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Research Article

The Impact of Marine Economic Development on Energy Efficiency: The Case of Zhoushan Archipelago New Area in China

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In recent years, the Chinese Central Government has put great emphasis on the marine economy, since it has been a new driving force of the national economic development. Yet, the relationship between marine economic development and energy efficiency remains unknown. In this paper, we investigate whether marine economic development affected energy efficiency. We focused on the Zhoushan Archipelago, the first National New Area for marine economic development in China. We applied panel data approach to construct the counterfactual of Zhoushan Archipelago. We compared Zhoushan and its counterfactual, the synthetic Zhoushan, and viewed the difference between them, after the Zhoushan Archipelago New Area, as the impact of marine economic development on energy efficiency. We found that compared with its counterfactual, the real Zhoushan had a more substantial improvement in energy efficiency after the National New Area construction. We estimated that the construction of the National New Area for Marine Economy increased energy efficiency by about 10 percentage points. We also applied the bootstrapping technique to illustrate the significance of the estimated results. The results suggest that the Zhoushan Archipelago New Area construction had a statistically significant impact on energy efficiency. In addition, we conducted two tests, including leave-one-out tests and permutation tests, to check the robustness of estimated results, which also serve as an illustration of significance of the estimated results from an alternative empirical perspective. The results from these two tests are similar to each other, both indicating that the Zhoushan Archipelago New Area construction had a statistically significant positive impact on energy efficiency. Overall, our results suggest that marine economic development had a sizable improvement in energy efficiency.

1. Introduction

The ocean accounts for about 71 percent of earth surface, which is rich in various kinds of marine resources [1–3]. Therefore, the marine economy is playing a more and more important role in economic growth [4–8]. On the other hand, with land resources becoming gradually exhausted due to the large-scale urban development, a growing number of countries have been aware of the importance of the ocean and are taking a series of measures to promote the marine economy development [9, 10].

China, the largest developing country worldwide, has 65 hundred oceanic islands and 32 thousand kilometers long coastline [11]. It shares maritime boundaries with North Korea, South Korea, Japan, Philippines, Brunei, Indonesia, Malaysia, and Vietnam [12]. The Chinese superior shoreline helps it to become the second largest economy around the world, behind the United States [13]. According to some estimates, the gross ocean product in China amounted to more than 9 thousand billion in 2021, a tenth of its gross domestic product [14, 15].

In order to further promote the marine economic development, the Chinese Central Government has chosen some regions across China to establish the marine economic development demonstration zones, over the past decade [16, 17]. These zones could be regarded as regional multifunction ocean platforms, performing some big tasks, including attracting marine industries, deepening marine economic construction, and promoting the coordinated development of land and sea [18–20].

Zhoushan Archipelago, a Chinese prefectural-level city grouping more than 4 hundred islands of the northern coast of Zhejiang Province, is blessed with abundant natural resources [21]. Lying on the Yangtze River Delta and the coast of Eastern China Sea, Zhoushan is playing an important role in the construction of the New Silk Road on the sea and the Marine Economic Belt [22]. Approved by the Central Government of China, it was listed as the first National New Area for marine economic development in 2011, and it is also expected to fuel the growth of new economic drivers for the Yangtze River Delta Urban Agglomeration [23].

A large existing literature were focused on the marine economic development and its affecting factors. For example, Ding et al. proposed an improved cross-efficiency model and used this new model to measure the marine economic development efficiency for Chinese 11 coastal provinces [24]. Li et al. codified the Chinese policies related to marine economic development, listed the difference across these policies, summarized the characteristics of policies, and predicted the direction of the future marine economic policy [25]. Guo et al. measured the efficiency of marine economic development for Chinese 11 coastal provinces, using a data envelopment analysis, and investigated these factors affecting the marine economic development efficiency, using a spatial econometric model [26].

