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Impact on Local Economy from Zhoushan National New Area

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Abstract: To empirically study the policy impact of a National New Area on the local economy, this paper evaluates the effect of the Zhoushan Archipelago New Area on local gross domestic product (GDP) growth rate and economic efficiency. Firstly, the economic efficiency of 20 prefectural-level cities in Jiangsu, Zhejiang, and Anhui provinces is estimated by data envelopment analysis with input and output data from 1995 to 2015. In selecting some cities except Zhoushan as a control group, we construct some counterfactuals of Zhoushan by a panel data approach. The difference between the actual and counterfactual values for the GDP growth rate and economic efficiency of Zhoushan is calculated and compared to conclude the treatment effect of the National New Area. The research shows that in the first four years, the policy of the National New Area promoted Zhoushan's economic quality by raising its efficiency, but relatively reduced its economic quantity by negatively affecting the local GDP growth rate. Then, the policy influence on Zhoushan's GDP growth rate and economic efficiency gradually disappeared after four years. Combining some other research on our study, we find that the policy effect on the GDP growth rate is related to the level of economic growth in these areas. The policy of the National New Area has less influence on GDP growth if approved in the developed region rather than in the undeveloped region. We think that it is better to set up a National New Area in a relatively undeveloped area.

Keywords: Zhoushan archipelago new area, GDP growth rate, economic efficiency, data envelopment analysis, panel data approach

1. Introduction

As a result of the global flow of production factors and the changing of production organization, the regional economic environment gradually becomes an appropriate unit to take part in global competition for promoting their countries' economic growth. In China, evolution of development policies to improve the local economic environment can be divided into three stages: the exploration stage led by Special Economic Zones, the expansion stage dominated by Economic Development Zones, and the optimization stage featuring National New Areas (NNAs) and National Comprehensive Reform Pilot Areas. China's NNA (Guojia Xinqu) approved by the State Council should be a functional urban areas, that undertake the strategic tasks of national development and reform. It is also becoming a policy tool for China's opening and transformation and an important way to integrate resources and cultivate functions. Supported by government policies, the NNAs have gathered a large number of innovative elements of institution and economy. It wants to promote the transformation of industrial structure to a modern industrial system through quality improvement and to enter one of the middle and high levels of the global production value chain by efficiency change [1]. But in practice, do the NNAs enhance the quality and efficiency of economic development and make it become the internal power of local economic agglomeration and industrial structure upgrading? This needs to be verified by actual cases. The NNA is a typical place-based industrial policy. It will also provide new evidence for the current industrial policy debate.

Since the start of the 21st century, China's opening up and economic development has been facing severe challenges. At the same time, with the process of urbanization crossing the inflection point, the dividend of urbanization is disappearing rapidly and the sustainable development of urbanization is also facing challenges. To solve these problems, the Chinese government is setting up more NNAs to deepen the opening up and promote regional economic development through their "first-act and first-try". Till June 2019, the number of NNAs has been increased to 19 in China and their importance to the economy has also on the rise. Nevertheless, different NNAs seem to have different effects on their local economy. For example, the Pudong New Area in Shanghai has greatly promoted regional economic growth in the past three decades. On the other hand, some research showed that the concentration of productive resources by policy advantages of NNAs may result in the lack of resources outside the host areas. This will hurt the regional economy [2]. So, whether the overall impact of an NNA on local economic growth was a positive or negative need for more empirical research. At the same time, timely evaluation of the influence is conducive to promoting the NNA's local economy and providing recommendations for NNAs' layout and adjustment.

NNA is an economic policy with China's identifiable characteristics. Although the practice of development zones has expanded worldwide, there are few studies on NNAs in foreign academic circles. In China, literature on NNAs was scarce before

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2016. With the increase of NNAs in recent years, the related research has increased significantly since 2016. Among them, there are only a few studies on the impact of NNAs on their local economic growth. Some researchers [3, 4] analyzed NNAs at district and county levels by diverse methods. They found that the studied NNAs had promoted local economic development, but their impact on the regional economy varies with their geographical location and establishment time. Fan and Wu [5] also found that some NNAs in South China hurt their local economic growth rate.

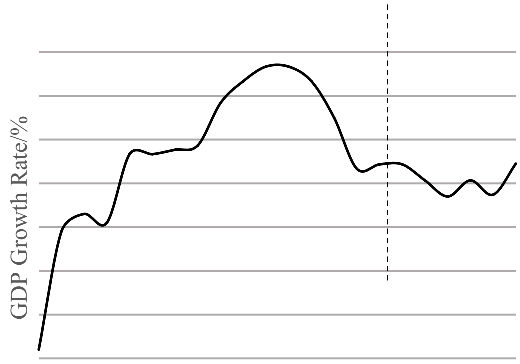
The above research mainly focused on the quantity, such as gross domestic product (GDP), when evaluating the impact of regional economic development. But at the national level, the only meaning of "competitiveness" is the productivity of the country, and the productivity of the country is mainly reflected in the economic efficiency of large cities and node cities on the transportation network. So analysis of these cities' economic efficiency can reflect the quality of indigenous economic development and the national competitiveness. However, in the majority of existing literature that evaluated the economic impact of NNAs, the quality of economic development hasn't been taken into consideration. Only a few studies have considered this. But there are some deficiencies in them. For instance, Wang and Li [6] used the data envelopment analysis (DEA) method to calculate the economic efficiency of the enterprises in Tianjin in the years 2004 and 2008, one of them was before and another is after the foundation of Tianjin Binhai New Area in 2006. Then they thought that Tianjin Binhai's New Area affected improving the local enterprises' efficiency. As the cross-sectional data used for analysis are only from one year before and after the New Area, their conclusion is lacking in persuasion. Using the data between the years 2000 and 2005, Lin et al. [2] studied the impact of some national economic development zones on the total factor productivity of enterprises. Because the needed data of this research are only obtained from the years 2000 to 2005, its conclusion has reflected the situation of the early national economic development zones. Now the internal and external environment for NNAs has changed with them. So whether the conclusion of this paper is suitable for NNAs after 2005 needs further verification.

