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Has the Construction of National High-Tech Zones Promoted Regional Economic Growth?—Empirical Research from Prefecture-Level Cities in China

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Abstract: As a "special economic zone" and "policy test field" in the region, the national high-tech zone is an important strategy for the country to promote the development of high-tech industries and regional economy, but its effect needs to be verified. This paper uses panel data of 281 prefecture-level cities in China from 1994 to 2019, and uses the differences-in-differences method to study the impact of high-tech zones on regional economic development. On this basis, the heterogeneity effects of different types of high-tech zones on regional economic growth are explored. The empirical research results show that the national high-tech zone promotes regional economic growth, and this conclusion still holds after conducting multiple robustness tests. Further research found that the promotion of national high-tech zones to economic development showed the law of "diminishing marginal effect": Compared with higher-level cities, lower-level cities gained faster development from the construction of national high-tech zones. Compared with the developed regions in the east, the underdeveloped regions in the west have achieved faster development from the construction of the national high-tech zone. In addition, this paper finds that growth-type high-tech zones have a greater marginal contribution to regional economic growth than mature high-tech zones; multi-zone high-tech zones have a greater marginal contribution to regional economic growth than single-zone high-tech zones. The research of this paper shows that the national high-tech zones as "policy test fields" and "special economic zones" can not only drive economic development, but also help narrow the economic development gap between regions through their rational distribution. This provides important inspiration for the future layout of the national high-tech zone and the establishment of other related policies.

Keywords: high-tech zone; economic growth; innovation; differences-in-differences

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1. Introduction

The establishment of a national high-tech industrial development zone is a major strategic plan made by the Party Central Committee and the State Council to develop high-tech industries, adjust the industrial structure, promote the transformation of traditional industries, and enhance international competitiveness. The high-tech zone is driven by innovation and promotes development through reform. It has become an area with fruitful achievements in high-tech industrialization, concentrated high-tech enterprises, strong atmosphere of innovation and entrepreneurship, and concentrated financial resources. It has played a good demonstration, leading, and driving role in China's socialist modernization construction. At present, China's economy is entering a stage of high-quality development in an all-round way. Whether or not to implement the innovation-driven development strategy is the key to the effective formation of China's high-quality economic development model. High-tech industrial development zones at all levels in China ("high-tech zones") are the key levers for governments at all levels to implement the innovation-driven development strategy deployed by the central government, and are also important policy innovations to promote the transformation of scientific and technological innovation achievements into real productivity. It is the system design with the most Chinese characteristics to promote the transformation and upgrading of the industrial structure, and the improvement of independent innovation capabilities [1–3].

After more than 30 years of development, the contribution of high-tech zones to the sustainable growth of China's economy is obvious to all. It has played an important role in promoting labor productivity and enhancing the ability of independent innovation [4–6]. Most literatures reveal that China's development zones with different economic functions, including economic and technological development zones, high-tech industrial development zones, etc., have many positive effects on promoting local economic growth [7–9]. In particular, those development zone policies that are in line with the local comparative advantages can effectively promote the shift of production factors to high-efficiency sectors, realize the adjustment of regional industrial structure, and then promote regional economic growth.

The core contribution of knowledge progress and technological innovation to economic growth has become widely recognized [10]. The construction of high-tech zones has had a significant impact on economic development, technological innovation, and industrial upgrading. At present, many scholars have conducted exploratory research in these areas. Hubeibei empirically tests the existence of an increasing scale effect in the knowledge production of innovative economies such as high-tech zones [11]. Zhang Lin found that high-tech zones significantly promote the evolution of urban agglomerations to an innovative multi-center spatial structure model [12]. The world economic development has entered the era of knowledge economy, and high-tech industries based on knowledge-intensive technologies have become an important source for a country to obtain long-term competitive advantages. The main economic indicators of high-tech zones have maintained a high growth rate, and have become an important growth pole driving the rapid development of the regional economy [13,14]. Moreover, the high-tech industry has become the main engine to promote the upgrading and transformation of China's economic development [15].

However, due to various institutional constraints during the transition period, the high-tech zone inevitably has some shortcomings while achieving certain results. For example, although the national high-tech zone is intended to promote policy innovation, it is often interfered by traditional administrative forces, and there is a phenomenon of "return of the system". In the development process of the national high-tech zone, various regions often rely too much on attracting investment through preferential policies and attaching importance to hardware. Along with infrastructure construction and scale expansion, problems in technological innovation and institutional innovation are prominent. Since various regions have tended to the extensive development model of land expansion and investment attraction in the early stage, since 2001, the high-tech zone has had obvious problems of diseconomies of scale of investment, and the economic growth mode driven by factors has gradually become weak. In the development of China's high-tech zones, there are problems such as lack of competitiveness, unclear ownership, and extensive government intervention. These unfavorable factors hinder the development of high-tech zones into high-tech R&D bases and industrial incubation parks similar to Silicon Valley in the United States. Therefore, does the construction of the national high-tech zone promote the economic development of the region? Further, if the national high-tech zone promotes regional development, in which cities are they more conducive to economic growth and regional balance? Accurately evaluating the role of national high-tech zones on regional economic growth is of great significance to the formulation and implementation of relevant policies by China in the future.

China has more than 30 years of construction since the establishment of the first high-tech development zone (Beijing Zhongguancun Science and Technology Park). The national high-tech zone has played an irreplaceable role in promoting economic development. The area where the high-tech zone is located has become the frontier and main position of scientific and technological development, and an important carrier for the implementation of China's innovation-driven development. Some literatures have discussed the economic development of high-tech zones [16]. The performance has been analyzed and evaluated in detail. However, from an overall perspective, there are still several points worthy of in-depth exploration: First, the empirical research on whether high-tech zones promote economic growth in the existing literature often only selects samples of high-tech zones, and compares the performance of high-tech zones before and after their establishment. However, even excluding the factor of setting up national high-tech zones, other drivers of economic growth will make regional economic performance change. The drawback of this simple comparison method is that it fails to find an effective control group. The net impact of the establishment of national high-tech zones on economic growth was identified after excluding other influencing factors. Secondly, due to the limitations of sample selection and methods, there are still some debates in the existing literature on the evaluation of the effect of high-tech zones on driving economic growth. Whether high-tech zones really promote regional economic growth still needs to be carefully examined. Moreover, the establishment of national high-tech zones has different promotion effects on regions with different endowment conditions, and the existing literature fails to further identify the regional differences in the promotion of economic performance of national high-tech zones.

