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LAND MARKETIZATION, SECONDARY LAND MARKET, AND EFFECTS ON INDUSTRIAL LAND PRICE

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Abstract. Land marketization and its effects are widely documented across developing countries. Few studies, however, have investigated the link between industrial land price determination and industrial land market reform, based on the establishment of a pilot open trading platform for the secondary market. Moreover, no studies have specifically examined the link between primary and secondary industrial land markets. This study, therefore, investigates industrial land price determination using a quasi-natural experiment to interpret distortions in industrial land prices in China. Using industrial land sales data for 2006–2017 in the city of Haining, Zhejiang Province, China, this study compares industrial land value in the secondary market with land transfer prices in the primary market and identify undervaluation in the primary market. The results show that the growth rate of industrial land transfer prices increased every year after the open trading platform was established. Moreover, compared with nonpilot districts and counties, industrial land prices in the pilot city (Haining) increased by 11.14% from 2015 to 2017. The findings suggest that, based on the pilot program, further market reforms should be undertaken by establishing open trading platforms in a broader area.

Keywords: land marketization, land-use policy, land-use regulation, spatial planning, industrial land price, secondary land market.

Introduction

Land marketization is an important and widely discussed topic among researchers (Haila, 2015; Christophers, 2016; Kenney-Lazar, 2021) and policymakers. Traditionally, researchers have focused on property rights and their influence on economic performance and individual welfare. Insufficient property rights and impediments to land transactions hinder economic growth in many developing countries. In China, urban land market reform was launched in 1987, in which land-use rights were separated from state ownership, making land-use rights a commodity that could be purchased through negotiation, auction, or tender (Huang et al., 2015).

In China, compared with the marketization of residential land, industrial land has been regarded as a growth-oriented development tool that local governments use to competitively attract investment (Wu, 2007; Zhang et al., 2017; Tu et al., 2021). This has resulted in low industrial land prices and inefficient land use. However, the effect of the industrial land supply on China's gross domestic product (GDP) has been reduced since 2010 (Liu, 2017). Therefore, the government has introduced various land market reforms to transform the traditional industrial land-use model into a new one based on more intensive land usage (Tu et al., 2014). In 2006, for example, the State Council issued an ordinance enforcing the minimum industrial transfer price. In most cases, however, because of a bundle of exclusive bidding conditions, only one enterprise applies for the land. As a result, the final transfer price is almost equal to the price set by local authorities. Accordingly, the primary industrial market is not competitive, and there are significant price gaps between the primary and informal secondary markets.

In September 2013, the government of Zhejiang Province approved a "Market-Oriented Pilot Program" in Haining, a county-level city under the jurisdiction of the prefecture-level city of Jiaxing. In this way, Zhejiang took the lead in market reform by establishing an open

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trading platform for industrial firms to retransfer land on the secondary market. This open trading platform allows for observing the market factors and shadow prices of industrial land. The trading platform was initiated at the end of 2014, and by December 2017, 223 secondary market land transactions had been finalized. During that time, the average price of land sold through the platform was 1302 yuan/m^2, roughly twice that of industrial land transferred through the primary market. The pilot reform has therefore had significant effects on the industrial land market. On the one hand, it allows us to observe whether and by how much previous land prices were undervalued, which may compel the government to adjust prices. On the other hand, because of the reform, industrial land will be better utilized through retransfer in the secondary market.

Researchers have investigated the mechanism of industrial land marketization in China from various perspectives. Such studies, however, mostly examine industrial land prices in the primary market and do not consider the link between the primary market and secondary market. Moreover, market reforms related to secondary market trading, and their effects on prices in the primary market, are rarely investigated.

This paper helps to strengthen the bridge between the literature on land marketization and also the land price studies that focus on the industrial sector. Taking advantage of Haining's establishment of an open trading platform as an exogenous shock to the local market, this study investigates the reform's effects on land transaction prices in the primary market. The causal identification is based on the difference-in-differences (DID) method, which is widely used in policy evaluation to overcome the disadvantages of traditional econometric models (Zheng et al., 2021). Using 2006–2017 data for industrial land plots, the study also estimates how the effects of industrial land prices vary based on firm heterogeneity.

This study's contributions are twofold. First, although many studies have highlighted price distortions in China related to industrial land marketization, no study has specifically examined the effect of an open secondary market on land prices in the primary market. The research suggests that the underlying influence of the secondary market needs to be considered, which has not been incorporated into research on the whole industrial land market. Second, this study advances the understanding of the formation of industrial land prices and the relationship between land-use regulations and industrial land prices (Gyourko et al., 2008; Tu et al., 2021).

The rest of this paper proceeds as follows. Section 1 reviews the literature and describes the institutional background. Then, a theoretical framework is proposed for how the secondary land market drives changes in industrial land prices, and a hypothesis is established to guide the empirical analysis. Section 2 describes the methods and data, while Section 3 and Section 4 reports and discusses the results. Finally, the last section concludes this paper.

1. Market reform and industrial land prices

1.1. Prior literature on land marketization and the determinants of industrial land prices

There is a long history of examining land marketization and its related effects in the land economics literature. Polanyi (2001, p. 497) notes that land, along with labor and money, is essential to the operation of self-regulating market economies. The role of the state in land commodification has been central to land marketization (Bradley, 2021). This includes the privatization of public land (Christophers, 2018), the deregulation of mortgage markets (Aalbers & Haila, 2018), and the separation of land-use rights from state landownership (Huang et al., 2015; Liu, 2017). The effects of land marketization have been investigated in many countries (e.g., China, Ethiopia, Malawi, and Zambia). Such effects include land allocation efficiency (Du et al., 2014; Chen, 2017; Chamberlain & Ricker-Gilbert, 2016), capital accumulation (Lin & Yi, 2011), economic growth (Cao et al., 2008; Feng et al., 2008; Huang et al., 2013), and the urban–rural income gap (Lin & Ho, 2005; Paik, 2014).

Other studies have explored the various determinants of industrial land prices. Partial equilibrium bid-rent models extend the site-related attributes reflected in the location-production paradigm of Moses (1958), in which equilibrium land rent must fully capitalize on location advantages in production, including site-related location characteristics and community-location attributes (Kowalski & Paraskevopoulos, 1990; Sivitanidou & Wheaton, 1995). In general, industrial land prices are influenced by location attributes, worker attributes, and agglomeration attributes. First, the effect of location attributes includes access to markets, raw materials, and productivity amenities (Erickson & Wasylenko, 1980; Wasylenko, 1980; Wheeler, 1981; Schmenner, 1982; Blackley, 1984, 1985; Kowalski & Paraskevopoulos, 1990; Asabere & Huffman, 1991; Atteberry & Rutherford, 1993; Fehribach et al., 1993; Sivitanidou & Sivitanides, 1995; Lockwood & Rutherford, 1996; Tu et al., 2021). Second, worker attributes, which factor variously in terms of labor cost and skill, play an essential role in industrial location and industrial rent differentials (Struyk & James, 1975; Erickson & Wasylenko, 1980; Wasylenko, 1980; Sivitanidou & Sivitanides, 1995). Finally, agglomeration is another factor that influences industrial firms' location. When firms are located together, it presents industrial agglomeration advantages and affects property value by achieving economic rent (Coe et al., 2004) and improving competitiveness (Tabuchi, 1986; Anderson & Gatignon, 2008).

