An Empirical Study of Luzhou on the Influence of Inland Port Free Trade Zone's Construction on Regional Economic Growth

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Abstract. This paper constructs a counterfactual state with no free trade zone in Luzhou, Sichuan, using the synthetic control method. Examining how Luzhou's economic growth has been affected by the construction of the Luzhou Free Trade Zone is the aim. Using balanced panel data from 30 cities between 2007 and 2022. The construction of FTZ (free trade zone) did have an enormous effect on Luzhou's economic growth, even though the synthetic control approach was able to accurately match the economic growth state of Luzhou before its establishment. Through a series of robustness tests, this positive promotion effect can be confirmed. Therefore, this paper puts forward the suggestions that must build a road of interregional and international coordinated development based on economic strategies such as the "Belt and Road" to ensure and stimulate the nation's overall development.

Keywords: Free trade zone; regional economic growth; synthetic control method; inland port

1 Introduction

Countries have free trade zones to advance global trade and economic growth as a result of globalization and free trade. China has created several free trade zones, each of which has aided in advancing the country's economic reform and quickening the pace of regional integration.

One of China's principal inland ports and a key hub for land and sea travel in the west of the nation is Luzhou, which has 136 kilometers of golden waterway of the Yangtze River and Luzhou Port, the largest port in Sichuan. There are only thirty port-type national logistics hub carriers' cities in China. Its excellent traffic conditions and growing port-facing and port logistics sectors serve as its economic cornerstones.

Theoretical research on FTZ once became a hot spot during the early stages, and a sizable number of documents were qualitative analyses on related FTZ construction

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issues, such as discussing the significance of construction, functional orientation, evolution direction, and other related topics of a particular type or FTZ[1-2]. The literature on the quantitative analysis of economic consequences is growing as a result of the steady advancement of econometric technology. The main objective of this research is to assess the economic impacts of free trade zones, there are also studies on governance strategies of free trade zones[3]. Some studies has shown how China's implementation of the FTZ policy consistently and favorably boosts the economic growth of the surrounding area[4-6], but some areas have not benefited from it[7], for the influence of regional fiscal policy, monetary policy and other factors[8].

The two most important ones for fostering economic growth are raising trade levels and taking in foreign investment, also, promoting the industrial structure upgrading is a key path for a country's high-quality economic development[9]. Can the construction of an FTZ affect the Luzhou's economy? Research with actual data is required.

2 Theoretical Analysis and Research Hypothesis

2.1 Theoretical of Free Trade Zone Affecting Economic Growth

Based on industrial agglomeration and diffusion theory, due to its institutional benefits, FTZ draws a large number of businesses, institutions, and social and economic departments to the park, resulting in the concentration of money, industry, and population. Objectively speaking, the growth pole radiates new ideas and technologies around it with its advanced advantages and propels the development of surrounding areas. Subjectively speaking, a leading industry or an economically leading region will always seek a bigger market for its own output with its conditions and strength. In the same way how the FTZ's construction has stimulated regional institutional innovation.

Based on customs union theory, an agreement reached by two or more nations to create a single customs territory where tariffs are lowered or eliminated and a single tariff rate and foreign trade policy are applied to the import of goods from non-member nations or regions is known as a customs union[10]. Within a customs union, there are two types of effects: trade creation and trade transfer. The trade creation impact boosts trade volume among allies, benefits member nations, and advances societal wellbeing in general. On the other hand, the trade diversion effect caused by the customs union limits trade between member and non-member nations, which lowers total social welfare.

2.2 Research Hypothesis

FTZ promotes economic growth in three ways. First, the FTZ's external radiation experience will drive economic development outside the zone; Second, the FTZ uses preferential policies to attract enterprises to settle in, promote employment, promote industrial agglomeration, and increase regional consumption and investment; Third, further opening to the outside world, attracting FDI, reducing enterprise costs, increasing profits and promoting exporting and importing commerce employing the trade policy that

includes tax exemption and reduction. In light of the mechanism presented above, **Hypothesis** is presented in this work.

Hypothesis: Luzhou's economic growth has been greatly boosted by Luzhou Free Trade Zone's construction.

3 Model Construction and Data Description

3.1 Model Construction

This paper draws lessons from Abadie and Gardeazabal's (2003) synthetic control method (SCM). With the idea of synthetic control, this paper assumes that it is possible to monitor the economic growth statistics of $N+1$ cities throughout T duration, when a free trade zone was created in one of them at time T_0 $(T_0 \in [1,T])$, that is, the processing group, while the other N cities didn't create, that is, the potential control group. At time t $(n \in [1,N+1],\ t \in [1,T])$, among them, the nth city's economic growth would be $Y_{n,t}$when it didn't establish a FTZ; Suppose that at time t, the nth city's economic growth as a result of a FTZ's establishment is ${Y_{n,t}}^*$.