Based on the aforementioned, this paper intends to use panel data of prefecture-level cities in China and the method of Differences-in-Differences (DID) to study the role of high-tech zones in regional economic growth. The marginal contributions of this paper are mainly in three points: First, this paper uses the data of 281 prefecture-level cities in China from 1994 to 2019 to verify the problem, which not only expands the sample size and makes the conclusion more robust, but also can use a more scientific evaluation method which systematically verifies the direct effect of the national high-tech zone on regional economic growth. Secondly, by using the DID method, this paper overcomes some estimation biases in previous studies, identifies the net effect of high-tech zones on economic growth, and uses a variety of methods to test the robustness of the results. Thirdly, this paper makes a detailed analysis of the regional differences in the driving of economic growth in high-tech zones. After considering the initial economic development status of different regions, it is found that the promotion of national high-tech zones to regional economic development presents the characteristics of "diminishing marginal effect". This means that the rational distribution of national high-tech zones between regions can not only promote rapid regional development, but also reduce regional disparities.

2. Literature Review

The high-tech zone has always been one of the research hotspots of scholars. Generally speaking, scholars' research on high-tech zones mainly focuses on quota research such as location selection and planning layout, industrial agglomeration, technological innovation, management system, policy environment, and performance evaluation.

The location selection and layout planning of science and technology parks have attracted the attention of many scholars. W. Christaller and August Losch put forward the central place theory and the market location theory. Bruno and Tyebjee summarized 12 factors that have a greater impact on the high-tech industry [17]. Nijkamp proposed six conditions for the selection of special locations in high-tech zones [18]. Markusen researched and analyzed the location conditions of science and technology parks from four aspects: environment, transportation, industrial agglomeration, and social politics [19]. Lofsten and Lindelof conducted a comparative study on 273 companies in Swedish technology parks [20]. The results show that the location of the park had a significant impact on the business performance of technology-based companies. Pan Jie proposed that the location selection of my country's high-tech zones should consider factors such as intelligence intensity, development technology conditions, information resources, infrastructure, production, and living environment [21]. On the basis of discussing the general rules of the layout of high-tech zones in the world and analyzing the contradictions in the layout of high-tech zones in China, Yang Ying proposed that a high-tech industrial park should be built at the junction of Guangdong and Hong Kong in China [22].

Scholars have also carried out extensive research on the industrial agglomeration of science and technology parks. Scott explained the formation mechanism of industrial clusters from the perspective of transaction costs [23]. After analyzing the successful development of high-tech industries in Japan, Taiwan, Singapore, and South Korea in Asia, Peter Gwynne stated that industrial agglomeration is the key to the development of high-tech zones [24]. John Phillimore conducted a study on the interaction between enterprises and universities in the Australian Science and Technology Park, and pointed out that the connection between enterprises and universities in the park has a significant positive effect on the speed of technological innovation knowledge dissemination [25]. Suma S. Athreye compared the Cambridge Hi-Tech Park with the U.S. Silicon Valley, and pointed out that the Cambridge Hi-Tech Park is not as successful as the U.S. Silicon Valley mainly because it does not form an efficient high-tech industrial cluster [26]. Some scholars have also analyzed the mechanism of industrial agglomeration on technological innovation from different perspectives, mainly in the following aspects: technology spillovers, network relationships, cooperative innovation, and technology trade. Lucia Cusmano studied the mechanism of technological spillovers on technological innovation in industrial agglomeration [27]. Meyer stamer analyzed the cooperation mode of enterprises in the industrial agglomeration area, and pointed out that the innovation environment of enterprises in the agglomeration area can be created by means of enterprise cooperation, and subsequently, the innovation ability and competitive advantage of enterprises can be improved [28].

The management system and policy environment of high-tech zones are also the research hotspots of scholars. Cooper Arnold analyzed the motivation of enterprises to enter the science and technology park, and believed that the important reason for promoting their entry into the park is that the science and technology park provides a technical and policy environment suitable for the development of enterprises [29]. Manuel Castells conducted a comprehensive comparative analysis of different science and technology parks around the world, and stated that the difference in the development level of each science and technology park was due to the differences in the policy environment of the countries and regions where they were located [30]. Storey and Tether took the EU science and technology parks as samples to study the technical support policies of EU countries for technology-based enterprises in the parks, focusing on the analysis of the interaction between their policies such as doctoral supply, industry–university–research cooperation, government financial support, and technical consulting services [31]. Dijk conducted an empirical study on the Bangalore Science and Technology Park in India, and found that an important reason for its rapid development was the implementation of many targeted policies by the local government [32]. Wang Tao analyzed the development process and coordination status of China’s high-tech zone policies since 1988, and pointed out that China’s high-tech zone policies have good continuity and complementarity, but there are also policy deficiencies and contradictions [33]. Wang Fang inspected and classified the policy changes of China’s high-tech zones from 1984 to 2011, and predicted that the policy of China’s high-tech zones will present three major development trends in the future [34].

In addition, some studies have also paid attention to the impact of high-tech zones on productivity and technological innovation. For example, Jiang Cailou and Xu Kangning’s analysis found that the productivity of high-tech zones is constantly improving [35]. Jiang Cailou analyzed the efficiency changes of China’s high-tech zones and their influencing factors [36]. Cheng Yu and Chen Xue applied the stochastic frontier model to study, and found that the TFP growth rate of high-tech zones was significantly higher than that of the provinces where they were located [37].

Judging from the existing research, the research on the high-tech zone has shifted from theoretical research to empirical research; research methods have also shifted from qualitative to quantitative; from a single research method to a combination of multiple research methods. From the perspective of research content, it mainly focuses on extensive research on the functions, location selection, industrial agglomeration, policies, and technological innovation of high-tech zones. The existing research has important reference significance for further research on high-tech zones in the future.