Although class-monopoly rent theory is a helpful tool, land price and rent still need to be situated in specific contexts, such as taking into consideration to the role of the government. This study attempts to combine two streams of literature to understand the recent trend of establishing secondary markets in China and their influence on industrial land prices, including the determination of industrial

land price and the implementation of industrial land market reform by a local government in China.

1.2. Industrial land market reform in China

Compared with commercial and residential markets, China's industrial land market is not competitive. Before 2006, land prices were negotiated between the government and industrial enterprises. Because of the challenges posed by low-efficiency industrial parks and an overheating economy, the "Rules on the Assignment of State-Owned Land-Use Rights Using Bid Tendering, Auction, and Quotation" was amended in 2006. It specified that commercial-, tourism-, and profit-oriented land, as well as land with two or more competitors, needed to be transferred by way of bids, auctions, or listings.

Even after 2006, however, industrial land sales were not strictly market-oriented, and a competitive market had not been formed, thus diverging from the original intention of the reform. The strategy adopted by local governments in industrial land sales has been to "negotiate first and then list publicly," using exclusive conditions to ensure that interested enterprises obtain land (Figure 1). According to the local government's industrial orientation, it contacts a few firms to attract suitable industrial enterprises to invest in. Then, when the local government has targeted certain enterprises, it focuses on the actual situation of the enterprise to develop targeted land sale conditions, usually involving investment scale, subsector, land price level, annual profits, and taxes. Finally, a publicly exclusive bundle of conditions is established to ensure that the enterprise will eventually obtain land-use rights.

Thus, the three-stage model of industrial land leasing described above did not solve the problem of low-efficiency land utilization in China. The low-cost transfer price mechanism of industrial land encourages enterprises to acquire more land. Moreover, enterprises that do not invest in the industry might intend to acquire land in the primary market, creating distortion in the allocation of land resources (Tu et al., 2020).

Under this three-stage transfer model, industrial firms do not have the flexibility to retransfer land or the part of the land that is not fully utilized or is vacant. Local governments prohibit enterprises from transferring land-use rights on the secondary market. Since industrial land obtained on the primary market includes implicit government subsidies, if industrial firms either retreat from production or transfer parts of the land that are not utilized, land-use rights are repurchased by the government in case the firms might try to obtain profits from selling the land. In practice, however, an informal secondary land market still exists, despite the fact that local governments do not support transaction prices that are much higher than the prices in the primary market. For example, in 2013, industrial land's mean price in urban Hangzhou's primary market was about 450 yuan/m^2. However, according to an analysis of 59 cases of industrial land mortgage prices in the same year, while in the secondary market, the mean price was about 1350 yuan/m^2 (the evaluation prices for these 59 plots ranged from 495 yuan/m^2 to 3733 yuan/m^2), which is higher than the price in the primary market.

1.3. Pilot experiment establishing an open trading platform in Haining

To address the shortcomings described above, Zhejiang Province, which is known for supporting private enterprise development, implemented a reform in 2013 to promote the marketization of industrial land transfer. Specifically, the "Pilot Program for Promoting Market-Oriented Land Allocation in Haining" established a pilot project for the market-oriented allocation of resources (Yao Su Shi Chang). The platform deals with three main factors: land-use right trading, carbon emission trading, and energy use quota trading. Transactions of industrial land on the secondary market officially began in 2015. This reform provides a quasi-natural experiment that this study can use to test whether open trading platforms can promote the marketization of industrial land prices. If the results confirm such an effect, it will validate our hypothesized positive effects of public trading platforms on marketization. This will provide evidence for China to reform its industrial land transfer model by establishing open trading platforms (Figure 2).

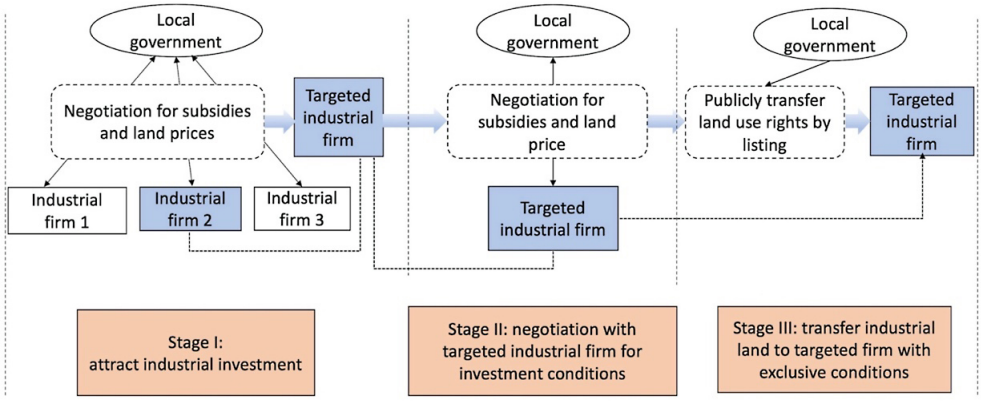


Figure 1. Industrial land transfer model

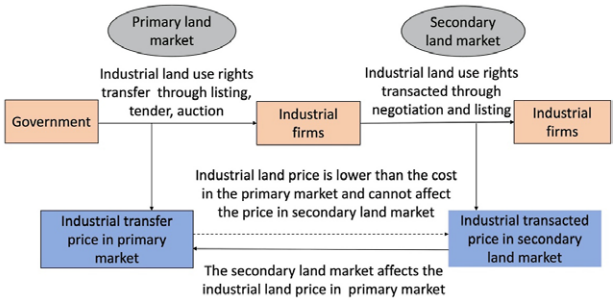


Figure 2. Relationship between the primary and secondary markets in industrial land transactions

