_treat_{it} , and the set of values for all the years before the establishment of FTZ in a certain region is set to 0, and in the year of the establishment of the FTZ in the region and beyond is set to 1. According to the year of the start of the policy of FTZ in Fujian Province in the study, the lagged value of the province in 2015 is set to 1, and the value of other provinces and cities is set to 0.

The set of control variables is set to X_{it} . To make the estimation results reliable, the selection of relevant control variables is the same as the above selection. β_1 The regression coefficients are β_2 and β_3 , and the parameters are α_0 , ε_{it} and μ_{it} . The relevant mathematical expressions involved in testing the impact of the establishment of FTZ on technological innovation are shown in Equation (4).

$$\begin{aligned} \ln rd_{it} = & \alpha_0 + \beta_1 t_treat_{it} \\ & + \beta_2 X_{it} + \varepsilon_{it} + \mu_{it} \end{aligned} \quad (4)$$

In Equation (4), the level of technological innovation is expressed as $\ln rd$ and is measured by the number of patents granted in several zones $\ln rd$. The mediating effect of technological innovation in FTZs affecting economic growth is tested, involving the relevant mathematical expressions shown in Equation (5).

$$\begin{aligned} \ln gdp_{it} = & \alpha_0 + \beta_1 t_treat_{it} \\ & + \beta_2 \ln rd_{it} + \beta_3 X_{it} + \varepsilon_{it} + \mu_{it} \end{aligned} \quad (5)$$

Based on the above regression equation, the innovation-driven mediation effect test is carried out to determine whether technological innovation is the mediating mechanism for the FTZ's effect on economic growth from the relevant regression coefficients obtained. The establishment of the FTZ has brought many conveniences to the companies in the region, such as tax breaks and exemptions. If companies in the FTZ can get more policy support for import and export and lower prices for imported goods, then for companies in other industries, the establishment of a branch in the FTZ can help them reduce costs and improve their productivity, thus enhancing their market competitiveness. Therefore, compared with regions without FTZs, regions with FTZs will have a certain "siphoning" effect on enterprises in the neighboring regions, thus attracting more enterprises to come. To analyze whether the level of industrial agglomeration is the intermediary mechanism of the establishment of FTZ affecting regional economic growth, the same method as that of the innovation-driven intermediary effect test is adopted to carry out the correlation analysis. Among them, the relevant mathematical expressions involved in the calculation of industrial agglomeration are shown in Equation (6).

$$aggl_{it} = \left(\frac{ind_{it}}{\sum_1^{31} ind_{it}} \right) / \left(\frac{\ln gdp_{it}}{\sum_1^{31} \ln gdp_{it}} \right) \quad (6)$$

In Equation (6), the index of industrial agglomeration is set to $aggl_{it}$, and the proportion of the output value of the secondary industry to the total output value of the secondary industry of the province is expressed as in the $ind_{it} / \sum_i^n ind_{it}$ t th year of the i province (city). In the year t of i province (city), the proportion of GDP to the total GDP of the sample province (city) after the GDP is expressed as $\ln gdp_{it} / \sum_i^n \ln gdp_{it}$. For $aggl$, the higher value means a higher level of industrial agglomeration. On this basis, the test of mediation

effect driven by industrial agglomeration is carried out, so that the results obtained can be judged relevantly. The establishment of FTZ will break the barriers to the flow of production factors, commodities, etc. Based on this, the study explores the impact of the establishment of FTZ on economic growth from the perspective of resource allocation efficiency. Total factor productivity is calculated through $deap2.1$, and in the selection of input variables, fixed capital stock, and employment are selected, and GDP is taken as the output variable. The Malmquist index was calculated assuming constant returns to scale. Using this index, the efficiency of resource allocation is measured. It is worth mentioning that regions with higher total factor productivity possess relatively higher resource allocation efficiency. The mediation effect driven by resource allocation efficiency is tested by the method of mediation effect test described above. Based on the regression estimation results, relevant judgments are made.

4 Empirical Analysis and Mechanism Test of Economic Effects of Fujian Free Trade Zone

The synthetic control method and placebo test are chosen to quantitatively assess the economic effects of Fujian FTZ. Through regression analysis, the mediating effect test of innovation-driven, industry agglomeration-driven, etc. is carried out.

