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Industry's going upstairs: The innovative usage of industrial land and evaluation of its economic effects

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ABSTRACT

The concept of 'Industry's Going Upstairs (IGU)' represents an innovative usage of industrial land that transfers the enterprises' production to high-rise industrial buildings. It is emerging in the developed areas of eastern China. This study discusses IGU policies to promote local economic development and conducts an empirical test using Guangdong city-level data and a difference-in-differences model. Theoretical analysis shows that IGU can broaden the development space of enterprises and realise industrial and labour agglomeration under supporting policies provided by local governments. The empirical results demonstrate that IGU can improve land-use efficiency and promote local industrial development. IGU is a feasible approach for addressing the current shortage of industrial land in China and is worthy of promotion and replication in other regions.

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1. Introduction

Since its reform and opening-up, China has been rapidly advancing in terms of industrialisation. Under the long-term extensive land-use mode, industrial land expansion and inefficient use coexist. With the continuous improvement in China's aggregate economic activity, the price of urban real estate continues to rise, and the number of enterprises is increasing (Chen & Wang, 2021; Xu et al., 2021). Specifically, in economically advanced cities, industrial land is becoming increasingly scarce as land costs increase. Owing to the vigorous development of the service industry in urban areas, the space utilised by the manufacturing industry is constantly being squeezed, and old industrial areas require renewal and restructuring. As the contradiction between land supply and demand becomes more prominent, the incremental land-for-development approach is becoming difficult to sustain (Wu et al., 2015). In the Pearl and Yangtze River Deltas, many industries and enterprises move from first-tier cities to neighbouring cities or remote areas in the central and western regions to seek development space and reduce land-use costs. Another direction of

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industrial transfer is to Southeast Asian countries with low labour and land costs (Diaconu, 2014). As talent and capital are concentrated in the Pearl River Delta, Yangtze River Delta, and other economically developed regions, industrial transfer is primarily conducted between nuclear and peripheral cities, and peripheral cities face the same problem of insufficient industrial land as central cities face (Liu et al., 2018).

In response to the shortage of industrial land and rising land prices, in recent years, a new mode of industrial land use, 'Industry's Going Upstairs (IGU)', has gradually emerged in developed cities along the eastern coast of China, particularly in the Pearl River Delta. IGU differs from the traditional mode of production in single-story factories. This represents a new industrial building mode of enterprise production, offices, R&D, and design all located in high-rise buildings. It also differs from the traditional multi-story industrial buildings used in China since the 1990s. Traditionally, a multi-story building with more than two stories (that has stairs, elevators, and lifting facilities) meant that industrial activities were carried out in buildings. The IGU concept, advocated by some cities in China, usually refers to industrial production and operation in high-rise factories (or high-rise industrial buildings) with a height of more than 24 m or level of more than six floors. The main advantage of this concept, which has been promoted by local authorities in China, is that it can greatly improve the utilisation efficiency of industrial land and include more industries and enterprises for city development.

After the implementation of IGU in Dongguan in 2019, 47 district leaders from 18 provinces visited the city to learn about this mode. Similar to the Pearl River Delta, the Yangtze River Delta faces the problem of industrial land scarcity, which imposes higher requirements on the utilisation efficiency of industrial land. An in-depth study of the policy content of IGU and an analysis of the preconditions for its success are the basis and premise for replicating and popularising this mode in other regions. However, the related literature is scarce, with most studies investigating building safety issues in multi-story industry buildings from an architectural perspective, such as in terms of structural design, vibration reduction, and shock resistance (Xie et al., 2019). Few studies have discussed the use of multi-story or high-rise industrial buildings from the perspective of intensive land use. Moreover, no literature discusses this mode from the perspective of urban and land economics.

In this study, we theoretically and empirically analyse the dynamic mechanism of IGU to promote urban economic development. This study makes three important contributions to the literature. First, through theoretical and empirical analyses, this study demonstrates the current land use innovation and successful implementation of IGU in China to supplement the lack of academic research. Second, it explains why China can maintain the stability and prosperity of its manufacturing industry under the pressure of many manufacturing factories transferring to Southeast Asia (due to the impact of COVID-19, many enterprises have moved back to China). Third, it offers suggestions for the replication and promotion of IGU in other regions of China. The remainder of this paper is organised as follows. The second section reviews the related literature. The third section discusses the theoretical hypothesis. The fourth section outlines the methodology. The fifth section presents our empirical results, and the final section summarises the conclusions and policy implications.

