Has the Free Trade Zone Construction Promoted the Upgrading of the City’s Industrial Structure?

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Abstract: Based on the panel data of 250 prefecture-level cities from 2006 to 2019, we adopted the idea and method of a “quasi-natural experiment” with difference-in-difference to assess the industrial-structure-upgrading effect of FTZ construction, analyze the factors and mechanisms influencing the effect, and further compare and analyze the regional heterogeneity and differences in spatial and temporal characteristics. We also propose policy recommendations to promote the orderly development of the FTZ. Empirical results show that, (i) compared with non-FTZ cities, the level of rationalization for industrial structures in FTZ cities increased by 9.69%, and the level of the advanced industrial structures increased by 7.01%. (ii) The innovation effect and the foreign investment effect enhance the effect of FTZ policy on industrial structure upgrading. (iii) Heterogeneity analysis found that the eastern and central FTZ have more significant roles in promoting industrial structure upgrading. (iv) Further spatial and temporal comparison analysis found that the promotion effect of the FTZ on industrial upgrading is temporally sustainable but with a certain lag. From the spatial perspective, the FTZ inhibits the level of advanced industrial structure in neighboring cities.

Keywords: free trade zone; industrial structure upgrading; difference in difference

1. Introduction

A modern industrial system is critical support for the high-quality development of the urban economy. The core of optimizing and upgrading the modern industrial system lies in improving the rationalization and advancements of industrial structures. The rationalization of the industrial structure is based on a horizontal perspective. In order to improve the sustainability of the economy, the balance of resources, technology, and supply and demand is achieved by adjusting the unreasonable industrial structure and the coordinated development of various industries. Industrial structure has advanced based on the longitudinal perspective. With the development of the economy, industrial structure development has changed from a primary industry to a secondary industry or a tertiary industry, mainly through the development of high-tech industries. As the “bridgehead” of the international and domestic “dual circulation,” the new ground revealed by pursuing opening up on all fronts, the free trade zone, has become a “booster” for high-quality industrial development through a preferential policy system and high-quality business environment, attracting innovative resources and providing strong talent. This has provided strong talent, technology, and financial support for optimizing and upgrading industrial structures and became a “booster” for high-quality industrial development. However, in the complex international environment, trade development is restricted, the functions of FTZ overlap, and the industrial and spatial layout is unreasonable, which hinders the effective performance of FTZ functions. As a “testing ground” for institutional innovation, has the construction of FTZ in China effectively promoted the upgrading of urban industrial structures? What mechanisms have played key roles? How effective is
the industrial upgrading? What problems still exist? The answers to these questions are of
great practical significance to improving the policies of the FTZ and promoting the healthy
and orderly development of the FTZ in depth. Based on all that, we adopted the idea and
method of a “quasi-natural experiment” with difference-in-difference and examined the
policy effects of the establishment of the FTZ on the upgrading of industrial structure with
respect to the evolution of the rationalization and level of advancement of the in FTZ cities
and non-FTZ cities before and after the policy.

2. Literature Review

Industrial structure optimization has an important impact on urban economic growth,
social employment, energy consumption, and sustainable development (Cheng et al.,
2022) [1]. A city’s industries will be transformed and reconstructed through industrial struc-
ture optimization, thereby changing industrial progress, economic models, and sustainable
development capabilities. For example, Peneder (2003) explored the mechanisms of action
of industrial restructuring affecting labor productivity, income, and economic growth, and
found that industrial structure has a significant impact on macroeconomic development
and growth [2]. Tian et al. (2017) found that industrial restructuring could reduce energy
consumption by 19% in China through a multi-objective optimization model study [3].
Zhang (2003) studied the transformation and reconstruction of the industrial structure of
the old industrial city of Shenyang [4]. Luken and Castellanos-Silveria (2011) explored
the effects of industrial transformation on employment, industrial output per capita, and
energy consumption intensity in terms of economic, social, and environmental factors [5].
Kodama (2017) examined how industrial structural transformation affects income and gross
regional product (GDP) [6]. Hou et al. (2019) proposed industrial structure diversification,
rationalization, and advancement indicators to assess the vital role of industrial transforma-
tion in urban economic growth from the perspective of industrial structure rationalization
and advancement [7].

Given the importance of industrial structure to regional sustainable development,
numerous scholars have explored the determinants of its transformation and upgrading at
the national and regional levels. Relevant studies have covered various aspects, such as
international trade, human capital levels, technological capabilities, financial development,
and institutional levels (Liu et al., 2021; Pipkin and Fuentes, 2017; Zhou, 2016) [8–10]. For
example, Zhao and Niu (2013) explored the spillover effects of FDI in terms of both scale
and structure and analyzed the positive impact of foreign investment on industrial structure
upgrading [11]. Liu and Xie (2018) studied the contributions of existing policies—such as
environmental policies, the strength of local government environmental regulation, and the
level of environmental information disclosure—and their implementation processes to the
industrial impact of structural adjustment [12]. With the booming construction of FTZ, Nie
(2020) argued that the construction of FTZ should include industrial structure upgrading as
an essential goal [13]. Hamada (1974) and Krugman (1979) argued that because FTZs enjoy
extremely high free trade policies and tax breaks for trade transactions, they can break down
trade barriers and achieve cross-regional flows of goods, production factors, and services,
thereby influencing the intra-regional industrial division of labor and locational choices, and
thus can effectively drive the optimization and upgrading of industrial structures [14,15].
However, Jenkins (2013) and others argued from the “backwash effects” of FTZ that the
construction of FTZ gives more resources to the strongest, which exacerbates the imbalance
of economic development between regions through the reverse effect of “hoeing the weak
and supporting the strong,” and is not conducive to the optimization and upgrading of
industrial structure in cross-regional synergy [16].

