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How did development zones affect China's land transfers? The scale, marketization, and resource allocation effect

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ABSTRACT

The land transfer is an important policy tool for development zones (DZs) to guide the allocation of industrial resources. The immovability of land and its high reallocation cost make the efficiency loss caused by any land resource mismatch more challenging to remedy. Therefore, exploring the effects of the establishment of DZs on the land transfer policies of local governments and subsequent resource allocation can contribute to the rational control of land transfer policies. Accordingly, this study used propensity score matching, difference-in-differences estimation, and the instrumental variable method to quantify the associations among the establishment of DZs, land transfer, and resource allocation efficiency in China. The results show that the establishment of DZs promotes local governments to expand the area of transferred industrial land and increases the ratio of listing transfers, which reduces the marketization degree of land transfers. Furthermore, the establishment of DZs weakens the selection effect of land transfers, which distorts resource allocation and hinders the resource allocation efficiency of the manufacturing industry. The results suggest that it is necessary to switch from the traditional "extensive" land development strategy to the economical and intensive use of DZ land. The marketization of land transfer in the DZs should be increased and land should be allocated to firms with higher marginal output.

1. Introduction

The optimal allocation of land resources is an important prerequisite for sustainable land use and high-quality economic development. To maximize the social value of land use, developed countries mainly regulate the allocation of land resources through planning, such as the zoning system widely adopted in American cities. Zoning, the physical regulation of land use, is a power delegated to the local government (Sclar, 2021). The regulation has impacted land supply scale and land price (Ihlanfeldt, 2007; Kok et al., 2014; Gyourko and Molloy, 2014). Based on the public ownership of land, China has implemented a land use control system like zoning, and further implemented the land use right transfer system, so that the local government can directly regulate the land allocation. Resource allocation is the core proposition of economic research. In the case of market failure and improper government intervention, the failure of input factors of firms to flow from inefficient firms to efficient firms will have a negative impact on the economic growth (Hsieh and Klenow, 2009; Jovanovic, 2014). The immovability of land and its reallocation cost make the efficiency loss caused by any land resource mismatch more challenging to remedy, with the mismatch also having serious consequences for economic development. The discussion on land transfer can indicate future directions for governments to efficiently regulate the allocation of land resources.

As the most representative place-based industrial policy implemented worldwide, the establishment of development zones (DZs) is an important mechanism whereby the government can guide the allocation of land resources. In 2008, there were approximately 3000 zones in 135 countries, accounting for over 68 million direct jobs and over $500 billion of direct trade-related value added within zones (The World Bank Group, 2008). In the United States, development zones exist at both the federal and state levels. For instance, under the federal Empowerment zone program, authorized in 1993, local governments could submit proposals for zones made up of relatively poor, high-unemployment census tracts (Neumark and Simpson, 2014). Development zone policies are also used in some European countries. During the 1980s, Spain implemented a reindustrialization zone policy and Belgium a program of

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employment zones. France also operated an earlier enterprise zone policy in 1997 (Gobillon et al., 2012). Since 1984, China has gradually created DZs in its municipalities with property rights protection, tax breaks and a preferential land policy. China's DZs have experienced a long-term development, which provides an ideal setting for exploring the causal effect of DZs on land resources.

The underutilization or inefficient use of land caused by the growth in DZ land requisition and transfer scales has led to sub-optimal factor allocation, whereby some land elements are not utilized or land elements fail to flow from inefficient firms to efficient firms. The growth of industrial productivity comes from the growth effect within firms and the resource allocation effect among firms (Syverson, 2011). The internal growth effect refers to the improvement of firm productivity, while the resource allocation effect means that efficient firms can obtain more production factors by changing the resource allocation among firms. If the elements are not allocated to firms with higher marginal products, it means a lower resource allocation efficiency (Foster et al., 2016; Hsieh and Klenow, 2009). The mismatch of land resources in DZs distorts land allocation among firms, preventing land allocation investments from reaching the optimal level. Therefore, it is necessary to explore the mechanism through which land transfers affect the resource allocation of DZs, to derive directions for the reasonable regulation and control of land transfer in DZs.

This study systematically explores the relationship between the establishment of DZs, land transfers, and resource allocation efficiency from theoretical and empirical perspectives, as well as the practical facts in China. This study contributes to existing research in the following ways: first, the existing literature on the policy evaluation and land transfer of DZs fails to address the internal transmission mechanism of the effect of land transfer behavior on resource allocation. This study identifies the effects of land transfer on resource allocation from the perspective of the entry and exit probabilities of heterogeneous firms. Further, based on the "*China Development Zone Audit Bulletin Directory (2018)*",[2] the study identifies the precise spatial location of DZs and land transfers by adopting spatial positioning technology; doing so helps provide micro data support for further exploring the impact of land transfers in DZs on manufacturing resource allocation efficiency at the county and firm levels, and broadens the spatial scale of the existing empirical research.

Our study proceeds as follows. The next section reviews existing research. Section 3 discusses the institutional background and identifies our assumptions and hypotheses. Data sources and the measurement of key variables are reported in Section 4. Section 5 empirically examines the effect of the establishment of DZs on land transfer and its resource allocation effect. Section 6 further identifies the mechanism through which land transfers affect the efficiency of resource allocation from the perspective of heterogeneous firm entry and exit. Finally, Section 7 briefly summarizes the findings and concludes.