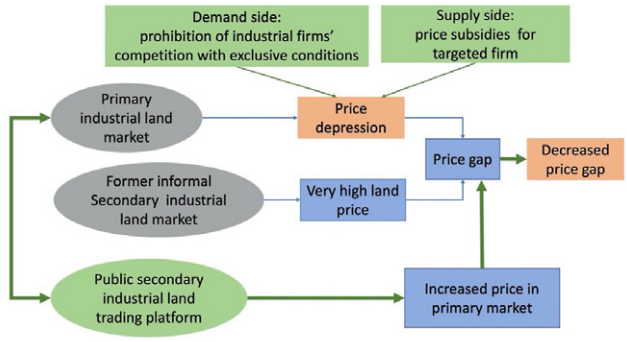


Figure 3. Theoretical framework

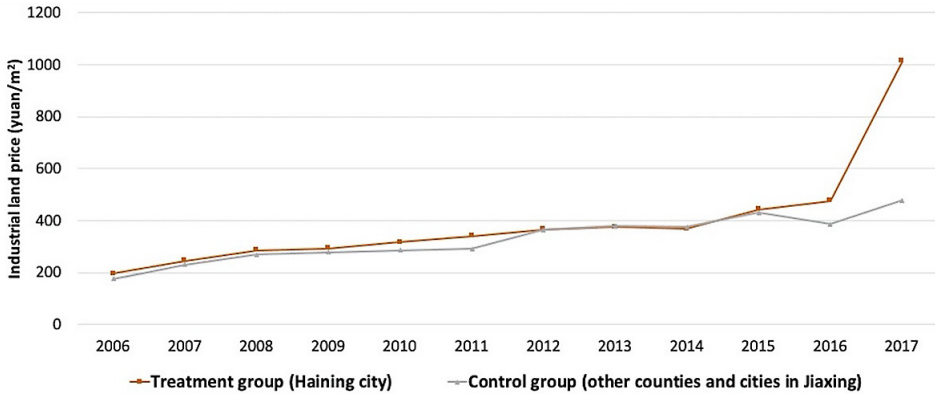


Figure 4. Parallel trends in the treatment and control groups

Given the mutual influence of the primary and secondary industrial land markets, the openness of the secondary market and the formalization of transactions might prompt the government to adjust industrial land pricing in the primary market according to market signals. This would reduce price distortions between the two markets (Figure 3). Using a DID model, the net effect of the open trading platform before and after its establishment is estimated based on the price difference in the control and treatment groups.

The research question concerns whether the reform establishing an open trading platform increased industrial land prices in Haining and whether there might be other reasons for the price changes. This study analyzes the effects using the DID method. The parallel trend test is essential when using DID. Specifically, the processing group and the control group must have the same trend of development before the reform. From 2006 to 2014, the average industrial land price in Haining and other areas in Jiaxing showed an upward trend. The average industrial land price in Haining was higher than that in other areas but with a small gap, generally in line with the parallel trend assumption (Figure 4).

2. Research area, data, and methods

2.1. Study area

Jiaxing is a prefecture-level city in Zhejiang Province, located in the central area of the Yangtze River Delta region in eastern China (Figure 5). Jiaxing has an administrative area of 4,230 km^2. It has two districts (Xiuzhou and Nanhu), three cities (Hanning, Tongxiang, and Pinghu), and two counties (Jiashan and Haiyan), with a population of 4.65 million at the end of 2017. The administrative area of Haining comprises 863 km^2, the per capita GDP is 118,213 yuan, and the resident population is 702,500 (Jiaxing Statistical Bureau, 2019). The GDP per capita in Jiaxing is 112,751 yuan (Jiaxing Statistical Bureau, 2019). All counties (cities and districts) under Jiaxing's jurisdiction are plain areas of river networks. The economic development level and geographic location advantages of the region's counties (cities and districts) are similar. Such similarities provide a reasonable basis for ensuring the reliability of the experimental results.

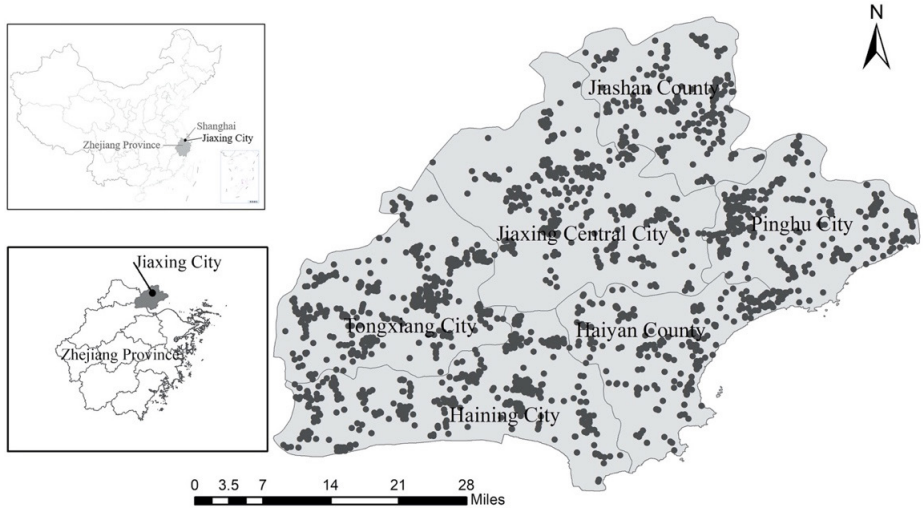


Figure 5. Location of the study area and distribution of industrial land transferred in the primary market

2.2. Data and variables

The explanatory variable is the unit price of industrial land in the primary market. Industrial land price transaction data are mainly obtained from the website of the Zhejiang Natural Resources Department, Jiaxing Natural Resources Bureau, and Haining Natural Resources Bureau. These include 4,665 industrial land parcels in the Jiaxing City Administrative Area for 2006–2017, 924 industrial land parcels in the Haining Administrative Area, and 223 industrial lots within the city of Haining sold on the secondary market. The specific locations of plot sample points are obtained using the Baidu Maps Open Platform. The vector maps at the county and township levels of Jiaxing come from the National Geographic Information Resource Directory (Figure 6).

Based on the literature (Ni et al., 2004; Gao et al., 2014; Tu et al., 2017), the explanatory variables are determined as location variables, plot feature variables, land regulatory feature variables, and demand attributes. Secondary industrial land parcel trading price variables are added to test whether the platform affects the primary land market (Table 1).

The geolocation characteristic variables include the following: (1) distance from the port (Harbor): the two largest deepwater ports in the Yangtze River Delta region are Ningbo Beilun Port (Harbor_beilun) and Shanghai Yangshan Port (Harbor_yangshan), and Zhapu Harbor in the city of Jiaxing, which is the deep harbor located in the Jiaxing area (Harbor_zhapu); (2) distance to airport: the nearest international airports from Jiaxing, Shanghai

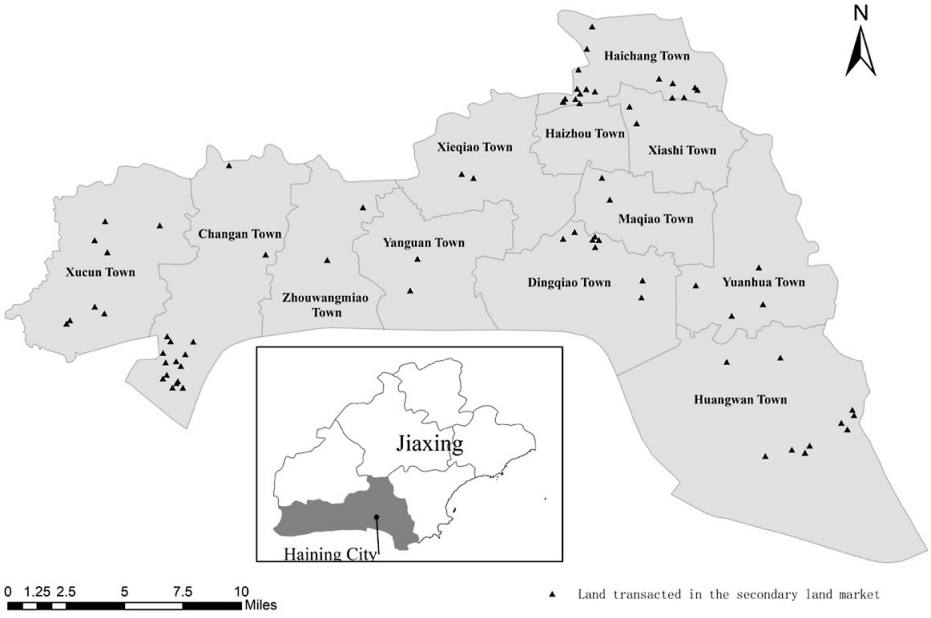


Figure 6. Distribution of industrial land plot transactions on the secondary market