Most of the existing studies on the policy effects of FTZ focused on economic effects
(Possebom, 2017) [17], trade facilitation effects (Yao et al., 2015) [18], spatial effects (Zhao
et al., 2014; Cheng et al., 2021) [19,20], etc. Some scholars have also analyzed the effects of
FTZ establishment on the financial industry (Shen et al., 2015) and manufacturing industry
(Ji et al., 2015; Yu et al., 2014) [21–23]. Based on this, some scholars have further explored
the mechanisms of the roles of FTZ policies in industrial development. For example, Song et al. (2019) argued that the construction of FTZ has changed the external environment of industries, in which the entry of foreign capital has contributed to increased industrial competition, thereby promoting the level of industrial innovation (Liu et al., 2018) [24,25]. In parsing the role of FTZ in promoting economic convergence, Liang et al. (2020) found that industrial structure advancement played a mediating role, and the mediating role of industrial structure rationalization was weaker [26].

Existing studies on the effect of FTZ establishment on industrial structure upgrading have mainly focused on qualitative analysis at the policy level. However, quantitative measures of the relationship between FTZ and industrial structure rationalization and advancement have become increasingly abundant. Feng et al. (2020) used the difference–in-difference method to assess the industrial structure upgrading effect of FTZ construction and concluded that FTZ construction could significantly promote an advanced industrial structure [27]. After testing, Nie (2020) found that FTZ can optimize the degree of rationalization of the manufacturing industry’s structure [12]. Li et al. (2019) found that the Shanghai FTZ has a significant positive effect on the advanced industrial structure and a weak policy impact effect on the high degree of processing [28]. Liang et al. (2020) empirically tested industrial structure transformation and the upgrading effect of the establishment of North American, European, ASEAN, and China–ASEAN FTZs [26].

Compared with the existing literature, the contributions of this paper are: (1) The existing literature mainly focuses on the Shanghai FTZ or uses inter-provincial panel data. However, we conducted a comprehensive comparative analysis of the three batches of FTZs established in China and chose the data of prefecture-level cities that are more representative of regional characteristics. (2) Most of the existing literature argues on the economic effects of FTZ construction, but there is less research on the upgrading effect of the industrial structure of FTZ construction, and most of the research has been conducted from a single perspective. (3) As a quasi-natural experiment, we used the multi-period difference-in-difference method to analyze the free trade zone policy, considering the different establishment times. Further, we analyze the regional heterogeneity and differences in spatial and temporal characteristics of the impact of the free trade zone policy on this basis.

3. Theoretical Analysis and Research Hypotheses
3.1. Analysis of the Impact of the Construction of the Free Trade Zone on the Upgrading of Industrial Structure

In 2013, China’s first FTZ, the Shanghai FTZ, was established, and since then, Tianjin, Guangdong, Fujian, Liaoning, Zhejiang, Henan, Hubei, Chongqing, Sichuan, and Shaanxi FTZs have been approved (as shown in Table 1). Although the FTZs differ in geographic location and level of economic development, in general, the policy objectives of the FTZs are consistent and can be divided into four categories:

1. Improve market mechanisms and establish a quality business environment to promote trade facilitation.
2. Based on the pre-entry national treatment and negative list system, lower the threshold of foreign entry to promote investment facilitation.
3. Promote financial sector reform and implement a floating exchange rate system to promote financial liberalization.
4. Deepen the reform of the administrative system to improve administrative efficiency and promote the transformation of government functions.
Table 1. FTZ establishment areas and batches.

| FTZs Batch and Establishment Time | Established FTZs         | City                          |
|----------------------------------|--------------------------|-------------------------------|
| The first batch of free trade zones September 2013 | Shanghai             | Shanghai                      |
| The second batch of free trade zones April 2015 | Tianjin              | Tianjin                       |
|                                   | Guangdong            | Guangzhou, Shenzhen, Zhuhai   |
|                                   | Fujian               | Fuzhou, Xiamen                |
| The third batch of free trade zones April 2017 | Liaoning            | Dalian, Shenyang, Yingkou     |
|                                   | Zhejiang            | Zhoushan                      |
|                                   | Henan               | Zhengzhou, Kaifeng, Luoyang   |
|                                   | Hubei               | Wuhan, Xiangyang, Yichang     |
|                                   | Chongqing           | Chongqing                     |
|                                   | Sichuan             | Chengdu, Luzhou               |
|                                   | Shaanxi             | Xi’an                         |

It can be seen that the FTZ has acquired unique advantages in terms of policy bias and system innovation. For example, the Dalian Free Trade Zone introduced support policies for emerging industries. In only the first half of 2021, the Dalian Free Trade Zone advanced equipment manufacturing, life, health, and new energy industries, reaching a year-on-year growth rate of more than 10%. In 2021, the Zhengzhou Free Trade Zone focused on signing 20 major projects centered on leading enterprises, emerging finance, new trade, emerging technology, and other industries. For high-end industries, the emerging industries gathered resources. To this end, we tested the following hypothesis:

**Hypothesis 1.** The FTZ policy can promote the upgrading of an industrial structure.

3.2. Analysis of the Impact Mechanism of the Construction of the Free Trade Zone on the Upgrading of Industrial Structure

3.2.1. Innovation Effect

Cai and Xu (2017) found that technological advances brought about by trade opening have contributed to the overall upgrading of China’s industrial structure [29]. As foreign trade markets with special policies, FTZs allow goods to be exempted from the usual customs control system, implement tax exemptions or even zero tariffs, simplify import and export procedures, and improve customs clearance efficiency through trade facilitation measures. The introduction of high-quality imported goods, on the one hand, accelerates international technology transfer and technology spillover; reduces the research and development costs of local enterprises; improves the enthusiasm for innovation; and stimulates local enterprises to take the initiative to connect to international standards and rules, promote industrial structure upgrading, and improve their competitive advantage in the domestic and international markets. On the other hand, high-quality imports force local enterprises to carry out technological innovation, and through the “advantage of backwardness” to catch up with imported goods, to achieve “corner overtaking” and drive the development of high-end industries in the region.