On the other hand, few studies had explored the interaction between marine economic development and marine environmental protection. For example, Ye et al. assessed the impact of government preference and environmental regulation on marine economic green development [27]. They found that government preference to industries had a negative impact on marine economic green development, while environmental regulation had a lag positive impact on marine economic green development. Qin et al. investigated whether environmental regulation affected marine economic green total factor productivity [28]. Their results exhibited that environmental regulation promoted marine economic green development.

Besides, there are a large number of studies available on economic growth, energy efficiency, carbon emissions, and their interaction [29, 30]. For example, Li et al. constructed a cross-country panel and used a Granger causality test to investigate the impact of economic, energy, social, and trade structural changes on carbon emissions [31]. Their results suggest that these factors had a large impact on carbon emissions. Wang et al. found that urbanization is an important factor affecting energy consumption, while its impact on energy consumption would be dependent on the level of income [32]. Candila et al. explored the relationship between oil return and exchange rate movement in oil-based countries during the Great Recession and the pandemic periods [33].

Finally, in the literature related to regional economic development, Mutalimov et al. assessed the performance of small business in the Far Eastern District of Russia, which helps policy makers to determine the direction of industrial policies [34]. Varyash et al. focused on Triple Bottom Line in Russia and investigated the relationship between it and corporate social responsibility [35]. Moiseev et al. discussed the association between regional economic growth and corruption. They thought that the growth of social wealth would reduce corruption [36]. Saqib et al. estimated the impact of Pakistani rupee volatility on monthly energy imports using an autoregressive distributed lag model. The results showed that the effect of volatility in exchange is sectoral specific and asymmetric in Pakistan [37]. Nie et al. found that the use of modern energy technologies in the production processes of public catering enterprises would reduce total costs and improve the overall environmental friendliness of the food industry [38].

Quite surprisingly, however, there is no literature available on the relationship between marine economic development and energy efficiency, given an important role that marine economy is playing in the green, low-carbon, and sustainable development [39]. In this paper, we filled that void. We estimated the impact of marine economic development on energy efficiency by focusing on Zhoushan, the first established National New Area for marine economic development. We adopted panel data approach to form the counterfactual of Zhoushan, the synthetic Zhoushan. We compared the real Zhoushan with the synthetic Zhoushan and referred to the difference in energy efficiency between them as the impact of marine economic development on energy efficiency.

Overall, our results exhibit that the Zhoushan Archipelago New Area construction did improved Zhoushan's energy efficiency. That is, compared with its counterfactual, Zhoushan experienced a more substantial improvement in energy efficiency after the Zhoushan Archipelago New Area construction. We estimated that the Zhoushan Archipelago New Area construction improved energy efficiency, on average, by about 10 percentage points. Our estimate is remarkably robust to the exclusion of a certain control city that is not the National New Area for marine economic development. Our estimate also has a statistically significant interpretation standing on an empirical perspective. Of course, our results suggest that marine economic development had a sizable improvement in energy efficiency.

Several features of this paper distinguished it from a large existing literature on marine economic development. Most significantly, this paper is the first to focus on the relationship between marine economic development and energy efficiency. While aforementioned studies point out that marine economy is playing an important role in the green, low-carbon, and sustainable development, they do not investigate the impact of marine economic development on energy. From an empirical perspective, this paper also is the first to quantity the impact of marine economic development on energy efficiency by focusing on Zhoushan Archipelago New Area, the first established National New Area for marine economic development. Besides, this paper is significant in that it provides an alternative path to improve energy efficiency and achieve sustainable development for policy makers. Our study suggests that marine economic development is beneficial to improve energy efficiency and to achieve sustainable development.

The rest of this paper is arranged as follows. Section 2 describes data and model. Section 3 reports results. Section 4 discusses our findings. Section 5 concludes.