Hongqiao Airport (Airport_hongqiao) and Hangzhou Xiaoshan (Airport_xiaoshan); (3) distance from train station: since there are a few train stations in the city, distance is set to the path distance from the nearest train station; (4) distance from nearest highway entrance (Highway); (5) distance of the plot from the administrative center of the county city (Government); and (6) zone level (Zoning). Development zones are divided into three categories: national development zones (Zoning_national), provincial development zones (Zoning_provincial), and others (Zoning_others).

Parcel characteristic variables include (1) plot area (Area) and (2) industrial enterprise industry category (Category). This factor has the potential to affect land prices since the intended industrial sector categories are established at the time of land listing. Based on the subindustry categories of the National Bureau of Statistics, 33 industry subcategories are classified into 10 industry categories by industry attribute, as follows: textile and garment industry (Category_textile), food manufacturing and processing industry (Category_food), furniture manufacturing and processing industry (Category_furniture), sporting goods manufacturing and recording media reproduction industry (Category_sports), chemical raw material processing and manufacturing (Category_chemicals), nonmetallic mineral products (Category_nonmetallic), metal smelting, processing and products (Category_metal), various types of equipment manufacturing (Category_equiptment), water and electricity production and supply (Category_utility), and other (Category_others).

In addition to the above geographic location and plot characteristic variables, factors affected by government policies are classified into land regulatory characteristic variables, including (1) annual supply of industrial land (Supply); (2) industrial land transfer mode (Transfer), including listing (Transfer_listing), auction (Transfer_bidding), negotiation (Transfer_negotiation), and tender (Transfer_tender); (3) floor area ratio (FAR); and (4) building density (Density). An auction requires the bidder to make an open bid at a specified time and place. Usually, the highest bidder wins land-use rights. The difference between a listing and an auction is that a listing usually lasts for a certain period (e.g., 10 days). By contrast, auctions occur on-site, and the time allotted to determine prices and make decisions is limited. Tender involves inviting specific organizations to bid, and the final land users are determined according to the tender conditions. In many cases, the final bidder is not the applicant with the highest bid. Finally, in terms of demand attributes, the number of industrial firms (Company) achieving the lands in one year are added as variables.

2.3. Difference-in-differences identification

This study aims to detect changes between industrial land prices in Haining and other parts of the Jiaxing area after the establishment of an open trading platform in Haining. A "quasi-experiment" (Angrist & Pischke, 2010) is conducted on land plots in Haining using DID to evaluate the effects of the platform. The DID estimator describes the difference between the change in outcomes before and after treatment takes effect between treatment and control groups. This study focuses on the end of 2014, when the open trading platform was established, for the time-division point for the pregroup before 2015 and the ex-

Table 1. Descriptive statistics of the variables

Variable		Unit	Mean	Standard deviation	Min.	Max.
Price		Yuan/m^2	322.48	217.97	16.28	4491.54
Location attributes	Zoning	/	1.25	0.49	1	3
	Harbor_beilun	km	164.89	17.04	127.90	203.20
	Harbor_yangshan	km	124.77	25.70	70.80	174.80
	Harbor_zhapu	km	44.51	19.58	0.30	85.00
	Airport_hongqiao	km	97.22	24.90	51.60	147.40
	Airport_xiaoshan	km	82.84	26.23	25.70	128.00
	Train	km	15.74	9.34	0.30	44.90
	Highway	km	9.03	4.80	0.10	23.90
	Government	km	13.98	8.44	0.22	67.10
Land plot attributes	Area	hm^2	1.89	2.81	0.01	65.48
	Category	/	5.51	3.22	1	10
Land-use regulation attributes	Supply	hm^2	1260.43	325.34	720.51	1743.76
	Transfer	/	1.44	0.83	1	4
	Floor Area Ratio (FAR)	/	1.35	0.71	0.00	3.50
	Density	/	47.59	11.96	0.00	80.00
Demand attributes	Company	Number	203.36	80.38	1	221

post group after 2015. All counties (cities and districts) under Jiaxing are divided into treatment and control groups. The treatment group is Haining, and other counties (cities, districts) act as control groups, which have no open trading platforms for secondary industrial land.

The DID model with two-way fixed effects can be expressed as follows:

$$\ln P_{it} = \alpha_0 + \alpha_1 G_i \cdot T_t + \alpha_2 X_{it} + \gamma_t + u_i + \varepsilon_{it}, \quad (1)$$

where: P_{it} is the explanatory variable, that is, the industrial land price of the primary market; α_0 is a constant; G_i is a dummy variable that represents whether the plot is located in Haining; T_t is a dummy variable representing the time of land transaction before and after the establishment of the platform; and the interaction term $G_i \times T_t$ is the DID estimator. The estimated coefficient of primary interest is α_1, which captures the effect of the secondary market on the industrial land market in Haining's primary market. X_{it} is a set of parcel-level and city-level control variables. γ_t is the city-fixed effect that controls the time-invariant characteristics in a particular city (e.g., natural endowment, location). u_i is the year-fixed effect, which controls the common trend of land prices at the national level. A fixed-effect model is used for time and individual differences to control the influence of other feature variables.

The hedonic model has been widely used in property research in recent years. However, this model does not take into account the spatial effects of property price (Tse, 2002). The error caused by spatial self-correlation can be overcome to some extent by introducing a spatial weight matrix. Equation (2) is the spatial model for estimating the effect of industrial land price in the secondary market on the price in the primary market:

$$P = \rho W_p P + X\beta + \xi; \quad \xi = \lambda W_\xi \xi + \varepsilon, \varepsilon \sim N\left(0, \sigma^2 \ln\right), \quad (2)$$

where: P is the industrial land transfer price in the primary market; W_p is the spatial weight matrix of land price; ρ represents the spatial correlation coefficient, which refers to the degree to which the price of an observed sample affects the price of other observed samples around it; X represents the factors that influence industrial land price; β is the coefficient of the various elements; ξ is the error term; W_ξ is the spatial weight matrix of error; λ is the spatial correlation coefficient of error; ε is the random perturbation item; σ is the variance of ε; and In is the unit matrix.