3.2.2. Foreign Investment Effect

According to Wang et al. (2020), the inflow of foreign direct investment has accelerated the free flow of goods, economy, and services and promoted the optimization and upgrading of industrial structure [30]. China’s FTZ implements the “national treatment before admission” and “negative list” management model for foreign investment, allowing foreign investors to enjoy treatment no less favorable than domestic investors in the estab-
lishment, acquisition, and expansion of enterprises in investment areas outside the negative list. Thus, this has effectively opened up the channels for foreign investment injection, lowered the financing threshold for industrial development, and provided strong financial support for industrial transformation and upgrading. At the same time, the flexible and diverse tax incentives and financial support modes of the FTZ create a high-quality business environment and a benign development mechanism for industrial development, enhancing the attractiveness of the FTZ to high-quality foreign-funded industries; enabling the FTZ to continuously gather cutting-edge technologies and talents in emerging industries such as artificial intelligence, financial technology, and digital economy; and enabling it to form a selection mechanism for the elimination of winners and losers through increasingly fierce market competition (Kugler, 2005), motivating local industries to take the initiative to improve production technologies and increase production efficiency, and to develop in the direction of high-end industries with high value-added, high quality, and high efficiency qualities [31].

Based on the above analysis, we tested the following hypotheses:

**Hypothesis 2A.** The FTZ promotes industrial structure upgrading through the innovation effect.

**Hypothesis 2B.** The FTZ promotes industrial structure upgrading through the foreign investment effect.

### 3.3. Heterogeneity Analysis of the Construction of FTZ in Relation to Industrial Structure Upgrading

Although the FTZ policy creates favorable advantages for local industrial transformation, the effect of FTZ construction on industrial structure upgrading varies from region to region due to resource heterogeneity and spatial differences in different regions. The phenomenon of unbalanced development among regions in China objectively exists, and there are apparent differences in the level of socio-economic development, regional spatial location, and natural resource endowment among regions. For example, the Eastern Fujian Free Trade Zone can take full advantage of the convenience of Fujian–Taiwan cooperation, take the lead in promoting investment and trade liberalization with Taiwan, deepen cross-strait exchanges and cooperation, and accelerate the integration of the “21st Century Maritime Silk Road.” The Henan Free Trade Zone in central China can make full use of its modern transportation system that connects north to south and east to west, and link up with national strategies such as “One Belt, One Road” and “Rise of Central China.” Chongqing FTZ in the west is located at the critical pivot point of the western development strategy and is also an important hub of the Yangtze River economic belt’s interconnection. While the Liaoning FTZ focuses on enhancing the overall competitiveness of the old industrial base in Northeast China, the Shanghai FTZ is internationally oriented and an important base for global investment and trade, international innovation, etc. Based on this, we tested the following hypothesis:

**Hypothesis 3.** There is heterogeneity in the effect of FTZs on industrial structure upgrading among regions.

### 3.4. Analysis of the Time Lag Effect of FTZ Construction on Industrial Structure Upgrading

As a new high ground for opening up to the outside world and a “bridgehead” for promoting domestic and international circulation, the policy objectives of the FTZ are forward-looking, continuous, and long-term. The system innovation of FTZ not only relies on the reforming of the administrative system and innovation of the original management model, but also depends on infrastructure support and digital construction. Integrating institutional innovation and technological innovation takes time, and the impact on industrial structure upgrading may have a time lag. In addition, there is a lack of experience to draw on in the early FTZs, but with the cumulative effect of policies and the continuous
improvement of the institutional system, the effect of its role will gradually appear. While the later established FTZs draw on the valuable experience of the early FTZs, there are differences in the industrial base and industrial structure of each FTZ, and the process of fitting the construction experience of the early FTZs with the upgrading of the industrial structure of the local FTZs takes time, and the policy effects will show different evolutionary characteristics. Based on this, we tested the following hypothesis:

Hypothesis 4. The impact effect of FTZ on industrial structure upgrading has a time lag.

3.5. Analysis of the Spatial Impact of the Construction of the Free Trade Zone on the Upgrading of Industrial Structure

From the spatial perspective, on the one hand, the central cities in the FTZ gather more resources than the surrounding areas, having a competitive advantage in the regional competition, and through the “siphon effect,” attracting high-end industries from neighboring cities to the FTZ, improving the quality of industrial development in the FTZ cities, and widening the distance between the central cities in the FTZ and the neighboring cities. At the same time, due to the limitations of environmental carrying capacity and development needs, the industrial or heavy pollution industries in the central city of the FTZ may be transferred to the surrounding cities, which further optimizes the industrial structure of the central city of the FTZ, but also increases the industrial and environmental burden of the surrounding areas. The central city of the FTZ becomes a “pollution haven,” further widening the distance between the central city of the FTZ and the surrounding areas in terms of industrial development quality. On the other hand, the high-quality development of the central cities in the FTZ may radiate and drive the development of industries in the surrounding areas and provide new momentum for the industrial development of the surrounding areas through technology spillover, and knowledge spillover manifested as technology spillover from enterprises in the FTZ with higher productivity to enterprises in the surrounding cities. Advanced technology spillover among enterprises through channels such as capital investment and labor flow promotes the development of high-tech industries in the surrounding areas and the upgrading of the industrial structure in the surrounding areas. Therefore, we tested the following hypotheses:

Hypothesis 5A. The impact of the FTZ on industrial structure upgrading in the surrounding areas has a positive spatial spillover effect.

Hypothesis 5B. The impact of the FTZ on the upgrading of industrial structure in the surrounding areas has a negative spatial spillover effect.

4. Empirical Analysis

This section describes the data, variables, model, and empirical results. Specifically, Section 4.1 introduces the data and variables. Section 4.2 analyzes the dynamic evolutionary trend of industrial structure upgrading from the description perspective. Section 4.3 constructs the benchmark model. Empirical results are shown in Section 4.4.

4.1. Data and Variables

1. Rationalization of industrial structure (strra).

In this paper, we adopt the approach of Cheng et al. (2020) to calculate the industrial structure rationalization based on the inverse of the theil index with the following Equation [32].

\[
\mu = \frac{1}{TL} = 1/\sum_{i=1}^{n} \frac{Y_i}{L} \left( \frac{Y_i}{Y_L} \right)
\]  

where TL represents the theil index, \( Y_i \) represents the value added of industry \( i \), \( L_i \) represents the number of employees in industry \( i \), and \( n \) represents the number of industry
classifications. On this basis, \( \mu \) is standardized and used as an indicator \( \text{strra} \) to measure the rationalization of industrial structure. The value of \( \text{strra} \) ranges from 0 to 1. The closer \( \text{strra} \) is to 1, the more reasonable the industrial structure. That means stronger coordination ability and a higher level of association between industries; otherwise, vice versa.