Assuming at time $t = T_0$, a FTZ is established in the nth city, the economic growth of this city is not affected by the establishment of FTZ during the t $(t \in [1,T_0])$ period before the FTZ's establishment. When $t \in [T_0,T]$, that is, after the establishment, the influence on economic growth brought by the construction of FTZ to the nth city at time $t$can be expressed as,

$$E_{n,t} = {Y_{n,t}}^* - Y_{n,t} \tag{1}$$

For the city that has established a free trade zone, the economic growth data $Y_{n,t}^*$ after time T_0 can be directly observed, but the economic growth data $Y_{n,t}$ under the assumption that it has not established a free trade zone cannot be observed. In order to estimate the counterfactual result of $Y_{n,t}$, the construction model is as follows:

$$Y_{i,t} = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{i,t} \quad (t = 1,2,\dots,T;\ \ i = 1,2,\dots,N,N+1) \tag{2}$$

The time-fixed influence affecting these $N+1$ cities is denoted by δ_t among them; Z_i is the $J \times 1$ dimensional covariant, indicating the control variable that is not affected by the FTZ's establishment, and θ_t is corresponding $1 \times J$ dimensional estimation parameter vector; λ_t is the unknown common factor vector in $1 \times K$ dimension, and μ_i is the urban fixed effect in $K \times 1$ dimension; $\varepsilon_{i,t}$ represents the unobservable short-term impact of each city, assuming that the average value is 0. Assuming that city $i = 1$ has set up a free trade zone, and the other N cities have not, consider constructing a weighted vector $W = (w_2, \cdots, w_{n+1})$, that fulfills any $w_i \geq 0,\ i = 2,\dots,N+1$ and $w_2 + \cdots + w_{n+1} = 1$. The weight vector Wrepresents the potential synthetic control combination for city have free trade zone, the weights of the remaining Ncities in the control group, and the weighted results are as follows:

$$\sum_{i=2}^{N+1} w_i Y_{i,t} = \delta_t + \theta_t \sum_{i=2}^{N+1} w_i Z_i + \lambda_t \sum_{i=2}^{N+1} w_i \mu_i + \sum_{i=2}^{N+1} w_i \varepsilon_{i,t} \tag{3}$$

Assuming the existence of $W^* = (w_2^*, \cdots, w_{n+1}^*)^{'}$, we can get:

$$\sum_{i=2}^{N+1} w_i^* Y_{i,1} = Y_{1,1}, \sum_{i=2}^{N+1} w_i^* Y_{i,2} = Y_{1,2}, \ldots, \sum_{i=2}^{N+1} w_i^* Y_{i,T_0} = Y_{1,T_0}, \sum_{i=2}^{N+1} w_i^* Z_i = Z_1 \quad (4)$$

If there is a nonsingular matrix $\sum_{t=1}^{T_0} \lambda_t^{'} \lambda_t$, then:

$$Y_{n,t} - \sum_{i=2}^{N+1} w_i^* Y_{i,t} = \sum_{i=2}^{N+1} w_i^* \sum_{j=1}^{T_0} \lambda_t (\sum_{s=1}^{T_0} \lambda_s^{'} \lambda_s)^{-1} \lambda_j^{'} (\varepsilon_{i,j} - \varepsilon_{1,j}) - \sum_{i=1}^{N+1} w_i^* (\varepsilon_{i,t} - \varepsilon_{1,t}) \quad (5)$$

Abadie et al. (2010) demonstrated that above formula's right portion of the equal sign usually tends to zero, so during the FTZ's construction, $t \in (T_0, T]$, the unbiased estimator of economic growth in the first city without the creation of a FTZ can be approximately replaced by the synthetic control group,

$$\hat{Y}_{1,t} = \sum_{i=2}^{N+1} w_i^* Y_{i,t} \quad (6)$$

The following represents the expected total amount of economic changes that the FTZ's construction would ultimately cause:

$$\hat{\pi}_{1,t} = Y_{1,t}^* - \sum_{i=2}^{N+1} w_i^* Y_{i,t}, \text{ where } t \in [T_0 + 1, \cdots, T] \quad (7)$$

3.2 Data Selection and Description

In this paper, Luzhou, Sichuan, which set up a free trade zone in 2017, was selected to be the treated group, 29 prefecture-level cities from Yangtze River Economic Belt provinces such as Guizhou, Sichuan, Hunan, Hubei, Jiangxi, Anhui, Zhejiang, and Jiangsu were randomly selected as the control group. Because these cities are geographically similar to the treated city, Luzhou, and have no free trade zone so far, they are chosen as potential control groups in this study. The balanced panel data of the aforementioned cities between 2007 and 2022, which is derived through statistical yearbooks as well as statistical bulletins from the national statistical bureaus of provinces, cities, and states. Missing values are calculated by linear interpolation.

