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RESEARCH ARTICLE

Impact of Place-Based Policy on Land Lease Price and Its Productivity Premium: Evidence From China's Development Zone Program

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ABSTRACT

Combining micro data of DZs, land and firm in China, this study examines the impact of DZs on land lease price and its productivity premium by using Boundary Discontinuity (BD) model and the unconditional distribution characteristic-parameter correspondence method. Under the condition of market-oriented allocation of land resources, the increase in land demand brought about by the agglomeration of firms in DZs and the tight supply of land will jointly promote the land lease price in DZs. Moreover, increasing the DZs' land lease price raises the entry threshold of firms, thereby reducing the entry proportion of inefficient firms due to the selection effect, and enhancing the productivity of incumbent firms under the influence of competition and agglomeration effects. Land lease price is an important mediator variable for place-based policy to promote firms' productivity.

JEL Classification: R14, R52

1 | Introduction

Broadly speaking, place-based policies refer to government efforts to enhance the economic performance of an area within its jurisdiction (Neumark and Simpson 2015). The development zone (DZ) is the most representative place-based policy, which has been pursued by many governments worldwide. Since the establishment of the first batch of national DZs in 1984, China's various DZs have developed rapidly, and have become an essential platform for accelerating industrialization and urbanization. As of 2018, China has approved the establishment of 560 national DZs, and 1991 provincial DZs, distributed in 330 cities, accounting for 98% of all cities in China. As the primary spatial carrier of land urbanization, the efficient allocation of land resources in DZs is a crucial step in achieving the goal of intensive land use. In 2019, the approved area of 218 national DZs accounted for only 0.03% of the country's land area, but it contributed 10.9% of the country's gross domestic product (GDP), 17.4% of the added value of the secondary industry, and 10.9% of the fiscal revenue.

The essence of DZs is that the government attracts firms to gather in the designated geographical space through tax incentives or subsidies, which results in an external economy and the creation of more economic output. There has been much research focused on the effectiveness of DZs. For example, Hanson and Rohlin (2013), Neumark and Kolko (2010), and Briant et al. (2015) take Federal empowerment zones, California enterprise zones, and the French enterprise zone

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program as respective examples to investigate the causal impact of the policy. However, research findings on the effectiveness of DZs have been mixed. Some scholars argue that firms and workers choose the DZs only to obtain preferential policies and cannot make a sustainable contribution to the local economy (Glaeser et al. 2010; Hanson and Rohlin 2013). By contrast, a large number of studies have pointed out that the establishment of DZs has a positive impact on economic indicators such as GDP, employment, productivity, and export trade (Alder et al. 2016; Busso et al. 2013; Kline and Moretti 2013; Combes and Gobillon 2015; Zheng et al. 2017; Lu et al. 2019). The effects of DZs on firms' productivity can be achieved mainly through the allocation of land, capital, and other resources by local governments, and thus, further exploration of the allocation of land resources in DZs is necessary.

Due to the immobility of land and the high cost of reallocation, the loss caused by the mismatch of land resources is difficult to repair (Xi and Mei 2022). Therefore, land leasing is the critical link to guide the efficient allocation of land resources. As a necessary factor of production, the change in land lease prices will affect firms' productivity by affecting production costs, and alter the location choice of heterogeneous firms by changing the entry threshold. Consequently, exploring the effects of the place-based policy on the land lease prices and the resulting changes in firms' productivity can provide guidance for the reasonable regulation of land leasing in DZs.

The research on land resource allocation in developed countries is mainly based on its land planning policy, like zoning, which involves land demand (Slater et al. 2022), land supply strategy (Hortas-Rico and Gómez-Antonio 2020) and land planning laws (Newton 2021). For developing countries, several studies take China as an example to explore the effects of land lease price on firms' productivity, which have been carried out from two aspects. On one hand, research focusing on the consequences of low-price land leasing argues that, under the pressure of attracting investment, local governments tend to transfer industrial land at a low price by agreement, leading to severe productivity losses (Li et al. 2016) and the distortion of the firms' investment behavior (Jiang et al. 2012; Huang et al. 2015). On the other hand, some studies have examined how land lease price increases driven by marketization reforms affect firm productivity. Since 2007, the implementation of the land bidding, auction, and listing system in China has enhanced marketization of land transfer (Wang and Xiong 2013). In a market competition environment, the increase in industrial land lease prices will affect the improvement of industrial productivity through the selection effect (Xi and Mei 2019). Existing studies have mainly taken cities and counties as spatial units, while there is a lack of evaluation of DZs. Based on the importance of DZs to the efficient allocation of land resources and the improvement of firms' productivity, this study attempts to systematically explore the relationship between the DZs, land lease price, and firms' productivity by using theoretical and empirical methods.

The contributions of this study are as follows. First, existing research on policy evaluation and land leasing in DZs does not discuss the internal mechanisms of the effects of land lease price on firms' productivity, which is expanded in this study. Based on the perspective of heterogeneous firms, this study identifies the mechanism of land lease price in the improvement of firms' productivity and verifies the selection effect brought on by the increase of land lease price. Second, based on the micro-level data, this study identifies the precise spatial locations of DZs, land parcels, and firms by spatial positioning technology, and constructs a spatial data set of "DZ–land–firm" by matching. It provides micro-level data support for further exploration of the relationship between DZs, land leasing, and firms' productivity. Third, most empirical studies on DZs use districts, streets, and communities as the primary spatial units to approximately measure the spatial scope of DZs, which will cause some bias. In this study, the scope of the DZ is defined accurately to improve the refinement of empirical research.

Industrial land is the main type of land in China's land supply market, and is used mainly in the construction of DZs. In 2019, industrial land accounted for 48.52% of the built urban construction land of national DZs, an increase of 3.05 percentage points over 2010. Therefore, this study takes the industrial land as the research object. This paper is organized as follows. Section 2 presents the institutional background and research hypothesis. Section 3 describes the data sources and dataset construction. Sections 4 and 5 respectively empirically test the effects of the establishment of DZs on land lease price and its productivity premium. Section 6 briefly summarizes the findings and concludes.

2 | Institutional Background and Research Hypothesis

Combing the evolution of land lease policies in China's DZs and the New Economic Geography (NEG) theory, this study analyzes the effects of the establishment of DZs on land lease prices. Then, this study constructs an analytical framework for the effects of land lease price on firms' productivity and proposes the research hypotheses based on the "New" New Economic Geography model (NNEG).

2.1 | Evolution of Land Lease Policies in China's DZs

Before establishing the first DZ, according to the Constitution of the People's Republic of China (PRC) in 1982, the allocation of state-owned land-use rights was a planned allocation system characterized by free and indefinite use of land and prohibition of leasing. In 1986, China began to implement paid land-use rights system based on the *"Land Management Law of the PRC"*. With the revision of the Constitution of the PRC in 1988, the land leasing system has become the basic urban land use system legally (Zhang 1997). Therefore, the expansion and construction of the DZs adopt the system of paid lease of land-use rights according to law. Since the establishment of the first DZ in 1984, the policy evolution of DZs and land leasing in China has gone through the following stages:

Stage 1: From 1984 to 2001, the "race to bottom" competition for industrial land and the DZs fever.

With the continuous implementation of the tax-sharing system reform, local governments are facing enormous financial pressure. Consequently, local governments have strong incentives to

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approve the establishment of various DZs without authorization to attract investments. The phenomenon of arbitrarily occupying arable land to set up DZs, illegally leasing land, and introducing preferential policies beyond their authority led to extensive construction of DZs. In 2003, 70% of the 6866 DZs in China were idle (Du and Peiser 2014).

Because of fiscal decentralization and the performance evaluation system with GDP as the core, China's industrial land leasing fell into the "race to bottom" competition, and a large amount of land was transferred in the DZ, resulting in low land-use efficiency. At this stage, land leasing was based mainly on an agreement with the highest degree of government intervention. From 1993 to 1999, the number of land leasing through agreement accounted for 88.5% annually, while the proportion of auction and bidding was only 9.1% and 2.4%, respectively (Guo 2004). Kong (1993) found that the area of industrial land sold by agreement accounted for more than 90% through the investigation of more than 20 DZs, and most of the lease prices were less than one-third of the development cost.

Stage 2: From 2002 to 2006, the market-oriented reform of land leasing and the rectification of DZs.

In 2003, to curb the waste of land resources in DZs, the General Office of the State Council issued two urgent notices on suspending the approval of various DZs and rectifying various DZs while strengthening the management of construction land. These documents had promoted the central government to rectify and rectify various DZs, resolutely correct the phenomenon of unauthorized establishment of DZs in violation of regulations and irrationally expanding DZs, effectively solve the prominent problems of excessive DZs and illegally use of land in DZs. It promoted the standardized and coordinated development of DZs. By the end of 2006, the number of DZs in China had decreased from 6866 in 2003 to 1568, with a decrease of 77.2%, and the planned area had decreased from 38,600 square kilometers to 9949 square kilometers, with a decrease of 74%.

Meanwhile, the central government vigorously promoted the market-oriented reform of state-owned land leasing, and its main measures was to adopt a higher degree of market-oriented leasing method. During 2002 to 2006, the Ministry of Land and Resources promulgated relevant regulations on the state-owned construction land leasing. In particular, the Notice on the "Issuance and Implementation of the Minimum Price Standard for the Leasing of Industrial Land" issued in 2006 stipulated that "from January 1, 2007, industrial land must be leased using bidding, auction, and listing, and the transaction price shall not be lower than the corresponding minimum price" and "for an industrial land, if and only if there is only one intended user, the local government may lease it by agreement."

Stage 3: Since 2007, the market-oriented allocation of land in DZs has been implemented.