4.1 Benchmark Regression Results and Robustness Testing Analysis

The provincial panel data selected for the study ranged from 2000 to 2018. Provinces and cities with relatively low data that did not meet the requirements were excluded, and data from 26 provinces (cities) were selected. According to the synthetic control method, a synthetic Fujian province is obtained, which includes provinces (cities) such as Liaoning Province, Ningxia Hui Autonomous Region, Jiangsu Province, Zhejiang Province, and Hainan Province. The relevant weights are shown in the previous text. The synthetic effect of synthetic Fujian Province under the synthetic control method is examined to analyze the real and synthetic values of control variables under synthetic Fujian Province, and the specific results are shown in Figure 4.

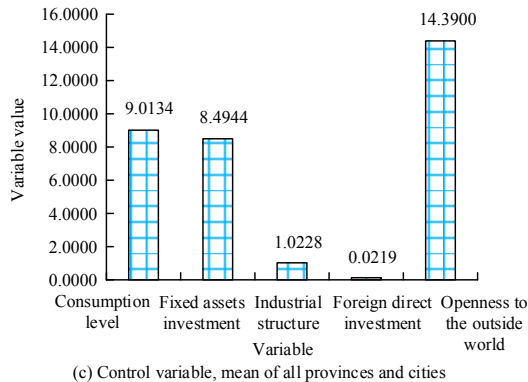
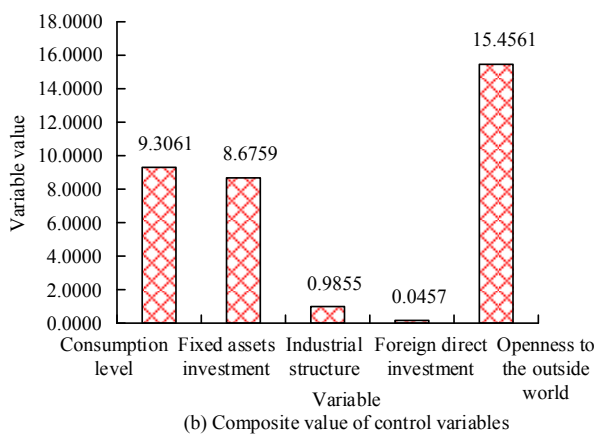
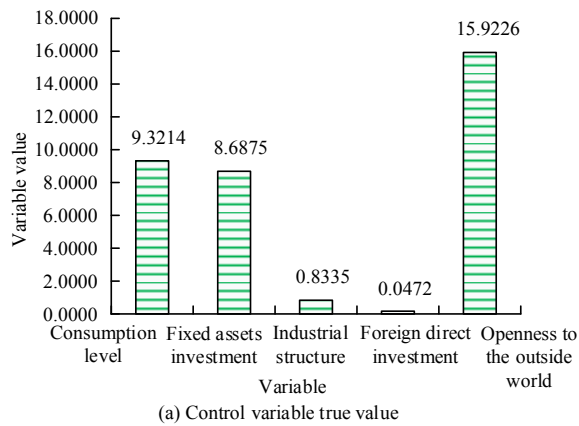


Fig. 4: Relevant explanations of control variables

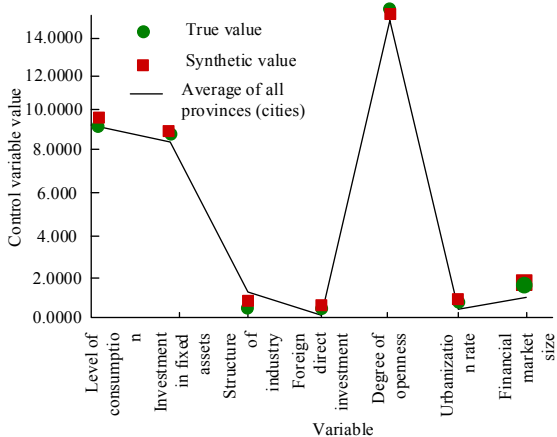
In Figure 4(a), the real values of different control variables are different, the real value of the degree of external openness is the largest, while the real value of foreign direct investment is the smallest. The real value of external openness is 15.9226, which is 6.6012 higher than the consumption level, while the latter's real value is 9.3214; the real value of industrial structure is smaller at 0.8335. In Figure 4(b), the synthetic value of external openness is the largest, followed by the consumption level. The synthetic value of the degree of openness to the outside world is 15.4561, which is 0.4665 smaller than its true value; the synthetic value of the consumption level is 9.3061, which is 0.0153 smaller than its true value. Comparing Figure 4(a) and Figure 4(b), it can be seen that the difference between the true value of the control variables and the synthetic stone is small. In Figure 4(c), the average value of all provinces and cities of the other party's openness is 14.3900, which is 5.8956 larger than the fixed asset investment. To study the economic growth of Fujian Province and synthetic Fujian Province, the specific results are shown in Table 1.