3. Results

3.1. Space-time distribution characteristics of industrial land prices after platform establishment

According to the sample plot statistics, the average transaction price in Haining's secondary market during 2015–2017 was RMB 1301/m^2, while the price in the primary market was RMB 658/m^2. The secondary land market transaction price increased by 97.72% compared with the transfer price in the primary market, indicating that the original industrial land market sales did not fully reflect market factors. Thus, there is a price depression in industrial land prices in the primary market (Figure 7).

The industrial land price in the city of Jiaxing is divided into five grades by the natural breakpoint grading method: low, low-medium, medium, medium-high, and high (Figure 8). Before establishing the open trading platform, Haining and Haixian County were in the medium-high region, Jiaxing was in the high-value area, Jiashan County was in the low-value area, Tongxiang was in the low-value area, and Pinghu was in the medium area. After establishing the platform, Haining changed from being a medium-high area to a high-value area. At the same time, other district and county levels remained unchanged, which shows that the trading platform increased industrial land transfer prices in Haining.

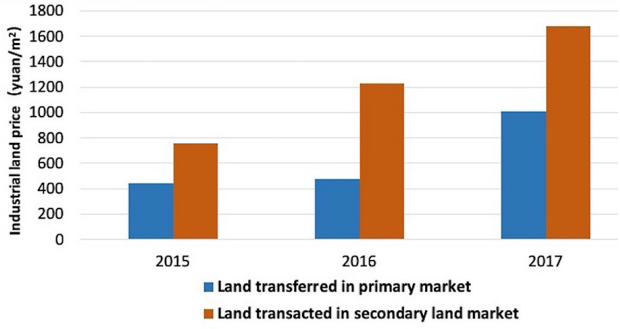


Figure 7. Comparison of industrial land prices in the primary and secondary markets

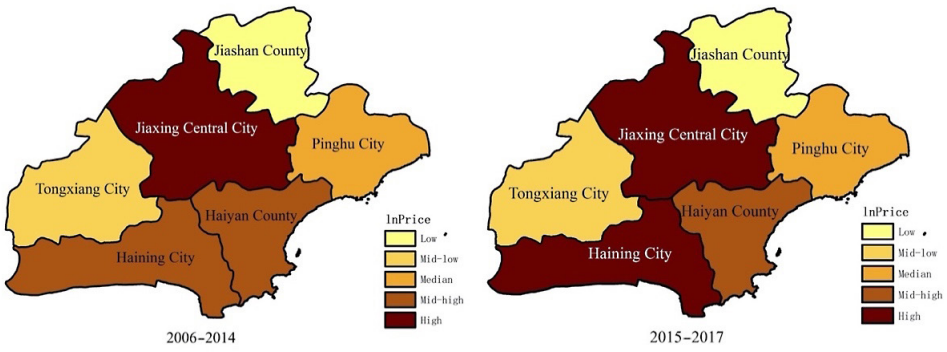


Figure 8. Spatial distribution of industrial land prices in Jiaxing's primary market before and after the pilot program

3.2. DID analysis results

Model 2 in Table 2 shows the results of DID analysis. The degree of interpretation is further increased from 0.508 in the Model 1 of Ordinary Least Square (OLS) to 0.663 in the DID model. The DID model's adjusted R^2 is larger and is a better fit than that of the OLS model. The DID variable is significant at the 5% level and is in the expected direction. This shows that after the platform was established in 2015, industrial land prices in the prime market increased significantly by 11.14% compared with the nonpilot districts and counties. Compared with the 17.66% increase in the industrial land prices of the secondary land market in the OLS model, the DID coefficient is the net effect established by the platform (Table 2).

Table 2. DID and PSM-DID results

Variable		Model 1 OLS	Model 2 DID	Model 3 PSM-DID
Treated		0.1766***		
		(0.018)		
DID			0.1114**	0.1167**
			(0.051)	(0.051)
Location attributes	Zoning_provincial	−0.0051	0.0110	0.0085
		(0.011)	(0.010)	(0.010)
	Zoning_national	0.1187***	0.0270	0.0291
		(0.025)	(0.027)	(0.027)
	lnHarbor_yangshan	−0.3844***	−0.2884***	−0.3257***
		(0.073)	(0.066)	(0.067)
	lnHarbor_zhapu	−0.0648***	0.0147	0.0237*
		(0.014)	(0.013)	(0.013)
	lnAirport_xiaoshan	−0.2892***	−0.2359***	−0.2430***
		(0.045)	(0.042)	(0.043)
	lnTrain	−0.0188**	−0.0166*	−0.0164*
		(0.010)	(0.009)	(0.009)
	lnHighway	−0.0411***	−0.0149**	−0.0145**
		(0.008)	(0.007)	(0.007)
	lnGovernment	−0.0867***	−0.0829***	−0.0839***
		(0.010)	(0.009)	(0.009)
Land plot attributes	lnArea	−0.0246***	−0.0308***	−0.0297***
		(0.005)	(0.004)	(0.004)
	Category_food	−0.0974***	−0.1438***	−0.1447***
		(0.031)	(0.025)	(0.026)
	Category_furniture	−0.1342***	−0.1175***	−0.1197***
		(0.025)	(0.019)	(0.020)
	Category_sports	−0.0342*	−0.0219	−0.0208
		(0.020)	(0.018)	(0.018)
	Category_chemicals	−0.0862***	−0.0996***	−0.0957***
		(0.018)	(0.014)	(0.014)
	Category_nonmetallic	−0.1399***	−0.1654***	−0.1734***
		(0.035)	(0.025)	(0.026)
	Category_metal	−0.1016***	−0.0983***	−0.0990***
		(0.017)	(0.015)	(0.015)
	Category_equiptment	−0.0677***	−0.1175***	−0.1157***
		(0.015)	(0.013)	(0.013)
	Category_utility	−0.0105	−0.1333**	−0.1309**
		(0.058)	(0.063)	(0.064)
	Category_others	−0.0053	−0.0685***	−0.0687***
		(0.018)	(0.016)	(0.016)

End of Table 2

Variable		Model 1 OLS	Model 2 DID	Model 3 PSM-DID
Land-use regulation attributes	lnSupply	0.1663***	−0.0082	−0.0062
		(0.018)	(0.020)	(0.021)
	Transfer_auction	0.4820***	0.5072***	0.5394***
		(0.079)	(0.093)	(0.094)
	Transfer_negotiation	−0.2805***	−0.0878***	−0.0867***
		(0.013)	(0.018)	(0.019)
	Transfer_tender	0.0124	0.0377	
		(0.101)	(0.081)	
	lnFAR	0.2667***	0.1156***	0.1138***
		(0.018)	(0.020)	(0.020)
	lnDensity	0.0845***	−0.0100	−0.0089
		(0.010)	(0.009)	(0.009)
Demand attributes	Company	−0.0039***	−0.0003	−0.0004*
		(0.000)	(0.000)	(0.000)
Constant		8.5572***	8.4214***	8.2669***
		(0.508)	(0.475)	(0.475)
Time fixed effect		Y	Y	Y
Individual fixation effect		Y	Y	Y
Observations		4665	4665	4610
R^2		0.508	0.663	0.663
Adj R^2		0.506	0.659	0.660
F-Stat		218.41***	240.18***	235.87***

Notes: ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.