According to the influencing factors of economic growth in theoretical analysis and considering the availability of data, the proportion of the secondary and tertiary industries' added values in the regional GDP of all cities in this experiment is calculated. In addition, the proportion of utilized foreign capital in the regional GDP, the proportion of total exports and imports in the regional GDP, the proportion of fixed asset investment in the whole society in the regional GDP, the proportion of general public budget expenditure in the regional GDP, the proportion of total retail sales of social consumer goods in the regional GDP and population density are selected as the prediction variables in the experiment.

The industrial structure, amount of external opening, infrastructure investment, level of financial support, and economic agglomeration level of an area are all factors that affect economic growth and are reflected in the predictive variables mentioned above. In addition, this paper regards ln GDP as the explained variable, which is the logarithm of GDP. As the explained variable, its value can be approximately regarded as a regional economic growth rate.

4 Empirical Analysis

4.1 Empirical Results

Table 1 compares the average values of the relevant predictive factors before the Luzhou policy implementation by applying the method of synthetic control (SCM). The processing group city's (Luzhou) actual data has been utilized to calculate its true value, and the synthetic value is the synthetic Luzhou data calculated by the synthetic control method. As can be seen from **Table 1**, in the control experiment, the real values of each predicted variable are quite close to their synthetic values, and the experimental mean square prediction error standard deviation (RMSPE) is very small, only 0.0073. This shows that the synthetic value generated by the SCM could well fit the regional economic characteristics of Luzhou before FTZ's construction. Consequently, after the policy intervention, a comparison between the synthetic and real Luzhou is used to evaluate the influence of the FTZ on the economy.

Table 1. True and synthetic value comparison of predicted variables

Predictor Variables	RMSPE	0.0073
	Treated	Synthetic
Proportion of added value from secondary industry to regional GDP (%)	55.3373	46.5323
Proportion of added value from tertiary industry to regional GDP (%)	31.3473	36.0264
Proportion of foreign capital(actually utilized) to regional GDP (%)	0.3102	0.9191
Proportion of fixed assets investment in regional GDP (%)	82.8142	91.4921
Proportion of general public budget expenditure to regional GDP (%)	20.9033	18.7884
Proportion of total retail sales of social consumer goods to regional GDP (%)	42.9732	42.7834
Proportion of total export and import volume to regional GDP (%)	1.2688	2.8238
Population density (Person/km^2)	347.7947	347.9089
Regional GDP in 2007 (Logarithmic)	6.0092	6.0203
Regional GDP in 2011 (Logarithmic)	6.7885	6.7819
Regional GDP in 2016 (Logarithmic)	7.3136	7.3127

Table 2 shows the main control group cities and their weights. Huanggang (0.286), Xianning (0.267), Ezhou (0.128), Changde (0.12) and Yibin (0.119) etc.(Cities with minimal weight are omitted). Those cities constitute the synthetic Luzhou.

Table 2. Main Composition and weight of Synthetic Cities

City	Weight	City	Weight	City	Weight
Huanggang	0.286	Xianning	0.267	Ezhou	0.128
Changde	0.12	Yibin	0.119		

Cities that mainly make up the control group can constitute a counterfactual situation in Luzhou when there's no FTZ. By comparing the differences between the calculated synthetic economic data and the real economic data after the FTZ's construction in Luzhou, we can draw an intuitive conclusion.