2. Literature review

In developing countries, the separation of land use and ownership is common. Existing studies have found that land reforms aimed at improving the access of the low-income population to land play an important role in poverty reduction and economic development (Besley & Burgess, 2000; Henderson et al., 2021). At present, the shortage of industrial land in China is due to China's industrial land leasing policy, in addition to the increasing development demand of industries and enterprises (Wang et al., 2021). Industrial land in China is owned by the state, and the maximum term for private management rights is 50 years. After the expiration of this 50-year term, if the industrial land is not reclaimed by the government for redevelopment, the original enterprises generally continue to renew the business contract. When China's economy was underdeveloped, enterprises were small, and industrial land leasing was generally small in scale. Moreover, different enterprises rented land at different times, resulting in scattered land use, which has made planning difficult. In the context of accelerating urban modernisation, continuous industrial development, and enterprise-scale upgrading, industrial land in many cities is scarce, and the situation is tense.

With the increasing urbanisation rate, industrial land plays an increasingly important role in promoting urban economic growth (Glaeser et al., 2021; Koroso et al., 2021). Economic research on urban industrial land use can be traced back to Weber's industrial location theory. Consequently, research on industrial land has expanded from traditional industrial locations to industrial land pricing (Aragonés-Beltrán et al., 2008) and industrial land-use evaluation (Harari, 2020; Masini et al., 2019). Aragonés-Beltrán et al. (2008) introduced the analytic network process (ANP) for asset valuation and applied the new approach to an industrial park located in Valencia (Spain). Masini et al. (2019) conducted a multidimensional analysis of land-use efficiency in terms of per-capita built-up area over 417 metropolitan regions from 27 European countries and found that the socioeconomic variable most associated with high land-use efficiency was per capita disposable income; that is, wealthier cities are characterised by higher land-use efficiency. Harari (2020) investigated the causal economic implications of city shape in India and found that land-use regulations can contribute to the deterioration of city shape.

In addition to research on land value pricing in the micro field and the evaluation of land use efficiency in the macro field, some studies have investigated industrial land use in East and Southeast Asia. Historically speaking, some cities in East Asia began to explore the use of high-rise industrial buildings in the 1990s, while Hong Kong and Singapore began to explore high-rise industrial buildings under objective pressure before the 1990s (Ren et al., 2014; Shelton et al., 2011; Shi & Chen, 2015). Specifically, flatted industrial buildings in Singapore, standard factory buildings in Taiwan, and apartment factories in South Korea have been discussed by some scholars with respect to pricing (Oh, 2019), use value (Park & Lee, 2015), enterprise moving decisions (Park, 2009), and the economic employment effect (Lee & Kim, 2014).

Overall, research on high-rise industrial buildings is scarce for two reasons. First, high-rise industrial buildings have many restrictions and requirements regarding fire protection, shock resistance, and energy consumption (Reisinger et al., 2021). Before

the maturity of architectural technology, Western countries entered the post-industrial era, and the manufacturing industry shifted to China and other developing countries in large proportions (Iammarino et al., 2018; Musson, 2004). Therefore, international scholars have focused on the renewal of old industrial parks and the reuse of industrial buildings rather than the utilisation of high-rise industrial buildings (Glumac & Islam, 2020; Vardopoulos, 2019). Second, they paid more attention to the division of labour and economic effects brought about by the transfer of industry between regions and countries (Timmer et al., 2019) than to the utilisation mode of specific elements of industrial land. One of the important characteristics of this study is the investigation of the new mode of industrial land use, as, with China considered 'the world's factory', its industrial land is in constant shortage.

Previous studies have focused on the measurement of industrial land use efficiency and identification of influencing factors (Cheng, 2020; Gao et al., 2020; Yang et al., 2018). To improve land-use efficiency, Tian et al. (2021) determined the optimal regulation of land-use information systems from the perspective of quality management. Jiang (2021) used a slacks-based measure (SBM) model to analyse the spatial and temporal differences in industrial land use efficiency in central China from 2003 to 2012. The results showed that the industrial land use efficiency of each province has significantly improved in terms of scale, pure technical efficiency, and comprehensive technical efficiency of land use, with the advantage of continuous enhancement of the scale effect. Liu et al. (2021) measured China's industrial land-use efficiency using stochastic frontier analysis (SFA) and discussed its spatiotemporal characteristics and influencing factors. Moreover, Zhang et al. (2019) found that an increase in industrial land prices can improve total factor productivity (TFP) with a selection effect, as the government's negative distortion of industrial land prices reduces local enterprises' total factor productivity.

The successful implementation of IGU in the Pearl River Delta has made it an important choice for industrial land use. Nevertheless, the new mode emerging in eastern cities in mainland China has the characteristics of a different development stage from that seen in Hong Kong. The main difference is that industries supported by the new land use mode in cities in China such as Shenzhen and Dongguan are not labour-intensive industries but high-tech industries that represent the direction of future industrial development, such as those related to 5 G, chip manufacturing, life, and health. IGU is not an independent behaviour of enterprises but a new type of industrial development pattern based on industrial agglomeration. This mode is designed and promoted by local governments using a top-down approach.