Table 1. GDP of Fujian Province and composite Fujian Province

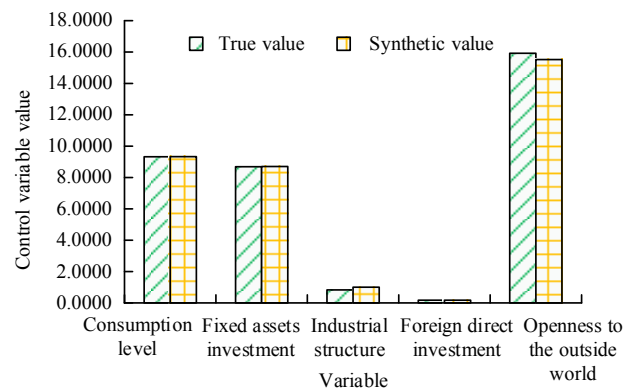
Time (year)	2000	2001	2002	2003	2004	2005	
Fujian's (real) GDP	8.23	8.31	8.40	8.51	8.66	8.79	
Composite GDP	8.19	8.28	8.38	8.50	8.63	8.80	
Difference	0.04	0.03	0.02	0.01	0.03	-0.01	
Time (year)	2006	2007	2008	2009	2010	2011	
Fujian's (real) GDP	8.93	9.13	9.29	9.41	9.60	9.77	
Composite GDP	8.95	9.13	9.32	9.42	9.61	9.80	
Difference	-0.02	0.00	-0.03	-0.01	-0.01	-0.03	
Time (year)	2012	2013	2014	2015	2016	2017	2018
Fujian's (real) GDP	9.89	9.99	10.05	10.19	10.37	10.48	10.56
Composite GDP	9.90	9.99	10.05	10.09	10.15	10.21	10.26
Difference	-0.01	0.00	0.00	0.10	0.22	0.27	0.30

In Table 1, the difference between the GDP of Fujian Province and synthetic Fujian Province under different years is different, the difference is very small before 2015, and after 2015, and the difference becomes bigger gradually. When the time is 2001, the real GDP value of Fujian Province was 8.31, which is 0.03 larger than that of synthetic Fujian Province; when the time is 2007, the GDP of Fujian Province and synthetic Fujian Province were both 9.13; when the time is 2015, the GDP of Fujian Province and synthetic Fujian Province are 10.19 and 10.09, respectively, and the difference between them is 0.10; and when the time is 2018, the real GDP value is 10.56, which is 0.30 larger than that of synthetic Fujian Province. It can be seen that compared with the control group for the establishment of FTZ, the GDP of Fujian Province is significantly improved, and the establishment of FTZ can significantly promote economic growth. For the robustness test, after adding the control variables such as financial market size, the control variables and the true value of the synthetic Fujian Province and the GDP of Fujian Province and the synthetic Fujian Province are shown in Figure 5.

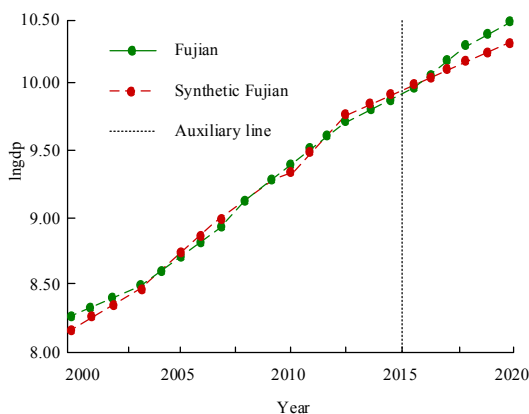
In Figure 5(a), except for individual control variables, the synthetic values of other variables are closer to the true values. The real value of industrial structure is 0.8335, which is 0.3200 smaller than the synthetic value, which is 1.1535; the synthetic and real values of consumption level are 9.3476 and 9.3214, respectively; and the real value of urbanization rate is 0.5459, which is 0.0069 smaller than the synthetic value. In Figure 5(b), the trend of the change in GDP of Fujian Province and synthetic Fujian Province over time is the same as that of Table 1. It is the same. When the time is 2005, the real GDP value of Fujian Province is 8.79, which is 0.05 smaller than that of synthetic Fujian Province, which is 8.84; when the time is 2017, the GDP of Fujian Province and synthetic Fujian Province are 10.48 and 10.33, respectively. Thus, it can be seen that the estimation results of the research method are robust. To avoid the impact of variable measurement error on the estimation results, the replacement of the explanatory variables is carried out, which is replaced by GDP per capita, and thus the control variables and GDP of Fujian Province and synthetic Fujian Province are shown in Figure 6.