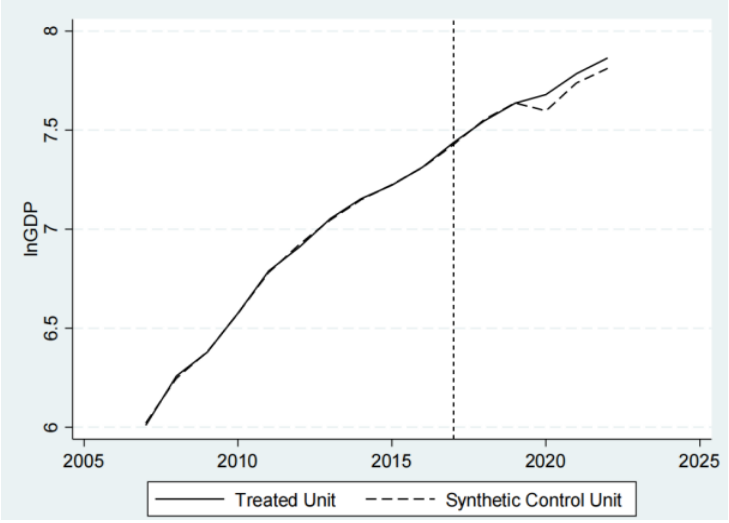

Fig. 1. Comparison between Luzhou's real and synthetic values in GDP (logarithm)

Figure 1 shows the development trend of the real Luzhou's GDP (logarithm) and the synthetic value calculated by SCM from 2007 to 2022. The vertical dotted line indicates the FTZ's establishment in 2017. The solid line depicts Luzhou's real economic growth path, and the dotted line depicts the counterfactual data synthesized and constructed. It can be seen that the synthetic Luzhou before 2017 fits the economic growth path of the real Luzhou well. Therefore, since FTZ's creation, the gap between them could be mainly attributed to the influence of FTZ policy, and the difference is the processing effect of FTZ's construction. Results demonstrate that, in the initial stage of FTZ's construction (2017-about 2019), there is no discernible difference in the real and synthetic values of Luzhou's GDP (logarithm), but with the passage of time, FTZ's construction achieved results one by one, and the real value of Luzhou's GDP (solid line) is above the synthetic value (dotted line), so it could be judged that Luzhou's regional economic growth has always benefited from the FTZ.

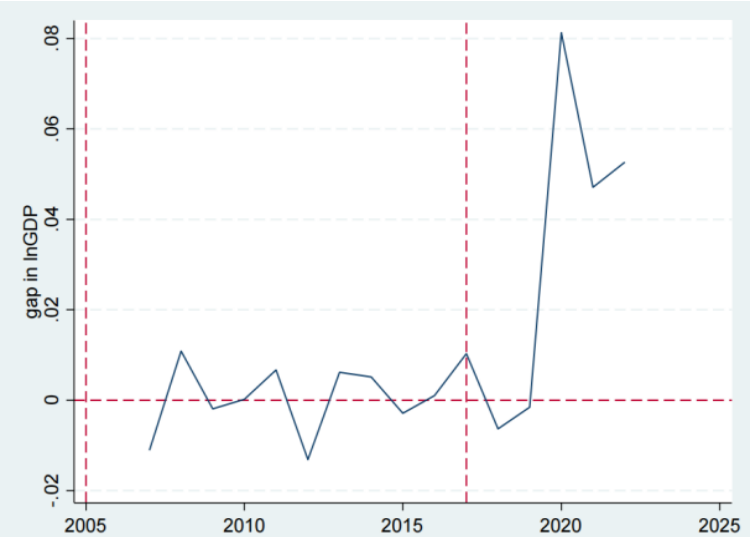

Fig. 2. Influence of Free Trade Zone on Luzhou's economic growth

Figure 2 shows the processing impact that FTZ's construction upon Luzhou's economic growth as the discrepancy between the logarithmic GDP's real and synthetic values. It's confirmed that the FTZ's construction has gradually supported Luzhou's economic growth, and the influence effect is remarkable. The broken line representing the treatment effect is located behind the policy implementation node and above the horizontal axis (zero gap line, representing zero effect).

4.2 Robustness Test

But is the influence effect obtained by the above synthetic control method entirely caused by accidental factors? This study will exclude contingency through placebo and permutation tests to assess the empirical model's robustness.

4.2.1. Placebo Test.

To test the influence of the Luzhou Free Trade Zone, need to borrow the idea of the placebo experiment: Randomly select a city from the control group for synthetic control estimation, assuming that the city set up a free trade zone in 2017, and take Luzhou as the control city. Then, from 2017 to 2022, compare the economic growth discrepancy of the selected one and the corresponding synthetic city, to see whether it can get a similar treatment effect as Luzhou. The Luzhou FTZ's construction cannot be shown to have had an impact on Luzhou's economic growth if the city's synthetic control estimation is similar to that of Luzhou.

In this paper, the placebo object is **Xianning**, one of the cities that make up Luzhou, with a relatively large weight **(0.267)**, which is a reasonable object choice.