3. Theoretical analysis

3.1. Policy specifics of IGU

In 2018, the Shenzhen Baoan District began to draft an IGU mode, including requirements on architectural design standards and suitable industries. In 2019, the District took the lead nationwide in issuing 'Guidelines for Industry's Going Upstairs in the Baoan District, Shenzhen (Trial)', providing design standards and operating guidelines for IGU. The guidelines, which mainly involve industry selection and

Figure 1. A traditional old factory building (left) and a standard high-rise factory building developed under IGU (right).
Source: The figure is from Songshan Lake Intelligent Valley Industrial Park.

architectural design standards, define IGU buildings as 'high-rise factories with a building height of more than 24 m and not more than 100 m'.

Implementing open innovation and developing a digital economy are important strategies for national competition (Adamides & Karacapilidis, 2020; Ode & Ayavoo, 2020; Ribeiro-Navarrete et al., 2021) and have become important top-down strategies for China's government. The main industries supported by local governments in promoting IGU are high-end manufacturing industries with high capital density and strategic emerging industries with large R&D investments. Moreover, to retain the advantages of traditional industries, stabilise the development of original enterprises, and maintain local fiscal revenue, enterprises with traditional advantages or weak links in the industrial chain that are suitable for production in high-rise factories are encouraged to apply IGU.

Shenzhen proposed key design points for concrete high-rise industrial buildings. Compared to traditional low-density and low-height industrial buildings, the IGU mode emphasises that the design of buildings should meet the requirements of enterprises for high-rise production processes, with special requirements for floor area, floor load, column network distance, and production facilities. Simultaneously, IGU has imposed higher requirements for the production environment, emphasising beautiful architectural design, comfortable public spaces, and a modern sense of park construction. Figure 1 shows the traditional old factory building and standard high-rise factory building under the IGU mode.

3.2. Policy motivation of IGU

With China entering the post-industrial era and the advancement of urbanisation, both the population and modern service industry continue to be heavily concentrated in eastern coastal areas, with the price of urban real estate continuing to rise. As the price of residential and commercial land is approximately 5-10 times that of industrial land, the newly added urban construction land supplied by the government is mainly residential and commercial land, thus restricting the supply of industrial land for manufacturing, with the price of industrial land showing an upward trend. The shortage of industrial land is particularly prominent in economically developed areas such as the Pearl and Yangtze River Deltas. In this context, strengthening the intensive use of industrial land and improving the efficiency of land use have become

active choices for cities in the Pearl River Delta to improve the quality of industrial development. The implementation of IGU and the placement of manufacturing enterprises in high-rise industrial buildings can effectively improve land use efficiency and increase the industry-carrying capacity per unit land area. IGU can increase the land plot ratio by 2-3 times; thus, it has been adopted as an initiative by some eastern coastal cities to cope with the scarcity of industrial land.

Another driving force behind IGU development is the internal need for modern industrial agglomeration. According to Padmore and Gibson (1998), industrial agglomeration refers to the highly intensive agglomeration of multiple types of enterprises producing a certain product as well as upstream and downstream enterprises and related service industries within an appropriately large regional scope. With the increase in various costs, such as the price of industrial land in central cities and the limitation of development space, there are many industrial transfers from central cities to peripheral cities in developed economic circles, such as the Pearl and the Yangtze River Deltas. Core enterprises often lead these industrial transfers. The transfer of a core enterprise or its manufacturing base from one city to another drives the transfer of supporting or industrial chain enterprises. IGU can fully increase land use space and provide a large number of industrial enterprises with space agglomeration opportunities, which helps restore or even improve the closeness of enterprise connections in a short period of time and reduce business costs between enterprises and logistics costs caused by physical distance. Additionally, as IGU is conducive to attracting investment, it has been vigorously promoted.

IGU can improve the land value per unit area, which is of great significance for urban renewal construction. Urban renewal in China is usually led by the government (Lichtenberg & Ding, 2009; Mo, 2018), which needs to pay the majority of the demolition and reconstruction costs for the development of old cities. These construction funds are typically provided by project companies established by the government (Ye et al., 2021). Debt repayments are largely dependent on land sales (Cai et al., 2020). IGU can improve the plot ratio of land use and the operating environment of industrial enterprises, thus raising the price of land sales or industrial building leases and providing more capital sources for urban renewal. Therefore, IGU is vigorously promoted by local governments to achieve a balance between investment attraction and government input.

3.3. Policy conditions for successful IGU

Here, we analyse the factors that influence enterprises to move into the IGU park, that is, the necessary conditions for the IGU to succeed. Partial equilibrium analysis is widely used to analyse the welfare or economic effects of a policy, which enables researchers to focus on specific influencing factors (Ciaian & Swinnen, 2006; Nganje & Addey, 2019; Wonyra & Bayale, 2020). In this study, enterprises maximise profit as their business goal, and they choose to move into the IGU park only if they can achieve greater profits compared to not changing the location of production and operation.