With the continuous improvement of the land leasing system, the listing mode with a higher degree of marketization gradually replaced the agreement mode with a lower degree of marketization after 2007, and became the main method for industrial land leasing, especially in the DZs. The proportion of industrial land leasing by agreement decreased from more than 96% in 2006 to about 60% in 2007 and about 20% after 2008 (Yang et al. 2014). Land leasing in China's DZs are done through the following methods: bidding, auction, listing, and agreement, among which agreement leasing with the lowest degree of marketization has been regulated to apply only to a small number of land leasing in the land marketization reform.

To encourage DZs to improve the land use efficiency, the Ministry of Land and Resources began to evaluate the intensive use of land in national DZs every 1–2 years since 2008. The DZs that meet the requirements of the land use assessment and passed the national examination may apply for the integration of the DZ established following the law. National DZs that meet the requirements of centralized layout, industrial agglomeration, and intensive land use are given appropriate preference when arranging annual new construction land indicators. Based on the implementation of the minimum lease price standard for industrial land, the DZs are encouraged to raise the entry threshold, formulate the investment intensity standards, and update them regularly. Stimulated by the above policies, the land use of national DZs has become increasingly intensive, and the investment intensity of fixed assets in industrial land has increased from 4.23 billion RMB per square kilometer in 2008 to 8.31 billion RMB per square kilometer in 2018. The output intensity of industrial land increased from 10.77 billion RMB per square kilometer in 2008 to 13.44 billion RMB per square kilometer in 2018.

2.2 | Effect of Establishment of DZs on Land Lease Price

After 2007, with the implementation of the bidding, auction, and listing leasing and the minimum lease price standard for industrial land, the degree of marketization of land leasing in DZs was greatly improved. The introduction of a series of policies has led DZs to raise the entry threshold and realize the market-oriented allocation of land resources.

Under the framework of New Economic Geography (NEG), the establishment of DZs will break the original urban industrial spatial structure, and the system will reach a new stable and balanced spatial structure under the combined effect of agglomeration and dispersion effects. DZs induce firm agglomeration, forming industrial agglomeration zones with high market potential. The NEG model confirms that the region with high market potential has a productivity advantage, and the source of this advantage is generally attributed to the agglomeration effect. The agglomeration of similar industries produces Marshall externalities, which improve productivity by sharing intermediate inputs, labor market pool, and knowledge spillover. Jacobs externalities generated by diversified industries will also promote innovation through knowledge spillovers, thereby improving productivity (Jacobs 1969). These two kinds of agglomeration effects will improve firms' productivity.

The productivity advantage brought by the agglomeration effect leads to the strong demand of industrial firms for industrial land in DZs, while the land available in DZs is relatively tight. According to the "*Evaluation of Land Intensive Use in National Development Zones (2018)*" issued by the Ministry of Natural Resources, among the 520 national DZs evaluated, the number of DZs with less than 10% of available land accounted for 41.15%, and the number of DZs with 10%–30% of available land accounted for 34.61%. Under the combined influence of tight

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land supply in DZs and rising land demand, the land lease prices in DZs will increase.

Hypothesis 1. *In the context of market-oriented allocation of land, the increase in land demand brought about by the agglomeration of firms in DZs and the tight supply of land will jointly promote the land lease price in DZs to be higher than that in non-DZs.*

2.3 | Effect of Land Lease Price on Firms' Productivity in DZs

The influence of the industrial land lease price in DZs on firms' productivity is reflected in two aspects. For new entrant firms, the change in industrial land lease price will bring about the selection effect on firms with different productivity, leading to the change in the proportion of heterogeneous firms entering the DZ. For incumbent firms, the increase in the land lease price of DZs raises the entry threshold for firms, which will intensify the competitive effect within the DZs. Together with the agglomeration effect, this will improve the productivity of incumbent firms.

Based on NEG theory, after considering the heterogeneity of micro-individuals, the NNEG theory proposes that regional productivity differences also come from the spatial selection effect of heterogeneous firms. The theoretical model of Baldwin and Okubo (2006) points out that the degree of competition among firms in agglomeration areas is more intense. The market mechanism makes it easier for inefficient firms to withdraw from the market, and only efficient firms can survive in large market areas (Melitz 2003; Melitz and Ottaviano 2008). The selection effect increases the proportion of efficient firms while decreasing the proportion of inefficient firms in large markets. The increase in the industrial land lease price in DZs will raise the entry threshold of firms, strengthen the screening effect of competitive pricing of market-oriented land leasing on firms with different efficiencies, make inefficient firms unable to obtain enough land resources, and promote the improvement of the firms' productivity in DZs.

Based on the methods of Melitz (2003) and Okubo (2010), this study analyzes the effects of land lease price on the spatial location of firms with different productivity in DZs. The initial assumptions include the following: (1) Firms make location choices between the DZ and the non-DZ; (2) An agricultural and a manufacturing sector can be found, and each manufacturing firm produces only one differentiated product; (3) Firm production requires human capital and unskilled labor, and human capital determines the productivity level of firmsϕ. Assuming that representative consumers prefer a variety of manufacturing products, it is represented by a Constant-Elasticity-of-Substitution (CES) utility function:

$$U = \left[\int_{j\in\Omega} q_j{}^{\rho} dj\right]^{1/\rho}, \quad 0 < \rho < 1 \tag{1}$$

where ρ is the consumer's preference for the product varieties, $\sigma = 1/(1-\rho)$ is the constant elasticity of substitution for any two goods, and the consumer's demand function for good j at price p is as follows:

$$q_j = p_j{}^{-\sigma} P^{\sigma-1} E \tag{2}$$

where the price index P is defined as $P = [\int_{j\in\Omega} p_j{}^{1-\sigma} dj\,]^{1/(1-\sigma)}$. If a firm wants to enter the DZ for production, it must pay the land leasing fee within the use period in a lump sum, representing the cost threshold for the firm to enter the DZ. The fixed cost of the firm entering the DZ is defined as the monotonous increasing function $f(r)$ of the land lease price r. The production cost function of the firm is as follows:

$$C(\phi) = f(r) + q/\phi \tag{3}$$

Every firm faces constant elasticity σ for the residual demand curve. The marginal cost pricing rule is adopted:$p(\phi) = \omega/\rho\phi$. Standardizing the firm wage level to 1, the profit function of the firm with the productivity ϕ is:

$$\pi(\phi) = [E(P\rho\phi)^{\sigma-1}/\sigma] - f(r) \tag{4}$$

Assume that the critical productivity for a firm to enter the market is ϕ^*. In the market equilibrium state, the critical productivity needs to meet the condition that the profit obtained by the firm in the critical productivity level is zero after entering the DZ. When the profit of the firm at the critical productivity is zero, the relationship between the critical productivity φ^* and the land lease price r of the DZ is as follows:

$$\pi(\phi^*) = 0 \;\;\Rightarrow\;\; \phi^* = (f(r)\sigma/E)^{1/\sigma-1}/P\rho \tag{5}$$

Because the constant elasticity of substitution σ is greater than 1, and $f(r)$ is a monotonically increasing function of the land lease price r, a positive correlation between φ^* and r exists.

Therefore, this study puts forward the following hypothesis:

Hypothesis 2. *The increase in land lease price in DZs raises the entry threshold for firms, thereby reducing the entry proportion of inefficient firms due to the selection effect, and enhancing the productivity of incumbent firms under the influence of competition and agglomeration effects.*

3 | Data Sources and Dataset Construction

3.1 | Data Sources

To accurately identify the effect of the DZs on land lease price and its productivity premium, this study used industrial land leasing and manufacturing firm observation microdata, and the blocks' data of DZs. The "China Land Market Network" provided microdata on industrial land leasing,[1] the "*Annual Survey of Industrial Firms*" (ASIF) was used to retrieve the microdata of manufacturing firms, and the "*Announcement Catalogue of National Development Zones (2018)*" provided information on the blocks of national DZs.

"The Regulations on the Leasing of State-owned Land Use Rights by Bidding, Auction and Listing" require the competent land authorities of municipal and county governments to announce the leasing plan of each state-owned land use right in advance on the China Land Market Network, and to announce the information of each land leasing, including land location, area, grade, leasing method, and other information. The provisions began to be implemented on August 1, 2006.

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Hence, the starting year of the microdata of industrial land leasing available from the China Land Market Network is set as 2007. Additionally, the latest year available of ASIF is 2013, considering the unity of national economic industry code standards, this study's empirical research period is 2007–2012.

3.2 | Database Construction

The spatial data set of “DZ-land-firm” (DLF) is constructed by the following steps:

1. **Identify the space boundary of the DZ block.** In compliance with the requirements of the State Council, and in accordance with the “*Announcement Catalogue of China's Development Zones (2018)*” promulgated by the National Development and Reform Commission and other departments, the Ministry of Natural Resources and the Ministry of Housing and Urban-Rural Development have verified the textual descriptions of the four boundaries and the coordinates of boundary inflection points of the DZs, resulting in the “*Announcement Catalogue of the Four Boundaries of National Development Zones (2018)*.” Concurrently, the four boundaries, boundary marker coordinates, and boundary shape maps of national DZs were made publicly accessible via the official website of the website of the Ministry of Natural Resources.[2] Based on the announcement catalogue and the boundary shape maps, the geographic coordinates of boundary piles of the National DZ are analyzed on AMAP. Subsequently, the spatial boundary vector data of national DZs are constructed employing ArcGIS.

   Certain DZs comprise two or more spatially discrete blocks. For instance, the Tianjin Economic and Technological DZ encompasses two distinct blocks—the East Block and the West Block—whereas the Hangzhou High-Tech Industrial DZ comprises three blocks: the Jiangbei Block, the Xiasha Block, and the Jiangnan Block. To more precisely characterize the spatial relationship between land parcels and their respective DZs, this study adopts the individual block as the fundamental unit of analysis. The research sample comprises 380 national-level economic and technological DZs and high-tech industrial zones, collectively encompassing 838 discrete blocks.[3] The spatial dataset of DZ blocks is illustrated in Figure 1: panel (a) presents the spatial distribution of all blocks, while panels (b) and (c) provide detailed representations of the Daxing Biomedical Base within Zhongguancun Science Park and the Hefei High-Tech Industrial DZ, respectively.