3. Research Hypothesis

Since the reform and opening up, China has gradually moved towards a market economy and has maintained high-speed growth for more than 30 consecutive years. Since the ideology and policy inertia under the traditional system have constrained the reform and development under the new situation, China's incremental reform needs to find a breakthrough [38,39]. In addition to setting up "special economic zones" and opening up "coastal ports" in coastal areas, China must also carry out institutional innovations in the interior. Further, China needs to explore the path of inland economic reform by building a national high-tech zone and implementing "policy experiments" and "special economic zones" within the region. Not only can we be rid of the shackles of the traditional system and carry out bold experiments, but we can also promote the balanced development of various regions, which has become an ideal path for institutional innovation [40,41]. On the other hand, for a long time, China's economic growth has mainly relied on factor input, which is a typical extensive growth mode. However, since the new technology revolution, high-tech industries characterized by technological innovation have developed rapidly, and technological progress has gradually become the main factor driving high-quality economic growth [42–44]. From the perspective of the development of high-tech industries abroad in the middle and late 20th century, industrial complexes, technology parks, and science cities with a relatively high degree of concentration are the main carriers for the development of high-tech industries; enterprises in the parks are affected by knowledge spillover, division of labor and scale. Influenced by favorable conditions such as the economy, China performs better in the development of new technologies and new products [45]. In order to improve the efficiency of China's economic growth and promote independent innovation, the Chinese government has also formulated a series of promotion policies. From the national level, the establishment of high-tech zones is the most important one. In 1988, in order to promote the development of national high-tech industrialization, China began to implement the famous "Torch Program", and the establishment and development of a national high-tech zone is an important part of the "Torch Program" [46,47]. In May 1988, China's first state-level high-tech industrial development zone (Zhongguancun Science and Technology Park) was approved by the State Council. In the following three decades, a large number of high-tech zones have been established according to the development status of high-tech industries in various regions and the assessment requirements of national high-tech zones. As of 2019, a total of 169 state-level high-tech zones have been established across the country.

Looking back at the development path in the past 30 years, there are some important reasons why the national high-tech zone can promote local economic development.

Firstly, as an important means for the government to promote regional industrial upgrading and economic transformation, the special policy treatment enjoyed by high-tech zones has become an important reason for many enterprises to gather in the park and promote regional economic growth. In order to encourage the development of national high-tech zones, in 1991, the State Science and Technology Commission and the State Administration of Taxation promulgated the Interim Provisions on Several Policies for National High-tech Zones and the Tax Policy Provisions for National High-tech Zones, respectively, which established the policies in the form of regulations. In order to attract high-quality enterprises and talents to enter the high-tech zone, local governments have formulated preferential policies for construction land and high-end talent introduction plans. This series of preferential policies has made the high-tech zone attract a large number of enterprises in the early stage of its establishment, which has an obvious driving effect on the regional economy.

Secondly, the establishment of high-tech zones provides a carrier for the agglomeration of high-tech industries and related industries, and at the same time, promotes regional economic growth. First of all, in order to attract high-quality enterprises to settle in, the government will make a great investment to complete the construction of supporting infrastructure. Secondly, industrial agglomeration is an important mode to promote regional economic development. It can improve the market competitiveness of agglomerated enterprises by reducing transaction costs, sharing infrastructure, and forming economies of scale. Finally, perfect infrastructure and the presence of high-quality enterprises also provide basic conditions for industrial agglomeration. Industrial agglomeration is promoted by means of division of labor, knowledge spillover, and shared infrastructure. The industrial agglomeration effect can support enterprises in the park to improve their innovation capabilities and promote regional economic growth.

The high-tech zone has gathered about one-third of China's high-tech enterprises and cultivated a number of world-class industrial clusters. For example, Zhongguancun High-tech Zone has cultivated a number of leading information technology enterprises, and the industrial scale accounts for 17% of China's information technology services. Wuhan East Lake High-tech Zone has cultivated a number of optoelectronic enterprises, and the industrial scale accounts for about 50% of China. Zhangjiang High-tech Zone has cultivated a number of integrated circuit enterprises, and the industrial scale accounts for 35% of China. Xi'an High-tech Zone vigorously develops technological industries such as intelligent manufacturing and new energy. Lanzhou High-tech Zone actively cultivates the biomedical industry. High-tech zones in other parts of China have also played a very important role in nurturing specialty industries. The three major international science and technology innovation centers in Beijing, Shanghai, and the Guangdong-Hong Kong-Macao Greater Bay Area are among the top 10 global science and technology innovation clusters. The agglomeration of these industries with core competitiveness has promoted China's economic growth.

Thirdly, the high-tech zone promotes local economic growth by enhancing the innovation capabilities of enterprises, thereby helping to achieve innovation-driven development. Innovation is regarded as an important driving force for economic development, and scholars have been paying attention to how innovation drives economic growth. Judging from the existing research, the theoretical mechanism of innovation-driven economic growth can be roughly attributed to the following three aspects: First, increase the diversity of products. More consumer markets are created through diversified product or service innovation, and the degree of specialization in production is enhanced [48]. Second, create new industrial sectors [49,50]. Replace original products with innovative products or services, promote the upgrading of production and consumption levels [51], and drive the development of new intermediate product sectors, extend and expand market space with complementary products or services, and enhance innovation value [52,53]. Third, improve the quality of input factors and promote factor accumulation, thereby improving productivity, including the human capital accumulation model [54], the knowledge accumulation model, capital accumulation [55], and technical capital accumulation [56,57]. Technological innovation can drive the rapid development of new technology industries, transforming the traditional factor-driven economic growth mode into an innovation-driven development mode [58]. The growth rate of TFP in high-tech zones is significantly higher than elsewhere, and the growth of TFP is mainly contributed to by technological progress. By promoting industrial clusters and other means, the high-tech zone has promoted the competition among enterprises in the region, changed the regional market size and demand, and income structure, as well as improved the innovation capability of the park industry [59–61].