Based on the above analysis, on the one hand, different NNAs seem to have different impacts on local economic quantity. The reliability of the conclusion needs more cases to support it. On the other hand, research on the impact of NNAs on local economic quality is still relatively few and imperfect. So evaluating the impact of NNAs on the regional economy in quantity and quality can give more cases to verify the above conclusion and make up for the weaknesses of the related research on efficiency. It is a meaningful work for research.

In June 2011, the Chinese State Council formally allowed to setting up of ZANA in Zhejiang Province. Zhoushan has become the first National Archipelago New Area in China. Zhoushan covers 22,000 square kilometers of sea area and 1,371 square kilometers of land area in east China. It is a prefecture-level city (Dijishi) in China with an archipelagic structure, including 1,390 islands, 270km of coastlines, and 1.1 million populations. It has a small land area and a large sea area. Its focus of economic development is on the marine economy. Therefore, the founding of ZANA is an important policy attempt to promote the economy of coastal areas in China. Analyzing its actual effects will be helpful not only for the evaluation of NNAs but also for the development of China's marine economy. So in this paper, we study whether ZANA has promoted the local economy in quantity and quality.

In Figure 1, we find that the GDP growth rate of Zhoushan did not increase significantly after 2010 when ZANA was founded (on the right side of the vertical line in Figure 1). Considering there are many factors affecting economic development, the chart can't directly prove ZANA has no impact on the local economy. To study the impact, the other affecting factors should be stripped, even though it is difficult sometimes. In addition, to study the impact on the economy, we should consider not only its quantity represented by the GDP growth rate but also its quality represented by economic efficiency.

Figure 1
GDP Growth Rate of Zhoushan from 1995 to 2016



Chinese process of economic reforms launched in 1978 and gradually extended until current days. Because a variety of new policies and institutions were introduced simultaneously, even today it is difficult to pinpoint their exact effect. This paper tries to analyze ZANA by the panel data approach to remove the impact of other factors and calculate efficiency by the DEA method to consider economic quality. This will contribute to a better understanding of the place-based policies. It also provides further evidence in the debate about the effect of these policies. So the main contributions of this paper are that: Firstly, using the panel data approach, a new way of evaluating the impact of NNAs is provided. To a certain extent, it solves the endogenous problem in the empirical study of NNAs. Secondly, the impact of ZANA on the local economy is studied from the aspects of quantity and quality. It enriches empirical cases in the study of policy effects of NNAs. Thirdly, Research on the impact of NNAs on economic efficiency has always been a weak link in the existing research. By combining the panel data approach with the DEA method, this paper helps to remedy this shortcoming.

The rest of the paper is organized as follows. Section 2 presents the research method and the sample. In Section 3, using the economic data from 1995 to 2015, the super-efficiency of Zhoushan and the other 19 selected prefectural-level cities are evaluated by DEA. Section 4 empirically studies the impact of ZANA on GDP growth rate and economic efficiency by the panel data approach. Section 5 concludes and discusses.

2. Method and Data

2.1. Selection of method

For predictive models to provide reliable guidance in decision-making processes, they are often required to be accurate and robust to distribution shifts [7]. To evaluate the impact on the regional economy, most practices usually construct a regression model by some selected economic indicators [8]. The commonly used methods based on the regression are the simultaneous equations model, VAR model, and DSGE model. However, these methods have many strict assumptions and are difficult to satisfy. For example, the simultaneous equations model relies on the prior assumptions of exogenous and endogenous variables, while the VAR model has the limitation of variable dimension and it is difficult to explain the economic mechanism. Sometimes, economists apply quasi-experimental methods to macro-policy evaluation. The method regards a project or policy as an experiment and tries to find a natural control group, which is under well-designed experimental conditions to its experimental group. Quasi-experimental methods include instrumental variables, difference in differences (DID), and regression discontinuity. There are some restrictions on their use. For example, the DID method must satisfy the assumption of randomness, which means that all uncontrollable factors should change randomly to influence the samples in the experimental group and the control group. Sometimes it's hard.

To improve these methods, Hsiao et al. [9] proposed a panel data approach for measuring policy effects. This approach considers the economic operation of each body in the cross-section to be driven by some common factors from the same economic system. Although the driven degree may be different for each body, there is a certain linkage or correlation between these cross-sections. Therefore, it is possible to predict the counterfactual value of an individual who are not affected by the policy, assuming they are affected by the policy. The panel data approach relaxes the assumption of randomness of the DID method. It can also overcome the difficulties of ambiguous causality, complex theoretical modeling, missing variables, and insufficient time series data in macro-policy evaluation. To some extent, it can reduce the interference of variable selection and estimation methods on the robustness of empirical results.

Although the panel data approach has not been put forward for a long time, it has been widely and successfully applied in the evaluation of policy effects. Using this approach, Hsiao et al. [9] assessed the impact of Hong Kong's political and economic integration with the mainland after its return; Ying and Fan [10] estimated the economic effect of the four Pilot Free Trade Zones in Shanghai, Tianjin, Fujian, and Guangdong. Chen et al. [11] studied the impact of the Guangdong Pilot Free Trade Zone on the import and export of Guangdong Province. Wang and Rui [12] evaluate the economic effects of the first and second batches of the comprehensive pilot area. Gao and Chen [13] took the Sichuan-Chongqing region as an example to conduct a counterfactual analysis of the economic effects of the pilot free trade zone. And Zhang and Zhao [14] assessed the economic growth effect of the industrial park constructed by China in the Central Sulawesi Province too.

These studies have verified the applicability of the panel data approach in the evaluation of macro-policy performance. So we choose the approach developed by Hsiao et al. [9] to construct a counterfactual economy of Zhoushan in ZANA for studying the impact of ZANA on the local economy. In addition, to analyze the impact of ZANA on economic efficiency, it is necessary to measure the economic efficiency of these selected cities first. For this purpose, the DEA method, which has been widely used in efficiency analysis, is used in this paper.

2.2. Determination of research scope

To study economic change by DEA and the panel data analysis, we select per capita real GDP as an output indicator, the number of employees in urban units at the end of the year, the area of land in the administrative area, public financial expenditure, and investment in fixed assets as four input indicators. The data are sourced from "China City Statistical Yearbooks".

