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A Study on the Impact of the Policy of "Promoting Construction by Promotion" in High-tech Zones on the Innovation of Enterprises in the Guangdong and Guangxi Provinces

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Abstracts: *As an important institutional framework designed to bolster enterprises' independent innovation capabilities and optimize industrial structures, high-tech industrial development zones hold substantial economic significance. In 2009, a policy was introduced to facilitate the transformation of provincial high-tech industrial development zones into national high-tech industrial development zones. In this study, we treat the 'upgrading to promote construction' policy as a 'quasi-natural experiment' and evaluate its impact on enterprise innovation using data from publicly listed companies between 2009 and 2018 in Guangdong and Guangxi. The findings of this research indicate that the 'upgrading to promote construction' policy has yielded significant and enduring positive effects on enterprise innovation within the two regions. Through an in-depth analysis of the empirical results, we elucidate the innovation incentive generated by the 'promotion for construction' policy in high-tech zones and offer policy recommendations pertaining to high-tech zone development and its potential benefits for enterprise innovation.*

Keywords: *High-tech Zone "Promotion for Establishment" Policy; Enterprise Innovation; Guangdong and Guangxi Provinces*

1. Introduction

High-tech industrial development zones (referred to hereinafter as 'hi-tech zones') represent a crucial instrument through which the government lends support to specific industries. These zones also serve as concentrated hubs where scientific and technological achievements can be maximally translated into tangible outcomes. High-tech zone" as the government to implement the innovation-driven development strategy, adhere to the scientific and technological innovation in China's modernization in the overall situation of the central position, in promoting enterprise innovation, enhance the level of urban innovation, optimize industrial structure, accelerate regional development and so on play a vital role[1]. The 'high-tech zone' concept aligns with the government's pursuit of an innovation-driven development strategy, solidifying scientific and technological innovation at the core of China's modernization agenda. This approach plays a pivotal role in propelling enterprise innovation, elevating the standard of urban innovation, optimizing industrial structures, and accelerating regional development, all within the broader context of China's overarching development vision."

In 2005, the State Council introduced the 'Principles and Procedures for Approval of Expansion, Modification, and Advancement of National and Provincial High-tech Zones,' commonly referred to as the 'Principles and Procedures' (2005). Subsequently, after 2009, the phenomenon of upgrading high-tech zones gained momentum, representing a significant milestone in China's pursuit of high-quality development. This trend signals a qualitative transition in the evolution of China's high-tech zones. As of the conclusion of 2018, the tally of high-tech zones featured in the 'China Development Zone Audit and Announcement Catalog' had reached 169. One of the paramount benchmarks for assessing the efficacy of China's national high-tech zone upgrading framework revolves around scrutinizing whether the 'promotion for construction' policy within high-tech zones genuinely elevates the level of enterprise innovation.

This study employs the document 'Several Opinions on Leveraging National High-tech Industrial Development Zones to Facilitate Stable and Swift Economic Growth,' released by the Ministry of Science and Technology in 2009, as the quasi-natural experimental setting. It constructs a multi-temporal

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Difference-in-Differences (DID) model, focusing on A-share listed companies in the Guangdong and Guangxi regions from 2009 to 2018. The investigation centers on the impact of the policy to upgrade provincial-level high-tech zones to national-level high-tech zones on enterprise innovation activities, taking into account spillover effects.

Compared to prior research, this paper makes several potentially valuable contributions. Firstly, concerning research methodology, given the disparity in the timing of high-tech zone upgrades, this study employs a multi-time point DID model. This approach offers a more scientifically rigorous and accurate assessment of the impact of high-tech zone upgrades on enterprise innovation, aligning better with the research objectives compared to alternative methods like the multiplier approach or fixed-time point DID. Secondly, from a research perspective, existing literature seldom refines its focus to specific regions. This paper, however, narrows its research scope to enterprises in the Guangdong and Guangxi regions. Through empirical analysis, it presents more targeted policy recommendations. Lastly, regarding data selection, this study utilizes enterprise data sourced from the CSMAR database, while measures of enterprise innovation are derived from the number of citations of licensed patents held by listed companies in CNRDS. This approach offers greater reliability in gauging enterprise innovation compared to previous research.