Finally, high-tech zones promote economic growth by optimizing the industrial structure. The high-tech zone builds diversified application scenarios, vigorously cultivates emerging industries and future industries, and promotes the development of industries to be intelligent, green, and low-carbon. The high-tech zone forms a more effective professional division of labor and social division of labor, which is conducive to the flow of resources to high-tech industries, optimizes the allocation of social resources, and promotes economic growth. For example, the construction of national independent innovation demonstration zones in Shenzhen and the Pearl River Delta has developed rapidly. The Ministry of Science and Technology of China has supported the construction of the National Technology Innovation Center in the Guangdong–Hong Kong–Macao Greater Bay Area, the National Technology Innovation Center for New Displays, the National Technology Innovation Center for the Third Generation Semiconductors, and a number of new R&D institutions. By gathering innovation resources, it will build an international technology transfer hub and lead the development of emerging industries. First of all, the high-tech zone has caused the transfer of production factors among departments, promoted the development of high-tech industries, and thus promoted the continuous evolution and upgrading of the industrial structure. Secondly, the high-tech zone will bring new and higher-level market demand, lead the development of industrial clusters, and change the industrial structure. The high-tech zone can also promote technological innovation and upgrading of traditional industries, and at the same time, realize its own transformation by means of industry–university–research cooperation, patent purchase, equipment renewal, and personnel introduction. Furthermore, new industries have also gained a larger and larger market share, making the high-tech industry an important carrier for transforming the structure of economic growth. Finally, by vigorously developing high-tech industries, Gaoxin continuously enhances the capabilities of technological innovation and service innovation, promotes the continuous development of green industries, and at the same time, promotes the coordinated development of the primary, secondary, and tertiary industries. Additionally, it has promoted the advancement and rationalization of China's industrial structure.

Through the above analysis, it can be found that the high-tech zone, as an important engine of China's economic development, plays an important role in promoting economic development. Therefore, this paper proposes the following research hypotheses:

Hypothesis 1 (H1). *The construction of national high-tech zones can promote regional economic growth.*

4. Materials and Methods

4.1. Estimation Methods and Data

If the difference in the economic performance data of prefecture-level cities before and after the approval of the high-tech zone is directly used to judge whether the high-tech zone has promoted the regional economic growth, it will lead to serious estimation errors, and it is difficult to exclude the influence of other factors. In addition to the establishment of high-tech zones, other policies or factors will also have an impact on regional economic growth. Therefore, the difference between the data before and after the establishment of high-tech zones cannot be used to test the actual impact of high-tech zones on regional economic growth. Therefore, this paper adopts the DID method to study the net effect of the establishment of high-tech zones on regional economic growth. Among the 281 prefecture-level city samples in this paper, 169 high-tech zones have been approved. This provides us with a good quasi-natural experimental sample. We take the prefecture-level cities that have established high-tech zones as the treatment group, and the remaining prefecture-level cities that have not established high-tech zones as the control group.

Since the relationship between spatial agglomeration and economic growth is mutually reinforcing, the regression of the ordinary panel data model will have strong endogeneity. Therefore, this paper regards the national high-tech zone as an economic policy to explore the relationship between its policy effect and regional economic growth. Referring to the research of Beck (2010) [62], this paper constructs the following two-way fixed-effects econometric model to test the net effect of high-tech industrial development zones on regional economic growth:

$$Y_{it} = \beta_0 + \beta_1 Hightech_{it} + \alpha X_{it} + \gamma_t + u_i + \varepsilon_{it}$$

Among them, Y_{it} is the explained variable; this paper uses the actual growth rate of urban GDP to measure the regional economic growth; β_0 is the intercept term; i represents the individual; t represents the year; γ_t represents the time fixed effect; μ_i represents the individual fixed effect; ε_{it} is the error term; X_{it} represents control variables; $Hightech_{it}$ represents a binary dummy variable due to differences in individual policy pilots. If city i is approved to build a high-tech zone in year t and becomes the treatment group, then the city will take the value of 1 in all subsequent years, otherwise, it will take the value of 0. If city i is approved to build a high-tech zone in year t and becomes the processing group, then the city takes the value of 1 in all subsequent years, otherwise, it takes the value of 0. The estimated value of β_1 measures the net effect of high-tech zones on regional economic growth. If the establishment of high-tech zones promotes regional economic growth, then the estimated value of β_1 should be significantly positive.

Based on the availability and completeness of data, this paper selects data from 281 prefecture-level cities in China from 1994 to 2019. Among them, the index data of control variables and explained variables come from databases such as *China Urban Statistical Yearbook*, statistical yearbooks of various provinces, and statistical yearbooks of various cities. The core explanatory variables refer to the high-tech zone directory data of the Ministry of Science and Technology of China, and some missing data, are imputed by the mean method.

The shortcoming of using the DID method is that the control group and the experimental group have the same time trend before the test. In order to ensure the robustness of the results of this paper, the time trend test was carried out on the control group and the experimental group, and it was found that the control group and the experimental group had the same time trend before the test.

4.2. Selection of Variables

1. The explained variable. In order to measure the regional economic development, this paper uses the logarithmic value of the regional real GDP lngdp as the explained variable. Considering the comparability of the data, this paper calculates the real GDP of each year with 1994 as the base year. Since the *China Urban Statistical Yearbook* reports the real GDP growth rate of prefecture-level cities at comparable prices, we take 1994 as the base year and use the regional real GDP growth rate to calculate the comparable real GDP data for each year.
2. Core explanatory variables. National high-tech zone dummy variable (Hightech). Since the data period of this article is from 1994 to 2019, we assign values to local-level cities according to the list of national-level high-tech industrial development zones approved by the State Council, as of 2019, published on the website of the Ministry of Science and Technology of the People's Republic of China. If a city starts to establish or has established a national high-tech zone in the current year, it will be assigned a value of 1, otherwise, it will be assigned a value of 0.
3. Control variables: In order to control the influence of other factors, this paper also selects a series of control variables: the level of government expenditure, the level of foreign direct investment, the level of human capital, the level of education, the proportion of the secondary industry, the proportion of the tertiary industry, the level of internet usage, fixed asset investment. See Table 1 for the calculation method of the control variables.