2. Advanced industrial structure (\( \text{strad} \)).

We drew on Gan et al. (2011) to use the ratio of the tertiary sector’s value-added to the secondary sector’s value-added as an indicator of the advanced industrial structure [33].

3. Control variables.

Referring to Liang et al. (2021), Zheng et al. (2021), and Fang (2020), the following variables were selected as control variables [34–36]:

- Level of economic development (\( \text{lngdp} \)): measured by the logarithm of GDP;
- Government intervention (\( \text{gov} \)): measured by the share of government fiscal expenditure in fiscal revenue;
- Level of trade openness (\( \text{lntra} \)): measured using the logarithm of total import and export trade;
- Level of financial development (\( \text{lnfina} \)): measured by the logarithm of year-end financial institution deposit and loan balances;
- Level of fixed asset investment (\( \text{lnfix} \)): measured by the logarithm of fixed asset investment.

4. Data source.

Data from 250 prefecture-level cities across China from 2006 to 2019 were used to analyze the first three batches of FTZs established in China, taking into account the policy implementation effect, and cities that established FTZs after 2018 were removed, and the original data of variables were obtained from the 2007–2020 China City Statistical Yearbook and the yearbooks of prefecture-level cities. To eliminate the effect of extreme values, the relevant continuous variables were winsorized, shrunk by 1% up and down. The sample was divided into “sample of cities with FTZs” and “sample of cities without FTZs” according to whether FTZs were established or not, and the descriptive statistics are shown in Table 2.

### Table 2. Descriptive statistics.

| Variables | Sample of Cities with FTZs | Sample Cities without FTZs | All Samples |
|-----------|---------------------------|---------------------------|-------------|
|           | Obs | Mean | Std.Dev. | Obs | Mean | Std.Dev. | Obs | Mean | Std.Dev. |
| strra     | 294 | 0.330 | 0.330    | 3206 | 0.399 | 0.321    | 3500 | 0.393 | 0.322    |
| strad     | 294 | 1.063 | 0.416    | 3206 | 0.872 | 0.448    | 3500 | 15.039 | 0.863    |
| lngdp     | 294 | 16.181 | 0.963    | 3206 | 14.934 | 0.773    | 3500 | 12085 | 11713    |
| gov       | 294 | 1.063 | 0.564    | 3206 | 2.814 | 1.675    | 3500 | 2.712 | 1.646    |
| lnfina    | 294 | 18.543 | 1.358    | 3206 | 16.877 | 1.049    | 3500 | 17.017 | 1.173    |
| lntra     | 294 | 16.129 | 2.079    | 3206 | 13.498 | 1.878    | 3500 | 13.719 | 2.031    |
| lnfix     | 294 | 16.655 | 1.001    | 3206 | 15.528 | 0.940    | 3500 | 15.623 | 0.995    |

4.2. Dynamic Evolution of Industrial Structure Upgrading in Each City and Region

The kernel density distribution of the rationalization and advanced level of the industrial structure of each prefecture-level city from 2006 to 2019 are shown in Figure 1.

In general, the wave of industrial structure rationalization shows a trend of rising-declining-rising with an obvious right trailing feature, and a sub-peak was even formed in 2019 in the region with a higher rationalization level, indicating that the level of industrial structure rationalization has been significantly improved by more cities; however, the wave of each year is still located in the region with lower rationalization level, and the gap of industrial structure rationalization level between cities is widened. The peaks of the advanced industrial structure are concentrated in the 1-2 interval, and the distribution curve gradually shifts from left-skewed to right-skewed, indicating that the differences in the advanced industrial structure of each prefecture-level city are not obvious, and the overall trend of improvement is shown.
Figure 1. Distribution of kernel density of industrial structure upgrading in each municipality. (a) Kernel density distribution of industrial structure rationalization. (b) Kernel density distribution of advanced industrial structure.

4.3. Model Construction

In this research, the FTZ policy was considered a quasi-natural experiment, and the relevant research was carried out based on the idea and method of difference-in-difference (DID). Since the FTZ policy is implemented in batches and the implementation time is not the same, a multi-period difference-in-difference model is used, and the model is set as follows:

\[
\text{strra}_{it} = \alpha_0 + \alpha_1 Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \quad (2)
\]

\[
\text{strad}_{it} = \alpha_0 + \alpha_1 Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \quad (3)
\]

where \(i\) denotes city and \(t\) denotes time. \(\text{strra}_{it}\) denotes rationalization of industrial structure and \(\text{strad}_{it}\) denotes advanced industrial structure. \(Z_{it}\) is the free trade zone policy, and takes the value of 1 if city \(i\) establishes a free trade zone at time \(t\) and after, and 0 otherwise. \(X_{it}\) is the control variable, \(\lambda_i\) is the individual fixed effect, \(\omega_t\) is the time fixed effect, and \(\epsilon_{it}\) is the random disturbance term.
A fixed-effects model based on Driscoll-Kraay standard errors (Driscoll and Kraay, 1998) was chosen as the estimation model, which takes into account the correlation disturbance due to the presence of unobserved factors common to all cross-sectional cells and introduces simultaneous and lagged cross-sectional correlations into the error term to solve the optimal linear unbiased estimation problem in the case that the classical assumptions of linear regression models (expected residuals equal to zero, chi-square and no autocorrelation) are not strictly satisfied [37].

The use of the difference-in-difference method is predicated on satisfying the parallel trend assumption so that we performed a parallel trend test. Although the difference-in-difference method can solve the endogeneity problem and obtain the policy treatment effect, it cannot solve the sample selection bias problem, so we further utilized the propensity score matching method (PSM) to eliminate the sample selection bias. In addition, another concern of using the difference-in-difference method is that unobservable time-varying factors can bias the estimation results. We conducted a placebo test to alleviate this problem.

Based on the above analysis, we construct the analytical framework for the empirical test, as shown in Figure 2.

Figure 2. Analytical framework for empirical testing.