2. **Spatial relationship identification between DZs and industrial land.** First, the spatial distribution of industrial land parcels is characterized based on their boundary delimitations. The geographic coordinates of each parcel are extracted and subsequently mapped as point data representing industrial land leasing across China utilizing ArcGIS. Second, internal and external buffer zones are delineated relative to DZ block boundaries. Drawing upon the spatial dataset of DZs, this study constructs buffer zones extending outward from DZ block perimeters at a specified radius R. Finally, through the spatial overlay of DZ buffer zones and industrial land point data, the spatial relationships between industrial land parcels and buffer zones are identified and attributed with corresponding categorical data, as illustrated in Figure 2.

3. **Spatial relationship identification between DZs and Firms.** The firm identification protocol mirrors the land identification methodology. First, firms' locations are georeferenced using registered addresses from the ASIF

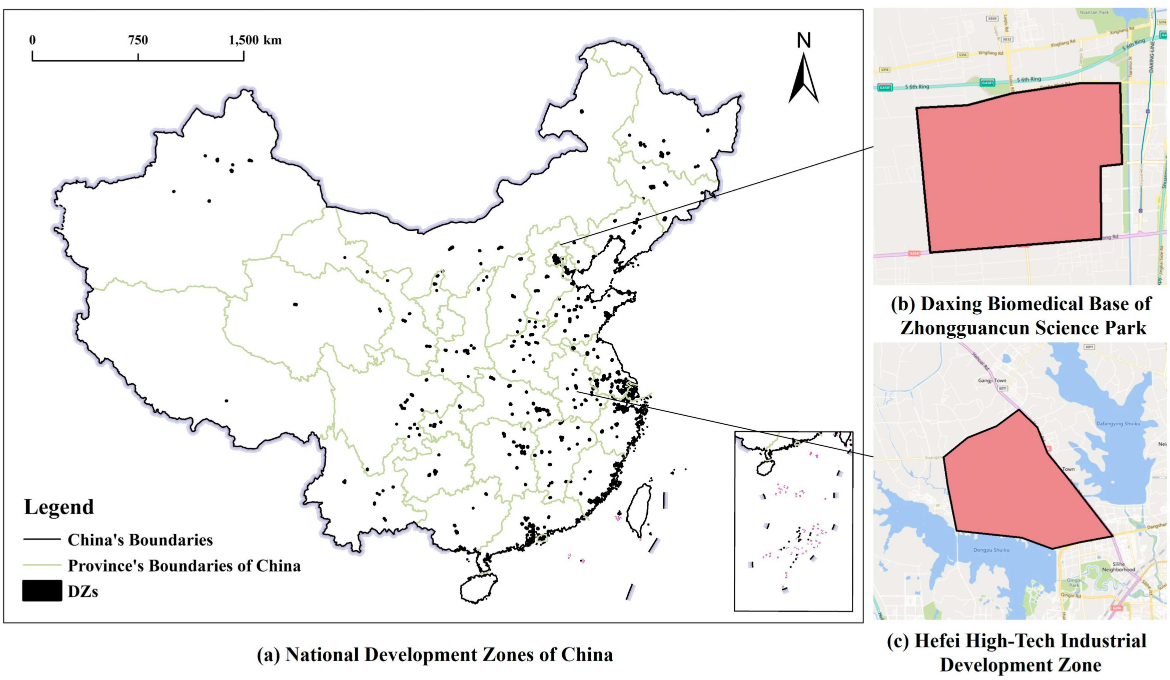

FIGURE 1 | Schematic diagram of spatial dataset of national DZs in China.

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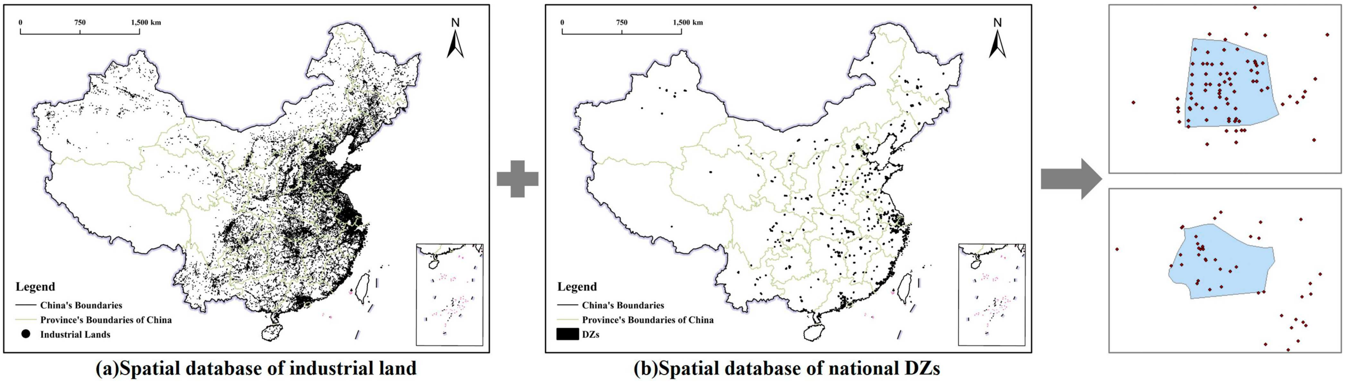

FIGURE 2 | Identification process of the spatial relationship between DZ and land.

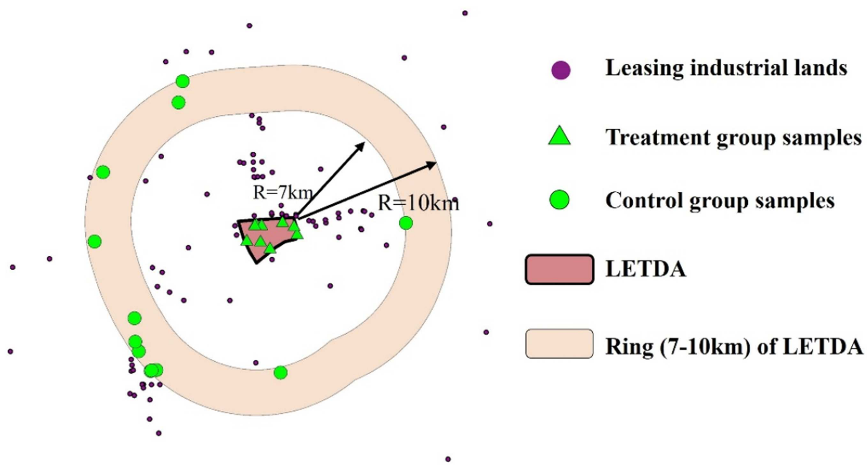

FIGURE 3 | Samples of Lu'an Economic and Technological Development Area (LETDA).

database, yielding geographic coordinates for each firm and enabling the generation of point-based spatial data for Chinese industrial firms. Second, internal and external buffer zones are established around DZ block boundaries. Specifically, this study constructs external buffer zones with radius R adjacent to DZ perimeters using spatial boundary data. Finally, spatial overlay analysis between DZ buffers and industrial firm points identifies firm-buffer spatial relationships, with attribute data assigned to the integrated spatial dataset.

3.3 | Model Specification

This study uses the boundary discontinuity (BD) model to estimate the effects of establishment of DZs on land lease prices, an approach pioneered by Holmes (1998) and Black (1999), to solve the problem of endogeneity. The BD model constructs discontinuities inside and outside the boundaries of the policy area based on physical distance. The BD framework in this study assumes that the treatment group has similar geographic characteristics as the control group for samples close to the boundaries of DZ except for the zone policies. When the discontinuous differences in land lease price between the treatment and control groups are observed, it can be attributed to the effects of the DZ policy. Because the treatment and control groups have obvious policy discontinuity, it can effectively control the problem of non-random selection of the DZ sites. Therefore, using the BD model for estimation can greatly control the estimation bias caused by the endogeneity problem.

This study implements two refinements to the conventional BD model. First, to expand the treatment group sample size and concomitantly improve estimation precision, all land parcels located within DZs are incorporated into the treatment group. Second, land parcels situated within the 7–10 km buffer zone circumscribing DZ boundaries constitute the control group. Proximate peripheral land is intentionally excluded from the control group, as spatial spillover effects would engender downward bias in the estimated treatment effects. Drawing on an average commuting speed of 30 km/h on urban road networks, and assuming commuting distance equals $\sqrt{2}$ times the straight-line distance, 7 km roughly aligns with the boundary of the 20-min public service circle in urban areas. Beyond 7 km, the spatial spillover effects of DZ policies nearly dissipate (Rosenthal and Strange 2020; Zheng et al. 2017); nonetheless, the unobservable characteristics of lands at this distance—such as local business culture and interpersonal networks—are relatively comparable to those within DZs. Accordingly, this specification guarantees conditional mean independence of the policy shock while adhering to the SUTVA assumption. Land parcels exceeding 10 km from DZ boundaries demonstrate inadequate comparability with treatment group observations and are therefore omitted from the sample. The geographic configuration of treatment and control groups is depicted in Figure 3. Alternative bandwidth specifications

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for treatment and control group delineation are examined in the robustness check section.