Table 1. Main variables and calculation methods.

Variable	Meaning	Calculation
Hightech	High-tech zone	Dummy variable (0, 1)
Growth	Regional economic growth rate	Urban real GDP growth rate
Gov	Government spending	City budget expenditure/city GDP
Fdi	Foreign direct investment level	Actual utilization of foreign direct investment/city GDP
Sec	The development level of the secondary industry	Output value of urban secondary industry/city GDP
Thi	The development level of the tertiary industry	Urban tertiary industry output value/urban GDP
Far	Fixed asset investment level	The city's new fixed asset investment/city GDP in the current year
Hum	Human capital level	City's permanent population at the end of the year/urban area
Inte	Internet usage level	Number of Internet users in the city/number of resident population at the end of the year in the city
Edu	Education level	The number of students in colleges and universities/the number of resident population at the end of the year in the city

The reason why the sample interval of this paper is determined as 1994–2019 is based on two reasons: on the one hand, due to the limitation of the data in the *China Urban Statistical Yearbook*, many important indicators before 1994 are seriously missing, considering the availability of data, therefore, this article selects from 1994. On the other hand, 1994 was the year when the tax-sharing system reform began, and the important impact of the tax-sharing system reform on China's regional economic development has been largely confirmed. In order to more effectively evaluate the role of high-tech zones on regional economic growth, this paper selects the sample interval from 1994 to 2019, which can better avoid estimation errors caused by the implementation of the tax-sharing system reform. All the original data came from the *China Urban Statistical Yearbook*, the historical statistical yearbook of each province, and the historical statistical yearbook of each city.

5. Empirical Results of the Models

5.1. High-Tech Zones and Regional Economic Development: Basic Results

Table 2 reports the estimation results of the model. Column (1) is the result without adding the control variable, and column (2) is the test result with the control variable added. In the case of controlling individual fixed effects and time fixed effects: when no control variable is added, the coefficient of the explanatory variable Hightech is positive at the 1% significance level; when the control variable is added, the coefficient of the explanatory variable Hightech is positive at the 5% significance level. Both can show that the construction of national high-tech zone has a positive effect on regional economic growth. Judging from the coefficient of the explanatory variable Hightech, when the control variable is added, the marginal contribution of the high-tech zone to the regional economic growth is 11.76%. It can be seen that the national high-tech zone has become an important support and growth point for China's economic development. Thus, hypothesis 1 is true.

By 2021, the annual operating income of China's 169 state-level high-tech zones will exceed 48 trillion yuan, with a total profit of 4.2 trillion yuan. The high-tech zone takes "developing high technology and realizing industrialization" as its own development mission, and has established a series of policies, systems, and environments that are conducive to the cultivation and development of high-tech enterprises and industries.

First, the high-tech zone has played the role of an experimental field for reform and exploration. Continuing to promote management reform, streamlining administration, and delegating power, and carrying out a series of reform measures such as policy innovation and pilot testing, China has opened up a new path of combining scientific and technological innovation with industrial development.

Second, the high-tech zone has strengthened its role as a source of innovation. The R&D expenditure of enterprises in the high-tech zone accounts for half of China's R&D expenditure, and the number of PCT international patent applications also accounts for half of China's. The high-tech zone provides the source of technical support for high-level innovation and the cultivation of high-end industries.

Third, the high-tech zone has played a role in attracting high-end talents. The high-tech zone has gathered nearly 20 million employees, and the full-time equivalent of R&D personnel per 10,000 employees is about 12 times the average level in China, providing high-quality talent supply for high-tech enterprises.

Fourth, the high-tech zone has played a role in the incubation of the whole chain. An incubation chain from maker space to incubators and accelerators has been formed, and the innovation and entrepreneurship service system for the entire life cycle of enterprises has been continuously improved.

Fifth, the high-tech zone has played a role in the agglomeration and radiation of international resources. The high-tech zone has attracted a large number of high-quality international technology, talents, projects, funds, and entrepreneurial service institutions to land in the high-tech zone. Enterprises accelerated their "going out" and established more than 2000 R&D institutions overseas.

The growth of regional economy is generally the high-speed growth of high-tech industries first, and then leads other departments and enterprises in the region to develop together. These high-tech industries have an agglomeration effect and a diffusion effect in the process of promoting regional economic growth, which is the core factor of high-tech zone's influence on the regional economic development. The agglomeration of production factors in the high-tech zone makes the input cost of high-tech enterprises drop gradually. In the case of stable product market prices, due to the reduction of factor input costs and the increase of profits obtained by enterprises, enterprises aiming at profit will choose to expand reproduction in their development strategy, thus promoting regional economic growth [63].

Table 2. Estimation results of benchmark measurement model.

Variable	**Growth**	
	(1)	**(2)**
Hightech	0.1312 *** (5.63)	0.1176 ** (2.15)
Gov	/	0.0745 ** (2.08)
Fdi	/	0.0039 (1.28)
Sec	/	0.0482 ** (2.36)
Thi	/	0.0634 ** (2.41)
Far	/	0.0082 (0.32)
Hum	/	0.0571 * (1.78)
Inte	/	0.0639 * (1.89)
Edu	/	0.0358 ** (2.48)
Individual fixed effects	Control	Control
Time fixed effects	Control	Control
Con_	12.5489 *** (8.96)	8.6937 *** (7.21)
N	4394	3603
R^2	0.6587	0.7628

Note: ① T values are in brackets; ② *, **, *** indicate significance at 10%, 5%, and 1% significance levels, respectively; ③ All regressions use cluster robustness with region as the cluster variable. Standard error, Con_is a constant term, and N is the number of samples. The following table remains the same.