4.4. Difference in Difference Estimation Results

The estimation results based on the difference-in-difference method are presented in Table 3, where the explanatory variables in columns (1)–(2) are industrial structure rationalization and in columns (3)–(4) are industrial structure advanced. Columns (1) and (3) introduce the core explanatory variable Z(treated*time) and control for time and individual fixed effects, and columns (2) and (4) further introduce control variables.
Table 3. Baseline regression results.

|         | (1)  | (2)  | (3)  | (4)  |
|---------|------|------|------|------|
|         | Strra| Strra| Strad| Strad|
| Z (treated × time) | 0.101 * | 0.0969 * | 0.0810 * | 0.0701 *** |
|         | (0.0501) | (0.0481) | (0.0381) | (0.0207) |
| lngdp   | −0.138 | 1.249 *** | 0.0537 *** | (1.218) | (0.339) |
|         | (0.0106) | (0.0141) |           |           |
| gov     | −0.0298 ** | 0.0109 | (0.0383) | (0.0305) |
| Infina  | 0.117 *** | 0.117 *** | (0.0383) | (0.0305) |
| Intra   | 0.0465 ** | −0.0463 *** | (0.0190) | (0.00541) |
| lnfix   | −0.000153 | −0.160 *** | (0.0217) | (0.0261) |

Individual effects: Yes Yes Yes Yes
Time effects: Yes Yes Yes Yes
R2: 0.0454 0.0596 0.538 0.6222
_cons: (8.31 × 10^{-15}) (18.57) (1.68 × 10^{-14}) (5.786)
N: 3500 3500 3500 3500

Note: * p < 0.10, ** p < 0.05, *** p < 0.01, Driscoll–Kraay standard errors are in parentheses.

As seen in Table 3, the coefficient Z of the core explanatory variables is always significantly positive at 10% significance level, and the estimated coefficients of columns (2) and (4) indicate that the establishment of the FTZ increases the level of industrial structure rationalization by 9.69% and the level of industrial structure advanced by 7.01%, and hypothesis 1 is confirmed. In terms of control variables, at 5% significance level, the level of financial development and the level of trade opening have positive effects on the index of industrial structure rationalization; the level of economic development and government intervention has positive effects on industrial structure advanced. Government intervention has a negative effect on the rationalization of industrial structure. The possible reason is that there is a “crowding out effect” of government intervention. The negative effect of trade openness comes from China’s role as the “factory of the world”, which has hindered the adjustment of industrial structure. Meanwhile, overheated real estate and large-scale infrastructure in previous years damaged the development of the real economy, leading to the slowdown of industrial upgrading.

5. Robustness Test
5.1. Parallel Trend Test

The parallel trend assumption is a prerequisite for the use of the difference-in-difference method, before the implementation of the FTZ policy. There was consistency in the development trends of rationalization and advanced industrial structure in the treatment and control groups. Since we used the multi-period difference-in-difference method, we drew on Beck and Levkov’s (2010) event study method for the parallel trend test [38].

\[
strra_{it} = \alpha_0 + \rho_1 \sum_{n=1}^{6} G_{t-n} + \rho_2 \sum_{n=1}^{5} G_{t+n} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \tag{4}
\]

\[
strad_{it} = \alpha_0 + \rho_1 \sum_{n=1}^{6} G_{t-n} + \rho_2 \sum_{n=1}^{5} G_{t+n} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \tag{5}
\]

where \(G_{t-n}\) indicates that the variable takes the value of 1 if the FTZ is established in period \(t-n\) and 0 otherwise, \(G_{t-1}\) indicates that the year before the establishment of the FTZ city is 1 and 0 otherwise, and \(G_{t+1}\) indicates that the year after the implementation of the FTZ
city policy is set to 1 and 0 otherwise. The results of the parallel trend test are shown in Figure 3.

Figure 3. Parallel trend test results. (a) Industrial structure rationalization parallel trend test. (b) Industrial structure advanced parallel trend test.

As seen in Figure 3, the first six years of FTZ policy implementation did not pass the significance test at the 95% confidence interval, indicating that the levels of industrial structure rationalization and industrial structure advanced in the treatment and control groups before the implementation of FTZ policy were not significantly different and passed the parallel trend hypothesis test. After the occurrence of the policy, the coefficients of industrial structure rationalization and industrial structure advanced are positive and mostly significant, indicating that the FTZ policy promotes the optimization and upgrading of industrial structure.
5.2. PSM-DID Test

To control for observable factors affecting the establishment of FTZs and to eliminate the problem of sample selection bias between the treatment and control groups, we screened the control group’s samples from cities that did not establish FTZs through propensity score matching (PSM) and performed a difference-in-difference test in the screened samples. For this purpose, the dummy variable Z dummy was set, and cities with FTZs were assigned a value of 1; otherwise, they were assigned a value of 0. All covariates were regressed on Z dummy separately to calculate the propensity score values, and after nearest neighbor matching, the samples that satisfied the common support hypothesis were retained. The results of the common support test and the PSM-DID results are shown in Tables 4 and 5, respectively.

### Table 4. Common support test results.

| Variables | Samples       | Mean | Bias (%) | Reduct | Bias | t-Value | P > |t| |
|-----------|---------------|------|----------|--------|------|---------|------|---|
|           |               | Treated | Control |        |       |         |      |---|
| lngdp     | Unmatched     | 16.153 | 14.935   | 144.1  | 99.6 | 25.55   | 0.000|   |
|           | Matched       | 16.153 | 16.148   | 0.6    | 0.07 | 0.07    | 0.948|   |
| gov       | Unmatched     | 1.6041 | 2.784    | −102.7 | −98.1| −13.19  | 0.000|   |
|           | Matched       | 1.6041 | 1.585    | 2.0    | 0.41 | 0.41    | 0.680|   |
| lnfina    | Unmatched     | 18.513 | 16.876   | 138.7  | 97.5 | 25.3    | 0.000|   |
|           | Matched       | 18.513 | 18.491   | 1.8    | 0.20 | 0.20    | 0.839|   |
| lntra     | Unmatched     | 16.098 | 13.504   | 133.3  | 97.5 | −0.39   | 0.000|   |
|           | Matched       | 16.098 | 16.163   | −3.3   | 0.035| 0.035   | 0.695|   |
| lnfix     | Unmatched     | 16.623 | 15.53    | 115.9  | 94.8 | 19.19   | 0.000|   |
|           | Matched       | 16.623 | 16.567   | 6.0    | 0.75 | 0.75    | 0.452|   |