In June 2011, ZANA was formally set up. In December 2015, the State Council once again approved the establishment of the China (Zhejiang) Bulk Commodity Exchange Center in Zhoushan, and in August 2016, the Zhoushan Free Trade Experimental Zone was established. These two events have impacted Zhoushan's economy with ZANA. To avoid their interference, only five-year data from 2011 to 2015 are collected to reflect the economy in ZANA. On the other hand, the panel data approach requires the period before the policy to be as long as possible as the ones in the policy. So 16 years of data from 1995 to 2010 are collected to reflect the economy before ZANA. Now collected data not only meet the requirements of the approach but also reduce the interference from other economic factors besides ZANA.

Assuming that an individual in an experimental group is affected by a policy, the individuals in a control group are not affected by the policy. For estimating a counterfactual value of the individual in the experimental group, which is assumed not to be affected although it is affected by the policy, the panel data approach requires that at the same time cross-section, the individuals in the experimental group and control group are driven by some common factors (such as population, capital, technology, etc.) in their development. Although these factors have different effects on different individuals, they make these individuals have some kind of correlation in their economy. Thus, the regression of the individuals in the control group can be used to predict the counterfactual values of the individuals in the experimental group [9].

China's administrative system has five hierarchical levels of government: (1) central; (2) provincial; (3) prefecture; (4) county; and (5) township. Zhoushan is a prefecture-level city, an administrative division ranking below a province and above a county in China's administrative structure. Generally, a prefecture-level city comprises a core urban area and a surrounding periphery that may include rural areas, other smaller cities, towns, and villages. The geographical and administrative position of the prefecture-level cities in Jiangsu, Zhejiang, and Anhui is close to Zhoushan, and therefore, these cities have a similar economic environment as Zhoushan. According to the panel data approach, there is a correlation between these cities and Zhoushan. So Zhoushan which has been affected by the policy of ZANA is selected as an experimental group in this paper, and some of the prefecture-level cities in Jiangsu, Zhejiang, and Anhui provinces might be selected to compose a control group for explaining the bulk of Zhoushan economy.

As for the selection principles of these cities, first of all, they need complete economic data from 1995 to 2015. Some cities are excluded because their data are broken for changes in administrative divisions during the research period. For example, Chaohu City was abolished and divided into Hefei, Wuhu, and Ma'anshan in Anhui Province in 2011. To avoid statistical error, these four prefecture-level cities are excluded. Secondly, according to the panel data approach, the economy of the selected cities should not be affected by the policy of ZANA, so Shanghai, Ningbo, and other cities are also excluded because of their close relationship with Zhoushan. Finally, 19 cities in Jiangsu, Zhejiang, and Anhui including Wuxi, Changzhou, Suzhou, Nantong, Lianyungang, Yancheng, Yangzhou, Zhenjiang, Wenzhou, Huzhou, Jinhua, Quzhou, Bengbu, Huainan, Huaibei, Tongling, Anqing, Huangshan, and Chuzhou are left to choose. Now we need to calculate the economic efficiency of the 19 cities and Zhoushan for further analysis.

3. Evaluation of Economic Efficiency

This section calculates the economic efficiency of the 20 cities selected above. The results not only can help these cities promote their resources to be rationally organized and allocated but also are used in the next section for analyzing the quality of economic development in Zhoushan.

3.1. Super-efficiency DEA model

The DEA method has been widely used in efficiency evaluation because it is suitable for multi-input and multi-output data [15–18]. It was proposed by [19] to evaluate the relative effectiveness between decision-making units (DMUs). In the DEA model, if some DMUs are effective at the same time, i.e., they all have maximum efficiency value θ = 1, they can't be further distinguished in efficiency. To make up for this deficiency [20] created the super-efficiency DEA model. Its difference from the traditional DEA model is that a DMU is excluded from the possible production set when its efficiency is evaluated. Therefore in the super-efficiency DEA model, for an ineffective DMU, the frontier of the possible production set is consistent with the traditional DEA model. But for an effective DMU, whose efficiency value measured by the traditional DEA model is 1, its production frontier of the super-efficiency DEA model may move backward compared to the traditional DEA model, so its efficiency value measured by the super-efficiency DEA model may be larger than 1. Therefore, the super-efficiency DEA model can further identify the differences between the effective DMUs, whose efficiency values are all equal to one in the traditional DEA models. It has overcome the shortcomings of the traditional DEA model and now has been more widely used than the traditional DEA model [21–23].

For DMU q (q = 1,2, . . . ,), the super-efficiency DEA model can be expressed as:

$$\min \theta_q \, s.t. \begin{cases} \sum_{j=1, j\neq q}^{n} X_{i,j}\lambda_j + s_i^- = \theta x_q, \; i = 1,2,\ldots, m \\ \sum_{j=1, j\neq q}^{n} Y_{k,j}\lambda_j - s_k^+ = y_q, \; k = 1,2,\ldots, r \\ \lambda_j \geq 0, j = 1,2,\ldots,q-1, \, q+1, \ldots, n \\ s_i^- \geq 0, \, s_k^+ \geq 0 \end{cases} \quad (1)$$

In this formula, θ represents a DMU's efficiency, x and y are input and output variables, respectively, and λ represents the combination proportion for a DMU's effective value. Here Σλ > 1, Σλ = 1, and Σλ < 1 respectively indicate the increasing returns to scale, the constant returns to scale, and the decreasing returns to scale, n is the number of DMUs in the system, and m and r are the numbers of input and output variables, respectively. s_i^- and s_k^+ are relaxation variables, and they indicate input excess and output deficit, respectively. When θ is less than 1, the DMU is not effective and needs to be improved as in a traditional DEA model. When the values of θ for several DMUs are greater than or equal to 1, these DMUs are all effective and not be distinguished in a traditional DEA model, but they can be further ranked by their value θ in the super-efficiency DEA model.

3.2. Evaluation of super-efficiency

To calculate the economic efficiency of the selected prefecture-level cities, the number of employees in urban units at the end of the year, the area of land in administrative areas, public financial expenditure, and fixed assets investment are chosen as four input indexes, and the GDP is taken as an output index according to the importance and availability of indicators. Although the input of technology and knowledge also has an impact on regional economic efficiency, their influence is significantly smaller than the four selected inputs, and their total amount is difficult to measure in macro-analysis, they generally won't be used as input indicators in the study of efficiency. So strictly speaking, the economic efficiency calculated by the selected input-output indexes in this paper means the economic efficiency of the main input.