The production function of an enterprise is given by the Cobb–Douglas production function:

$$Y = AK^{\alpha}(EL)^{\beta}S^{\gamma}M^{\delta} \tag{1}$$

where ***A*** is the technical parameter, ***K*** is the capital stock, ***L*** is the labour force, ***E*** is the labour force efficiency, ***EL*** is the number of efficient workers, ***S*** is land, and ***M*** is the intermediate input.

The long-term profit maximisation of an enterprise can be expressed as follows:

$$Max\{\pi = PY - RK - WEL - PsS - PmM\} \tag{2}$$

where $\boldsymbol{\pi}$ is enterprise profit, ***P*** is product price, ***R*** is the rent of capital goods, ***W*** is the wage after excluding labour efficiency, ***Ps*** is the rent of land (price), and ***Pm*** is the price of intermediate inputs.

We assume that the product and capital goods markets of the enterprise exist in a perfect competition structure, and the prices of ***P*** and ***R*** have nothing to do with where the enterprise chooses to produce but are instead determined by the market. The wage level ***W*** is determined by the local living cost and economic development level, which varies by region. Similarly, the level of labour efficiency varies by region, depending on local higher education resources and the level of urban public service. Generally, the richer the urban higher education resources and the higher the level of urban public service, the easier it is for talent to gather, and the higher the level of labour efficiency. Land rent $\boldsymbol{P_S}$ varies by city depending on the level of economic development. The price of intermediate inputs ***Pm*** depends on the average market price of the inputs as well as the transportation cost, which, in turn, depends on the physical distance between the enterprise and the intermediate enterprises.

$$W = W(\overset{+}{lifecost}, \overset{+}{eco}) \tag{3}$$

$$E = E(\overset{+}{uni}, \overset{+}{pubsev}) \tag{4}$$

$$P_s = P_s(\overset{+}{eco}, \overset{-}{Q_s}) \tag{5}$$

$$P_m = P_m(\bar{p}_m + \overset{+}{tran}) \tag{6}$$

In Equations (3)–(6), the superscript of the variable with the + sign indicates that the dependent variable is the increment function of the independent variable, and the superscript with the– sign indicates that the dependent variable is the decreasing function of the independent variable. ***Lifecost*** is the cost of living, ***econ*** is the level of economic development, ***uni*** is the level of higher education resources, and ***pubsev*** is the level of public services including transport, primary education, healthcare, and business facilities. ***Qs*** refers to the quantity of land supply, which is determined by the government. The government can expand industrial land supply through the IGU

policy. $\bar{p}_m$ represents the average price of intermediate goods, which is determined by the market, with no difference among regions. ***Tran*** represents the transportation cost for intermediate goods.

Corporate profits are a negative function of wages, land prices, and intermediate prices and, thus, of the cost of living, level of regional economic development, and cost of transportation as well. However, labour efficiency can simultaneously increase output levels and wage expenditure. In our profit maximisation problem, an increase in labour efficiency will initially increase the profit level; after reaching a certain degree, it will instead reduce the profit level of enterprises. The condition for choosing to move into the IGU park is that an enterprise can achieve greater profits than if it does not change the location of production and operation. That is, the following conditions must be met.

$$\pi' - C_t > \pi \tag{7}$$

$$PY' - RK' - W'E'L' - P_s'S' - P_m'M' - C_t > PY - RK - WEL - P_sS - P_mM \tag{8}$$

Ct is the transfer cost of the enterprise moving into the IGU park, including relocation costs, new worker recruitment and training costs, and the management costs incurred during the transformation of the production place. The left side of inequality (7) is the net profit of production after deducting the transfer cost, whereas the right side is the profit without changing the place of production and operation. Therefore, it is necessary for the local government of the destination to create conditions to increase the profits of enterprises after they move in. According to the above analysis, the destination should utilise the low wage level and land price relative to the destination, strive to improve the level of regional public service, and attract more efficient workers. Simultaneously, when building industrial parks, attention should be paid to industrial agglomeration, attracting industrial chain investments, and reducing the transportation cost of intermediate goods. The analysis conclusion in Table 1 is deduced according to the chain rule of the derivatives.

Table 1. Policy conditions for successful IGU implementation.

Influence path	Influencing factors	The effect	Government response strategy
Labour costs	Local cost of living	Negative	While improving the level of economic development, control the cost of living such as housing prices.
	Level of local economic development	Negative	
Labour efficiency	Local higher education resources	First positive, then negative	Develop higher education and upgrade the level of public services such as local education, healthcare, and infrastructure.
	Level of local public services	First positive, then negative	
Land costs	Level of local economic development	Negative	Increase the land supply while improving the level of economic development.
	Quantity of land supplied	Positive	
Intermediate input costs	Transportation costs	Negative	Implement industrial agglomeration and develop industrial chain investment promotion.
Transfer costs	Relocation costs	Negative	Give tax incentives to enterprises and introduce incentive policies for labour inflow.
	Labour retraining costs	Negative	
	Manage costs	Negative	

Source: made by the author based on the analysis of article.