2. Methods

2.1. Data. We used the annual panel data on 21 cities in the Yangtze River Delta Economic Circle over the 1995 to 2014 period. Zhoushan Archipelago was listed as the National New Area for marine economic development in 2011, giving a period of 16 years before its establishment. Our sample period ends in 2014 because a relatively narrow period of 4 years after the Zhoushan Archipelago New Area construction helps us to remove additional confounding factors, like the other policies implemented in Zhoushan that might affect Zhoushan's energy efficiency.

The outcome variable of our interest is energy efficiency, which is measured by the ratio of gross regional product to the total regional energy consumption. Note that we take the logarithm of energy efficiency in our later analysis, so that the difference in energy efficiency between Guizhou and synthetic Guizhou has an interpretation of percentage change. We obtained the data from the National Bureau of Statistics of China.

2.2. Model. As we have a treated unit, the Zhoushan Archipelago and a lot of control cities that are not exposed to the policy, an alternative approach is to perform a difference-in-differences analysis. However, the difference-in-differences analysis heavily relies on parallel trends assumption, which is not testable directly. Thus, we adopted panel data approach to assess the impact of the Zhoushan Archipelago New Area construction on energy efficiency. The panel data approach does not require the parallel trends assumption. More significantly, it avoids the subject choice of comparative unit. Besides, the panel data approach allows us to investigate the dynamic impacts of the Zhoushan Archipelago New Area construction on energy efficiency. Next, we describe the approach.

2.2.1. A Motivating Model. Let y_{it}^1 represents the potential outcome for a unit i at time t if the unit i receives a treatment. Let y_{it}^0 represents the potential outcome for the unit i at time t if the unit i does not receive the treatment. Then, as we know, the effect of the treatment on the outcome for the unit i at time t could be simply expressed as follows:

$$\delta_{it} = y_{it}^1 - y_{it}^0, \tag{1}$$

where δ_{it} represents the effect of the treatment on the outcome for the unit i at time t.

However, we cannot observe y_{it}^1 and y_{it}^0 at the same time. The observed data could be expressed by the following:

$$y_{it} = d_{it} \cdot y_{it}^1 + (1 - d_{it}) \cdot y_{it}^0, \tag{2}$$

where d_{it} would take the value of the one if the unit i receives the treatment at time t, otherwise it takes the value of the zero.

Let f_t be a $K \times 1$ vector of unobserved common shocks, which would be the main force driving all the y_{it} to vary with time. Following Hsiao et al., we consider a situation where the first unit receives a treatment at time $T_1 + 1$, while the other cities do not receive the treatment throughout the whole sample period. Let T represents the whole sample period [40]. Let T_1 represents the time prior to the treatment. Thus, we have the following factor model:

$$y_{it}^0 = a_i + b_i' f_t + u_{it}, \tag{3}$$

where $i = 1, 2, 3, \cdots, N$ at time $t = 1, 2, 3, \cdots, T_1$, and a_i represents the unit feature. b_i is a $K \times 1$ vector of the factor loading. u_{it} represents the error term for the unit i error term at time t.

Let $y_t = (y_{1t}, y_{2t}, y_{3t}, \cdots, y_{Nt})'$ be an $N \times 1$ vector of the observed data y_{it} at time t. Since there is no treatment prior to the time $T_1 + 1$, then the observed data y_{it} could be expressed as follows:

$$y_t = y_t^0 = a + Bf_t + u_t, \tag{4}$$

where time $t = 1, 2, 3, \cdots, T_1$, $a = (a_1, a_2, a_3, \cdots, a_N)'$, $B = (b_1', b_2', b_3', \cdots, b_N')$, and $u_t = (u_{1t}, u_{2t}, u_{3t} \cdots, u_{Nt})'$.

Since the first unit receives the treatment at time $T_1 + 1$, we have the following expression for the observed outcome of the first unit:

$$y_{1t} = y_{1t}^1, \tag{5}$$

where time $t = T_1 + 1, T_1 + 2, T_1 + 3, \cdots, T$.