By above design, more than 2,200 relevant data are collected from China Urban Statistics Yearbook for Zhoushan, Wuxi, Changzhou, Suzhou, Nantong, Lianyungang, Yancheng, Yangzhou, Zhenjiang, Wenzhou, Huzhou, Jinhua, Quzhou, Bengbu, Huainan, Huaibei, Tongling, Anqing, Huangshan, and Chuzhou between the year of 1996 and 2016. Using the super-efficiency model shown in Formula (1), the economic efficiency of the selected 20 cities in 21 years is calculated by EMS software. The results are listed in Table 1.

In the calculated results, the average efficiency of Wuxi, Suzhou, Zhenjiang, and Jinhua is higher than 1. It means that they are more efficient in the 21 years than others. The first three of them are in Jiangsu province and the last is in Zhejiang province. We also find in the last column of Table 1 that the ranges between the highest and lowest efficiency of these cities are decreasing. For example, the range of efficiency between 1995 and 2000 is more than 1.2, while the range between 2003 and 2015 is no more than 0.89. Considering the relativity of efficiency measured by the DEA model, this shows that the polarization of economic efficiency has been reduced in the Yangtze River Delta in recent years. It may be indicated that the economic integration development in the Yangtze River Delta has promoted the rational allocation of resources. At the same time, it is noted that the economic efficiency of Zhoushan has been at a relatively low level in these years. Does it mean that the policy of ZANA has not promoted the economic efficiency of Zhoushan?

4. Analysis of the Economic Effect by ZANA

From Figure 1 and the above-calculated results, we have seen the GDP growth rate and economic super-efficiency of Zhoushan not increasing significantly since 2010, when ZANA was founded in Zhoushan. But this can't explain the actual role of the policy of ZANA, because an economic phenomenon is a combined result of many factors. To separate other factors besides ZANA, we construct a panel data approach as follows.

4.1. Construction of the theoretical model

By the panel data approach [9], we assumed that the period of study is from t = 1 to t = T, and the number of studied cities is N. An economic output of the city i (I = 1,2, . . . , N) in year t is denoted as yit. Zhoushan, as an experimental group, is expressed as the city 1 without loss of generality, namely i = 1 is for Zhoushan and y_{1t} is its output. We will select from other N-1 cities to form a controlled group. The other N-1 cities are represented by i = 2, 3, . . . , N, and their output in year t is expressed in y_{2t}. y_{3t}, . . . , y_{Nt} respectively and denote the economic output of the city i in year t with and without the policy intervention. Because ZANA was approved in June 2011, we assume T_1 is the year of 2010, so ZANA has taken effect in time $T_1 + 1$. Based on these assumptions, we have:

$y_{1t} = y_{1t}^0, t = 1, \ldots, T_1; y_{1t} = y_{1t}^1, t = T_1 + 1, \ldots, T$ As the total economic amount of Zhoushan is relatively small in Jiangsu, Zhejiang, and Anhui, we think it has little impact on the economy of the other selected cities and ignore it in this paper. Therefore, whether or not the policy of ZANA was carried out in Zhoushan,

Table 1
Economic efficiency of 20 cities in Jiangsu, Zhejiang, and Anhui from 1995 to 2015

Year	Zhoushan	Wuxi	Changzhou	Suzhou	Nantong	Lianyungang	Yancheng
1995	0.70	1.54	0.95	1.27	0.85	0.56	0.96
1996	0.58	1.59	0.85	1.19	0.90	0.80	1.00
1997	0.59	1.55	0.90	1.11	0.82	0.68	0.91
1998	0.47	1.54	0.69	1.16	1.00	0.48	1.09
1999	0.32	0.86	1.18	0.55	0.93	1.13	1.21
2000	0.50	1.42	0.73	1.10	0.90	0.55	1.04
2001	0.54	1.41	0.93	1.03	1.04	0.58	1.45
2002	0.49	1.35	0.77	1.18	1.03	0.58	1.57
2003	0.70	1.20	0.87	0.92	0.93	0.71	0.97
2004	0.70	1.21	0.86	1.03	0.92	0.72	0.92
2005	0.76	1.28	0.85	1.00	0.98	0.60	0.85
2006	0.67	1.33	0.86	1.01	0.99	0.58	0.87
2007	0.62	1.33	0.85	1.03	0.96	0.52	0.79
2008	0.60	1.20	0.91	1.07	0.91	0.50	0.74
2009	0.56	1.14	0.94	1.21	0.91	0.51	0.71
2010	0.60	1.15	1.13	1.26	0.91	0.50	0.67
2011	0.64	1.18	0.89	1.14	0.84	0.53	0.69
2012	0.64	1.16	0.92	1.10	0.77	0.54	0.69
2013	0.80	1.31	0.97	1.10	0.77	0.64	0.74
2014	0.85	1.30	1.04	1.27	0.87	0.67	0.81
2015	0.46	1.28	1.05	1.35	0.79	0.62	0.69
mean	0.61	1.30	0.91	1.09	0.91	0.62	0.92
Year	Yangzhou	Zhenjiang	Wenzhou	Huzhou	Jinhua	Quzhou	Bengbu
1995	0.95	1.04	1.08	0.84	1.53	0.82	0.81
1996	0.67	1.01	0.98	0.82	2.06	0.81	0.84
1997	0.78	0.89	0.79	0.87	2.16	0.86	1.13
1998	0.72	0.85	0.87	0.94	2.00	0.62	0.60
1999	1.11	1.40	0.45	0.54	0.78	0.35	0.37
2000	0.93	0.99	0.79	0.99	1.82	0.55	0.47
2001	0.79	1.06	0.92	0.94	1.37	0.59	0.57
2002	0.74	0.88	1.05	0.97	1.28	0.63	0.53
2003	0.94	1.10	0.98	0.93	0.88	0.63	0.75
2004	0.94	1.06	1.08	0.94	0.85	0.60	0.84
2005	0.92	1.03	1.27	0.88	0.89	0.63	0.86
2006	0.94	1.01	1.08	0.87	0.96	0.62	0.94
2007	0.92	1.04	1.11	0.89	1.07	0.63	0.75
2008	0.90	1.12	1.14	0.88	1.07	0.66	0.67
2009	0.91	1.12	1.10	0.83	1.01	0.59	0.56
2010	0.92	1.05	1.17	0.88	0.98	0.63	0.52
2011	0.86	0.98	0.83	0.87	1.14	0.71	0.50
2012	0.88	0.96	0.82	0.85	1.03	0.73	0.47
2013	0.90	1.00	0.81	0.95	0.97	0.82	0.62
2014	1.04	1.02	0.97	0.96	1.10	1.08	0.85
2015	0.85	0.92	0.78	0.76	0.77	0.76	0.68
mean	0.89	1.03	0.95	0.88	1.22	0.68	0.68
Year	Huainan	Huaibei	Tongling	Anqing	Huangshan	Chuzhou	range
1995	0.30	0.45	0.34	0.65	0.44	0.97	1.23
1996	0.32	0.54	0.35	0.88	0.92	0.91	1.75
1997	0.59	0.78	0.65	0.98	0.97	1.50	1.57
1998	0.35	0.28	0.29	0.66	0.66	0.99	1.72
1999	0.33	0.17	0.24	0.37	0.41	0.58	1.24
2000	0.47	0.34	0.35	0.60	0.51	1.16	1.48
2001	0.75	0.55	0.45	0.68	0.53	1.23	0.99
2002	0.67	0.58	0.44	0.61	0.49	1.06	1.13
2003	1.08	0.83	0.77	0.77	0.64	1.47	0.83
2004	0.88	0.89	0.85	0.84	0.59	1.32	0.73
2005	0.72	0.84	0.91	0.94	0.59	0.98	0.69
2006	0.65	0.73	1.01	0.88	0.50	0.91	0.83
2007	0.59	0.68	0.91	0.67	0.44	0.67	0.89