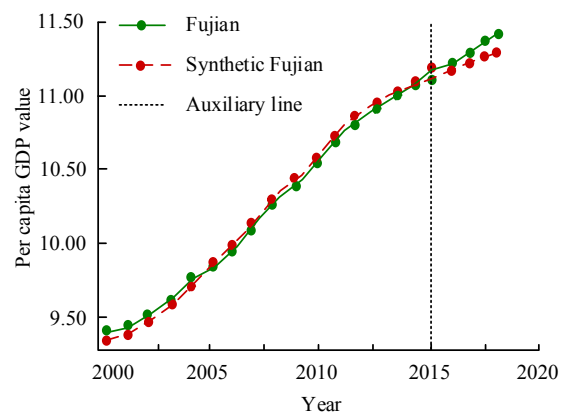
(a) Comparison of real and synthetic values of control variables



(a) Control variable true value



(b) Economic growth in Fujian Province and Fujian combined

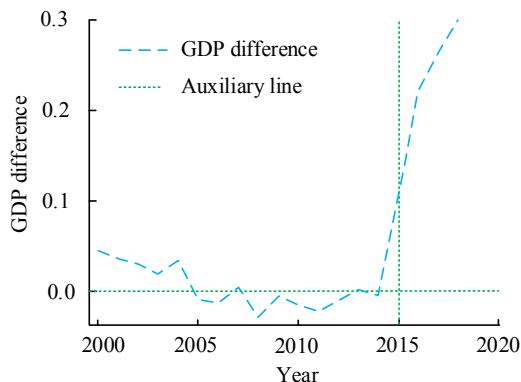


(b) Per capita GDP of Fujian Province and Synthetic Fujian Province

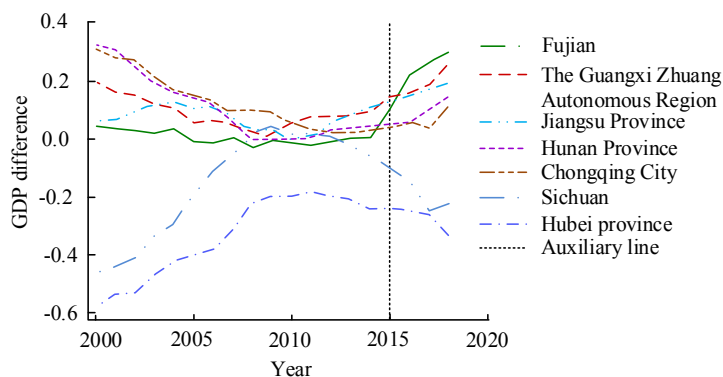
Fig. 5: Control variables and GDP of Fujian Province and composite Fujian Province

Fig. 6: Control variables and GDP of Fujian Province and composite Fujian Province

In Figure 6(a), the synthetic and real values of the control variables are closer to each other, the synthetic and real values of the degree of openness to the outside world are 15.5184 and 15.9226 respectively, with a difference of 0.4042; and the synthetic and real values of the foreign direct investment are the same, both are 0.0472.



(a) Net effect



(b) Sorting test

Fig. 7: Net effect and ranking test

From the trend of the graph in Figure 6(b), the trend of the change is still the same as that of Table 1, and after 2015 the real GDP per capita increases significantly, and when the time is 2016, the GDP per capita of Fujian Province and synthetic Fujian Province are 11.23 and 11.18 respectively. Further proving that the estimation results of the research method are robust. A placebo test is conducted to obtain the net effect of the FTA and the partial ranking test after the multiple synthetic control method is shown in Figure 7.

Figure 7(a) shows the difference between the GDP of the treatment group and the control group, and it can be seen from the trend of the graph that the net effect before 2015 stays near 0, and the net effect increases significantly after 2015, which indicates that there is a promotion effect of the FTZ on economic growth. In Figure 7(b), the results of the synthetic control method in different provinces and cities differ, and by comparing their graphs, it can be seen that compared with other provinces and cities, the difference between the real GDP and the synthetic group GDP in Fujian Province is more obvious, and other provinces and cities have 1/26 probability of obtaining the same policy effect as that of Fujian Province. The RMSR ratio test is carried out, which is shown in Figure 8.