Taking the spatial relationship between the land and the boundary of the DZ buffer as the basis for sample identification, the BD model is constructed as follows:

$$lpri_{l,n,t} = \gamma_0 + \gamma_1 zbd_{l,n,t} + \phi L_{l,n,t} + \mu_{n,t} + \varepsilon_{l,n,t} \quad (6)$$

Where subscript l denotes land, n denotes DZ's block, and t denotes the year. The lease price of land n, $lpri_{l,n,t}$ is counted by taking the logarithm after dividing the total land lease fee by the area. $zbd_{l,n,t}$ is an interactive item with the dummy variable that measures the spatial relationship between the land and DZ's block ($zone_{i,n}$) and the time dummy variable of whether the DZ is established ($time_{i.t}$). When land n is located inside of the DZ's block n, the value $zone_{i,n}$ is 1, whereas when the buffer zone is located at the 7–10 km buffer ring outside the boundary of the block n, $zone_{i,n}$ take the value 0. $time_{i.t}$ is a dummy variable that takes a value of 1 if block n associated with land l has been established by year t; otherwise, it equals null. $\mu_{n,t}$ denotes the block-year fixed effects, which absorbs the confounding effects of time-varying factors at the DZ's block level—including adjustments in the regional economic environment and personnel changes in local governments. $\varepsilon_{i,n,t}$ is the stochastic error term. $L_{l,n,t}$represents the characteristic variable of land n, including the area of the land (*lare*), whether to lease by agreement (*lagr*), and the industrial land grades stipulated in the "*National Minimum Price Standard for the Leasing of Industrial Land*" (*lgra*). γ_0 is a constant term, γ_1 denotes the impact coefficient capturing the effect of DZ establishment on land lease prices, which is the core parameter of interest in this study. The descriptive statistics of the variables are shown in Appendix.

The model specification incorporates time-varying block fixed effects and controls for key firm-level characteristics. Furthermore, by employing samples from geographically adjacent regions as the control group, this study effectively mitigates potential confounding arising from small-scale unobservable factors—including local business culture and interpersonal networks. Consequently, the empirical specification satisfies the conditional mean independence assumption.

4 | Effect of DZs on Land Lease Price

The effects of the establishment of DZs on the industrial land lease price have analyzed based on the theory and facts mentioned above. This section will empirically verify the effect by building an econometric model.

4.1 | Boundary Discontinuity Model Regression

Based on the Model (6), we estimate the effect of DZ establishment on industrial land lease prices; the results are presented in Table 1. Columns (1) and (2) report estimates with progressively augmented control variables. Land attribute controls are introduced sequentially: the coefficients remain qualitatively robust across specifications, while the goodness-of-fit improves monotonically. The regression results reported in Column (2) indicate that industrial land lease prices at DZ block boundaries are 17.11% higher than those in the 7–10 km buffer ring outside the boundary; this estimate is statistically significant at the 1% level, thereby confirming Hypothesis 1.

Turning to the control variables, the coefficient on *lagr* is statistically significant and negative: relative to land parcels transferred through bidding, auction, or listing, those leased by agreement command prices that are 0.557% lower. Agreement-based land leasing has historically served as the primary instrument for investment attraction, typically implemented through below-market pricing strategies. The coefficient on *lare* equals −0.0039, indicating that a 1% increase in land area is associated with a 0.0039% decrease in the unit land lease price. In China, the maximum lease term for industrial land is 50 years, with lessees required to remit the total land lease fee in a single lump-sum payment to secure land-use rights for the designated period. Holding unit price constant, larger parcels entail higher aggregate lease payments, thereby attenuating firms' bidding willingness. The coefficient on *lgra* equals −0.0283: each one-grade increase in industrial land classification is associated with a 0.0283% decrease in land lease prices, statistically significant at the 1% level. Under the "*National Minimum Price Standards for Industrial Land Transfer*," all urban land in China is categorized into 15 grades, with each grade assigned a distinct minimum transfer price threshold. Higher grade numbers correspond to lower minimum transfer prices.

Should land lease prices within DZ blocks differ systematically from those in the 7–10 km buffer ring prior to zone establishment, sample selection bias would arise. Accordingly, it is imperative to examine the parallel trends assumption prior to DZ policy implementation, thereby validating the zero conditional mean hypothesis and enhancing the credibility of the benchmark regression estimates. Drawing upon the Model (6), this study substitutes $zbd_{l,n,t}$ for $pre\_zbd_{l,n,t}$, to assess differential land lease prices between treatment and control groups

TABLE 1 | Benchmark regression results base on BD model.

Variables	(1) lpri	(2) lpri	(3) lpri
zbd	0.2224***	0.1711***	
	(0.0394)	(0.0415)	
pre_zbd			0.1141
			(0.0730)
lagr		−0.5570***	−0.4729***
		(0.1112)	(0.0630)
lare		−0.0039***	−0.0023*
		(0.0012)	(0.0012)
lgra		−0.0283***	−0.0163**
		(0.0095)	(0.0082)
Block-year fixed effect	Y	Y	Y
Constant	5.1561***	5.4655***	5.1736***
	(0.0108)	(0.0517)	(0.0637)
Observations	18,046	16,466	9401
R-squared	0.5974	0.6513	0.7030

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at the city level are in parentheses.

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prior to DZ block establishment. Here, $pre\_zont_{i,n,t}$ is a dummy variable: it takes a value of 1 if land parcel l is located within the block n and the DZ has not yet been established in the year of land leasing; the value $pre\_zont_{i,n,t}$ is 1. When land l is located in the 7–10 km buffer ring zone outside the boundary of DZ n and the zone had not been established in the leasing year, the value of $pre\_zbd_{l,n,t}$ is 0. The regression coefficients of $pre\_zbd_{l,n,t}$ in columns (3) are not significant, indicating the absence of a significant difference in the land lease price between inside and outside the boundary of the DZ before its establishment. This finding satisfies the condition that "individuals cannot precisely manipulate their position relative to the policy boundary" (Keele and Titiunik 2011), thereby corroborating the validity of the benchmark regression results.

4.2 | Robustness Test

To bolster the robustness of our regression findings, we conduct a battery of robustness tests grounded in Model (6). The results are reported in Table 2. First, we modify the treatment group definition. In columns (1) and (2), we progressively incorporate land parcels within 1 km and 2 km of the DZ boundary into the treatment group. In column (3), we restrict the treatment group exclusively to parcels within a 1 km buffer inside the DZ boundary. Second, we adjust the control group composition. In columns (4)–(6), we redefine the control group as parcels located within buffer rings of 7–9 km, 6–10 km, and 8–10 km from the DZ boundary, respectively. Finally, we adjust the temporal scope. In column (7), we run a separate regression using only data from 2012, which is the year with the largest number of observations in our sample.

Across the regression results reported in Columns (1)–(7), the core explanatory variable exhibits substantial robustness: its coefficient remains statistically significant at the 1% level across all specifications. The signs and significance levels of all control variables align with those from the baseline regression, attesting to the robustness of our findings. Comparing the coefficients in columns (1) and (2), we observe that as the buffer boundary of the treatment group expands outward, the magnitude of the DZ policy coefficient diminishes monotonically. This pattern suggests that the positive impact of DZs on land lease prices attenuates as the buffer zone extends beyond the official boundary. The outward expansion of the buffer zone amplifies the influence of confounding factors on land parcel transactions, thereby attenuating the estimated DZ policy effect on land lease prices.

4.3 | Heterogeneity Analysis

The above test verifies the promotion effect of the DZ policy on the land lease price, and we further consider the differences of this effect in different industries, DZs, and cities.

4.3.1 | Industry Heterogeneity

4.3.1.1 | Heterogeneity of Local Key Industries

China's DZs have formed three types of management modes: local agency management, regional government overall planning, and firm management. Regardless of the mode, the formulation and implementation effect of industrial policies in the DZs will be affected by the central and local governments (Xi et al. 2025). First, we designate industries explicitly identified in national and provincial Five-Year Plans for Economic and Social Development as local key industries (Zhao and Chen 2019). Second, this study obtained each DZ's key manufacturing industries from the "Announcement Catalogue of China's Development Zones (2018)". Third, we matched local key industries and DZ's key industries with the corresponding two-digit code from the "Industrial Classification for National Economic Activities (GB/T4754-2002)." Based on the alignment between DZ key industries and local key industries, we partition the sample into key-industry and non-key-industry subsamples. The sub-sample regression results are shown in columns (1)–(4) of Table 3. The positive impact of DZ policies on industrial land lease price is statistically significant exclusively for key industries; estimates for non-key industries remain insignificant across all specifications. This finding indicates that the land lease price-boosting effect of DZ policies is critically contingent upon alignment with key industrial plans at both national and provincial levels.

TABLE 2 | Robustness regression results of BD model.

Variables	(1) *lpri*	(2) *lpri*	(3) *lpri*	(4) *lpri*	(5) *lpri*	(6) *lpri*	(7) *lpri*
zbd	0.1613***	0.1588***	0.2122***	0.154***	0.175***	0.173***	0.1506***
	(0.0331)	(0.0308)	(0.0472)	(0.0445)	(0.0386)	(0.0428)	(0.0367)
Treatment group	Inside and within 1 km buffer	Inside and within 2 km buffer	Inside 1 km buffer	Inside	Inside	Inside	Inside
Control group	Buffer ring 7–10 km	Buffer ring 7–10 km	Buffer ring 7–10 km	Buffer ring 7–9 km	Buffer ring 6–10 km	Buffer ring 8–10 km	Buffer ring 7–10 km
Constant	5.4375***	5.4405***	5.4629***	5.437***	5.484***	5.483***	5.2710***
	(0.0498)	(0.0482)	(0.0516)	(0.0566)	(0.0524)	(0.0576)	(0.0592)
Observations	19,366	18,123	14,872	12,740	18,984	13,528	3853
R-squared	0.6452	0.6501	0.6483	0.664	0.635	0.660	0.7288

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression; control variables are consistent with Model (6).

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TABLE 3 | Regression results of industry heterogeneity.