(*Continued*)

Table 1
(*Continued*)

Year	Zhoushan	Wuxi	Changzhou	Suzhou	Nantong	Lianyungang	Yancheng
2008	0.70	0.67	0.72	0.60	0.42	0.57	0.78
2009	0.66	0.58	0.58	0.49	0.40	0.47	0.81
2010	0.65	0.60	0.68	0.56	0.42	0.52	0.83
2011	0.59	0.55	0.71	0.58	0.48	0.56	0.70
2012	0.63	0.51	0.57	0.60	0.46	0.56	0.70
2013	0.47	0.57	0.69	0.65	0.64	0.77	0.84
2014	0.80	1.10	0.90	1.04	0.66	0.83	0.65
2015	0.56	0.53	0.76	0.59	0.62	0.73	0.89
mean	0.61	0.61	0.63	0.70	0.56	0.89	1.01

Note: Range is the difference between maximum and minimum efficiency in the same year.

the other selected cities almost had no impact. It is denoted as follows:

$y_{it} = y_{it}^0, (i = 2, \ldots, N, t = 1, 2, \ldots, T)$ Then, the effect of ZANA on Zhoushan's economy at time t is simply represented by

$$\Delta_{1t} = y_{1t}^1 - y_{1t}^0, \; t = T_1 + 1, \ldots, T \tag{2}$$

where Δ_{1t} is the treatment effect of economic output by the policy of ZANA for Zhoushan. However, y_{1t}^1 and y_{1t}^0 can't be simultaneously observed. For the city i ($i = 1, 2, \ldots, N$), the observed data are taken in the form of (y_{it}; d_{it}),

$$y_{it} = d_{it} y_{it}^1 + (1 - d_{it}) y_{it}^0, t = 1, \ldots, T \tag{3}$$

where $d_{it} = 1$ if the city i is in the policy treatment and $d_{it} = 0$ otherwise. Under the variable of policy intervention, the specific random components of regional economic growth in N-1 cities except Zhoushan are assumed conditionally independent, namely

$$E(\varepsilon_{is} \mid d_{1t}) = 0, i = 2, \ldots, N, s \geq t$$

By Formula (3), there wasn't any policy treatment to y_{it} for $i = 1, 2, 3, \ldots, N$ and $t = 1, \ldots, T_1$. For $t = T_1 + 1, \ldots, T$, the output of Zhousan, i.e., y_{1t}, is treated by the policy. All other output except Zhoushan, i.e., y_{it} ($i = 2, \ldots, N$), don't be affected by the policy.

It has been documented empirically that there are common factors to explain the most macroeconomic data of the unit in the experimental group with selected units in the control group [24]. So for estimating the data y_{1t}^0 of Zhoushan in Formula (2) after T_1, we assumed that the output of all selected cities can be decomposed into two components: the first is impacted by K common factors, f_t, which drove the output of all cities to change. K common factors may be national macropolicies, international political and economic shocks, trade development, technological progress, etc. They may be unobserved or unknown. The second is the idiosyncratic components, $\alpha_i + \varepsilon_{it}$, where α_i represents the specific effect for the city i and ε_{it} is the idiosyncratic error with $E(\varepsilon_{it}) = 0$ and uncorrelated with ε_{jt} for $j \neq i$. So the output of Zhoushan (y_{1t}) is captured by the common factors, the city's specific effect, and the idiosyncratic error as follows.

$$y_{1t} = b_1 f_t + \alpha_1 + \varepsilon_{1t}, \; t = 1, 2, \ldots, T \tag{4}$$

Among them, $f_t(K \times 1)$ is a K-dimensional column vector representing K common factors and changing with time t, $b_t(K \times 1)$ denotes a K-dimensional row coefficient vector, which describes different influence degrees of K common factors on Zhoushan. α_1 represents the fixed effect of Zhoushan. ε_{1t} is its random disturbance term and satisfied $E(\varepsilon_{1t}) = 0$.