5.2. Robustness Test

An important assumption in the use of DID is that the control and treatment groups are required to satisfy the parallel trend test. There is no significant difference between cities that have not built high-tech zones and cities that have built high-tech zones before the implementation of the policy. This paper conducts a parallel trend test from 3 years before policy implementation to 3 years after policy implementation. Column (1) of Table 3 is the regression result of the parallel trend test: the coefficients of cities in the three years before the construction of high-tech zones are not significant; the coefficients of cities in the year of construction of high-tech zones, and in the three years after that, are significantly positive. These results indicate that the control group and the treatment group satisfy the equilibrium trend before policy implementation.

Table 3. Robustness test.

Variable	**Growth**	
	Parallel Trend Test (1)	**Counterfactual Test (2)**
Hightech-3	0.0082 (0.21)	/
Hightech-2	0.0113 (0.34)	/
Hightech-1	0.0145 (0.18)	/
Hightech0	0.1176 ** (2.15)	/
Hightech1	0.1193 ** (2.21)	/
Hightech2	0.1227 *** (3.52)	/
Hightech3	0.1251 *** (3.68)	/
Approval 3 years in advance		0.0045 (1.32)
Approval 5 years in advance		0.0031 (0.84)
Control variable	control	control
Individual fixed effects	control	control
Time fixed effects	control	control
Con_	9.8638 *** (3.85)	5.7681 ** (2.27)
N	3603	3603
R^2	0.6827	0.6493

Note: **, *** indicate significance at 5%, and 1% significance levels, respectively.

To further verify the robustness, this paper conducts a counterfactual test. High-tech zones promote regional economic growth, but this may also be affected by other factors. For example, the introduction of some other policies or changes in random factors will also affect regional economic growth, and these factors may lead to errors in empirical results. For this reason, this paper conducts a counterfactual test. We assume that the approval time of the high-tech zone is advanced by 3 and 5 years, respectively, and the counterfactual analysis is carried out. If the coefficient regression result of the explanatory variable (Hightech) is significantly positive, it means that there are other factors that promote regional economic growth, which are not related to the establishment of high-tech zones. Otherwise, the regression results of the baseline model are robust. Column (2) in Table 3 shows the regression results of the counterfactual test. It can be found that the coefficient of Hightech is not significant, whether the policy approval is 3 years in advance or 5 years. However, it does show that it is indeed the establishment of high-tech zones that promotes local economic growth.

6. Heterogeneity Test

6.1. Periodic Heterogeneity Test

It has been more than 30 years since the construction of the first high-tech zone, and more than 100 high-tech zones have been established in batches. Some of these high-tech zones were established earlier and took a long time to build, while others were established later and took a short time to build. As a result, the growth cycle of each high-tech zone is quite different. This difference will have different effects on economic growth to a certain extent. In order to study whether high-tech zones with different growth cycles have heterogeneous effects on economic development, this paper divides high-tech zones into two categories: one is those established before 2005, which is called mature high-tech zones in this paper; the other is those established after 2005, which is called growth high-tech zone in this paper. The test results of the impact of mature and growth high-tech zones on regional economic growth are shown in Table 4: column (1) is the regression results of growth high-tech zones on regional economic growth; column (2) is the regression result of mature high-tech zones on regional economic growth. From the regression results in Table 4, the coefficient of mature high-tech zones is positive, which is statistically significant at the significance level of 5%. The coefficient of growth high-tech zone is positive, which is statistically significant at the significance level of 1%. From the perspective of the coefficient, the marginal contribution of growth high-tech zones to regional economic growth is 12.08%, and the marginal contribution of mature high-tech zones to regional economic growth is 8.27%. The marginal contribution of growth high-tech zones to economic growth is greater than that of mature high-tech zones. Growth high-tech zones can learn from the achievements and experiences of the construction and development of mature high-tech zones, and summarize the problems and lessons in development, so as to plan and build high-tech zones more scientifically. In order to attract high-tech industries, growth high-tech zones will formulate some more attractive policies than mature high-tech zones in terms of investment attraction.

Table 4. Results of Periodic and distribution heterogeneity test.

Variable	Growth			
	(1)	**(2)**	**(3)**	**(4)**
Growth	0.1208 *** (5.39)			
Mature		0.0827 ** (2.36)		
Single zone			0.0856 ** (2.41)	
Multi-zone				0.1424 *** (5.89)
Control variable	control	control	control	control
Individual fixed effects	control	control	control	control
Time fixed effects	control	control	control	control
Con_	8.2697 ** (1.99)	7.6139 ** (2.38)	9.7842 *** (4.95)	5.9634 ** (2.26)
N	3603	3603	3603	3603
R^2	0.5347	0.6874	0.7328	0.5798

Note: **, *** indicate significance at 5%, and 1% significance levels, respectively.

From the perspective of the development process of the high-tech zone, it generally follows the development path of "isolation–diffusion–symbiosis–integration", mainly as follows: The initial stage of development of high-tech zones must be based on cities and requires capital, talent, technology, and infrastructure provided by local cities. The degree of infrastructure improvement in the local city directly affects or even determines the survival rate of settled enterprises. At this stage, the internal connection between regions is weak, and the development goal of the high-tech zone is to develop basic science and technology industries, and lay the foundation for becoming a regional economic growth pole. With the development of high-tech zones, the diffusion effect of growth poles appears, and the economic cooperation within the region is strengthened, and high-tech zones have begun to "feed back" cities. In the third stage, due to the rapid development of the traffic information network, the gap between regions gradually narrowed. The cooperation is gradually implemented from the strategic level to the spatial level, and the degree of economic connection is gradually improved. In the fourth stage, the role of the market is becoming more and more obvious, and the inter-regional development is interdependent, entering into a highly integrated and integrated collaboration stage. At this time, the high-tech zone needs a new development driving force to solve the common problems of regional economic development. This phased development of high-tech zones leads to different impacts on economic growth from growth-type high-tech zones and mature high-tech zones.