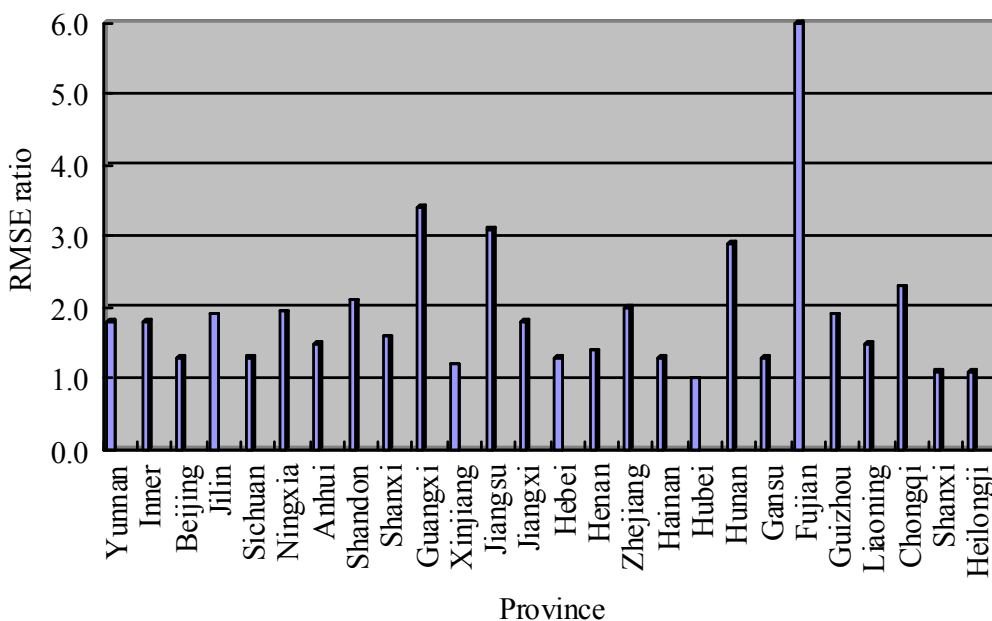


Fig. 8: Net effect and ranking test

In Figure 8, Fujian Province has the largest RMSR ratio of 6.0, followed by Guangxi Zhuang Autonomous Region, whose RMSR ratio is 3.4. Jiangsu Province has an RMSR ratio of 3.2, which is 0.5 larger than that of Hunan Province, which is 2.7, and Shandong Province and Chongqing Municipality have RMSR ratios of 2.2 and 2.3, respectively. It can thus be seen that Fujian Province receives the largest treatment effect, and the study estimation results are robust.

4.2 Empirical Analysis of the Economic Effects of the Fujian Free Trade Zone

The mechanism of Fujian FTZ affecting economic growth is analyzed, and based on regression analysis, the innovation-driven mediation effect test is carried out, and the relevant results are shown in Table 2.

Table 2. Correlation regression results of technological innovation

Variable	Equation (3)	Equation (4)	Equation (5)
	lngdp	lnrd	lngdp
<i>t_treat</i>	0.438####	0.462####	0.429####
lnrd	/	/	0.031##
lnxf	0.522####	0.630####	0.505####
lnmc	0.192####	-0.026	0.192####
isl	0.048####	-0.067	0.050####
lnopen	0.043####	0.286####	0.035##

Note: ### indicates $P < 0.01$ and #### indicates $P < 0.001$.

In Table 2, the regression coefficient of FTZ establishment on economic growth is significantly positive, which is consistent with the above estimation results. The coefficient in column 3 is significantly positive ($P < 0.001$), which means that FTZ can positively and significantly affect technological innovation. The coefficients of and in column 4 are significantly positive ($P < 0.001$), which means that technological innovation is the mediating mechanism of FTZs affecting economic growth effects. The test of the mediating effect driven by industrial agglomeration is conducted, as shown in Table 3.

Table 3. Relevant inspection results

Variable	aggl	lngdp
<i>t_treat</i>	0.369####	0.365####
aggl	/	0.476##
lnxf	0.339####	0.361####
lnmc	0.281####	0.058####
isl	0.004	0.046####
lnopen	0.112####	-0.010

Note: ### indicates $P < 0.001$.