### Table 5. PSM-DID test results.

|   | (1)          | (2)          | (3)          | (4)          |
|---|--------------|--------------|--------------|--------------|
|   | Strra        | Strra        | Strad        | Strad        |
| Z (treated \times time) | 0.104 **     | 0.0998 *     | 0.103 ***    | 0.0699 ***   |
| lngdp | 4.868         | 5.022 ***    | (0.0436)     | (0.0510)     |
| gov  | −0.0349      | 0.0515 ***   | (0.0416)     | (0.0107)     |
| lnfina | −0.108     | 0.0721 *     | (0.0918)     | (0.0354)     |
| lntra | 0.0851       | −0.0335      | (0.0633)     | (0.0208)     |
| lnfix | 0.0899 *     | −0.148 ***   | (0.0430)     | (0.0277)     |
| Individual effects | Yes          | Yes          | Yes          | Yes          |
| Time effects | Yes          | Yes          | Yes          | Yes          |
| R2  | 0.078        | 0.101        | 0.645        | 0.7055       |
| _cons | 0.435 ***    | −77.75       | 0.837 ***    | −77.55 ***   |
|      | (0.00760)    | (45.49)      | (0.00533)    | (16.87)      |

| N  | 775          | 775          | 775          | 775          |

Note: *p < 0.10, **p < 0.05, ***p < 0.01, Driscoll–Kraay standard errors are in parentheses.

As seen in Table 4, the absolute values of the standard deviations of both the matched treatment and control groups were within 10%, the differences between the treatment and control groups were reduced, and the two groups were comparable.

As shown in Table 5, the free trade zone policy increases the rationalization of the industrial structure by 9.98% and the advanced industrial structure by 6.99%, which is
basically consistent with the previous results, indicating that the impact of the free trade zone policy on the rationalization of industrial structure and the advanced industrial structure is robust.

5.3. Placebo Test

Based on the estimation results of the difference-in-difference method, it is argued that the FTZ policy drives the optimization and upgrading of industrial structure, but we still need to worry about whether the trend changes in the treatment and control groups after the time point of policy intervention are influenced by other policies or random factors. Although fixed effects control for unobservable factors that do not change over time, some factors that change over time were not taken into account. The robustness of the results can be confirmed by a placebo test by randomly generating a list of experimental groups from all prefectures, based on which the time variable was randomly selected for one year as the time of the policy shock, generating a coefficient of error estimate $a_{mis}^*$; we repeated this process 500 times to obtain 500 $a_{mis}^*$. The results of the placebo test are shown in Figure 4.

As shown in Figure 4, the estimated coefficients of industrial structure rationalization and industrial structure advanced are around 0 and obey normal distribution. The scattered points in the figure are the significance levels of the estimated coefficients $a_{mis}^*$. The dashed line at the level of the x-axis is the significance level of 10%, and it can be seen that most of the estimated coefficients are around 0 and obey a normal distribution, and most of them are insignificant. These results indicate that the baseline estimates are valid even in the presence of unobservables, and the placebo test is passed.

![Figure 4](image-url)
6. Further Analysis

6.1. Impact Mechanism Test

To further test hypotheses 2A and 2B, the interaction models of innovation effect (rpatent) and foreign investment effect (lnfdi) with FTZ policy (Z) were constructed, respectively. As shown in Equations (6)–(9).

\[
strad_{it} = \alpha_0 + \alpha_1 (rpatent \times Z_{it}) + \alpha_2 rpatent + \alpha_3 Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \quad (6)
\]

\[
strad_{it} = \alpha_0 + \alpha_1 (rpatent \times Z_{it}) + \alpha_2 rpatent + \alpha_3 Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \quad (7)
\]

\[
strad_{it} = \alpha_0 + \alpha_1 (lnfdi \times Z_{it}) + \alpha_2 lnfdi + \alpha_3 Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \quad (8)
\]

\[
strad_{it} = \alpha_0 + \alpha_1 (lnfdi \times Z_{it}) + \alpha_2 lnfdi + \alpha_3 Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it} \quad (9)
\]

The model regression results are shown in Table 6, where columns (1)–(4) are the effects of the innovation effect, the foreign investment effect, and the interaction term of the FTZ policy on the rationalization of industrial structure and the advanced industrial structure, respectively.

As can be seen in columns (1) and (2) of Table 6, the innovation effect of the core interaction term is always positive, indicating that the innovation effect and the FTZ policy have synergistic effects on the promotion of industrial structure upgrading, and the innovation effect is an important way to promote the transformation and upgrading of high-end and efficient industrial structures. The regression results show that the innovation effect increases the rationalization of industrial structure and the advanced industrial structure at the 1% and 10% levels, respectively. Columns (3) and (4) show that the core interaction term innovation effect is always positive, the foreign investment effect and the FTZ policy synergistically promote industrial structure upgrading, and the foreign investment effect promotes industrial structure rationalization and the advanced industrial structure at the 1% and 5% significance levels. Hypothesis 2A and hypothesis 2B are confirmed.
Table 6. Mechanism test results.

|                  | (1)   | (2)   | (3)   | (4)   |
|------------------|-------|-------|-------|-------|
|                  | Strra | Strad | Strra | Strad |
| rpatent × Z (treated × time) | 0.00308 *** | 0.00127 * | (0.000757) | (0.000690) |
| lnfdi × Z (treated × time) | 0.129 *** | 0.0944 ** | (0.0339) | (0.0327) |
| lnfdi | 0.0151 ** | 0.0000207 | (0.00683) | (0.00341) |
| rpatent | −0.00148 | 0.000770 | (0.00188) | (0.00110) |
| Z (treated × time) | 0.00607 | 0.0167 | 0.580 *** | 0.425 *** |
| (0.0394) | (0.0179) | (0.157) | (0.132) |
| Control variables | Yes | Yes | Yes | Yes |
| Individual effects | Yes | Yes | Yes | Yes |
| Time effects | Yes | Yes | Yes | Yes |
| R2 | 0.603 | −10.28 | 6.615 | −12.76 ** |
| (22.92) | (7.385) | (20.28) | (5.650) |

N: 3500 3500 3500 3500

Note: * p < 0.10, ** p < 0.05, *** p < 0.01, Driscoll–Kraay standard errors are in parentheses.