We further assume that the other cities are not affected by the treatment that the first unit receives. Thus, we have the following expression for the other cities:

$$y_{it} = y_{it}^0 = a_i + b_i' f_t + u_{it}, \tag{6}$$

where $i = 2, 3, 4, \cdots, N$ at time $t = 1, 2, 3, \cdots, T$.

Since y_{1t}^0 is not observed at time $t = T_1 + 1, T_1 + 2, T_1 + 3, \cdots, T$, we need to estimate y_{1t}^0 for the first unit at time $t = T_1 + 1, T_1 + 2, T_1 + 3, \cdots, T$. Hsiao et al. provided a panel data approach to estimate y_{1t}^0 by exploiting the cross-sectional dependency across cross-sectional cities [30]. Next, we describe how the panel data approach works.

2.2.2. Panel Data Approach. Let $y_t = (y_{1t}, y_{2t}, y_{3t}, \cdots, y_{Nt})' = (y_{1t}, Y_t')'$. y_t^0 prior to the treatment is generated by the following factor model:

$$y_t^0 = a + Bf_t + u_t, \quad (7)$$

where time $t = 1, 2, 3, \cdots, T_1$, $a = (a_1, a_2, a_3, \cdots, a_N)'$, $B = (b_1', b_2', b_3', \cdots, b_N')$, and $u_t = (u_{1t}, u_{2t}, u_{3t} \cdots, u_{Nt})'$.

Let $\alpha = (1, -\gamma')' = (1, \gamma_2, \gamma_3, \gamma_4, \cdots, \gamma_N)'$ so that $\alpha' B = 0$. Then, we have the equation below:

$$\alpha' y_t = y_{it} - \gamma' Y_t = \alpha' a + \alpha' u_t. \quad (8)$$

Because $\alpha' B = 0$, we rearrange the above equation, and obtain the following:

$$y_{1t} = \gamma_1 + \gamma' Y_t + \mu_{it}, \quad (9)$$

where $\gamma_1 = \alpha' a$ and $\mu_{it} = \alpha' u_t$.

The above equation could be further expressed as follows:

$$y_{1t} = \gamma_1 + \sum_{i=2}^{N} \gamma_i y_{it} + \mu_{it}. \quad (10)$$

Thus, we are able to use the above equation to fit the data prior to the treatment,and use the data during the posttreatment period and the training model to impute the counterfactual of the first unit. Following the convention of the econometric literature related to program evaluation, we refer to the counterfactual of the real unit, who receives the treatment, as the synthetic unit.

In practice, we adopt a regression model, where the dependent variable is the outcome for the first unit who receives the treatment at a certain time, while the explanatory variables are the outcomes for the other cities who do not receive the treatment throughout the whole sample period to fit the data during the pretreatment period and obtain the estimate in y_{1t}^0 and $\widehat{y}_{1t}^0$ based on the data during the posttreatment period. Thus, the estimate in the effect of the treatment on the outcome of our interest would be as follows:

$$\widehat{\delta}_{it} = y_{it}^1 - \widehat{y}_{it}^0, \quad (11)$$

where $\widehat{\delta}_{it}$ represents the estimate in the effect of the treatment on the outcome at time t.

For example, in this paper, we aim to estimate the impact of the Zhoushan Archipelago New Area construction on Zhoushan's energy efficiency. First, we use the panel data approach to construct a counterfactual, the synthetic Zhoushan, for the real Zhoushan, in the absence of the Zhoushan Archipelago New Area construction. We then compared Zhoushan and its counterfactual and referred to the differences between them as the estimates in the impacts of the Zhoushan Archipelago New Area construction.

3. Results

3.1. The Impact of the Zhoushan Archipelago New Area Construction on Energy Efficiency. In Figure 1(a), we plot the trends in energy efficiency for Zhoushan and its counterfactual, the synthetic Zhoushan that is formed by panel data approach. In this panel, the dark red line corresponds to the real Zhoushan, whereas the light red line corresponds to the synthetic Zhoushan. From this panel, we see that before the Zhoushan Archipelago New Area construction, the synthetic Zhoushan almost reproduced the energy efficiency evolution for Zhoushan. However, after the Zhoushan Archipelago New Area construction, the evolution of energy efficiency in Zhoushan and its counterfactual diverged to the end of our sample period.