2. Literature Review

The high-tech zone serves as a crucial institutional design to enhance enterprise innovation, optimize and integrate industrial structures, and promote regional economic development. With a developmental history spanning over a century, globally recognized high-tech zones include Silicon Valley, Tsukuba Science City, Munich High-Tech Industrial Development Zone, among others. Foreign scholars have identified several positive incentives associated with high-tech zones, summarizing their research findings as follows: First of all, High-tech zones, acting as carriers of various preferential policies, facilitate the attraction of innovative resources. Notably, regions like Silicon Valley exhibit strong endemic and regional integration capabilities, resulting in superior innovation effects compared to other high-tech industrial parks[2]. This makes it easier to attract external enterprises to settle in the zone, benefiting from government subsidies in technological innovation. Secondly, the decision of enterprises to establish a presence in a high-tech zone is influenced by the regional impact of the zone. High-tech zones approved and supported by the national government enjoy a better reputation and status, boast more comprehensive infrastructure, and attract a greater willingness from enterprises to settle. Thirdly, the innovation generated by existing enterprises within the zone leads to technology spillover and knowledge transfer effects. Through various explicit or implicit channels, these effects provide avenues for innovation exchange with external enterprises, simultaneously facilitating the development of newly established enterprises. This process reduces innovation risks for companies[3], thereby driving an overall enhancement in the innovation levels of the entire region's enterprises. Additionally, cities with established high-tech zones often benefit from increased trade opportunities, with the total export value of enterprises within the zone generally surpassing that of those outside. The economies of scale resulting from increased exports contribute to a further elevation of innovation levels among enterprises within the zone[4].

Since the initiation of reforms and opening-up in China, the State Council has approved the establishment of high-tech industrial zones such as Zhongguancun in Beijing and the Shenzhen Science and Technology Park. Subsequently, domestic scholars have conducted extensive research on high-tech zones, primarily focusing on three aspects. Firstly, the impact on regional economic growth. High-tech zones, by attracting innovative resources, recruiting a substantial number of talents and advanced technologies, enhance the overall factor productivity, exerting a significant positive influence on regional GDP and per capital GDP. Simultaneously, the establishment of high-tech zones facilitates the attraction of advanced enterprises, propelling the formation and development of emerging industries, thereby driving regional economic growth. Secondly, the influence on economic performance. In the initial stages of enterprise settlement, high-tech zones may not fully exploit their innovation incentives[5]. As the high-tech zones continue to develop, the overall factor productivity within the zone shows an upward trend, exhibiting a "growth effect" in the early stages of enterprise development and a "catch-up effect" in the later stages[6]. Thirdly, the impact on corporate and urban innovation. For enterprises within high-tech zones, the integration of a planned innovation network contributes to the formation of a knowledge-sharing mechanism, thereby enhancing the innovation level of both extra-zone and inter-zone enterprises. From a city perspective, the construction of high-tech zones creates an innovation platform effect, stimulating the interaction of innovation resources within and outside the zone, driving reciprocal investments between urban areas, and ultimately raising the city's innovation level[7]. However, the

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innovation efficiency within and outside the zone is not uniform[8]. Due to geographical factors, the innovation efficiency of high-tech zones in the eastern region surpasses that of those in the central and western regions[9]. From the standpoint of green economic development, the establishment of high-tech zones significantly elevates regional green innovation levels, albeit with its effectiveness constrained by the level of economic development[10].

However, the impact of the upgrade of national-level high-tech zones on enterprise innovation has not been clearly explained by existing scholars, especially in the case of specific regions like the "Guangdong and Guangxi," where research on the innovation incentive effects of high-tech zone upgrades is scarce. After reviewing various scholars' studies, the impact can be summarized in the following two points: 1. **Leverage Effect:** The "upgrading to promote construction" policy of high-tech zones can effectively promote enterprise innovation. Firstly, the upgrade of provincial high-tech zones enhances regional innovation intensity, indirectly improving the technological efficiency of enterprises within the high-tech zone[11]. Secondly, the incentive effects of high-tech zone upgrade policies can directly impact enterprise innovation, with noticeable differences between extra-regional and inter-regional effects. 2. **Crowding-out Effect:** The "upgrading to promote construction" policy of high-tech zones may not effectively promote enterprise innovation. Scholars holding this view argue that high-tech zone upgrades may reduce the scale of enterprise exports, and the uneven distribution of innovation ecological factors leads to insufficient spillover effects[12][13][14]. Consequently, the overall innovation capability of enterprises within the zone is generally weak, making it challenging to effectively drive industrial innovation transformation. But generally speaking, the positive incentive effects of high-tech zone upgrade policies on enterprise innovation outweigh the crowding-out effects. In other words. Therefore, the hypothesis of this paper is proposed:

The "upgrading to promote construction" policy of high-tech zones can enhance the innovation level of enterprises in the Guangdong and Guangxi provinces..