3.4. IGU mechanism to promote economic development

As stated above, the original intention of a local government's implementation of IGU is to maximise land use efficiency and, ultimately, to attract enterprises with high value-added production and gain more tax revenue to support regional economic growth. As enterprises' agglomeration development will bring about an inflow of labour force, IGU can achieve the dual goals of industrial and population agglomeration. Clustered industries may originate from other cities or other parts of the local city. Regardless of enterprise origin, the realisation of industrial and labour agglomeration is closely related to the institutional, geographical, and economic environments of the region where the IGU is implemented. That is, IGU implementation must be based on certain preconditions, and appropriate path selection is key to achieving policy objectives.

We summarise the contents of the analysis from 3.1 to 3.3 in Figure 2, which illustrates the IGU mechanism for promoting local economic development.

4. Methodology

Based on the above analysis, the IGU mode primarily addresses the scarcity of industrial land and promotes industrial upgrading and agglomeration. Its success depends on urban location, convenient transportation, talent attraction, the industrial agglomeration effect, and other factors. This section evaluates the existing policies for implementing IGU using the difference-in-differences (DID) model.

According to our field research, IGU policies are primarily implemented in Shenzhen, Dongguan, and Foshan in Guangdong Province. In this study, the IGU policy issued by these cities in 2019 is considered a quasi-natural experiment. Using a DID model, we analysed the trend of the change in industrial value-added in various cities in Guangdong Province to evaluate the promotion effect of the IGU policy on industrial development. The DID method is widely used in policy evaluations (Dhoubhadel & Azzam, 2021; Donald & Lang, 2007; Saha, 2019; Zheng et al., 2021). In our DID model, Shenzhen, Dongguan, and Foshan were in the treatment group, whereas other cities in Guangdong Province, including Guangzhou, Huizhou, Zhuhai,

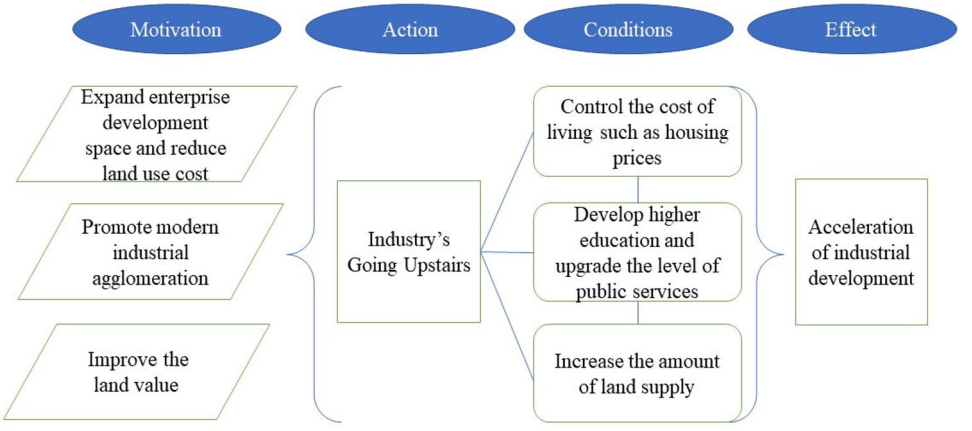

Figure 2. The IGU mechanism to promote local economic development.
Source: drawn by the author based on theoretical analysis.

Maoming, Jiangmen, Zhongshan, Zhanjiang, Meizhou, Shantou, Shanwei, Qingyuan, Zhaoqing, Yunfu, Chaozhou, Jieyang, Yangjiang, Shaoguan, and Heyuan, were in the control group. The study period was 2016 to 2020.

The response variable is the proportion of industrial value added to the gross domestic product (GDP). According to the above analysis, IGU can revitalise land elements and resources, provide space and a platform for enterprise development, attract high-quality projects, and entice enterprises to move into the local area or local enterprises to stay and grow in the local area, thus improving the industrial value added. As the statistical department has not released the data on industrial value-added for 2020, and the value added of the secondary industry is composed of more than 90% of the industrial added value, the proportion of the value added of the secondary industry in the regional GDP is used as a proxy variable.

The explanatory variable is the IGU policy, which is a dummy variable expressed as Treat × Time. 'Treat' refers to whether the city implements an IGU policy, and 'Time' indicates whether the year is the implementation year. When the enterprise belongs to a city that implements IGU, the 'Treat' value is 1; otherwise, it is 0. When the year is greater than or equal to 2019, the 'Time' value is 1; otherwise, it is 0.