Industrial land is sensitive to distance to deepwater ports, highway access, airports, and railway stations, with port distance being the most important. From Jiaxing's geographic location, the effect of Shanghai Yangshan Port is the greatest; with every 1% increase in distance from the port, land prices fall by 38.44%. Airports in Zhejiang Province also have a great effect. Closer to Hangzhou Xiaoshan Airport, it can be noted in Model 2 that the price increase is 23.59%. The closer to the nearest highway, train station, or seat of local government, the higher the price of industrial land.

From the characteristics of the land plot, the area of industrial land and the price of industrial land are inversely related, but the degree of influence is less than that of geographic location characteristics. The analysis in Model 2 shows that the effect is only about 3.08%; this is because the land characteristics and output of industrial enterprises are very different among various industry subsectors. Industry categories have significant heterogeneous effects on the differences in industrial land prices.

Among the land regulation factors, mode of transfer and FAR have stable and significant effects on industrial land prices in Model 2. Compared with the listing transfer mode, the industrial land price in the auction approach is 50.72% higher in Model 2, but if the method of negotiation is reversed, it is 8.78% lower. Therefore, according to the level of marketization, the auction method is the highest among transfer modes, followed by tendering and listing, and the lowest mode is negotiation. For FAR and lot coverage, the increase in FAR has a greater effect on land price increase.

In the category variable, the textile and garment industry is the base group, and the development zone level is based on the region located outside the national and provincial development zones. In the transfer variable, the listing transfer mode is the base group.

To address data-selection bias, propensity score matching (PSM) is used to construct an artificial control group by matching each treated unit with a nontreated unit with similar characteristics. This method mainly uses the nuclear matching method to test the tendency score. The covariances used for matching are plot characteristics (area, FAR, zoning, highway), geographic location characteristics (highways), and government regulatory features (development zone level). The matching passes the balance test and the comprehensive test of all variables. In this study, the standard deviation of control variables after matching the treatment group and the control group is controlled to less than 10%. This indicates that there is no significant difference between the control variables of the matching posttreatment group and the control group (Figure 9). The common support domains for the treatment groups and the control group samples are basically the same, meaning the common support assumptions and matching effect

are good (Figure 10). The matching sample estimates are basically consistent with the previous DID analysis and indicate the robustness of our conclusions (Table 3). The PSM-DID indicator (DID) is significant at 5% and has an increased effect on industrial land prices compared to the DID regression.

To further verify that all effects are caused by the establishment of the platform, the policy before the implementation year is selected for further analysis. The reform took actual effect around 2015; assuming the policy implementation year is 2013 or 2014, if the DID is still significant, the original results are problematic. Empirical analysis shows that DID is not significant, regardless of whether the policy node is assumed to be at about 2013 or about 2014, indicating that it passes the placebo test (Table 3).

In the category variable, the textile and garment industry is the base group, and the development zone level is based on the region located outside the national and provincial development zones. In the transfer variable, the listing transfer mode is the base group.

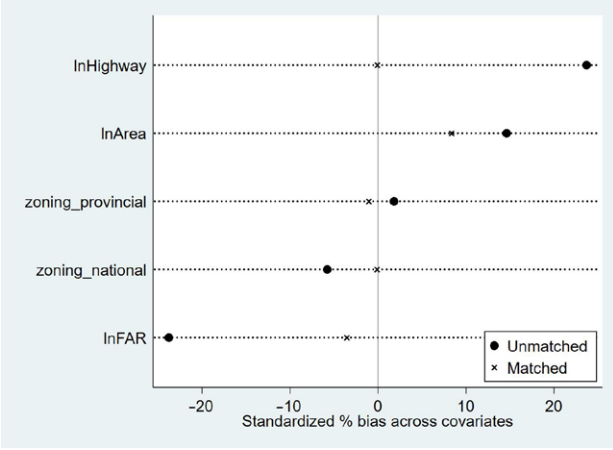


Figure 9. Standard deviation of control variables

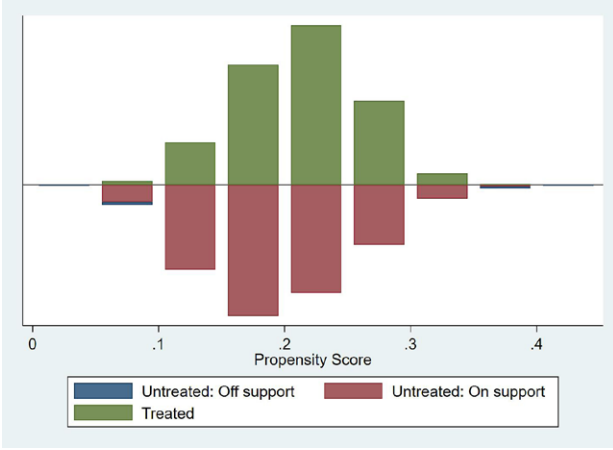


Figure 10. Match conditions

Table 3. Robustness test of the DID model

Variable		Assume that the policy node is 2013				Assume that the policy node is 2014			
		Coef.	Std. Err.	*t*	*P* > *t*	Coef.	Std. Err.	*t*	*P* > *t*
DID		0.034	0.037	0.900	0.368	0.064	0.042	1.550	0.122
Location attributes	Zoning_provincial	0.008	0.010	0.840	0.401	0.009	0.010	0.880	0.378
	Zoning_national	0.022	0.027	0.850	0.397	0.023	0.027	0.880	0.381
	lnHarbor_zhapu	−0.326***	0.066	−4.910	0.000	−0.322***	0.066	−4.860	0.000
	lnHarbor_yangshan	0.020	0.013	1.620	0.106	0.020	0.013	1.580	0.114
	lnAirport_xiaoshan	−0.242***	0.043	−5.630	0.000	−0.238***	0.042	−5.610	0.000
	lnTrain	−0.018**	0.008	−2.150	0.032	−0.018	0.008	−2.110	0.035
	lnHighway	−0.016**	0.007	−2.330	0.020	−0.016**	0.007	−2.300	0.021
	lnGovernment	−0.083***	0.009	−9.210	0.000	−0.082***	0.009	−9.180	0.000
Land plot attributes	lnArea	−0.028***	0.004	−6.930	0.000	−0.028***	0.004	−6.910	0.000
	lnFAR	0.099***	0.019	5.140	0.000	0.102***	0.020	5.190	0.000
	lnDensity	−0.011	0.009	−1.200	0.229	−0.010	0.009	−1.170	0.241
	Category_food	−0.142***	0.025	−5.610	0.000	−0.142***	0.025	−5.610	0.000
	Category_furniture	−0.119***	0.019	−6.270	0.000	−0.119***	0.019	−6.250	0.000
	Category_sports	−0.023	0.018	−1.300	0.195	−0.023	0.018	−1.300	0.193
	Category_chemicals	−0.097***	0.014	−6.820	0.000	−0.097***	0.014	−6.790	0.000
	Category_nonmetallic	−0.169***	0.025	−6.730	0.000	−0.169***	0.025	−6.720	0.000
	Category_metal	−0.101***	0.015	−6.860	0.000	−0.101***	0.015	−6.870	0.000
	Category_equiptment	−0.119***	0.013	−9.060	0.000	−0.119***	0.013	−9.050	0.000
	Category_utility	−0.135**	0.061	−2.220	0.027	−0.137**	0.062	−2.230	0.026
	Category_others	−0.071***	0.016	−4.490	0.000	−0.071***	0.016	−4.490	0.000