3. Research Design

3.1. Model Building

This paper takes the policy of "promoting construction by upgrading" in the two high-tech zones as a quasi-natural experimental condition, and takes into account that the time point of upgrading provincial high-tech zones to national high-tech zones in the two regions is different, and adopts a multi-temporal DID model to investigate the effect of upgrading high-tech zones to national high-tech zones on the innovation of enterprises in the region. The econometric model designed in this paper is as follows:

$$Patent_{ijt=} \alpha + \beta \times D_{jt} + \lambda \times Controls_{ijt} + \omega_t + \varsigma_{ijt} \quad (1)$$

Among them, the explanatory variable Patentijt is an indicator to measure the innovation level of enterprises, and the subscripts i, j, and t denote enterprises, cities, and years, respectively. The core explanatory variable D_{jt} is the point in time when the high-tech zone policy is upgraded, when city j has a provincial high-tech zone upgraded to a national high-tech zone in year t, D_{jt} is assigned a value of 1 in that year and after that year, and D_{jt} is assigned a value of 0 in the year that has not been upgraded. β is the coefficient of the core explanatory variable. $Controls_{ijt}$ denotes the various control variables that may affect the innovation of the enterprise, including the enterprise level and the city level influencing factors. ω_t is the time fixed effects and firm fixed effects, and ς_{ijtt} is a randomized disturbance term.

3.2. Description of Variables

3.2.1. Explained Variable

The innovation level of enterprises serves as the dependent variable in this paper, measured by the logarithm of the sum of invention patent applications plus one from the CNRDS database[15]. Typically, innovation output in enterprises is gauged by the quantity of patents, a method that is intuitively effective and signals a positive message of competitive advantage for startups. However, this approach has limitations, notably in the realms of strategic innovation and the phenomenon of a "patent bubble." Recognizing the constraints of measuring innovation solely by patent quantity, this paper utilizes the number of invention patent applications. While patent applications generally encompass invention, utility model, and design patents, the latter two often innovate in product form and presentation, with true reflections of enterprise product innovation found in invention patents. Although the total number of patents obtained can indicate the quality of innovation, acquiring patents may be a result of early-stage

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efforts, leading to endogeneity issues[16]. Selecting the number of filed invention patents provides a more accurate reflection of innovation quality, better measuring innovation with practical application value.

3.2.2. Core Explanatory Variables

The primary explanatory variable in this study is the dummy variable representing high-tech zone upgrading. Given the varying upgrade timings across different cities, the upgrading of a high-tech zone in a specific city at time 't' is treated as a policy shock. Consequently, if city 'j' witnesses an upgrade of its high-tech zone to national status during year 't', the dummy variable D_{jt} is assigned a value of 1 for that year and the subsequent year, while the years in which the high-tech zone upgrade policy is not in effect are designated with a value of zero.

3.2.3. Control Variables

To enhance the precision of measuring the influence of the 'promotion for construction' policy on enterprise innovation within high-tech zones and to minimize regression errors arising from covariates, this study incorporates control variables. These control variables are drawn from existing literature and are categorized into two levels: city-level and enterprise-level controls. City-level controls encompass regional GDP per capita and regional wage per capita. On the other hand, enterprise-level controls consist of enterprise age, enterprise profitability, and equity concentration. The combination of city and firm-level control variables constitutes the comprehensive set of controls utilized in this study. See Table 1 for variable definitions:

Table 1: Main variables and their meanings

Variable type	variant	expressed symbol	calculation method
explanatory variable	Number of citations of authorized patents for inventions	$Patent_{ijt}$	Number of citations of authorized patents for inventions
explanatory variable	Hi-Tech Zone Upgrade Policy	D_{jt}	1 for the year of upgrade and subsequent years, 0 for the rest.
control variable	Age of business	Age_{it}	Difference between the current year and the year of establishment of the enterprise
	Corporate profitability	$Profit_{it}$	Ratio of corporate net profit to operating income
	shareholding concentration	$Equityradio_{it}$	Proportion of largest shareholders of listed companies
	Regional GDP per capita	Per_gdp_{jt}	Regional GDP per capita
	Regional per capita wages	Per_wage_{jt}	Regional per capita wages