The control variables were the proportion of exports, consumption, government expenditure, and credit in the gross regional product. The four variables represent internal and external demands as well as policy changes in the capital supply faced by industrial enterprises. The sample cities are all located in Guangdong Province, with obvious export-oriented economic characteristics, and their industrial growth is greatly affected by the international trade environment. Consumption is expressed in terms of total retail goods, which represents the region's internal demand. Government expenditure represents government intervention in economic activities. Although expansionary fiscal expenditure will bring commodity demand, it is more likely to crowd out private investment through the crowding-out effect, thus affecting industrial value added. Simultaneously, credit has been widely used by the Chinese government to stimulate economic growth. As the statistics department has not published the loan data for industrial enterprises, we use total credit as the proxy variable for enterprise credit.

The calculation formulas for the response and control variables are summarised in Table 2, and their descriptive statistical results are presented in Table 3. All data were obtained from official statistical yearbooks published by each city.

Our econometric model is as follows:

$$IVA = \beta_0 + \beta_1 treat \times time + \sum_{i=2}^{5} \beta_i control_{it} + \gamma_t + \delta_i + \varepsilon_{it} \tag{9}$$

Table 2. Variables in the econometric model.

Category	Name	Expression	Way to calculated
Response variables	Industrial value added	IVA	Value added of secondary industry/gross regional product
Explanatory variables	Policy dummy	Treat × Time	Dummy variable Treat × dummy variable Time
Control variables	Export	Export	Exports/gross regional product
	Consume	Sales	Total retail sales/gross regional product
	Government spending	GE	Fiscal expenditure/gross regional product
	Credit	Loan	Loans/gross regional product

Source: made by the author based on the analysis of article.

Table 3. Descriptive statistics.

	IVA	Export	Sales	GE	Loan
Mean	0.42	0.26	0.45	0.18	1.04
Median	0.42	0.13	0.45	0.16	0.97
Maximum	0.59	0.96	0.73	0.40	2.46
Minimum	0.26	0.02	0.25	0.08	0.38
Standard deviation	0.08	0.26	0.11	0.08	0.49

Source: empirical analysis results, which are all from stata 12 software.

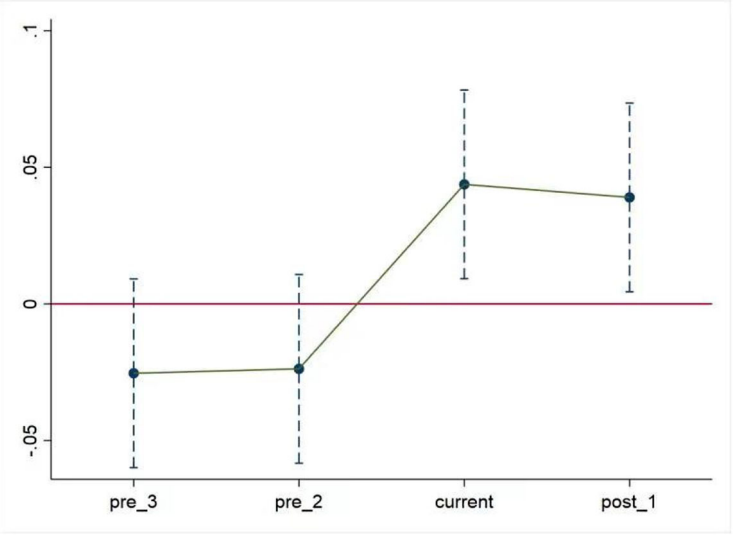

Figure 3. Parallel trend test.
Source: result of empirical analysis by stata12 software.

where $\boldsymbol{control_{it}}$ represents the control variables, γ_t and δ_i represent time and individual effects, respectively, ε_{it} represents the random error term, t represents time, and i represents the city. If β_1 is positive and passes the significance test, it indicates that the IGU policy can promote an increase in industrial value added.

5. Results

5.1. Empirical results

The premise of using the DID model to estimate the IGU policy's impact is that the development trend of urban industrial value added in the treatment and control groups was consistent before the policy. To test whether this condition was satisfied, we conducted a parallel trend test. The test results are shown in Figure 3. pre_3 indicates 2016, the third year before the policy implementation. pre_2 refers to 2017. 2018, the year before the policy implementation and the base year, was dropped. 'current' refers to 2019. post_1, one year after the policy, is 2020. There was no significant difference between the pre_3 and pre_2 years, but there was a significant difference between pre_2 and the current year. The parallel trend test was valid, indicating that the DID model can be applied for analysis.

Table 3 shows regression results for the DID model. When the OLS method was used for regression, the coefficients of the policy dummy variable Treat × Time were

Table 4. Regression results of the DID model.