In Figure 1(b), we plot the differences in energy efficiency between Zhoushan and its counterfactual, which are marked with the red line. We referred to these differences, after the Zhoushan Archipelago New Area construction, as the dynamic impacts of the New Area construction on energy efficiency. From this panel, we see that after the Zhoushan Archipelago New Area construction, its energy efficiency had a persistent improvement, although there existed a small dig at the end of our sample period.

Overall, our results suggest that the Zhoushan Archipelago New Area construction had a substantial and persistent impact on its energy efficiency. In our estimation, the Zhoushan Archipelago New Area construction improved energy efficiency in Zhoushan, on average, by 10 percentage points.

3.2. Inference about the Impact of the Zhoushan Archipelago New Area Construction on Energy Efficiency. To illustrate the significance of our estimated results, we adopted the bootstrapping technique, which helps us to produce an empirical distribution of the estimate in the Zhoushan Archipelago New Area construction on energy efficiency. We call the process of inference, which uses the bootstrapping technique, the bootstrapping test.

In the bootstrapping test, we first produced a new control group, each unit of which is randomly drawn with replacement from the raw control group. The new control group has the same number to the raw control group. We then combined the new control group and the treated group, Zhoushan Archipelago, to form a new sample. Next, we applied panel data approach to the new sample, and calculated the average difference in energy efficiency between Zhoushan and its counterfactual after the Zhoushan Archipelago New Area construction, which is referred to as the average impact of the Zhoushan Archipelago New Area construction on energy efficiency. Finally, we repeated the above three steps 1000 times and obtained an empirical distribution of the average impact on energy efficiency.

Figure 2 depicts the results from the bootstrapping test. In this figure, the blue shadow corresponds to the empirical distribution of the average impact on energy efficiency, with the green line corresponding to the fit line for this empirical distribution. The red solid line corresponds to the raw estimate in the average impact of the Zhoushan Archipelago New Area construction on energy efficiency, whereas the

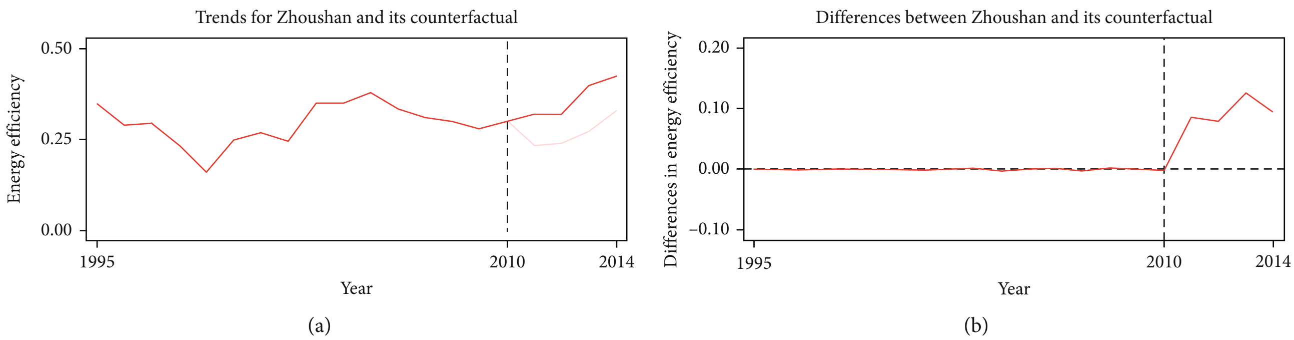

Figure 1: Zhoushan and its counterfactual, the synthetic Zhoushan. (a) The dark red line represents the real Zhoushan, while the light red line represents the synthetic Zhoushan. (b) The red line represents the difference between Zhoushan and its counterfactual.