3.3. Sample Selection and Data Sources

The data for high-tech zone upgrades was sourced from the 'China Development Zone Audit and Announcement Catalog (2018 Edition). Enterprise innovation data was acquired from the CNRDS database. The research scope of this paper pertains to A-share listed companies within the time frame of 2009 to 2018. City-level data was obtained from the China Urban Statistical Yearbook, while enterprise data was exclusively selected from CSMAR. Prior to conducting regression analyses, the variables in this paper underwent several preprocessing steps: (1) Exclusion of ST enterprises and *ST enterprises. (2) Elimination of data related to financial institutions. (3) Application of the natural logarithm to non-zero patent citation counts. (4) Handling of cases where the number of citations for authorized invention patents was zero by adding 1 to all citation counts before applying the logarithm transformation. (5) Data reduction procedures were implemented.

3.4. Descriptive Statistics

As shown in Table 2 for the descriptive statistics of the main variables in this paper, the maximum value of the explanatory variable $Patent_{ijt}$ is 7.074, the minimum value is 0, and the standard deviation is 2.046, indicating that there is a large gap in the number of authorized invention patent applications of the

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research object in this paper. The mean value of the core explanatory variable D_{jt} is 0.618, indicating that more than 60% of the time in 2009-2018, provincial high-tech zones have implemented the policy of "promotion for construction". The rest are descriptive statistics of the control variables.

Table 2: Descriptive statistics of main variables

variant	sample size	average value	(statistics) standard deviation	minimum value	maximum values
$Patent_{ijt}$	650	3.270	2.046	0	7.074
D_{jt}	650	0.618	0.486	0	1
Age_{it}	650	0.0930	0.131	-0.319	0.625
$Profit_{it}$	650	24.77	21.00	0	82.51
$Equityradio_{it}$	650	1.186	0.289	0.718	2.295
Per_gdp_{jt}	650	10.76	0.545	9.923	12.58
Per_wage_{jt}	650	10.73	0.273	10.14	11.18

4. Empirical Test Results and Analysis

4.1. Benchmark Regression Results

Table 3 presents the findings regarding the impact of the 'upgrading for building' policy on the innovation levels of firms within high-tech zones. In column (1), the regression results in this column robustly affirm the anticipated impact of the upgrading policy, demonstrating its significant role in fostering innovation among enterprises in both regions. Columns (2)-(4) progressively introduce year-fixed effects and enterprise-fixed effects into the analysis. Even after these controls, the empirical results consistently support the notion that the 'promoting construction by promotion' policy within high-tech zones substantially and positively impacts regional enterprise innovation. Finally, we augment the regression analysis with additional control variables, as depicted in the last column. In this configuration, the estimated coefficient for the central explanatory variable 'D' (high-tech zone upgrading policy) stands at 1.244, and it attains statistical significance at the 0.01 level. Collectively, these findings underscore that the upgrading policy for provincial high-tech zones in Guangdong and Guangxi exerts a generally positive and incentivizing effect on regional enterprise innovation."

Table 3: Benchmark regression results of the impact of provincial high-tech zone upgrading policies on enterprise innovation

Explained variable (level of innovation)	(1)	(2)	(3)	(4)	(5)
D	2.407***	2.891***	2.282***	1.314***	1.244***
Age					0.000
Profit					-0.734
Equityratio					0.001
Per_gdp					0.002
Per_wage					0.435
Time Fixed Effect	uncontrolled	containment	uncontrolled	containment	containment
Firm Fixed Effect	uncontrolled	uncontrolled	containment	containment	containment
Observed Value	650	650	650	650	650
Adjusted R^2	0.582	0.66	0.795	0.927	0.928

4.2. Parallel Trend Test

In order to ensure the reliability and scientificity of the regression results, this paper makes the parallel trend test[17] is conducted with reference to the practice of previous scholars to examine the role of the effect of the upgrading policy of high-tech zones in each city before and after the implementation of the policy. The paper depicts the dynamic effect of high-tech zone upgrading by estimating the coefficient trend. As shown in Figure 1, the horizontal axis indicates the upgrading time point of high-tech zones (0) and the distance of years before and after upgrading, and the vertical axis is the size of the estimated value. According to the estimated coefficient chart, it can be seen that the estimated coefficients are significantly positive in the year of upgrading of Hi-tech zones and the years afterward, while the estimated coefficients before the upgrading of Hi-tech zones are insignificant, which indicates that the

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policy of "upgrading to promote the construction of Hi-tech zones" has a sustained and positive impact on the innovation of the enterprises in the two Guangdong regions.