6.2. Distribution Heterogeneity Test

Among the prefecture-level cities approved by the state to establish high-tech zones, some prefecture-level cities have set up one high-tech zone ("single-zone"), and some prefecture-level cities have established two high-tech zones ("multi-zone"), such as Changchun, Shanghai, Suzhou, Wuxi, Changzhou, Hangzhou, and Chongqing. Single-zone and multi-zone should have different effects on regional economic growth. For this reason, this paper divides the high-tech zone into two groups: one is single-zone and the other is multi-zone. We used two sets of data to study whether there is a differential impact on the regional economic impact of single-zone and multi-zone. Table 4 shows the regression results: column (3) is the regression result of the impact of a single-zone on the regional economic growth; column (4) is the regression result of the multi-zone impact on the regional economic growth. From the regression results of the model, the coefficient of single-zone is positive at the 5% significance level, and the coefficient of multi-zone is positive at the 1% significance level, indicating that both single-zone and multi-zone promote the regional economic growth. Judging from the regression result coefficients of single district and multiple districts, the marginal contribution of single district to regional economic growth is 8.56%; the contribution of multiple districts to regional economic growth is 14.24%. This shows that multi-zone has a greater effect on promoting regional economic growth than single-zone.

In addition to the basic advantages of single-zone, multi-zone can better promote synergy, better develop industrial innovation capabilities, and promote industrial competition and cooperation. Multi-zone can better promote the efficient allocation of innovation resources and the aggregation of innovation elements, further improve the development level of science and technology parks, and accelerate the promotion of industrial innovation and transformation. Multi-zone has a better function in gathering talents, technologies, and achievements. For the regional economy, coordinated development can effectively avoid serious industrial structure convergence and resource waste caused by vicious competition, reduce market transaction costs, and actively promote collaborative innovation between enterprises and advantageous resources in the region. Multi-zone can achieve "1 + 1 > 2" effect, which is of great significance for promoting economic growth.

6.3. Regional Heterogeneity Test

From the perspective of China's regional development pattern, there are 86 high-tech zones in eastern China (East), 44 high-tech zones in central China (Mid), and 39 high-tech zones in western China (West). Therefore, will the high-tech zones distributed in the eastern, central and western regions have different effects on regional economic growth? In order to study this problem, we divide the research objects into eastern, central, and western cities, and use this grouped data to test whether the high-tech zone has regional heterogeneity on regional economic growth. The model is set as follows:

$$Y_{it} = \beta_0 + \beta_1 Hightech_{it} * Position_i + \alpha X_{it} + \gamma_t + \mu_i + \varepsilon_{it}$$

Among them, Position is the dummy variable of urban area. When testing the impact of high-tech zones in the eastern region on regional economic growth, set East = 1, Mid = West = 0; when testing the impact of high-tech zones in the central region on regional economic growth, set East = West = 0, Mid = 1; when testing the impact of high-tech zones in the western region on regional economic growth, set West = 1, East = Mid = 0. The regression results of the impact of high-tech zones in the eastern, central, and western regions on regional economic growth are shown in Table 5. Column (1) is the regression result of the impact of high-tech zones in eastern cities on regional economic growth; column (2) is the regression result of the impact of high-tech zones in central cities on regional economic growth; column (3) is the regression results of the impact of high-tech zones in western cities on regional economic growth. From the regression results, the coefficient in the east is positive at the 5% significance level; the coefficient in the middle is positive at the 5% significance level, and the coefficient in the west is positive at the 1% significance level. This shows that the high-tech zones in the eastern, central, and western regions have all promoted economic growth. Judging from the coefficients of the three regions: the marginal contribution of the eastern high-tech zone to the regional economic growth is 9.19%; the marginal contribution of the central high-tech zone to the regional economic growth is 10.26%, and the marginal contribution of the western high-tech zone to the regional economic growth is 13.84%. This shows that from the perspective of the marginal effect on regional economic growth, the western region is larger than the central region, and the central region is larger than the eastern region. Judging from the regression results, the construction of high-tech zones in places with a backward economic foundation has a stronger marginal utility and a stronger role in promoting economic growth. It shows that there is regional heterogeneity in the impact of high-tech zones on regional economic growth, reflecting the law of "diminishing marginal effect". This means that the establishment of national high-tech zones can not only promote regional economic growth, but also help narrow the gap in economic growth, and reduce the gap between the rich and the poor.

Western China is an economically backward region in China. Western China includes 12 provinces, municipalities, and autonomous regions, with a total area of about 6.86 million square kilometers, accounting for about 72% of China's total area. At the same time, the western region of China borders 12 countries including Mongolia, Russia, Tajikistan, Kazakhstan, Kyrgyzstan, Pakistan, Afghanistan, Bhutan, Nepal, India, Myanmar, Laos, and Vietnam, with a land border line of more than 18,000 km. It accounts for about 91% of China's land border. Western China faces many countries in Southeast Asia across the sea, with a mainland coastline of 1595 km, accounting for about 1/10 of China's coastline. The population of western China is 379,558.7 million, accounting for 27.2% of the country's total population. Therefore, western China has a very important role and function to China. Whether China can realize the development of the western economy is of great significance for China to narrow the gap between the rich and the poor. Due to the low level of economic development and poor economic foundation in the western region of China, once there is policy support, there is huge room for its economic development. From the empirical results, it was found that the construction of high-tech zones in western China have a greater marginal effect on the economy. Therefore, the government should give priority to the construction of high-tech zones in cities in underdeveloped areas, which can help reduce the gap between the rich and the poor, and promote sustainable social development.

Table 5. Regression results of regional- and city-level heterogeneity test.

Variable	Growth						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
East	0.0919 ** (2.29)						
Mid		0.1026 ** (2.38)					
West			0.1384 *** (5.96)				
ZB				0.0617 * (1.71)			
FB					0.0863 ** (2.09)		
JD						0.1155 ** (2.36)	
YB							0.1325 *** (5.31)
Control variable	control	control	control	control	control	control	control
Individual fixed effects	control	control	control	control	control	control	control
Time fixed effects	control	control	control	control	control	control	control
Con_	13.6975 * (1.76)	10.5876 ** (2.42)	11.6589 *** (6.87)	6.8769 * (1.84)	5.8543 *** (5.32)	7.8439 ** (2.35)	3.6749 *** (4.89)
N	3603	3603	3603	3603	3603	3603	3603
R^2	0.4638	0.4876	0.5879	0.6179	0.7849	0.7219	0.6938

Note: *, **, *** indicate significance at 10%, 5%, and 1% significance levels, respectively.