Variables	(1) Sub-sample p1 *lpri*	(2) Sub-sample p0 *lpri*	(3) Sub-sample c1 *lpri*	(4) Sub-sample c0 *lpri*	(5) Sub-sample high-ild *lpri*	(6) Sub-sample low-ild *lpri*
zbd	0.1734***	−0.0616	0.1716***	0.0076	0.1434***	0.1755***
	(0.0420)	(0.0726)	(0.0421)	(0.0873)	(0.0449)	(0.0562)
Constant	5.4472***	5.6397***	5.4477***	5.7292***	5.4380***	5.4852***
	(0.0527)	(0.0298)	(0.0526)	(0.0798)	(0.0664)	(0.0656)
Observations	15,762	622	15,883	501	4504	5208
R-squared	0.6470	0.5340	0.6488	0.3273	0.7468	0.7305

Note: The sub-sample p0, the DZ's key industry is not mentioned by the provincial government; p1, the DZ's key industry is mentioned by the provincial government; c1, the DZ's key industry is mentioned by the central government; c0, the DZ's key industry is not mentioned by the central government. Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression; control variables are consistent with Model (6).

TABLE 4 | Regression results of DZ heterogeneity.

Variables	(1) Growing DZ *lpri*	(2) Mature DZ *lpri*	(3) Industry-city integration DZ *lpri*	(4) Industry-dominated DZ *lpri*
zbd	0.1496***	0.1865***	0.1285*	0.1685***
	(0.0397)	(0.0661)	(0.0646)	(0.0488)
Constant	5.1264***	5.6531***	5.4924***	5.4287***
	(0.0490)	(0.0743)	(0.0647)	(0.0679)
Observations	5526	10,940	4587	11,159
R-squared	0.7178	0.6141	0.6139	0.6486

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression; control variables are consistent with Model (6).

4.3.1.2 | *Heterogeneity of Land Dependence*

Based on the method of Li et al. (2016), the correlation coefficient between the land-related tax paid by firms and its fixed assets (*ILD*) is used to measure the degree of land dependence of different industries.[4] The greater the *ILD*, the higher the degree of land dependence. We partition the sample into high-land-dependence and low-land-dependence industry subsamples based on the mean *ILD* value. The subsample results are reported in columns (5)–(6) of Table 3. The results indicate that regression coefficients for both subsamples are positive and statistically significant; however, the land lease price increase is more pronounced for low-land-dependence industries. In designing and implementing investment attraction strategies, national DZs systematically prioritize high-technology, high-value-added industries characterized by low land dependence. This well-documented selection effect engenders a substantially larger land lease price increase for low-land-dependence industries in response to DZ policy shocks.

4.3.2 | *DZ Heterogeneity*

4.3.2.1 | *Establishment Year of DZs*

We examine heterogeneous effects across DZs of varying ages, with zone age calculated from the official approval date. We partition the sample into mature and growing DZ subsamples based on the mean zone age. The regression results are shown in columns (1)–(2) of Table 4. Comparing regression coefficients across the two subsamples, the price-enhancement coefficient for mature DZs is smaller in magnitude than that for growing zones. Lu et al. (2019) and Zheng et al. (2017) note that the policy of DZs has a spatial spillover effect and the continuous construction of DZs led to the development of environs areas, which reduced the price difference of industrial land inside and outside the boundary of the DZ.

4.3.2.2 | *Intensive Land Use Monitoring Type of DZs*

Following the "*2020 Technical Scheme for Monitoring, Statistics, and Aggregate Analysis of Intensive Land Use in Development Zones*," we classify national DZs into industry-dominated DZs and industry-city integration DZs to examine their heterogeneous effects on industrial land lease prices. The regression results are reported in columns (3)–(4). Both DZ types exert positive impacts on industrial land lease prices; however, the policy effect is stronger and more robust for industry-dominated zones.

On the one hand, industry-dominated DZs are primarily oriented toward industrial production, featuring land-use structures centered on industrial development. According to the "*2020 Technical Scheme for Monitoring, Statistics, and Aggregate Analysis of Intensive Land Use in Development Zones*," the share of industrial land in China's industry-dominated DZs reaches 58.47%, significantly higher than the 23.81% recorded in

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industry–city integrated DZs. The relatively concentrated industrial land supply in these zones, combined with high industrial project density within their boundaries, substantially intensifies land scarcity and market competition, thereby elevating industrial land lease prices. On the other hand, industry-city integrated DZs emphasize the integration of industrial and urban functions. In terms of land use allocation, they reserve a large proportion of land for urban functional uses, including residential, commercial, and public service facilities, which generates a notable "crowding-out effect" on industrial land. The resulting relative contraction in industrial land supply consequently exerts upward pressure on land lease prices from the supply side.

4.3.3 | City Heterogeneity

4.3.3.1 | City Size

To identify heterogeneous policy effects across DZs located in cities of varying sizes, we partition the sample by city size. Chinese cities are divided into different levels according to the size of the resident population in urban areas. According to the size of the city where the DZ is located, the samples are divided into two groups: large cities, and medium-small cities. The results are shown in columns (1)–(2) of Table 5. The regression coefficients of the large city samples are higher, indicating that DZs located in large cities have a stronger effect on the promotion of industrial land lease price. These cities have a stronger agglomeration effect and a higher degree of competition among firms (Yu and Yang 2014). Moreover, the government of medium and small cities is more inclined to adopt the strategy of selling industrial land at a low price to attract investment, thereby weakening the role of DZs in promoting the industrial land lease price.

4.3.3.2 | Administrative Hierarchy

From the perspective of urban administrative hierarchy, we classify prefecture-level cities and non-sub-provincial capital cities as low-administrative-hierarchy cities, while municipalities directly under the central government, sub-provincial cities, and cities specifically designated in the state plan constitute high-administrative-hierarchy cities. The regression results are reported in columns (3)–(4). As the urban administrative hierarchy rises, the regression coefficient on the DZ policy variable increases monotonically, indicating that the land lease price-boosting effect of DZs strengthens in higher-hierarchy cities. A higher urban administrative hierarchy represents greater political authority and usually brings advantages in corporate subsidies, talent attraction, financing convenience, and local tax burdens (Jiang et al. 2012), which in turn intensifies the degree of competition among firms.

4.4 | Policy Rent and Market Potential Effect

DZs represent government-led industrial agglomerations established through the attraction of firms via comprehensive preferential policy packages. Relative to firms located outside zone boundaries, the excess returns captured by intra-zone firms constitute policy rents. Firms agglomerate within DZs in pursuit of policy rents, thereby elevating zone-level market potential, which in turn stimulates land demand and drives up land lease prices. To empirically validate this theoretical mechanism, this section addresses two sequential research questions: (1) Does DZ establishment enhance intra-zone market potential through the tax incentive provision? (2) Does DZ establishment elevate land lease prices through market potential improvement?

Based on this, we take the intra-zone area and the 7–10 km outer buffer ring zone as sample units, and construct a regional panel data model to test the impact of DZ policy rents on intra-zone market size. The model is specified as follows:

$$firmn_{z,t} = \alpha_0 + \alpha_1 zonebd_{z,t} + \Theta Z_{z,t} + \eta_z + \vartheta_t + \tau_{z,t} \quad (7)$$

where $zonebd_{z,t}$ is a difference-in-differences interaction dummy variable, defined as $zone_z \times ztime_t$, which indicates whether region z is located within a DZ in year t. $zone_z$ equals 1 for the intra-zone area and 0 for the 7–10 km buffer ring zone. $ztime_t$ equals 1 for years after the DZ is established, and 0 otherwise. The dependent variable $firmn_{z,t}$ is the total number of firms in region z in year t, which we use to measure the level of regional market potential. $Z_{z,t}$ is a set of control variables for region z in year t, including: firms' leverage ratio, *leve* (which is expressed from the proportion of total liabilities to total assets); and firms' management burden, *mana* (which is measured using the proportion of firms' management expenses in the main business income). the degree of innovation intensity, *hitr* (which is measured using the proportion of the output value of high-tech manufacturing firms in the total industrial output

TABLE 5 | Regression results of city heterogeneity.

Variables	(1) Small people size *lpri*	(2) Large people size *lpri*	(3) Low administrative level *lpri*	(4) High administrative level *lpri*
zbd	0.1575***	0.1836**	0.1608***	0.1780*
	(0.0411)	(0.0712)	(0.0401)	(0.0960)
Constant	5.4053***	5.4835***	5.3655***	5.5815***
	(0.0672)	(0.0723)	(0.0604)	(0.0925)
Observations	7171	9160	9655	6787
R-squared	0.6836	0.6242	0.6584	0.6323

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression; control variables are consistent with Model (6).

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value). All control variables are lagged by one period. η_z denotes region fixed effects, ϑ_t denotes year fixed effects, and $\tau_{z,t}$ is the stochastic error term. The descriptive statistics of the variables are shown in Appendix.

To further examine the impact of DZs on market potential through policy rents, we measure the magnitude of policy rents using the regional level of tax incentives. Following the method of Aghion et al. (2015), we calculate the corporate income tax incentives received by each firm with the following formula: Tax Incentives = Statutory Applicable Tax Rate × Total Profit−Actual Income Tax Payable. Prior to 2008, the statutory corporate income tax rate in China was 33% for domestic-funded enterprises and a unified 15% for foreign-funded enterprises. After 2008, the statutory rates were adjusted to 25% for domestic-funded enterprises and 20% for foreign-funded firms. We classify firms into domestic and foreign-funded categories based on their registration type, calculate the amount of tax incentives for each firm separately, and then aggregate the firm-level data to obtain the regional tax incentive intensity. Building on Model (7), we split the full sample into high policy rent and low policy rent subsamples based on the mean value of regional tax incentive intensity, and estimate the model separately for each subsample. The results are reported in Table 6.