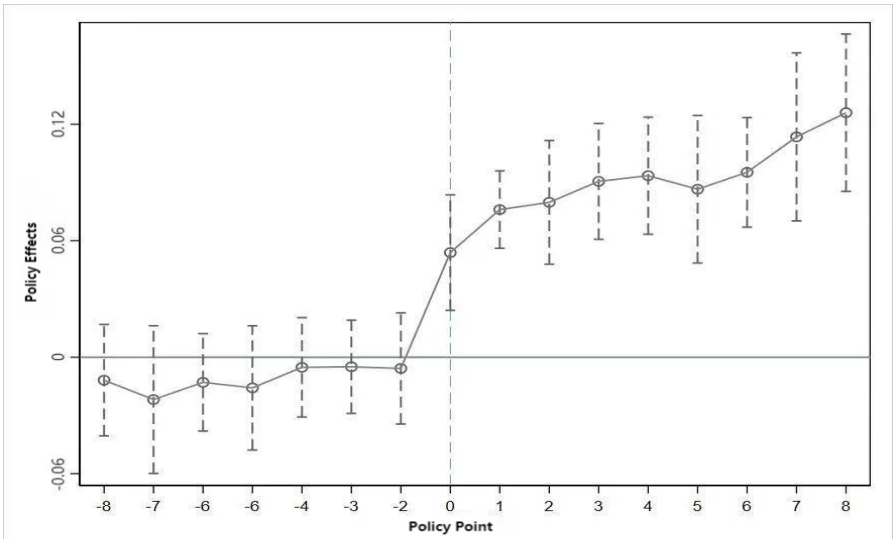

Figure 1: Trend of estimated coefficients

4.3. Robustness Check

Investigating the innovation incentive effect of the high-tech zone upgrading policy necessitates a careful consideration of potential confounding factors that may influence enterprise innovation. To address this concern, we introduce a lagged one-period policy implementation time into our analysis. A significantly positive coefficient in the regression results would imply that the high-tech zone upgrading policy, while it is not the predominant driver of enterprise innovation in the two regions of Guangdong.

5. Conclusions and Policy Recommendations

This study employs the 'promoting construction by upgrading' policy of high-tech zones as a quasi-natural experimental condition. It utilizes a multi-temporal double-difference model to investigate the relationship between enterprise innovation levels and the high-tech zone upgrading policy within the regions of Guangdong and Guangxi. And we yield two pivotal conclusions: (1) we observe a significant and sustained positive impact of high-tech zone upgrading on local enterprise innovation in Guangdong and Guangxi. This finding underscores the substantial innovation incentive effect associated with China's high-tech zone upgrading policies, thereby affirming the imperative of implementing such upgrades within the strategic context of innovation-driven development. (2) Reflecting the influence of regional economic development levels, more advanced cities tend to adopt high-tech zone upgrading policies earlier. For instance, during the period spanning 2009-2018, Guangdong Province implemented these policies far more extensively than Guangxi Province. Consequently, due to differences in policy implementation timelines, the innovation levels of enterprises in Guangdong Province surpass those in Guangxi Province."

In light of the aforementioned findings, this paper offers valuable policy recommendations: (1) Government Involvement: It is crucial for the government to sustain efforts in advancing the 'promote construction through upgrading' policy. This entails expediting the enhancement of relevant approval processes and procedural efficiencies. On one front, streamlining the application process for elevating provincial high-tech zones to national status, coupled with eliminating superfluous approval procedures, should be a priority. This streamlining will simplify the process for cities seeking high-tech zone upgrades. On the other hand, it is imperative to curtail excessive government intervention in microeconomics operations. Creating a more permissive business environment for enterprises in high-tech zones. (2) Regional Economic Development: Policies for promoting high-tech zone upgrades should be tailored to the region's economic development goals. These policies should synergize with the local industrial characteristics and resource endowments to leverage the region's comparative advantages effectively. (3) Incentives and Knowledge Flow: High-tech zones often contend with the outflow of knowledge, talent, and technology. To counteract this trend, governments can provide appropriate subsidies to incentivize

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innovation within these zones. Enterprises located outside these zones can harness the knowledge and technology spill-over effects engendered by high-tech zone upgrading policies. By enhancing the working and living environments for their employees and appealing to high-end talent, enterprises can further bolster their capacity to accumulate human capital.

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