The f_t in Formula (4) is not easy to observe in practice, but ($y_{1t}, \ldots, y_{Nt}$) are driven by these common factors ft. So the panel data approach thinks there is a linear correlation between them. This makes Zhoushan's output y_{1t} can be predicted by the other cities' outputs ($y_{2t}, \ldots, y_{Nt}$), i.e., the counterfactual output y_{1t}^0 of Zhoushan is predicted by the observed data $\tilde{y}_t^0 = (y_{2t}^0, \ldots, y_{Nt}^0)$ instead of f_t in Formula (4). So the different regressions for Zhoushan are constructed with all different output combinations from the above selected 19 cities. Through comparing these regressions with some selection criteria, a combination of M cities is selected. M cities from a control group and their related optimal fitting are gotten as follows:

$$\hat{y}_{1t}^0 = \hat{\alpha} + \hat{\alpha}_2 y_{2t}^0 + \ldots + \hat{\alpha}_M y_{Mt}^0, t = 1, \ldots T_1 \tag{5}$$

Then substitute the observed output of the M cities into Formula (5) between $T_1 + 1$ and T, the out-of-sample prediction of Zhoushan is obtained. The calculated results give the counterfactual output of Zhoushan without the interference of ZANA after the establishment of ZANA. Namely:

$$\hat{y}_{1t}^0 = \hat{\alpha} + \hat{\alpha}_2 y_{2t}^0 + \ldots + \hat{\alpha}_M y_{Mt}^0, t = T_1 + 1, \ldots, T \tag{6}$$

With the estimated y_{1t}^0 in Formula (6), the affected effect Δ_{1t} of ZANA can be obtained by Formula (2).

In the above fitting process to get Formula (5), the important problem is how to choose the best control group. Using more y_{jt} may improve the within-sample fit, but lead to inaccurate out-of-sample prediction. Hsiao et al. [9] proved that the error of the affected effect estimated by Formula (5) is better for some small samples. According to their research, the steps to find the best predictors in Formula (5) are given as follows:

- **Step 1:** For a fixed j ($j = 1, 2, \ldots, N$-1), we take any j individuals from the selected N-1 prefecture-level cities except Zhoushan. A combination of C_{N-1}^j groups can be obtained. With each of these groups ($y_{2t}^0, y_{3t}^0, \ldots, y_{(j+1)t}^0$), and Zhoushan's output (y_{1t}^0) is fitted by Formula (4) in time $t = 1, 2, \ldots T_1$. The best fitting group is selected by R-square and noted as $M^*(j)$. We repeated this process from 1 to N-1 for j and can select N-1 groups, they are noted as $M^*(j)$, for $j = 1, 2, \ldots N$-1.
- **Step 2:** In $M^*(j)$, for $j = 1, 2, \ldots N$-1, a group M^* will be chosen as a control group in terms of the Akaike Information Criterion (AIC) [25]. Using the cities in M, the output of Zhoushan can be best fitted with formula (4) between time $t = 1$ and T_1.
- **Step 3:** Substituting the output of the cities in M^* in time $t = T_1 + 1, \ldots, T$ into Formula (4), the out-of-sample prediction

of Zhoushan is obtained and presented by Formula (5). It is the counterfactual value of Zhoushan without the interference of ZANA after ZANA has been approved. With the counterfactual value, the affected effect Δ_{1t} of ZANA could be estimated by Formula (2).

4.2. Empirical analyses of the economy of Zhoushan

4.2.1. Empirical analysis of GDP growth rate

For analyzing the policy impact of ZANA on local economic quantity, we take the GDP growth rate as an output index. According to the above three steps, firstly, before ZANA (1995–2010), for a fixed j ($j = 1, 2, \ldots, 19$), we take j cities from 19 selected cities to construct a group. There are c_{19}^{j} different groups for a fixed j. The GDP growth rate of Zhoushan is fitted by each of them to get the best group with a maximum correlation coefficient. Let's take j from 1 to 19, the 19 best groups are chosen. Secondly, we calculate AIC for each of the 19 selected groups and then among them choose a group with minimum AIC as a control group. The selected control group is composed in this paper by Changzhou (X_1), Nantong (X_2), Jinhua (X_3), and Tongling (X_4). Their fitting for Zhoushan is shown by Formula (7). Fitting and choosing processes are completed by Pampe Package in R software and get the fitting formula as follows.

$$Y = -3.797 + 2.647X_1 - 0.561X_2 - 0.414X_3 - 0.302X_4 \tag{7}$$

By Formula (7), we get the fitted GDP growth rate of Zhoushan from 1995 to 2015. They are counterfactual values and are shown in Figure 2 with the actual values. In the pre-intervention period (the left side of the vertical line in Figure 2, i.e., before 2010), the fitted path produced by the selected cities in the control group closely adhered to the actual path of Zhoushan. So it's believable that the counterfactual GDP growth rate of Zhoushan can be deduced well by Formula (7) after ZANA.

Based on the above analysis, we computed Zhoushan's counterfactual GDP growth rate from 2011 to 2015 by Formula (7). All the counterfactual and actual values were listed in Figure 2 (on the right side of the vertical line in Figure 2, i.e., after 2010). By subtracting counterfactual values from actual values, the treatment effect of ZANA is estimated and listed in Table 2. We find the treatment effects are negative, and their absolute values gradually decreased from 2011 to 2014. Until 2015, the treatment effect is turned into a positive. But its mean in the five years still is negative, -1.07%. It shows that ZANA had some negative effect on the GDP growth rate at its beginning, and then, the negative effect gradually diminished and disappeared five years later. So we have reason to believe that the policy of ZANA does not improve the quantity of Zhoushan's economic growth. Next, we want to know how the policy impacts on the quality of Zhoushan's economic growth.