End of Table 3

Variable		Assume that the policy node is 2013				Assume that the policy node is 2014			
		Coef.	Std. Err.	*t*	*P* > *t*	Coef.	Std. Err.	*t*	*P* > *t*
Land use regulation attributes	lnSupply	0.001	0.019	0.070	0.943	−0.002	0.020	−0.090	0.929
	Transfer_auction	0.509***	0.093	5.440	0.000	0.509***	0.093	5.450	0.000
	Transfer_negotiation	−0.088***	0.018	−4.820	0.000	−0.089***	0.018	−4.860	0.000
	Transfer_tender	0.036	0.081	0.440	0.658	0.036	0.081	0.450	0.654
Demand attributes	Company	0.000*	0.000	−1.740	0.081	0.000*	0.000	−1.650	0.099
Time fixed		Y				Y			
Individual fixed		Y				Y			
CONSTANT		8.417	0.478	17.60	0.000	8.398	0.475	17.660	0.000
Test		Stat	Prob			Stat	Prob		
R^2		0.661				0.662			
Adj R^2		0.658				0.659			
F-Stat		243.114***	0.000			240.464***	0.000		

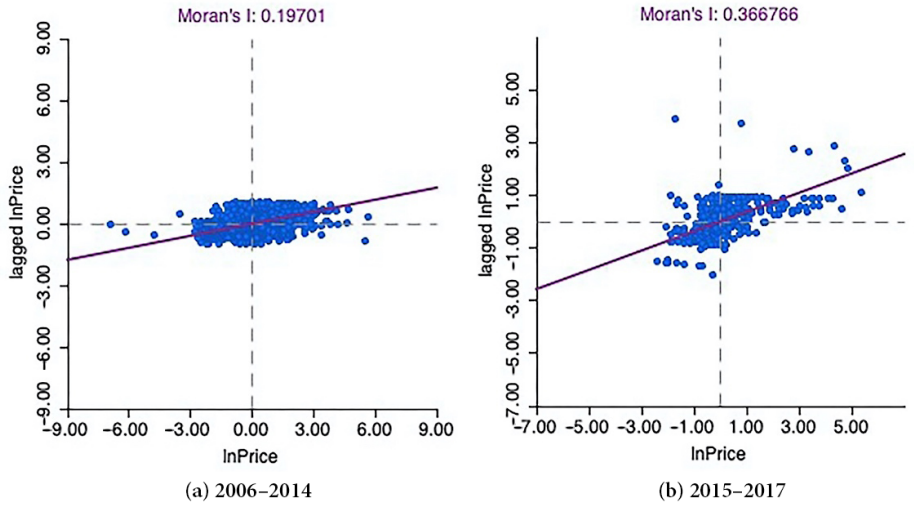
Notes: ***, **, and * indicate 1%, 5%, and 10% levels of significance, respectively.

3.3. Spatial effect of open trading platform

Before the establishment of the open trading platform, although there were informal secondary market transactions, dissemination of this information had a small range and nonpublic characteristics. With formal establishment of a secondary market for industrial land, transfer information could be expanded and transaction information disseminated, thus influencing other transactions. It can be assumed, therefore, that there is price transmission from the secondary land market to the primary market, mainly through information about land prices and the number of plots traded on the platform.

GeoDa software is used to detect the global spatial correlation of industrial land prices in Jiaxing during 2006–2014 and 2015–2017. Global Moran's *I* is used to evaluate whether the industrial land prices are clustered, dispersed, or random. Moran's *I* and the Z-value are both larger than 0 during 2006–2014 and 2015–2017, and *p*-value passes the significance test. This confirms that there is a spatial correlation and spatial clustering of industrial land prices in Jiaxing before and after the implementation of the platform. The Moran's *I* value for 2015–2017 is higher than that for 2006–2014 (Figure 11). This shows that after the establishment of the open trading platform, the global spatial correlation of industrial land prices was greater, and the spatial clustering effect was stronger.

In the presence of spatial autocorrelation, estimation and prediction using spatial models that extend the hedonic model to include the lag variable and/or the error term are more accurate and robust than is the case with OLS (Dubin, 2003). This study uses two indicators of the secondary industrial land market–number of transactions (SMQ) and transaction price (SMP)–to analyze the effect



(a) 2006–2014 (b) 2015–2017

Figure 11. Local indicators of spatial association (LISA) scatterplots before and after the secondary market pilot

Table 4. Comparison of SLM, SEM, and OLS models (5–10 km)

Variable	SLM				SEM				OLS			
	Coef.	Std. Err.	*t*	*P* > *t*	Coef.	Std. Err.	*t*	*P* > *t*	Coef.	Std. Err.	*t*	*P* > *t*
ρ/λ	0.247**	0.113	2.180	0.029	0.215*	0.126	1.705	0.088				
CONSTANT	−9.003	5.945	−1.514	0.130	−13.539**	6.601	−2.051	0.040	−12.321**	5.912	−2.084	0.038
lnDensity	−1.370**	0.550	−2.492	0.013	−1.405**	0.555	−2.531	0.011	−1.362**	0.581	−2.344	0.020
lnHarbor	−0.061	0.400	−0.153	0.879	−0.028	0.493	−0.057	0.954	−0.058	0.422	−0.136	0.892
lnAirport	4.281***	1.421	3.012	0.003	5.643***	1.563	3.611	0.000	5.298***	1.364	3.884	0.000
lnGovernment	−0.284*	0.149	−1.908	0.056	−0.421***	0.159	−2.640	0.008	−0.361**	0.146	−2.472	0.014
lnArea	−0.072**	0.037	−1.972	0.049	−0.079**	0.038	−2.093	0.036	−0.069*	0.039	−1.780	0.077
Category_food	−0.387**	0.184	−2.106	0.035	−0.360*	0.187	−1.921	0.055	−0.464**	0.194	−2.390	0.018
Category_furniture	−0.066	0.244	−0.271	0.787	−0.073	0.246	−0.296	0.767	−0.035	0.258	−0.136	0.892
Category_sports	−0.230	0.215	−1.070	0.285	−0.199	0.217	−0.915	0.360	−0.280	0.228	−1.231	0.220
Category_chemicals	−0.230*	0.127	−1.804	0.071	−0.224*	0.129	−1.731	0.083	−0.283**	0.134	−2.102	0.037
Category_ nonmetallic	−0.020	0.333	−0.061	0.952	−0.026	0.334	−0.077	0.939	−0.049	0.352	−0.138	0.891
Category_metal	−0.204	0.199	−1.027	0.304	−0.187	0.198	−0.946	0.344	−0.180	0.210	−0.856	0.393
Category_ equiptment	−0.080	0.098	−0.814	0.416	−0.061	0.101	−0.608	0.543	−0.125	0.104	−1.201	0.231
Category_utility	−0.424*	0.256	−1.656	0.098	−0.401	0.276	−1.453	0.146	−0.461*	0.271	−1.702	0.090
Category_others	−0.324***	0.081	−3.986	0.000	−0.314***	0.082	−3.838	0.000	−0.351***	0.086	−4.092	0.000
lnSMQ5-10	0.182**	0.073	2.492	0.013	0.209**	0.082	2.538	0.011	0.225***	0.074	3.015	0.003
lnSMP5-10	−0.105	0.126	−0.835	0.404	−0.129	0.150	−0.862	0.389	−0.099	0.132	−0.748	0.455
R^2	0.345				0.336				0.324			
Log likelihood (LogL)	−142.095				−143.489				−144.940			
Akaike information criterion (AIC)	320.189				320.977				323.880			
Schwartz criterion (SC)	381.518				378.899				381.802			