6.4. City-Level Heterogeneity Test

In order to study the differential impact of setting up high-tech zones in cities of different administrative levels on the regional economy, this paper divides cities into ministerial-level cities, vice-ministerial-level cities, larger cities, and general cities according to the administrative levels of Chinese cities. The ministerial-level cities (ZB) are Beijing, Shanghai, Tianjin, and Chongqing. Ministerial-level cities are directly under the jurisdiction of the Chinese People's Government. Ministerial-level cities have a concentrated population, and obvious regional and resource endowment advantages. They have a very important position in the country's politics, economy, culture, tourism, and other aspects. There are 15 sub-ministerial cities (FB) including Guangzhou, Wuhan, Harbin, Shenyang, Chengdu, Nanjing, Xi'an, Changchun, Jinan, Hangzhou, Dalian, Qingdao, Shenzhen, Xiamen, Ningbo, etc. Larger cities (JD) are all provincial capital cities except those at the sub-provincial level, such as Hefei, Nanchang, Kunming, Shijiazhuang, Zhengzhou, Changsha, Taiyuan, Xining, Lhasa, and other cities. The remaining cities are classified as general cities (YB). This paper builds the following model:

$$Y_{it} = \beta_0 + \beta_1 Hightech_{it} * City\text{rank}_i + \alpha X_{it} + \gamma_t + \mu_i + \varepsilon_{it}$$

Cityrank represents the city-rank dummy variable. If it is significantly positive, it means that the high-tech zone in the region has promoted regional economic growth. Sections (4)–(7) of Table 5 are the regression results of regional economic growth for high-tech zones of different city levels. From the regression results, we can find that ministerial-level cities are positive at the 1% significance level, vice-ministerial-level cities and larger cities are positive at the 5% significance level, and general cities are at the 1% significance level are positive. It shows that the high-tech zones in the four types of cities can promote regional economic growth. From the perspective of coefficient size: the marginal contribution effect of high-tech zones established in ZB to regional GDP is 6.17%; the marginal contribution effect of high-tech zones established in FB to regional GDP is 8.63%; the marginal contribution effect of high-tech zones in JD to regional GDP is 11.55%, and the marginal contribution effect of high-tech zones established in YB to regional GDP is 13.25%.

The aforementioned shows that the role of the high-tech zones in these four types of cities in promoting regional economic development declines with the rise of the city-level, reflecting the law of "diminishing marginal effect".

Administrative hierarchy plays an important role in urban development. Urban administrative hierarchy is the product of government administrative intervention, and cities with different administrative hierarchy have different financial resources, institutional arrangements, and management authority. Related research on China's urban development found that from the perspective of resource allocation, cities with higher administrative levels in China generally can obtain more resources from the government, such as construction funds, education, medical care, and various preferential policies. In addition, cities with higher administrative levels can rely on administrative means to make the resources of cities with low administrative levels flow into cities with high administrative levels, and further improve the development level of cities with high administrative levels. There is an obvious correlation between urban development power and urban administrative level. This has led to a growing gap in economic development between cities with high administrative levels and cities with low administrative levels, resulting in a serious gap between the rich and the poor. The empirical results show that high-tech zones can make a higher marginal contribution to economic growth in cities with low administrative levels. Therefore, the government should give priority to building high-tech zones in cities with low administrative levels, so as to help narrow the wealth gap between cities and promote sustainable development of society.

7. Conclusions

After more than 30 years of development, China's high-tech zones have become an important carrier for China to implement the innovation-driven development strategy, build an innovative country, and achieve high-quality development in the new era of China. How to accurately recognize and evaluate the role of high-tech zones on regional economic development is a key issue that people pay attention to. Based on the panel data of 281 prefecture-level cities in China from 1994 to 2019, this paper constructs a Differences-in-Differences model to test whether high-tech zones promote regional economic growth. The following conclusions are found through empirical research: High-tech zones promote regional economic growth, with a marginal contribution of 11.76%. Further research found that the promotion of high-tech zones to regional economic growth showed the law of "diminishing marginal effect": compared with cities with higher administrative levels, cities with lower administrative levels achieved faster development from the construction of high-tech zones. Compared with the developed areas in the east, the underdeveloped areas in the west have achieved faster development from the construction of high-tech zones. It shows that the construction of high-tech zones can help to shorten the economic development gap between developed and underdeveloped areas. Given that high-tech zones have a significant role in promoting regional economic growth, we should continue to vigorously promote the construction of high-tech zones. In order to narrow the gap between the rich and the poor, and shorten the economic growth gap between regions, China should give priority to less developed regions and cities with lower administrative levels when establishing new high-tech zones in the future. In addition, this paper also finds that the growth-type high-tech zone has a greater marginal contribution to the regional economic growth than the mature high-tech zone, and the multi-zone high-tech zone has a greater marginal contribution to the regional economic growth than the single-zone high-tech zone.

According to the current situation of China's development, although all regions have achieved development under the policy of reform and opening up, there are still problems such as slow development in some regions, and a growing gap between the rich and the poor. As an important "policy experiment" in China, the high-tech zone undoubtedly provides a solution to these problems. On the one hand, in view of the positive effect of high-tech zones on regional economic growth, we should make full use of this "policy experiment field" and "special economic zone" to further promote the construction of national high-tech zones, and encourage the gradual exploration and promotion of similar policy experiments. On the other hand, due to the poor initial economic conditions, the backward areas have a lot of room for improvement in economic development, and can obtain faster economic development from this policy. Therefore, China should proceed from the overall development strategy, grasp the empirical laws in the construction of high-tech zones, and rationally plan the layout of high-tech zones and other related policy experiments. China should continue to build high-tech zones in areas with lower administrative level or less developed cities, which will help narrow the gap between the rich and the poor.

Future research can further compare the high-tech zones in China with other developing and developed countries. According to the empirical results and countries with different levels of development, appropriate development policies are formulated to better promote global economic development, help reduce the wealth gap in the global economy, and promote the sustainable development of the global economy.

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