For the high tax incentive subsample, the estimated coefficient on the core interaction term *zonebd* is 5.7598, which is statistically significant at the 1% level. This indicates that DZ establishment leads to a significantly larger increase in the number of firms within the zone relative to the outer buffer area. In contrast, the coefficient is statistically insignificant for the low tax incentive subsample, suggesting that DZs have a weaker attraction for firms when policy rents are limited. The cross-subsample comparison confirms that DZ establishment can increase the number of intra-zone firms by providing policy rents, thereby shaping regions with high market potential.

TABLE 6 | Results of the impact of policy rent on the market potential.

Variables	(1) High policy Rent Samples *firmn*	(2) Low policy Rent Samples *firmn*
zonebd	5.7598***	−0.6857
	(2.0214)	(1.9864)
l.man	12.3704	−2.4318
	(8.3205)	(10.0668)
l.hir	5.1484	−2.8139
	(4.2332)	(3.0781)
l.lev	0.5763**	0.1652
	(0.2222)	(0.2268)
Constant	27.6872***	58.1554***
	(2.1580)	(0.9069)
Observations	1377	2736
R-squared	0.8290	0.9473

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses.

Furthermore, based on Model (6), the sample is divided into high and low market potential regions according to the mean number of firms within each DZ, to examine whether the establishment of DZ boosts land lease prices by improving market potential. The regression results are reported in Table 7. A comparison of the two subsamples shows that the coefficients are both significantly positive at the 5% level. Specifically, in the high market potential subsample, land lease prices inside DZs are 0.4323% higher than those outside, whereas the corresponding differential in the low market potential subsample is merely 0.3015%. The stronger positive impact of the DZ on land lease prices in high market potential regions confirms that the establishment of DZ increases land lease prices by raising market potential.

4.5 | Spatial Spillover Effect

Furthermore, drawing upon the empirical strategies of Lu et al. (2019) and Butts (2023), this study integrates the concentric ring method within a spatial event study framework, maintaining specifications consistent with model (6). The procedure proceeds as follows: First, a concentric ring situated sufficiently distant from the DZ boundary (> 7 km) is designated as the baseline control group. Land parcels within this ring can be regarded as a clean control group unaffected by direct policy spillovers, while remaining comparable to the treatment group in terms of geographic characteristics. Second, the area between the baseline ring and the treatment zone is partitioned into seven equidistant concentric rings. We estimate the policy effect separately for each ring relative to the baseline, thereby characterizing the spatial gradient of policy impacts. The bandwidth is fixed at 1 km.

Regression results based on the concentric ring method are reported in Table 8. The land lease price-boosting effect of DZ policies on surrounding land lease prices exhibits a pronounced distance-decay pattern. Within the 0–3 km bandwidth from the DZ boundary, the spillover effect on land lease prices is economically substantial and highly statistically significant. For the 3–4 km ring, the coefficient declines sharply to 0.0477,

TABLE 7 | Results of the impact of the market potential on the land lease price.

Variables	(1) Low market potential samples *lpri*	(2) High market potential samples *lpri*
zbd	0.3015**	0.4323**
	(0.1268)	(0.1741)
Constant	5.3824***	5.5005***
	(0.1562)	(0.1149)
Observations	2741	4778
R-squared	0.7867	0.6019

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression; control variables are consistent with Model (6).

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TABLE 8 | Results of the spatial spillover effect.

Variables	(1) *lpri*	(2) *lpri*	(3) *lpri*	(4) *lpri*	(5) *lpri*	(6) *lpri*	(7) *lpri*
zbd	0.142***	0.158***	0.115***	0.0477	0.0336	0.0151	0.0368
	(0.0446)	(0.0380)	(0.0411)	(0.0365)	(0.0287)	(0.0316)	(0.0315)
Ring of treatment group	0–1 km	1–2 km	2–3 km	3–4 km	4–5 km	5–6 km	6–7 km
Constant	5.420***	5.376***	5.413***	5.443***	5.423***	5.466***	5.450***
	(0.0571)	(0.0651)	(0.0510)	(0.0628)	(0.0570)	(0.0651)	(0.0715)
Observations	9762	9450	8852	8904	8674	8724	8184
R-squared	0.716	0.729	0.699	0.700	0.715	0.731	0.726

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression; control variables are consistent with Model (6).

accompanied by a marked attenuation in statistical significance. Beyond 4 km from the zone boundary, the estimated coefficients become economically trivial and statistically indistinguishable from zero. These findings are fully consistent with the geographic distance-decay hypothesis. They confirm that the capitalization effect of DZs is driven by elevated location expectations, induced agglomeration demand, and improved public infrastructure. This effect attenuates progressively with increasing distance from the DZ boundary, and policy spillovers exhibit a welldefined spatial boundary. Failure to account for this localized spatial spillover effect would engender downward bias in the estimated aggregate land lease price-boosting effect of DZ policies.

5 | Effect of Land Lease Price in the Productivity Premium of the DZ

As a core production factor for firms, land and its corresponding lease price exert a significant impact on firms' production and operational behavior. A core research question follows: Can rising land lease prices improve the productivity of firms within DZs? To answer this question, this section conducts empirical tests via econometric regressions and the unconditional distribution characteristic-parameter correspondence method, based on three sets of DZ's firm samples: incumbent firms, new entrant firms, and the total firm samples.

5.1 | Econometric Regressions Method

5.1.1 | Model Specification

The regression model is used to reveal the effect path of DZ policy on firms' productivity under the influence of land lease price. The estimation model is set as follows:

$$tfp_{f,n,t} = \beta_0 + \beta_1 zbdf_{f,n,t} + \psi F_{f,n,t} + \rho_{n,t} + \zeta_{f,n,t} \tag{8}$$

Where the subscripts n, t, f represents the DZ, year, firm, respectively. *tfp* is the total factor productivity of a firm, calculated by the OP method (Olley and Pakes 1996). $zbdf_{f,n,t}$ is the dummy variable, The variable coding method is consistent with *zbd* specified in Model (6). β_1 is the core coefficient we concerned about. $F_{f,n,t}$ is the characteristic variables of firms, which includes characteristic variables of firms and lands. The characteristic variables of firms include firm asset-liability ratio (*flev*); firm management cost (*fman*), measured by the proportion of firm management expenses to the prime operating revenue; and *hite* represented whether it is a high-tec firm. These control variables were treated with a one-stage lag. β_0 are constant terms. $\rho_{n,t}$ represent the block-year fixed effect. $\zeta_{f,n,t}$ is the residual term. The descriptive statistics of the variables are shown in Appendix.

5.1.2 | Regression Results

We partition the sample regions into high and low land lease price subsample based on the average land lease prices of zones. We then conduct separate regressions using three firm samples: the full sample, incumbent firms, and the new entrant firms. The results are reported in Table 9. Columns (1)–(3) present results for incumbent firms, columns (4)–(6) for new entrant firms, and columns (7)–(9) for the full sample.

The results indicate that the coefficients of $zbdf_{f,n,t}$ are significantly positive across all specifications, suggesting that the establishment of DZs significantly improves the *tfp* of firms within the zones. This core finding remains highly robust for incumbent firms, new entrant firms, and the full sample. However, the productivity-enhancing effects exhibit clear heterogeneity across firm types.

The effect is strongest for incumbent firms, while the productivity premium effect is relatively weaker for new entrant firms. These results suggest that DZ policies exert a more pronounced productivity-enhancing effect on long-operating incumbent firms within the zones than on newly entered firms. Owing to the agglomeration externalities within DZs, incumbent firms can capture agglomeration rents to a significantly greater extent than new entrant firms, thereby boosting their productivity.

Regarding heterogeneity across land lease price levels, all three firm groups exhibit a consistent pattern. The productivity-enhancing effect is significantly stronger in high land lease price regions than in low land lease price regions. This finding confirms the presence of a significant productivity spillover effect of land lease prices within DZs. Specifically, for new entrant firms, the gap between high and low land lease price regions is the most striking: the coefficient reaches 0.2616 in high land lease price regions, more than double the coefficient in low land lease price regions. A high land lease price environment amplifies the enhancing effect of DZ policies on firms' *tfp*, with this moderating effect being most prominent for

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TABLE 9 | Regression results of the land lease price in the productivity premium of DZs.

Variables	Incumbent firm sample			New entrant firm sample			Total firm sample		
	(1) Total zone *tfp*	(2) High price zone *tfp*	(3) Low price zone *tfp*	(4) Total zone *tfp*	(5) High price zone *tfp*	(6) Low price zone *tfp*	(7) Total zone *tfp*	(8) High price zone *tfp*	(9) Low price zone *tfp*
zbdf	0.3223***	0.4032***	0.3706***	0.1336***	0.2616***	0.1196**	0.1404***	0.2410***	0.1352***
	(0.0761)	(0.1445)	(0.0923)	(0.0445)	(0.0888)	(0.0507)	(0.0407)	(0.0868)	(0.0458)
l.fman	−0.6458**	−1.0906***	−0.1839	−1.0187***	−1.2298***	−0.7825***	−0.7538***	−1.0859***	−0.4037***
	(0.2594)	(0.3926)	(0.2416)	(0.1744)	(0.2332)	(0.1500)	(0.1531)	(0.2041)	(0.1333)
l.flev	−0.0087	−0.0211**	0.0290	−0.0157	−0.0126	−0.0257	−0.0047	−0.0151	0.0147
	(0.0145)	(0.0093)	(0.0295)	(0.0203)	(0.0201)	(0.0288)	(0.0127)	(0.0110)	(0.0232)
hitech	0.8703***	1.0049***	0.6875***	1.0396***	1.0459***	1.0299***	0.9865***	1.0246***	0.9340***
	(0.0889)	(0.1288)	(0.0950)	(0.0812)	(0.0877)	(0.0866)	(0.0689)	(0.0778)	(0.0689)
Constant	2.6512***	2.5932***	2.5949***	2.7296***	2.7016***	2.6721***	2.7183***	2.7048***	2.6486***
	(0.0575)	(0.1210)	(0.0618)	(0.0304)	(0.0690)	(0.0293)	(0.0280)	(0.0675)	(0.0289)
Observations	7,392	4,060	3,331	23,746	12,253	11,493	33,999	17,755	16,244
R-squared	0.3152	0.3541	0.2724	0.3401	0.3501	0.3091	0.3166	0.3344	0.2815

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; robust standard errors clustered at city level are in parentheses; block-year fixed effect is controlled in the regression.

new entrant firms. As a core component of costs, land lease prices generate a selection effect that screens for high-productivity firms with stronger cost-bearing capacity. This selection effect has a far more pronounced impact on new entrant firms.