on industrial land prices in the primary market 0–5 km and 5–10 km from land plots in the secondary market.

Lagrange multiplier (LM) is conducted to test spatial dependence and spatial error autocorrelation, and likelihood ratio (LR) to test parameter restrictions. A lower value of the Akaike information criterion (AIC) indicates an improvement in the goodness of fit of the spatial specification with respect to the nonspatial one. Comparing the estimates of the spatial lag model (SLM), spatial error model (SEM), and OLS, the results show that the log likelihood (LogL) of SLM and SEM is larger than that for OLS, and the AIC and the Schwartz criterion (SC) are smaller than that for OLS, which validates the rationality of using the spatial econometric model. SLM is more appropriate when judging using the LM (LM_{lag} and LM_{error}) and its robustness (R-LM_{lag} and R-LM_{error}).

The SLM estimates show that the spatial coefficient of ρ is positive and significant at 5%. The number of land plots traded in the secondary market within 5–10 km has a spillover effect on the prime market. Every 1% increase in the number of industrial land parcels in the secondary market results in an increase of 18.2% in industrial land transfer price in the primary market (Table 4), while the effect of the transaction price of industrial land parcels in the secondary market is not significant.

4. Discussion

Analyzing the impact of the open trading platform and factors that influence industrial land prices over a longer period can help improve the understanding of the mechanism behind land prices. As shown in the previous section, the operating mechanism behind industrial land transfer after establishment of the open trading platform is the optimized transfer model, which is reflected in the results of the DID model.

1. Reducing government intervention through restricted policies in the land market

The competition in the primary market should be open and non-preferential for particular firms. China's industrial land market has strong government regulation

characteristics. China uses low-cost land in local government competition, but this price subsidy used for industrial enterprises to obtain land is selective and preferential, which leads to low-efficiency industrial land use (Lu & Wang, 2020; Park & Kim, 2022) and price dispersion in the primary and secondary markets, reflecting distortions in land market efficiency. Early studies by Wilson (1986), and Turnbull and Niho (1986) assume a single uniform tax rate on all types of property (residential and non-residential) (Mitra & Webster, 2008). The Wolkoff model chooses the effectiveness of policy subsidies as the research perspective, noting that because the government and enterprises have asymmetrical information, the preferred strategy is for the government to provide moderate subsidies to all enterprises (Wolkoff, 1992). Thus, a policy that promotes open participation and equal opportunities for firms is essential for market efficiency.

2. Open trading platform will help form reasonable trading price

The price in the primary market should be decided by the market itself, not the government. There are debates in China about reasonable industrial land prices when the government transfer land to industrial firms. Although most previous studies agree that there is low industrial land pricing because of intense competition among local governments, some scholars support the opposing view that increasing industrial land price will increase the cost of firms. Unlike many countries where land is privately owned and the market determines prices, China has been trying to determine reasonable prices for industrial land transfer under a government-led supply model (Xu et al., 2017). This study justified that establishing the secondary industrial market will be a practical approach for observing the more reasonable price scope for reference.

3. Establishment of an open trading platform will help optimal allocation of resources

The withdrawal of inefficient construction land from the stock of the development zone is an important way to improve intensive utilization of land. Imperfect market mechanisms prohibited enterprises' withdrawal of industrial land. Improper intervention by local government makes industrial land a seller's market, and the listing, tendering, and negotiation price of industrial land is often lower than the fully competitive market price (Ren et al., 2016). Establishing a secondary market trading platform would change the way enterprises obtain land only through government transfer. Its advantages are promoting the use of undeveloped land and helping enterprises capture the real value of land after the enterprise withdraws from production.

Conclusions

This study investigates the effect of establishing an open trading platform for the secondary market on industrial land prices in the primary market. Using industrial land sales data for 2006–2017 in the city of Haining, Zhejiang Province, China, the research compares the industrial land value in the secondary market with land transfer prices in the primary market and identifies undervaluation in the primary market. Moreover, compared with nonpilot districts and counties, industrial land prices in the pilot city (Haining) increased by 11.14% from 2015 to 2017. The quasi-natural experiment validates the depression of industrial land prices in the primary market and the marketization of prices promoted by establishing an open platform.

The policy implication of this paper is that the government can promote marketization of industrial land prices by establishing an open trading platform for secondary industrial land transaction. The trading platform will promote the price of secondary land being adjusted according to market supply and demand. This can not only play a reference role in establishing the market price at the primary market but can also help form a closed loop of industrial land transfer, retransfer, and withdrawal (Lou et al., 2021) and promote the market-oriented allocation of land resources (Lu, 2015; Zeng, 2017; Zhang, 2018). Not only the free entry of the industrial land market is essential for land marketization, but also free retreat and re-transfer of land-use rights is the critical element for the mature land market. The land-use rights are complete on the condition that their value is decided by the market and can be captured if the factories are closed, purchased, or assigned claim.

This study is not free from limitations, as it is focused explicitly on developed areas in eastern China that may differ from middle and the western regions. Additionally, in this case, the data after the reform cover three years from 2015 to 2017, and subsequent years observed and analyzed might have more in-depth analysis. For future research, more experiences regarding different policies promoting industrial land marketization would enrich the literature.

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Author contributions

Fan TU conceived the study and were responsible for the design framework, methodology and the first draft of the article; Fan TU, Shuangling ZOU, Siwen HU and Sinan ZHANG were responsible for the development of the data analysis and data interpretation. Shuangling ZOU and Siwen HU were responsible for data collection and visualization.

Disclosure statement

Authors do not have any competing financial, professional, or personal interests from other parties.

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