Figure 2: The results from the leave-one-out test. The dark red line represents the real Zhoushan, while the light red shadow represents the synthetic Zhoushan formed by panel data approach.

red dash line corresponds to the mean of this empirical distribution of the average impact.

From this figure, we see that these two red lines were very close to each other, and at the same time, both of them were quite far from the zero, indicating that our estimate in the average impact of the Zhoushan Archipelago New Area construction on energy efficiency has a statistically significant interpretation. That is, the Zhoushan Archipelago New Area construction had a statistically significant impact on energy efficiency.

In our raw estimation, we estimated that the Zhoushan Archipelago New Area construction improved energy efficiency by about 10 percentage points. In this bootstrapping test, we estimated that the Zhoushan Archipelago New Area construction improved energy efficiency by about 12 percentage points. Taken together, we think that the Zhoushan Archipelago New Area construction improved energy efficiency by about 10 to 12 percentage points.

4. Discussion

4.1. Sensitivity Analysis. Here, we explore whether our estimate is robust to a certain control city in our raw sample. We employed the leave-one-out test to do such an analysis. In this leave-one-out test, we first discarded a certain control city in the raw sample to form a new sample. We then applied panel data approach to the new sample, which produces the counterfactual of Zhoushan, the synthetic Zhoushan. Finally, we repeated the above two steps until all the control cities in our raw sample were discarded one time. The leave-one-out test produced an empirical distribution of the synthetic Zhoushan.

Figure 3 depicts the results from the leave-one-out test. In this figure, the red line corresponds to the real Zhoushan, whereas the red shadow corresponds to the empirical distribution of the synthetic Zhoushan, which is formed by panel data approach for each sample where a certain control city is discarded. From this figure, we see that before the Zhoushan Archipelago New Area construction, Zhoushan is quite similar to its counterfactual. However, after the Zhoushan Archipelago New Area construction, they diverged. In detail, after the Zhoushan Archipelago New Area construction, the real Zhoushan had a more substantial improvement in energy efficiency, relate to its counterfactual. The results give us confidence that our results are not sensitive to a certain control city. Besides, this result suggests that the Zhoushan Archipelago New Area construction had a substantial persistent and positive impact on energy efficiency.

4.2. Permutation Tests. In the previous section, we used the bootstrapping test to illustrate the significance of the estimate in the impact of the Zhoushan Archipelago New Area construction on energy efficiency. In this subsection, we apply an alternative test to examine whether our results are credible. Following Abadie et al., we conducted the permutation test.

In the permutation test, we first reassign the treatment, the Zhoushan Archipelago New Area construction, to a certain control city. We then applied panel data approach to estimate the impact of the Zhoushan Archipelago New Area

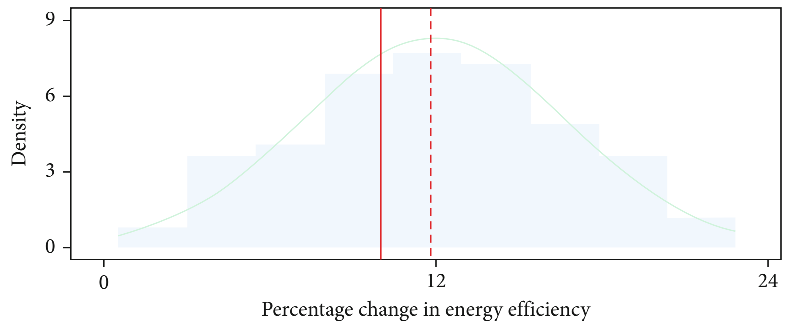

Figure 3: The results from the bootstrapping test. The blue shadow represents the empirical distribution of the impact of the Zhoushan Archipelago New Area construction. The green line represents the fitted curve of the empirical distribution. The red solid line represents the raw estimate, while the red dash line represents the mean of the empirical distribution.

construction on energy efficiency in that control city. Finally, we repeated the above two steps until each control city receives the treatment one time. Using the permutation test, we obtained an empirical distribution of the estimated faked impact of the Zhoushan Archipelago New Area construction on energy efficiency. We could compare the estimated real impact, obtained for Zhoushan Archipelago, with the empirical distribution. We would deem the impact of the Zhoushan Archipelago New Area construction on energy efficiency mainly significant if the estimated real impact for Zhoushan Archipelago is extremely large relative to the empirical distribution.