5.2 | Unconditional Distribution Characteristic-Parameter Correspondence Method

5.2.1 | *Model Specification*

This section examines whether the productivity premium within the DZ is due to the entry of a smaller proportion of inefficient firms than outside the DZ boundary to verify the selection effect. This study uses the unconditional distribution characteristic-parameter correspondence method proposed by Combes et al. (2012) to analyze the differences in the distribution of firms' productivity inside and outside the boundaries of the DZ and their sources. The process and results of this nonparametric estimation method do not depend on the control variables, thereby avoiding the endogeneity problem caused by missing variables. Assumptions Ω_i and Ω_j represent the distribution of *tfp* inside and outside DZ, respectively. Then, the quantile of *tfp* at u within the DZ can be expressed as follows[5]:

$$\Omega_i(u) = D\Omega_j(\underline{S} + (1 - \underline{S} - \overline{S})u) + A,$$
$$u \in \left[\max\left(0, \frac{-\underline{S}}{1 - \underline{S} - \overline{S}}\right), \min\left(1, \frac{1 - \underline{S}}{1 - \underline{S} - \overline{S}}\right)\right] \tag{9}$$

Because the domain contains parameters, it cannot be estimated directly, and the above formula is transformed to obtain the following:

$$m_\theta(u) = \Omega_i(r(u)) - D\Omega_j(\underline{S} + (1 - \underline{S} - \overline{S})u) + A, \quad u \in [0, 1] \tag{10}$$

Similarly, the distribution of firm productivity outside the DZ can be written as

$$\Omega_j(u) = \frac{1}{D}\Omega_i\left(\frac{u - \underline{S}}{1 - \underline{S} - \overline{S}}\right) - \frac{A}{D},$$
$$u \in [\max(0, 1 - \underline{S}), \min(1 - \overline{S}, 1)] \tag{11}$$

Then, the following can be obtained:

$$m'_\theta(u) = \Omega_j(r'(u)) - \frac{1}{D}\Omega_i\left(\frac{r'(u) - \underline{S}}{(1 - \underline{S} - \overline{S})}\right) + \frac{A}{D},$$
$$u \in [0, 1] \tag{12}$$

By minimizing the sum of the squares of $m_\theta(u)$ and $m'_\theta(u)$, we can obtain an estimate of $\theta = (A, D, \underline{S}, \overline{S})$, i.e., $\theta = \underset{\theta}{\operatorname{argmin}} M(\theta)$, where u is the quantile of the *tfp* distribution. When $A > 0$, it shows that the internal agglomeration effect of the DZ is stronger. When $D > 1$, it shows that the high-productivity firms in the DZ gain more benefit. When $\underline{S} > 0$, it shows that the proportion of low-productivity firms in the DZ is lower, that is, a selection effect within the DZ exists, and when $\overline{S} > 0$, it is the reverse.

5.2.2 | *Distributional Characteristics of Firm* tfp

This paper quantifies the productivity premium effect of land lease prices in DZs by comparing the *tfp* levels of the full sample of firms, incumbent firms, and new entrant firms across different regions. The specific comparison groups are set as follows: (1) inside-DZ areas versus the 7–10 km buffer ring outside the DZ boundary; (2) inside areas of high land lease price DZs

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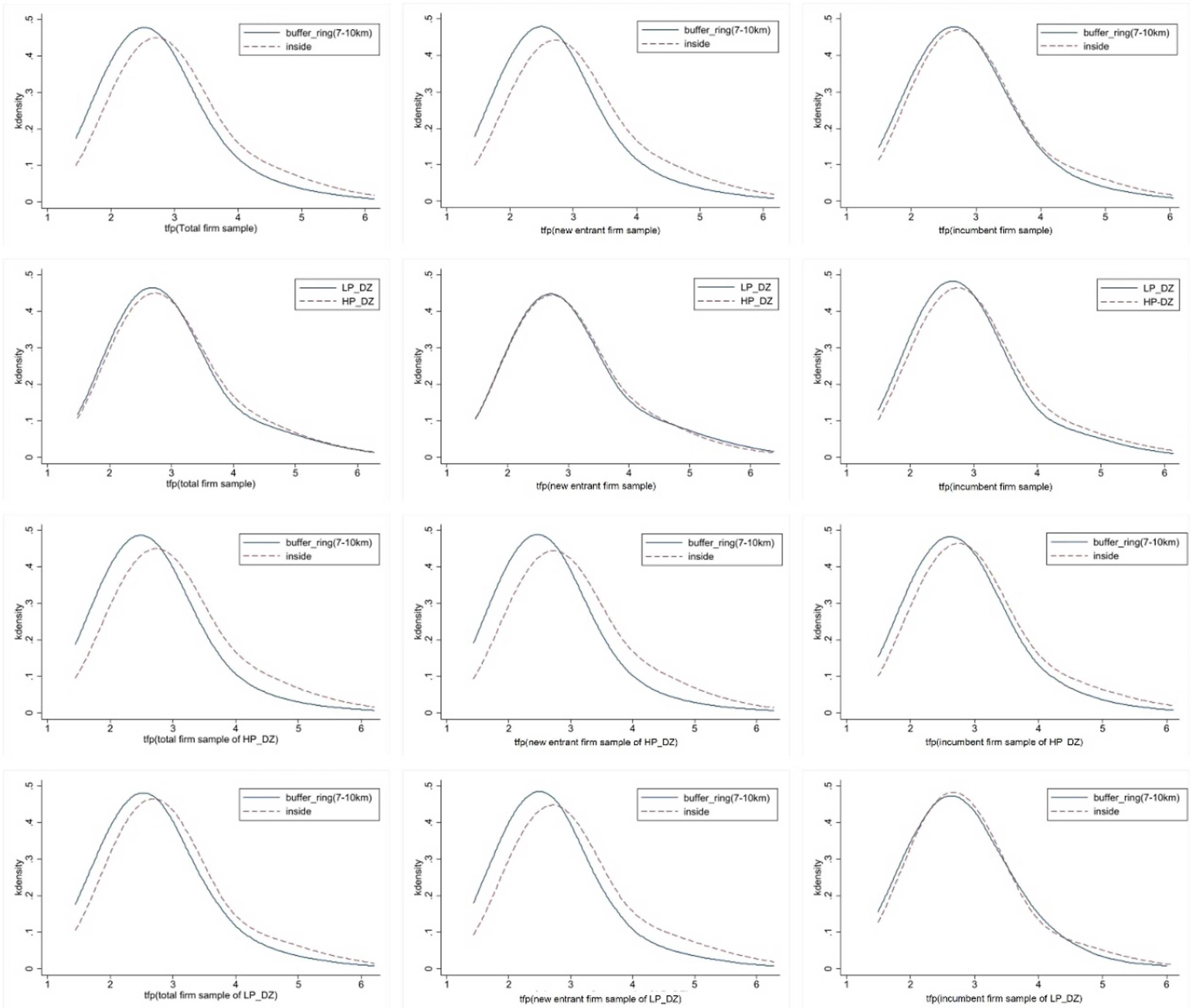

FIGURE 4 | Kernel density of *tfp* by regions.

(hereafter HP_DZ) versus inside areas of low land lease price DZs (hereafter LP_DZ) based on the median of the DZ's land lease price; (3) inside areas versus the 7–10 km buffer ring of HP_DZ; (4) inside areas versus the 7–10 km buffer ring of LP_DZ. The kernel density curves of firm productivity distribution are presented in Figure 4.

Figure 4 illustrates both the selection effect and agglomeration effect of China's DZ policies on firm's *tfp*, with these effects exhibiting significant heterogeneity across DZs with varying land lease price levels and across different firm types. Across the full sample, the new entrant firm subsample, and the incumbent firm subsample, the average *tfp* of firms within DZs is significantly higher than that of firms in the 7–10 km buffer ring outside. Within zones, the proportion of low-productivity firms is lower, while the proportion of high-productivity firms is higher. The productivity distribution is more concentrated within the 7–10 km buffer ring. These findings consistently confirm the spatial selection effect of DZs operating through entry thresholds, as well as the aggregate productivity-enhancing effect driven by industrial agglomeration.

Regarding heterogeneity across firm types, the *tfp* gap between inside and outside DZs is the most pronounced for the new entrant firm sample. The proportion of low-productivity firms among new entrants within DZs is far lower than that in the corresponding buffer ring, indicating that the selection effect of DZs is mainly realized through entry selection of new entrant firms. For the incumbent firm sample, gaps in average *tfp* and distribution concentration between inside and outside DZs are also statistically significant, confirming the sustained productivity-enhancing effect of DZ agglomeration on incumbent firms. Results for the full sample comprehensively reflect the combined effects of both firm groups.