In Table 3, the regression coefficient of the establishment of FTZ on industrial agglomeration is significantly positive, indicating that the establishment of FTZ has a certain positive effect on regional industrial agglomeration. The coefficients in column 3 are significantly positive ($P < 0.001$),

which implies that the level of industrial agglomeration is the intermediary mechanism of the FTZ's effect on economic growth. The test of the mediating effect driven by resource allocation efficiency is conducted, which is shown in Table 4.

Table 4. Correlation regression results

Variable	tfpch	lngdp
<i>t_treat</i>	0.033#	0.430####
tfpch	/	0.367####
lnxf	0.041##	0.508####
lnmc	0.016##	0.186####
isl	0.024####	0.039####
lnopen	-0.003	0.044####

Note: #, ###, #### indicate $P < 0.05$, $P < 0.01$, $P < 0.001$, respectively.

Table 4, denotes the resource allocation efficiency, and the coefficients, in column 3 are significantly positive ($P < 0.001$), which implies that the resource allocation efficiency is the intermediary mechanism of the FTZ affecting the economic growth effect. From the analysis results in Table 2, Table 3, and Table 4, it can be concluded that the establishment of free trade zones affects three mechanisms of economic growth: firstly, to improve the level of technological innovation; Secondly, improving industrial agglomeration; The third is to improve the efficiency of resource allocation.

5 Discussion

Analyze it based on empirical results. Overall, the establishment of the Fujian Free Trade Zone has a significant promoting effect on economic development, industrial agglomeration, and other aspects of development. The establishment of the Fujian Free Trade Zone has played a positive role in promoting economic growth, investment, financial openness, and trade in Guangdong Province. That is to say, the establishment of the Fujian Free Trade Zone has promoted financial openness through a series of institutional innovations, improved the level of investment and trade liberalization and facilitation, and thus promoted local economic growth. However, in relatively developed regions, its policy effect is not sustainable. Therefore, the Fujian Free Trade Zone should further deepen institutional innovation, deepen reforms, and formulate new strategic goals based on the actual situation. From this, we can draw relevant policy insights. Firstly, we should focus on maintaining the vitality and effectiveness of economic and trade policies, continue to deepen the facilitation process of promoting cross-border trade and investment and continue to seek innovative development. Optimize the economic and trade environment to "safeguard" the continued expansion of opening up to the outside world. The Fujian Free Trade Zone can adopt the policy of a "pre-admission national treatment+negative list". Under this institutional framework, the approval system for foreign investment admission will be transformed into a record-keeping system, and the threshold will be relaxed while strengthening management, focusing on both sides. In addition, it is possible to gradually improve the optimization and reform of the financial system, promote the upgrading of the industrial structure of the free trade zone, seek impetus for long-term economic growth within the province, and achieve healthy, stable, and sustainable development of the economy in the previous period.

6 Conclusion

To explore the situation of economic effects of Fujian FTZ, the study takes Fujian FTZ as the research object, chooses the synthetic control method, selects 25 provinces and cities as the control unit, and evaluates the economic effects of the establishment of Fujian FTZ based on the annual panel data, and conducts the placebo test and the mediation effect test such as innovation drive. The results show that after the synthetic control method, the difference between the real and synthetic values

of the control variables is small, and the synthetic effect is better. The real value of the degree of openness to the outside world is the largest at 15.9226, which is 0.4665 larger than its synthetic value, which is 15.4561. Before 2015, the difference between the GDP of Fujian Province and the synthetic Fujian Province is smaller; after 2015 its difference becomes larger, and the real GDP of Fujian Province is larger. When the time is 2018, the real GDP value of Fujian Province is 10.56, which is 0.30 larger than that of the synthetic Fujian Province. In the robustness test, the estimation result of the research method is robust, and the synthetic and the real values of the consumption level are 9.3476 and 9.3214 respectively after adding the control variables. Compared with the other synthetic results, Fujian Province has the largest RMSR ratio, which is 6.0, which is 2.8 larger than that of Jiangsu Province. Technological innovation, industrial agglomeration level, and resource allocation efficiency are the mediating mechanisms of FTZs affecting the economic growth effect. Among them, the coefficient of β_1 is significantly positive ($P < 0.001$). This shows that the application of the research method is better. The refinement of research data and variable selection needs to be optimized, and in the future, the economic effect can be analyzed from more subdivided perspectives.

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