6.2. Heterogeneity Analysis

According to China’s new economic zone division standards, all free trade zones were divided into three major regions: eastern, central, and western. We set dummy variables \( g_m (m = 1, 2, 3) \), corresponding to the eastern, central, and western regions, respectively. When the sample attribution is consistent with the meaning of the dummy variable, the corresponding dummy variable \( g_m \) takes 1, and otherwise takes 0. The specific model is as follows:

\[
strra_{it} = \alpha_0 + \alpha_1 \sum_{m=1}^{3} (g_m \times Z_{it}) + \beta X_{it} + \lambda_i + \omega_t + \varepsilon_{it} \tag{10}
\]

\[
strad_{it} = \alpha_0 + \alpha_1 \sum_{m=1}^{3} (g_m \times Z_{it}) + \beta X_{it} + \lambda_i + \omega_t + \varepsilon_{it} \tag{11}
\]

The model regression results are shown in Table 7. The results of column (1) and column (4) show that the construction of the eastern regional FTZ positively promotes the level of rationalization of industrial structure and the level of advanced industrial structure at the 5% significance level. The results of column (2) and column (5) show that the construction of central regional FTZs contributes significantly to the rationalization level of industrial structure and advanced level of industrial structure at 5% and 1% significance levels. Columns (3) and (6) show that the western regional FTZ has a negative effect on the rationalization of industrial structure but positively promotes the advanced industrial structure at 5% and 1% significance levels. Hypothesis 3 is confirmed, but the direction of the specific effect has wide variability.
Table 7. Heterogeneity analysis based on different regional FTZs.

|                      | (1)     | (2)     | (3)     | (4)     | (5)     | (6)     |
|----------------------|---------|---------|---------|---------|---------|---------|
| Eastern FTZ policy   | 0.105 **| 0.0832 **|         |         |         |         |
| effect               | (0.0437)| (0.0347)|         |         |         |         |
| Central FTZ policy   | 0.231 **| 0.0298 ***|         |         |         |         |
| effect               | (0.0796)| (0.00871)|         |         |         |         |
| Western FTZ policy   | −0.149 **|         |         |         |         | 0.0740 ***|
| effect               | (0.0588)|         |         |         |         | (0.0205) |
| Control variables    | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Individual effects   | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Time effects         | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| R2                   | 0.0591  | 0.0605  | 0.0587  | 0.622   | 0.621   | 0.6212  |
| _cons                | (18.54) | (17.24) | (17.22) | (6.374) | (5.146) | (5.243) |
| N                    | 3500    | 3500    | 3500    | 3500    | 3500    | 3500    |

Note: ** p < 0.05, *** p < 0.01, Driscoll–Kraay standard errors are in parentheses.

6.3. Time Lag Effect Test

To further test the time lag of the FTZ industrial structure upgrading effect, drawing on Mao et al. (2016), a time dummy variable was further added to the difference-in-difference models (2) and (3) with the following equations [39]:

\[
strra_{it} = \alpha_0 + \sum_{\tau=0}^{n} v_{\tau} Z_{it} \times N(\tau) Y + \beta X_{it} + \lambda_i + \omega_i + \epsilon_{it} \tag{12}
\]

\[
strad_{it} = \alpha_0 + \sum_{\tau=0}^{n} v_{\tau} Z_{it} \times N(\tau) Y + \beta X_{it} + \lambda_i + \omega_i + \epsilon_{it} \tag{13}
\]

Among them, \(N(\tau) Y\) is the annual dummy variable of the free trade zone policy. When the city is in the \(\tau\)-th period of the free trade zone policy, the value of \(N(\tau) Y\) is 1; otherwise, it is 0. The value of \(\tau\) is 0, 2, 4, or 6, representing, in turn, the year in which the FTZ policy was implemented, 1–2 years, 3–4 years, or 5–6 years after the implementation of the policy; the estimated coefficient \(v_{\tau}\) reflects the dynamic impact of the implementation of the FTZ policy period \(\tau\) on the upgrading of the industrial structure. The empirical results are shown in Figure 5.

In Figure 5, the dashed line shows the estimated results without the inclusion of control variables, and the solid line shows the estimated results with the inclusion of control variables. It can be seen that with or without the inclusion of control variables, the FTZ fails to contribute significantly to the rationalization of industrial structure in the period of its establishment and the 1–2 years after its establishment. From the third year of establishing the FTZ, the effect of industrial structure rationalization is significantly enhanced, and the estimated coefficient reaches a peak of 0.5098 in 5–6 years. This indicates a time lag effect of free trade zone policy on upgrading industrial structure rationalization; i.e., industrial structure rationalization is consistently improved only after 3–4 years of the establishment of the free trade zone. Therefore, the free trade zone policy has a continuous promotion effect on industrial structure rationalization, but there is a time lag effect on its impact.
Figure 5. Test of dynamic effect of FTZ policy on industrial structure upgrading. (a) Test of dynamic effects of industrial structure rationalization. (b) Test of dynamic effects of advanced industrial structure. Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

For the advanced industrial structure, it can be seen that the current period of the establishment of the FTZ fails to increase the advanced industrial structure. From the first year of the establishment of the FTZ, the effect of industrial structure advanced was significantly improved, and the estimated coefficient reached a peak of 0.6279 in 5–6 years. It can be seen that the effect of FTZ policy on the advanced industrial structure has a certain time lag effect, and the effect of advanced industrial structure only appears after the first year of FTZ establishment. Therefore, the free trade zone policy has a continuous promotion effect on the advanced industrial structure, but there is a time lag effect on its impact.

In summary, hypothesis 4 is confirmed.