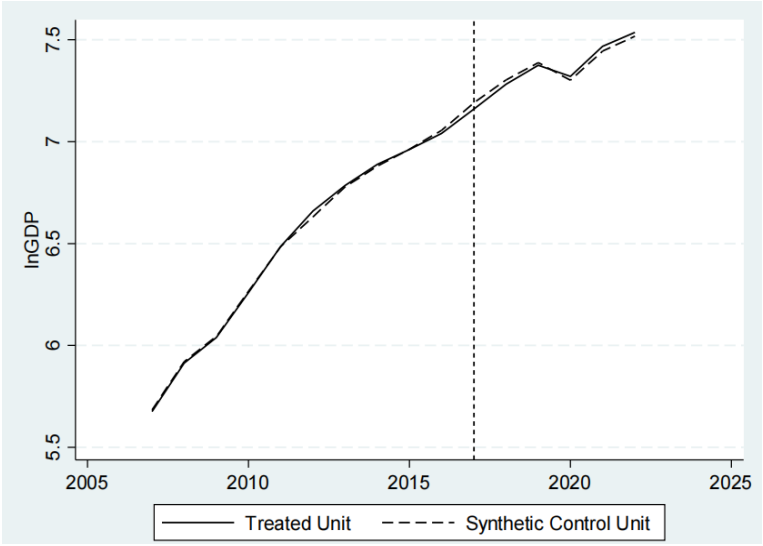

Fig. 3. Comparison between real value and synthetic value of Xianning GDP (logarithm)

Figure 3 shows the results of Xianning placebo test. Obviously, there is almost no difference between the real value of gross domestic product (logarithm) and its synthetic value in Xianning area, and their changing trends are basically the same. On the premise that the SCM can well fit Xianning's economic growth trajectory before 2017, there is no significant difference between the real situation and the fitting situation after 2017. This test result proves that Luzhou's economic growth has been impacted by the FTZ's construction in a certain extent, which is not caused by accidental factors.

4.2.2. Permutation Test.

The idea of the ranking test is: to treat each city in the experiment (30 cities, including treatment group cities) as an imaginary treatment area in turn, that is, assume that it was approved to set up a free trade zone in 2017, and treat Luzhou as a control group, and use SCM to estimate, under the supposition, the treatment affect of its FTZ's construction. Comparing the policy effects under the hypothesis and the actual situation. If the policy effect gap is large enough, it shows that the FTZ's construction provides an enormous influence on the city's economic growth.

In addition, prior to the policy's execution, each city's synthetic control objects must exhibit a good fitting effect. If the fitting effect is poor and the error value is large, even if the forecast gap is large after the policy has been implemented, it's unable to account for the policy's implementation efficiency. Thus, in this sorting test, it's required to eliminate the samples that have weak fitting effects.

Luzhou and 29 other cities were put through a ranking test. Based on the mean square prediction error (MSPE, RMSPE squared) of Luzhou, the sample cities with 1.5 times the average prediction error were excluded.

Fig. 4. Treatment effect map of Luzhou and other cities in control groups
Note: Figure 4 shows the error distribution after excluding samples with an error greater than 1.5 times that of the Luzhou, and the solid line represents the processing effect of Luzhou.

Figure 4 shows the distribution of the treatment effect between Luzhou and 12 other cities after excluding the samples with poor fitting effects. It's evident that, for a while, Luzhou's positive treatment effect(above the horizontal axis) was **significantly greater** than that of other cities after FTZ's construction.

Assuming that Luzhou FTZ's construction has no impact on economic growth, the experiment's probability of 8.33% (1/12) happens to have a big gap in per capita GDP (logarithm) between Luzhou and synthetic Luzhou, which is less than the significance level commonly used in statistical inference of 10%.

After the above robustness test, we can rule out a series of accidental factors and prove **Hypothesis**, which is, to a certain extent, FTZ's construction can influence the region's economic growth, and it is a positive promotion effect.

5 Conclusions and Recommendations

Using balanced panel data from 30 cities between 2007 and 2022 studies the influence of FTZ on the Luzhou's economic growth. It is found that when the synthetic control method accurately matches the economic growth state of the city before FTZ's construction. The FTZ has a significant impact on the local economy. The FTZ's construction can, to a certain extent, support the region's economic growth, as demonstrated by the results of the permutation test.

Based on the thinking of the future construction direction of Luzhou, this paper proposes the following policy recommendations: Luzhou must combine the "The Belt and

Road Initiative" strategy and the Yangtze River Economic Belt development strategy, explore FTZ's development mechanism and industries along the route, regions along the route, and even countries along the route, and constantly improve the cooperation framework and interconnection channels.

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