Figure 2
Comparison between actual and counterfactual GDP growth rate of Zhoushan

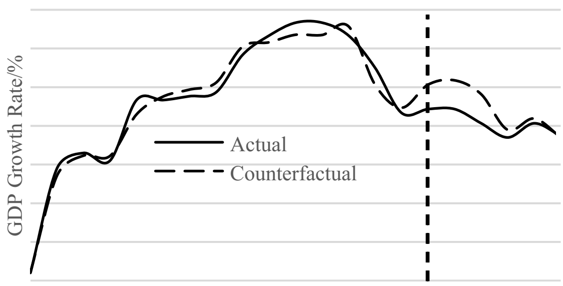


Table 2
Treatment effect of ZANA for GDP growth rate in Zhoushan

year	Real growth rate (%)	counterfactual growth rate (%)	treatment effect (%)
2011	11.3	13.53	−2.22923
2012	10.2	12.45	−2.25266
2013	9.1	9.69	−0.5946
2014	10.2	10.57	−0.36948
2015	9.22	9.11	0.10628
mean	10.00	11.07	−1.07

Table 3
Treated effect of ZANA for super-efficiency in Zhoushan

Year	Real efficiency	Counter-factual efficiency	Treatment effect
2011	0.6415	0.4003	0.2412
2012	0.6383	0.3969	0.2414
2013	0.7987	0.4949	0.3038
2014	0.8542	0.5263	0.32795
2015	0.4627	0.5264	0.0637
mean	0.67908	0.4690	0.2101

4.2.2. Empirical analysis of economic efficiency

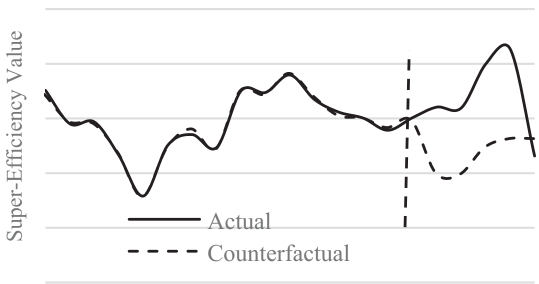
To analyze the policy impact of ZANA on local economic quality, the economic efficiency is given as an output index. With the sup-efficiency of 20 cities from 1995 to 2010, which has been calculated in Section 3.2 and listed in Table 3, the best fitting of Zhoushan's economic efficiency(y) before ZANA is chosen by the above three steps and expressed as follows:

$$\begin{aligned} y = & -0.989 + 0.549x_1 + 0.439x_2 + 0.527x_3 + 0.323x_4 \\ & - 0.379x_5 + 0.240x_6 \end{aligned} \tag{8}$$

In the above formula, x_1 to x_6 represent the economic efficiency of Nanjing (x_1), Zhenjiang (x_2), Wenzhou (x_3), Bengbu (x_4), Huaibei (x_5), and Chuzhou (x_6), respectively. The six cities are composed of a control group. The regression coefficient R^2 to Formula (8) is 0.998. Its equation's overall significance test (F-test) and the variable's significance test (t-test) also passed well. The fitted and the actual economic efficiency are shown in Figure 3 for comparison (on the left side of the vertical line in Figure 3, i.e., before 2010). It can be seen that the fitted values derived from the control group can fit Zhoushan's actual values well between 1995 and 2010.

By Formula (8), the out-of-sample for Zhoushan, which is counterfactual super-efficiency values without the interference of ZANA in 2011–2015, could be predicted. The counterfactual and actual paths are shown separately in Figure 3 (on the right side of the vertical line in Figure 3, i.e., after 2010). The treated effect of ZANA could be obtained by subtracting counterfactual values from the actual values. The results are positive from 2011 to 2014 and have increased from 0.223 to 0.305 in Table 3. It shows that the economic efficiency of Zhoushan has improved significantly in these years. ZANA has indeed effectively promoted the economic development quality of Zhoushan. But in 2015, the treated effect almost got close to 0. It shows that the positive treatment effect of ZANA disappeared after four years.

Figure 3
Comparison between actual and counterfactual super-efficiency of Zhoushan



Comparing Table 3 with Table 2, we get a broad view of the impact of ZANA on Zhoushan's economy. ZANA has negatively affected the local GDP growth rate but improved local economic efficiency. After four years, the effect of ZANA on GDP growth rate and economic efficiency all weakened and disappeared gradually. It is said that the direct impact period of ZANA on Zhoushan's economy isn't long.

4.3. Robustness check of the used model

We noted that there are some assumptions about Hsiao et al.'s [9] panel data approach. According to this approach, much of the cities' economy in the control group must be driven by the same common factors as the ones of Zhoushan. So the robustness of the approach in this paper is that a fundamental relation among all the studied cities must remain unchanged from pre-intervention to post-intervention and should not be related to a specific time point. To verify the treatment effects estimated in Section 3.2 are not related to the time point of 2010, we select any time point before ZANA replaces the year 2010 and then take the same counterfactual analysis. If the fitted results are still as same as the above analysis, the approach will be proven stable in this paper and its result will be reliable.

We verified the approach from both sides of the GDP growth rate and economic efficiency. Without losing generality, we assume the approved time point of ZANA is two years ahead of schedule. So in the subsequent analysis, we fit Zhoushan's economy from 1995 to 2008 and do its counterfactual analysis from 2009 to 2015.

Firstly for GDP growth rate, similar to section 4.2.1, in the given 19 cities, Changzhou (X_1), Nantong (X_2) and Wenzhou (X_3) are selected to form a control group by Pampe Package in R software. Their regression equation for Zhoushan (y) was got as follows:

$$y = 3.202 + 1.954X_1 - 0.560X_2 - 0.533X_3 \quad (9)$$

The test values of Formula (9) are listed in Table 4. They are an ideal result. By Formula (9), the counterfactual GDP growth rate without the interference of ZANA has been predicted from the year 2009 to 2015. All the fitted and actual values are shown in Figure 4. They are fitted well between 1995 and 2008 (on the left side of the vertical line in Figure 4, i.e., before 2008). Fatherly, comparing the counterfactual values in Figures 2 and 4 from 2010 to 2015, both of them have similar values and trends, that is, the counterfactual values are larger than and gradually close to the actual values. This shows that the approach is stable and reliable for the analysis of the GDP growth rate in this paper.