6.4. Spatial Effect Test

A spatial econometric model was constructed to test hypotheses 5A and 5B and further examine the spatial spillover effects of FTZ policies on industrial structure upgrading:

$$str_{it} = a_0 + a_1 Z_{it} + \theta W Z_{it} + \beta X_{it} + \lambda_i + \omega_t + \epsilon_{it}$$  \hspace{1cm} (14)
\[ strad_{it} = a_0 + a_1 Z_{it} + \theta WZ_{it} + \beta X_{it} + \lambda_i + \omega_t + \varepsilon_{it} \]  

where \( W \) is the spatial matrix of city inverse distance (the inverse of city geographic distance). Table 8 reports the test results of the spatial effects. It can be seen that the estimated coefficient of the FTZ policy on industrial structure rationalization is significant at the 5% level, which indicates that the implementation of the FTZ policy can effectively improve the level of industrial structure rationalization in cities. However, the coefficient of \( Wx \) is not significant, which indicates that the impact of the FTZ policy on industrial structure rationalization in neighboring cities is not significant. The coefficient of the FTZ policy on the advanced industrial structure is significant at the 1% level, which indicates that the FTZ policy is beneficial to the advanced industrial structure of cities. In comparison, the coefficient of \( Wx \) is significantly negative at the 1% level, which indicates that the FTZ cities have a suppressive effect on the advanced industrial structure of neighboring cities. The possible reason is that the FTZ cities have a “siphon effect,” as the central city attracts high-end industries and advanced service industries from the neighboring cities and transfers the backward production capacity to the neighboring areas, which reduces the level of industrial structure advancement of the neighboring cities. Hypothesis SB is confirmed.

Table 8. Spatial effect analysis.

|                  | (1) Strad | (2) Strad |
|------------------|----------|----------|
|                  | Coefficient | Wx          | Coefficient | Wx          |
| \( Z \) (treated \times time) | 0.097 ** | -0.74 (0.0491) | 0.133 *** | -2.446 *** (0.693) |
| Control variables | Yes | Yes | Yes | Yes |
| Individual effects | Yes | Yes | Yes | Yes |
| Time effects | Yes | Yes | Yes | Yes |
| N | 3500 | 3500 | 3500 | 3500 |

Note: ** \( p < 0.05 \), *** \( p < 0.01 \), Driscoll-Kraay standard errors are in parentheses.

7. Conclusions and Policy Recommendations

Based on the data from 250 prefecture-level cities in China from 2006 to 2019, this paper examined the effect of free trade zone construction on industrial upgrading. We selected three batches of free trade zones established in 2013, 2015, and 2017 as quasi-natural experiments to analyze the mechanisms of the effects of free trade zone policies on industrial structure upgrading using the difference-in-difference method. The relevant findings are as follows: The free trade zone policy can increase the level of rationalization of industrial structure in cities by 9.69% and the level of advanced industrial structure by 7.01%. This will improve the industrial efficiency and promote the sustainability of urban development. Further analysis of the effect mechanism revealed that the interactions of the FTZ policy effect and the innovation effect or the foreign investment effect can effectively promote the rationalization of industrial structure and the advanced industrial structure. The effect of FTZs on industrial structure upgrading in different regions is heterogeneous, and the eastern and central FTZs have significant industrial structure upgrading effects. The spatial and temporal comparison found that the effect of FTZs on industrial upgrading is considered temporally sustainable but with a certain lag. Based on the spatial perspective, we found that the FTZ inhibits an advanced level of industrial structure in the neighboring cities and still needs to build a sustainable industrial development system. Based on the above study, the following policy recommendations are proposed to optimize the FTZ strategies to promote the sustainable development of cities.

1. New FTZs should draw on the experience and lessons from existing FTZs to promote the sustainability and quality of urban industries. Table 3 shows that the FTZ policy can increase the rationalization level of the industrial structure by 9.69% and the level...
of advanced industrial structure by 7.01%. Meanwhile, the government should make more use of market mechanisms rather than government intervention (a negative effect of government intervention is shown in Table 3). What is more, because of the heterogeneous effect of different regions, the government should combine top-level design and local practice to improve the rationalization of industrial structure and advanced industrial structure according to local conditions.

(2) Arrange different functions for FTZs and make full use of industrial innovation resources and foreign direct investment. Table 6 shows that the innovation effect and foreign investment effect of FTZs are the keys to upgrading the industrial structure. Therefore, each FTZ should establish an innovation platform of “sub-industry, grading, and classification” based on innovation-oriented functional positioning. The FTZs build an innovation bridge to support upgrading the industrial structure according to “front-end clustering, middle-end synergy, and back-end transformation,” which play the role of innovation in promoting production, consumption, and circulation and promoting the deep integration of the industrial chain and innovation chain. By attracting foreign investment into relevant industries, the FTZ creates industrial clusters around key industries; integrates foreign investment, talents, and other elements within the FTZ; and promotes the diffusion of advanced technologies, thereby promoting the optimization and upgrading of industrial structure.

(3) FTZs should be established in terms of different resource endowments and learning experience. Since FTZs are geographically heterogeneous, as shown in Table 7, they have a more pronounced industrial structure upgrading effect in the eastern and central regions. Each FTZ should clearly define its development direction, and fully reflect the advantages of the region’s endowments, differentiation, and dislocation in functional positioning, not only to avoid low-level duplication of construction but also to prevent disorderly competition between FTZs. In addition, the FTZ should establish a sustainable industrial testing and early warning system and establish a series of elimination mechanisms, support mechanisms, and growth mechanisms to lay the foundation for the industry’s long-term development.

(4) Optimize the spatial layout of FTZs. Effectively employ the spatial spillover effect to drive the synergistic transformation and upgrading of industries in the surrounding areas. The spatial effects test in Table 8 show that the FTZ inhibits the level of advanced industrial structure in neighboring cities. According to the strategic planning and top-level design, the FTZ coordinates and optimizes the spatial layout of the city, improves infrastructure construction and related supporting facilities, improves the overall efficiency of space utilization, builds a sustainable industrial development system, and forms a spatial pattern of industry–city integration. Relying on the strategic orientation of the FTZ, the neighboring cities should take the initiative to adjust the industrial layout and overall planning, deeply embedding themselves in the industrial chain of the FTZ. By this way, industrial linkage within and outside the FTZ would be established.

Due to the different development levels, technological conditions, and resource endowments of FTZ cities, the effects and mechanisms of FTZ policy may vary greatly. In the heterogeneity analysis, we only considered the influence of location factors in the east, middle, and west on the policy effect of the FTZ. In the next step, the interactions between city size, industrial characteristics, transportation conditions, and the policies of the FTZ will be further analyzed. The spatial spillover effect and the mechanism of the FTZ policy would also be an interesting topic.

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