	OLS				FE	
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Treat × Time	0.0347	0.0448	0.0160	0.0631***	0.0160	0.0631*
	(0.0296)	(0.0317)	(0.0190)	(0.0205)	(0.0339)	(0.0328)
Export	0.2026***	0.1910***	0.0751	0.0145	0.0751	0.0145
	(0.0465)	(0.0507)	(0.0694)	(0.0674)	(0.0436)	(0.0619)
Retail	0.1025*	0.0864	0.1202***	−0.0503	0.1202**	−0.0503
	(0.0591)	(0.0659)	(0.0415)	(0.0720)	(0.0575)	(0.1046)
GE	−0.3462***	−0.3336***	−0.7359**	−0.0807	−0.7359	−0.0807
	(0.0855)	(0.0856)	(0.2936)	(0.2044)	(0.4537)	(0.2489)
Loan	−0.0780***	−0.0737***	−0.0550***	0.1032**	−0.0550***	0.1032
	(0.0225)	(0.0240)	(0.0189)	(0.0473)	(0.0193)	(0.0731)
Individual effect	No	No	Yes	Yes	Yes	Yes
Time effect	No	Yes	No	Yes	No	Yes
Constant	0.4659***	0.4812***	0.5064***	0.4317***	0.5392***	0.3936***
	(0.0394)	(0.0449)	(0.0764)	(0.0684)	(0.0776)	(0.0420)
Within-R^2	0.4893	0.4995	0.8984	0.9286	0.3912	0.5720
F value	18.69***	10.79***	139.37***	131.85***	10.50***	15.43***

Note: ***, **, and* indicate significance at the 1%, 5%, and 10% levels, respectively. The values in brackets are t values.
Source: empirical analysis results, which are all from stata 12 software.

all positive. After controlling the individual and time effects, IGU was significant at the 1% level, indicating that it promoted industrial development. Columns (5) and (6) are regression results using the panel fixed-effect model. Column (5) controls for only the individual effect, while Column (6) controls for both the individual and time effects. The model that controls for both the individual and time effects passed the significance test at the 10% level. Taking the regression result of column (4) in Table 4 as an example, the coefficient of Treat × Time is 0.0631, which is significant at the 1% level, indicating that the IGU policy significantly promoted industrial growth. In addition, the F values of the six regression models all were significant at the 1% level, indicating that the model was a good fit.

Regarding the regression results for the control variables, the coefficient of Export was positive in all models. Although regression result (4) failed to pass the significance test, it still indicates that the industrial development of cities in Guangdong Province with obvious export-oriented economic characteristics was significantly affected by the international trade situation. The coefficient of retail sales that reflects consumer demand changes in different regression models, indicating that this variable is not a good indicator of local industrial development. The coefficient of government expenditure is negative, indicating that government expenditure squeezed out private investment activities. This is an important feature of local economic development in China. In particular, over the past decade, Chinese local governments have accumulated a large amount of government debt and squeezed out more credit resources for private and real economies. After controlling for individual and time effects, the coefficient of the loan in Column (4) of the regression results was positive and significant at the 5% level, indicating that the loan played a greater stimulating role in industrial investment.

5.2. Robustness test

First, we performed a placebo test using an alternative control group. The basic idea is that cities in the treatment group (i.e. Shenzhen, Dongguan, and Foshan) are

Table 5. Regression results of the DID model with a placebo test (1).

Variables		Treat × Time	Export	Retail	GE	Loan	Constant	Within-R2
Original DID model	Without covariates	0.0577***	–	–	–	–	0.4115***	0.5624
	With covariates	0.0631*	0.0145	−0.0503	−0.0807	0.1032	0.3936***	0.572
New model with placebo test	Without covariates	0.0250*	–	–	–	–	.4037***	0.1917
	With covariates	0.0274**	−0.1376	0.1434	1.2290***	−0.0485	0.3310**	0.3911

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: empirical analysis results, which are all from stata 12 software.

Table 6. Regression results of the DID model with a placebo test (2).

Variables		Treat × Time	Export	Retail	GE	Loan	Constant	Within-R2
Coefficient	Original model	0.0631*	0.0145	−0.0503	−0.081	0.103	0.394***	0.57
	New model	0.0381	0.021	0.0167	−0.294	0.083	0.415***	0.52

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: empirical analysis results, which are all from stata 12 software.

Table 7. Regression results of the DID model with a placebo test (3).

Variables	L.Treat × Time	L.Export	L.Retail	L.GE	L.Loan	Constant	Within-R2
Coefficient	0.0416**	−0.0252	−0.0301	−0.0424	0.1316	0.3574***	0.52

Note: ***, **, and* indicate significance at the 1%, 5%, and 10% levels, respectively. For the new regression, we used a two-way fixed-effects model.
Source: empirical analysis results, which are all from stata 12 software.

economically developed cities in Guangdong Province. The regional GDP each of the three cities, which all have a good industrial development foundation, is among the top four in Guangdong Province. Thus, to effectively match the treatment group cities, cities with similar economic development characteristics or initial conditions should be selected to avoid policy selection bias. Therefore, we selected cities in Zhejiang and Jiangsu Provinces, which have good economic development, similar to the control group. The selected cities were Hangzhou, Ningbo, and Wenzhou in Zhejiang Province and Nanjing, Suzhou, and Wuxi in Jiangsu Province. These cities are the top three cities in their respective provinces in terms of their regional GDP. In the new DID model, if the treatment effect of IGU policies still exists, then the IGU may indeed promote the city's industrial development.