Figure 4 depicts the results from the permutation test. In this figure, we report the ratio of mean squared prediction error in the period after the Zhoushan Archipelago New Area construction to mean squared prediction error in the period before the Zhoushan Archipelago New Area construction for each city in our sample.

Recall that mean squared prediction error measures the magnitude of the difference in energy efficiency between each city and its counterfactual. Note that, however, a large mean squared prediction error in the period after the Zhoushan Archipelago New Area construction does not indicate a large impact of the Zhoushan Archipelago New Area construction on energy efficiency, as synthetic control might not closely produce the dynamics of energy efficiency in the period before the Zhoushan Archipelago New Area construction. That is, a large mean squared prediction error in the pretreatment period is not indicative of a large impact of the Zhoushan Archipelago New Area construction on energy efficiency, if the mean squared prediction error in the posttreatment period is also large. For each city, we divide the posttreatment mean squared prediction error by its pretreatment mean squared prediction error.

In Figure 4, each green point corresponds to the ratio of mean squared prediction error in the period after the Zhoushan Archipelago New Area construction to mean squared prediction error in the period before the Zhoushan Archipelago New Area construction for each city in our sample. From Figure 4, we see that Zhoushan clearly stood out as the city, which had the largest mean squared prediction error ratio among these cities in our sample. For Zhoushan,

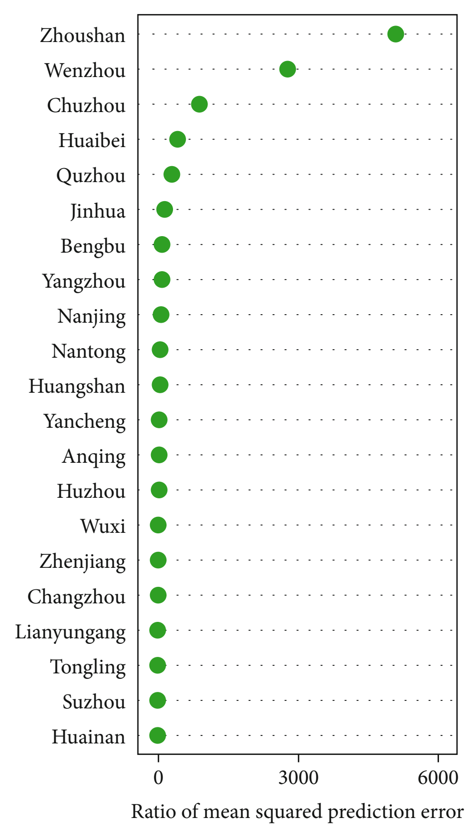

Figure 4: The results from the permutation test. Each green point represents an estimate if the corresponding city implemented a similar policy like the Zhoushan Archipelago New Area construction.

the squared prediction error in the period after the Zhoushan Archipelago New Area construction is about 5 thousand times larger than the squared prediction error in the period after the Zhoushan Archipelago New Area construction. If one was to draw a city at random from the sample, the possibility that we obtained such a ratio would be less than 5 percentage points. Thus, we could say that the Zhoushan Archipelago New Area construction had a statistically significant and substantial impact on the improvement in energy efficiency.

5. Conclusion

The marine economy has been serving as the blue engine for Chinese economic growth since the reform and opening-up. To further promote the marine economic development, the Central Government of China approved that Zhoushan Archipelago was listed as the National New Area for marine economic development in 2011.