Comparisons of inside zone firm *tfp* distributions between HP_DZ and LP_DZ reveal that, across the full sample, new entrant firms, and incumbent firms, the TFP distribution within LP_DZ is more concentrated, while both new entrant and incumbent firms in HP_DZ have a higher proportion of high-productivity firms. A comprehensive analysis of *tfp* distribution characteristics of firms inside and outside HP_DZ and LP_DZ reveals that the gaps in the proportion of high-productivity new

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entrant firms and average *tfp* between inside and outside zones are larger for HP_DZ. This indicates that land lease prices exert a stronger selection effect on new entrant firms, which in turn constitutes the productivity premium effect of high land lease price DZs. For incumbent firms, the gap in the proportion of high-productivity firms between inside and outside zones is also more pronounced in HP_DZ, indicating that incumbent firms obtain a stronger agglomeration effect from high land lease price DZs.

5.2.3 | *Parameter Estimation Results*

The estimation results of the *tfp* distribution parameters of firms inside and outside the DZ are presented in Table 10. To ensure result credibility, we estimate using both ASIF-based firm samples and firm-land matched samples. The results are as follows:

Agglomeration and selection effects drive the productivity premium of firms within DZs. Across all specifications, coefficient A is significantly positive at the 1% statistical level, with the agglomeration effect being more pronounced in high land lease price DZs (HP-DZs). Specifically, agglomeration gains for inside-zone firms relative to those in the buffer ring are significantly higher in HP-DZs than in low land lease price DZs (LP-DZs). This indicates that while the high land lease price threshold does not directly amplify agglomeration gains, it elevates overall productivity level of DZs through superior locational advantages and improved resource allocation efficiency.

Coefficient $\underline{S}$ varies notably across specifications, being more prominent in HP-DZs and new entrant firm subsamples. High land lease price threshold strengthens the entry propensity of high-productivity firms, effectively selection for more competitive entrants. In contrast, the positive selection effect is relatively weaker for incumbent firms, whose productivity advantage derives mainly from long-term operational accumulation and continuous efficiency improvement, rather than self-selection at entry.

6 | Conclusions and Discussions

6.1 | Conclusions

This paper exploits China's national Development Zones. These zones constitute the world's largest and most enduring quasi-natural experiment in place-based policy. We systematically estimate the causal effects of DZ policy on industrial land lease prices and quantify the associated productivity premiums effects. The principal findings are as follows: (1) Following the implementation of China's bidding, auction, and listing land

TABLE 10 | Results of unconditional distribution characteristic-parameter correspondence method.

Sample comparisons		A	D	$\underline{S}$	$\bar{S}$	R^2
Total firm sample	Inside of DZ versus 7–10 km buffer ring	0.7515***	0.7910***	0.0664*	−0.0916	0.9532
		(75.2238)	(93.1531)	(1.8297)	(−9.7936)	
New entrant firm sample		0.7624***	0.7966***	0.0744**	−0.1039	0.9525
		(87.5098)	(192.9958)	(3.5377)	(−5.1421)	
Incumbent firm sample		0.7286**	0.7570***	0.0725	−0.0857	0.9374
		(4.9991)	(16.8757)	(1.2366)	(−1.9421)	
Total firm sample	Inside of HP-DZ versus Inside of LP-DZ	0.7066***	0.7678***	0.0743**	−0.0646	0.8642
		(6.8516)	(22.6926)	(3.4966)	(−9.4877)	
New entrant firm sample		0.7007***	0.7714***	0.0897***	−0.0385	0.8449
		(11.2527)	(44.4016)	(8.3508)	(−16.1595)	
Incumbent firm sample		0.7180***	0.7248***	0.0971***	−0.0336	0.8726
		(214.8025)	(150.5817)	(11.6855)	(−17.8792)	
Total firm sample	Inside of HP-DZ versus 7–10 km buffer ring of HP-DZ	0.7826***	0.7925***	0.0576**	−0.1037	0.9533
		(4.5897)	(14.8666)	(2.2879)	(−7.2400)	
New entrant firm sample		0.7551***	0.8046***	0.0496***	−0.1111	0.9491
		(7.0319)	(5.5213)	(6.3558)	(−0.7007)	
Incumbent firm sample		0.7351***	0.7683***	0.0423**	−0.0977	0.9517
		(61.0081)	(66.7997)	(3.0417)	(−4.8342)	
Total firm sample	Inside of LP-DZ versus 7–10 km buffer ring of LP-DZ	0.7429***	0.7846***	0.0655**	−0.0761	0.9505
		(6.5605)	(21.0850)	(3.4060)	(−22.4456)	
New entrant firm sample		0.7353***	0.7921***	0.0680***	−0.1261	0.9493
		(59.4590)	(28.3042)	(33.1997)	(−16.7587)	
Incumbent firm sample		0.7492***	0.7335***	0.0672***	−0.0729	0.9203
		(77.6294)	(83.0918)	(4.5985)	(−4.9876)	

Note: Statistical significance is denoted as follows: ***$p < 0.01$, **$p < 0.05$, and *$p < 0.10$; A and S are significantly different from 0 at 1%–5%; D are significantly different from 1 at 1%.

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leasing system, the establishment of national DZs has led to a significant increase in industrial land lease prices. This finding remains highly robust across alternative specifications of treatment and control groups. The land lease price-boosting effect is stronger for land transferred to industries with lower land dependence, and for DZs whose leading industries are aligned with the key industries designated by the central and provincial governments. The effect is also more pronounced for mature DZs, industry-dominated DZs, and DZs located in large cities and cities with higher administrative levels. (2) Through the implementation of policy incentives such as tax breaks, DZs induce greater firm entry through agglomeration rents and elevate local market potential, which in turn drives up land lease prices. (3) DZ policies exert a significant spatial spillover effect on surrounding land lease prices, with an effective spillover range of 0–4 km from DZ boundaries. (4) The rise in land lease prices within DZs generates a significant productivity premium effect. For new entrant firms, this effect manifests primarily as a stronger selection effect, while incumbent firms mainly benefit from the agglomeration effect.

6.2 | Discussions

China's DZ model provides replicable and scalable empirical evidence for the design of place-based policies in economies at different stages of development worldwide. Place-based policies such as the French Urban Free Zones (Zones Franches Urbaines, ZFUs) and the Federal Empowerment Zones in the United States have mostly resulted in only the spatial relocation of economic activities within a narrow geographic scope, rather than net job creation and productivity growth, due to the lack of screening mechanisms for high-productivity firms (Neumark and Simpson 2015). Our findings demonstrate that attracting high-value-added, high-productivity firms through competitive land pricing delivers two core complementary benefits. On the one hand, this market-based screening mechanism elevates the aggregate productivity of intra-zone firms through the selection effect. On the other hand, it enables DZs to foster specialized industrial agglomeration, allowing even low-productivity incumbent firms to capture agglomeration spillovers and realize sustained efficiency gains. This dual mechanism generates a sustainable productivity premium, while mitigating the misallocation of policy resources toward rent-seeking behavior and underperforming firms. In turn, it provides a viable, evidence-based solution for other economies seeking to narrow regional development disparities and advance their reindustrialization objectives.

The main policy optimization recommendations proposed in this paper are as follows: First, DZ policies should uphold and strengthen the decisive role of the market mechanism in land resource allocation. It is necessary to continuously optimize the transparent and competitive land pricing mechanism, fully leverage the screening and allocation functions of land lease prices, promote the reallocation of land resources toward high-productivity and high-innovation firms, and amplify the positive productivity spillover effects of agglomeration economies.

Second, DZs should continue to serve as a core policy instrument for guiding industrial agglomeration and promoting coordinated regional development, with differentiated policy designs tailored to the development stage, type, and industrial characteristics of each DZ. Differentiated land management and industrial support policies should be implemented for industry-led DZs and industry-city integrated DZs, as well as for industries with varying degrees of land dependence.

Third, policymakers should improve the dynamic selection mechanism for firms within DZs, and fully unlock agglomeration effects and ensure the long-term sustainability of policy outcomes. We recommend establishing a full-life-cycle supervision system that links the supply, transfer, and withdrawal of industrial land to firms' production efficiency, phasing out low-productivity firms in a timely manner, maintaining a high-quality industrial ecosystem within DZs, and avoiding the zero-sum spatial relocation of economic activities that is widely observed in enterprise zone policies globally. In the long run, this institutional design will strengthen the positive productivity premiums of DZ policies on both incumbent and new entrant firms, and drive sustained high-quality economic development through the scientific design of place-based policies.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Endnotes

[1] Data source: https://www.landchina.com.

[2] Data source: https://www.gov.cn/zhengce/zhengceku/2019-10/14/content_5439616.htm.

[3] As of 2018, 382 national DZs have been approved, totaling 847 blocks, of which nine blocks cannot be accurately defined by the description of the boundaries, and the final sample is 380 development zones and 838 blocks.

[4] Data on land-related taxes are from the World Bank's 2005 Business Investment and Environment Survey.

[5] For a detailed derivation, see Combes et al. (2012).

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Appendix A

Table A1

TABLE A1 | Summary statistics of key variables.

Variable		Number of samples	Mean	Standard deviation (SD)	Min.	Max.
Variables of land	*lpri*	18,496	5.1988	0.7079	1.7665	6.8412
	lagr	18,521	0.2026	0.4019	0.0000	1.0000
	lare	18,521	3.7278	6.0565	0.0150	50.0000
	lgra	16,953	5.2767	3.1547	1.0000	18.0000
Variables of firm	*tfp*	32,884	2.8694	0.8611	1.4276	6.1654
	l.fman	48,343	0.0723	0.0722	0.0003	0.4905
	l.flev	48,344	0.6036	0.4465	0.0128	4.9351
	l.hitech	82,853	0.1351	0.3418	0.0000	1.0000
Variables of DZ	*firmn*	6349	47.6245	80.7356	1.0000	1066.0000
	l.man	4739	0.0672	0.0498	0.0004	0.7866
	l.hir	4739	0.1542	0.2426	0.0000	1.0000
	l.lev	4739	0.8264	1.4036	0.0082	19.2498

Note: All firm-level and land-level variables are winsorized at the 0.5th and 99.5th percentiles.

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