The results of the placebo test are presented in Table 5. After establishing the new control group, the treatment effect of the IGU policy remained significant. In the model with no covariates, the significance level was $< 10\%$. After covariates were added, the level of significance was $< 5\%$. Therefore, the placebo test indicates the robustness of the DID model and the existence for the treatment effect of IGU policies.

We set the policy implementation year to 2017, two years before the actual policy implementation. The reason for choosing two years in advance rather than one year in advance was to overcome the impact of the continuity of the decision-making process. As shown in Table 6, the coefficient of Treat × Time was 0.0381 in the new regression, which was not significant at the 10% level, indicating that the original regression result was robust and that the IGU policy significantly promoted industrial growth.

To test the lag effect of the policy, we lagged all of the explanatory variables by one period. As shown in Table 7, the coefficient of Treat × Time was 0.0416, which was significant at the 5% level, indicating that the policy had a positive lag effect on

industrial development. The IGU policy affected not only current industrial development but also that of the following year.

6. Conclusions and implications

6.1. Conclusions

This study investigated a new pattern of industrial land use, IGU, which has emerged in developed areas of eastern China. IGU is an important practical choice for cities to mitigate rising land prices, increase the attraction of projects and enterprises, and make intensive and efficient use of industrial land. IGU can help broaden the space for enterprise development, reduce land-use costs, promote the agglomeration of modern industries, and enhance property market value. IGU's success depends on the efforts and support measures of the government, which include effectively controlling the cost of industrial land and labour, improving local services, and increasing worker efficiency by enhancing the quality of higher education. The empirical results based on the DID model found that IGU implementation significantly increased urban industrial development.

From the perspective of China's political and economic reality, local governments' intrinsic motivation to promote IGU arises from two factors. The first is competition between local governments. Chinese local governments have a strong desire to control resources (particularly revenue and tax revenue), as these can provide opportunities for achievement and promotion to local government officials. IGU policies can attract larger and more productive enterprises to cities in their respective provinces. Second, there is real demand for industrial land market reform. As China's industrial land is acquired through transfer, its rights are similar in nature to private property rights during the use period. The transferred industrial land is acquired by some individuals, and it is becoming increasingly difficult for new market players to obtain land. Meanwhile, either it is difficult to match the appropriate scale of land through the market or the cost is too high. In this case, the government must replan the land use using its administrative power and select advantageous industries for development.

6.2. Implications for theory

This study makes two theoretical contributions. First, the results can help us better understand the endogenous growth momentum of China's economy. Thus, China's economic development can be promoted through policy guidance and market-oriented reforms related to land factors. A shortage of industrial land is increasingly becoming a constraint on China's industrial economic growth; however, local governments can reverse this trend by adopting new land-use patterns. This study provides academic support for the success of Chinese government intervention in the economy. Second, this study demonstrates the necessity of China's land system reform, especially industrial land system reform. Compared with the emphasis on agricultural land systems, the reform of industrial land systems in China has been neglected in academic research.

6.3. Implications for practice

With regard to practical implications, this study notes the following points: Eastern developed provinces such as Zhejiang and Jiangsu in the Yangtze River Delta also face the problem of an insufficient supply of industrial land. Cities in Zhejiang and Jiangsu are vigorously developing high-end manufacturing, high-tech industries, and the digital economy, which creates a great practical and urgent demand for the intensive use of industrial land. Thus, the promotion and replication of the successful experience of IGU in the Pearl River Delta can be initiated based on three factors.

First, it is especially important to select specific cases for detailed study, including behaviour analysis of all stakeholders (including local governments, park builders and operators, local enterprises, investment enterprises, and workers), which should be an important direction for policy research.

Second, local governments should analyse the feasibility of promoting IGU in terms of natural conditions, enterprise subjects, industrial structure, and economic strategy. For natural conditions, the basic situation and current utilisation status of industrial land should be analysed. Enterprise subjects must evaluate the scale and distribution of enterprises and realistic demand for IGU. Regarding industrial structure, local governments should analyse high-end manufacturing, strategic emerging industries suitable for IGU, and disadvantages of the industrial chain. Economic strategies must outline the objectives, requirements, and relevant support policies for industrial development.

Third, local governments can construct an implementation path of 'industry upstairs', consisting of selecting regions for promotion, formulating supportive policies, building modernised industrial chains, and establishing competitive cooperation among cities. In particular, to boost industrial upgrading, IGU should be closely linked to local cities' industrial chain construction. Therefore, it is necessary to cooperate with other cities within the industrial chain, thereby benefiting from industrial divisions and enhancing regional cooperation.

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