In this paper, we consider the Zhoushan Archipelago New Area construction as a quasinatural experiment to explore the relationship between marine economic development and energy efficiency. We compared Zhoushan and its counterfactual, the synthetic Zhoushan that is formed by panel data approach, and referred to the difference in energy efficiency between the real Zhoushan and the synthetic Zhoushan as the estimate of the impact of the Zhoushan Archipelago New Area construction on energy efficiency.

Overall, our results suggest that the Zhoushan Archipelago New Area construction had a substantial impact on energy efficiency. That is, in comparison with the synthetic Zhoushan, the energy efficiency in Zhoushan had a larger improvement after the Zhoushan Archipelago New Area construction. We estimate that the Zhoushan Archipelago New Area construction improved energy efficiency, on average, by about 10 percentage points.

To illustrate the significance of the estimate of the impact of the Zhoushan Archipelago New Area construction on energy efficiency, we performed a bootstrapping test, which produces an empirical distribution of the estimate of the impact of the Zhoushan Archipelago New Area construction on energy efficiency. The estimated results suggest that our estimate has a statistically significant interpretation from an empirical perspective.

We also conducted a leave-one-out test to examine whether our estimate is sensitive to a certain control city. We find that Zhoushan had a more substantial improvement in energy efficiency than its each counterfactual, which is formed by panel data approach integrating the leave-one-out technique, after the Zhoushan Archipelago New Area construction. The results indicate that our estimate of the impact of the Zhoushan Archipelago New Area construction on energy efficiency is not sensitive to a certain control city in our sample.

In addition, we do a permutation test, which allows us to illustrate the significance of our estimate from an alternative empirical perspective. Not only are the estimated results quite similar to those from the bootstrapping test but it is also very close to the results obtained from the leave-one-out test, indicating that the Zhoushan Archipelago New Area construction has a statistically significant impact on energy efficiency from an empirical perspective.

Our study contributes to the investigation into the relationship between marine economic development and energy efficiency by focusing on Zhoushan Archipelago New Area, the first National New Area for marine economic development. Our results suggest that marine economic development had a substantial improvement in energy efficiency. That is, the Zhoushan Archipelago New Area construction improved energy efficiency in Zhoushan. Of course, our work is the first one to estimate the impact of the Zhoushan Archipelago New Area construction on energy efficiency in Zhoushan. Its results have some policy-related implications. For example, the local government of Zhoushan should deepen the Zhoushan Archipelago New Area construction, and the Central Government of China should expand the range of the construction of the National New Area for marine economic development, in order to increase the local energy efficiency and promote the general substantial development.

Our study has limitations. Its ecological nature means that our analysis is based on a single case, the Zhoushan Archipelago New Area construction, and put a strict limit on generalizing our conclusion to other cities that are little similar to Zhoushan. If, however, the cities are very similar to Zhoushan, then we have a large confidence that developing marine economy in these cities could substantially improve local energy efficiency. Besides, we do not explore the mechanisms, through which the Zhoushan Archipelago New Area construction affected energy efficiency. Future inquiry should carry out an exploration of the mechanisms. Of course, future research, assessing the impact of marine economic development on energy efficiency by focusing on other National New Areas for marine economic development, is needed to confirm our findings in this paper. That is, marine economic development had a substantial improvement in energy efficiency.

Data Availability

Data are available from corresponding author upon reasonable request.

Disclosure

This paper does not reflect an official statement or opinion from the organizations.

Conflicts of Interest

The authors declare no competing interests.

Authors' Contributions

All the authors equally contributed to this paper. Tian Tang and Jiayang Kong conceptualized the study and provided supervision. Fei Cheng and Cong Wei collected the data. Tian Tang and Jiayang Kong conducted the statistical analysis and drafted the manuscript. Fei Cheng, Cong Wei, and Jiayang Kong contributed to the interpretation of the results. All the authors provided critical feedback on drafts and approved the final manuscript.

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