Secondly, just as the counterfactual analysis in Section 3.2.2, Nanjing (X_1), Zhenjiang (X_2), Wenzhou (X_3), Bengbu (X_4), Huaibei (X_5), Chuzhou (X_6) are selected in the given 19 cities by Pampe Package in R software to form a control group, Their regression equation for economic efficiency of Zhoushan (y) is gotten as follows:

Table 4
Optimal fitting coefficient and its test value of GDP growth rate from 1995 to 2008

Control group	Coefficient	Std. error	*t*-value	*t* (*p*)
Changzhou (X1)	1.9535	0.1147	17.029	0
Nantong (X2)	−0.5601	0.0407	−13.777	0
Wenzhou (X3)	−0.5330	0.0643	−8.283	0

Figure 4
Comparison between actual and counterfactual GDP growth rate of Zhoushan (Assuming ZANA approved in 2009)

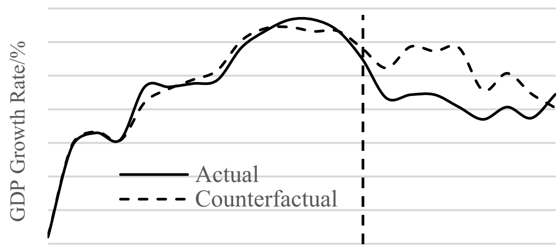


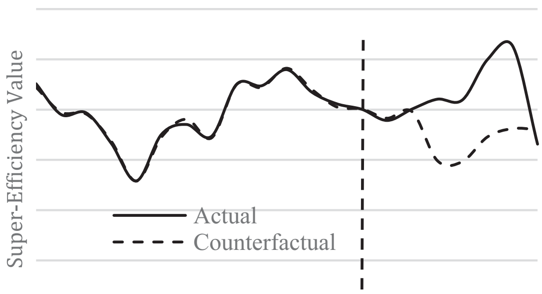
Table 5
Optimal fitting coefficient and its test value of economic efficiency for Zhoushan from 1995 to 2008

Control group	Coefficient	td. Error	*t*-value	*t* (*p*)
Nanjing (X_1)	0.531	0.1107	4.80	0.002
Zhenjiang (X_2)	0.443	0.0475	9.34	0
Wenzhou (X_3)	0.529	0.0462	11.45	0
Bengbu (X_4)	0.325	0.0313	10.39	0
Huaibei (X_5)	−0.375	0.055	−6.79	0
Chuzhou (X_6)	0.238	0.023	10.50	0

$$y = -0.987 + 0.531X_1 + 0.443X_2 + 0.529X_3 + 0.325X_4 - 0.375X_5 + 0.238X_{6\ldots} \quad (10)$$

The test values of Formula (10) are listed in Table 5. By Formula (10), counterfactual economic efficiency without the interference of ZANA is predicted from 2009 to 2015. Then, all the fitted and actual values are shown in Figure 5. They are shown to fit well between 1995 and 2008(in the left side of the vertical line in Figure 5, i.e., before 2008). Comparing the counterfactual values in Figures 3 and 5 from 2010 to 2015, we find that both of them have similar values and trends, that is, the actual values were larger than the counterfactual values between 2011 and 2014, and in 2015, they were the same. This shows that the approach in this paper is stable and reliable for the analysis of economic efficiency too.

Figure 5
Comparison between actual and counterfactual super-efficiency values of Zhoushan (Assuming ZANA approved in 2009)



5. Conclusions and Discussion

Sustainable and rapid development of regional economy has always been a research hotspot [26]. In this paper, the input and output data of 20 cities in Jiangsu, Zhejiang, and Anhui provinces of China are collected from 1995 to 2010. The economic efficiency of these cities is measured by the super-efficiency DEA model with these data. Furthermore, the GDP growth rate and economic efficiency of Zhoushan are analyzed by Hsiao et al.'s [9] panel data approach to study the impact of ZANA. In the analysis, the actual values and the counterfactual values have been best fitted, and the robustness check also shows that the approach is stable. So the results in this paper are reliable.

The research shows that: in the first four years, ZANA promoted Zhoushan's economic quality by raising its economic efficiency, but relatively reduced its economic quantity by negatively affecting its GDP growth rate. However, the impact on Zhoushan's GDP growth rate and economic efficiency gradually disappeared in the fifth year.

It is somewhat unexpected that the policy of NNA doesn't promote the local GDP growth rate. Is this a special case? We found similar results in other studies, although those authors did not pay special attention to their causes. Fan and Wu [5] found that some NNAs in south China, such as Liangjiang New Area, Nansha New Area, Guian New Area, Tianfu New Area, and Xiangjiang New Area, had a negative influence on the GDP growth rate of their hosting provinces. Chao et al. [3] also found that the contribution to GDP growth of NNAs in Chinese eastern regions is significantly less than that in the central and western regions. These studies simply attributed these phenomena to the geographical location of the NNAs. In addition, some studies have also shown that the impact of NNA on GDP growth is greater in the past than now. Analyzing this research and combining our study on Zhoushan in this paper, we find that the geographical location or establishment time of NNAs is only a superficial reason; the nature of these phenomena is due more to the economic development level of these NNAs' hosting areas. The policy of NNAs has less impact on GDP growth if approved in the developed region rather than in the undeveloped region. It is said that approving an NNA in some relatively underdeveloped areas will improve the local economic growth rate.

This study also shows that ZANA improves local economic efficiency in a certain period. However, there are few case studies in this area, so whether this conclusion is right for other NNAs needs to be further empirical research. But theoretically, we think it is reasonable. Because the policy advantages of NNAs gathered resources and enterprises [4], the concentration improves local economic efficiency. But Wang and Zhang [27] found that the "agglomeration effect" lasts for a very short time and gradually disappears about three years after the establishment of the NNA. The case of Zhoushan in this paper verified this conclusion.

Based on the above analysis, we think that it is better to set up a NNA in a relatively undeveloped zone. We suggest that when an NNA is approved, the local government should make full use of the policy benefits to adjust its industrial structure and promote advantageous industries as soon as possible; otherwise, the effective time of the policy will not be too long.

Therefore, the management significance of this study lies in providing a reference basis for policymakers. When formulating national-level policies with economic support, such as NNA, it is appropriate to tilt towards underdeveloped areas, which is more conducive to driving the local economy. If it is mostly placed in economically developed areas like now, its driving effect on the regional economy will be limited. For developed regions, it is only necessary for the government to reduce unnecessary intervention.

Finally, although the implementation of the NNA policy in China has not been very long, the conclusions of empirical analysis in this paper still need to be further verified through more accumulated data from practice. However, the method provided in this research is effective in evaluating the implementation effect of the policy. So it is very meaningful to further apply and improve this method in future research to enhance the evaluation level of policy performance.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Yi Zheng: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Jiayun Zheng:** Methodology, Software, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization.

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