2. Literature review

2.1. Research on the effectiveness of DZs

As the most representative place-based program globally, DZs have attracted the most attention from researchers (Neumark and Simpson, 2014). There has been much research focused on the effectiveness of place-based programs in the United States and Europe. For example, Hanson and Rohlin (2013), Neumark and Kolko (2010), Criscuolo et al. (2019), and Briant et al. (2015) respectively take federal empowerment zones, California enterprise zones, the UK's regional selective assistance (RSA) program, and French enterprise zone program as examples to investigates the causal impact of the policy. There also have been several studies attempting to evaluate interventions in China (Alder et al., 2013; Zheng et al., 2017; Lu et al., 2019).

The effectiveness of the DZ program, which some scholars are skeptical of, is inconsistently established. These scholars argue that some firms and labors locate in the DZs only because of the benefits of preferential policies. Furthermore, these firms and labors do not substantially benefit the development of local areas and even generate crowding-out effects on the productivity and survival time of surrounding firms (Glaeser et al., 2010; Neumark and Kolko, 2010). However, most studies have confirmed the positive effect of DZs on economic development (Criscuolo et al., 2019; Busso et al., 2013; Kline and Moretti, 2013; Combes and Gobillon, 2015).

The literature on the effectiveness of DZs has focused on the impact of the establishment and development of DZs on economic indicators such as foreign direct investment (FDI), export growth, gross domestic product (GDP), firm productivity, and industrial upgrading (Glaeser et al., 2010; Combes and Gobillon, 2015). However, local governments realize the impact of DZs on economic development by allocating land, capital, and other resources. Therefore, it is necessary to explore the effects of land transfers on resource allocation efficiency and the transmission mechanism of these effects.

2.2. Research on the impact of land transfers on resource allocation

As an essential input factor of firm production, the allocation of the land of DZs has also attracted the research of many scholars. For developed countries, there is much research interest focusing on the land allocation in the United States and Europe based on its land planning policy, like zoning, which involves land demand (Slater et al., 2022), land supply strategy (Hortas-Rico and Gomez-Antonio, 2020) and land planning laws (Newton, 2018; Alemohammad et al., 2022).

For developing countries, extant research focuses on two aspects: First, agriculture is an important industry in most developing countries, some scholars discussed the utilization efficiency of agricultural land in Bangladesh (Sultana et al., 2019), Indonesia (Lusiana et al., 2012) and other countries. Second, developing countries have a solid motivation to convert agricultural land into urban land while in the process of urbanization. Some scholars examined the dimensions (Parwez, 2016) and resistance movement (Bedi, 2013; Ramachandraiah and Srinivasan, 2011) based on the land acquisition experiences from India. China is a representative country that implements public ownership of land. The research on China's land allocation mainly involves the land transfer system (Shi and Wang, 2019), the evaluation of land intensive use (Sun et al., 2020), the balanced land allocation (Lu et al., 2015), and so on.

Moreover, different land allocation methods will have an impact on resource allocation. In terms of theoretical studies, some scholars constructed general models, including land allocation, and its impact on firms' behavior (Friedrich and Chang, 2011), and resource misallocation (Banerjee and Moll, 2010; Brandt et al., 2013; Restuccia and Richard, 2013). It is agreed that land mismatch is an essential factor causing the low resource allocation efficiency. Considering the improvement of micro-data availability, more and more scholars have carried out quantitative analysis on land mismatch and resource allocation efficiency. The literature mainly focused on the impact of agricultural land allocation on production efficiency (Restuccia and Santaeulalia-Llopis, 2015; Adamopoulos et al., 2017; Le, 2020; Restuccia, 2020). Only a few kinds of literature have discussed the effects of industrial land allocation on manufacturing industrial efficiency (Li et al., 2016). Furthermore, there is little literature has discussed the effect of land allocation on resource allocation efficiency in DZs.

Although previous studies have significantly advanced our knowledge of land allocation, several issues should be further examined to provide necessary implications on how to innovate land transfer policy within the context of high-quality development. Firstly, the land transfer is an important policy tool for developing global DZs. It is necessary to evaluate the scale and marketization of land transfer in DZs based on

[2] Data source: The National Development and Reform Commission, https://www.ndrc.gov.cn/.

microdata. Secondly, the research on the impact of land transfers on the resource allocation efficiency of the manufacturing industry was relatively rare, an empirical analysis is needed to illustrate the multiple influential pathways from land transfer on resource allocation efficiency in DZs.

3. Institutional background and research hypothesis

3.1. Institutional background

Since the establishment of the first DZ in 1984, 552 national and 1991 provincial DZs have been established in China as of 2018. Before the establishment of the first DZ, the right to use state-owned land was allocated through a planned system characterized by the free use of land, indefinite use, and prohibition of transfer, according to the constitution of the People's Republic of China (the "Constitution"). However, with the promulgation of the Law of the People's Republic of China on Land Administration (the "land administration law") by the central government in 1986 and the amendment of the Constitution in 1988, the land transfer system has become the fundamental system of urban land use in China (Zhang, 1997), and the paid transfer of land use rights has become a legal mechanism for the expansion of DZs. The land management law and the interim regulations on the assignment and transfer of the right to the use of urban state-owned land endow county governments with monopolistic development rights over the primary land market.

DZs have been the main channel for urban expansion in China since the 1990s. With the implementation of the fiscal reform in 1994 and the income tax reform in 2002, local governments are facing enormous financial pressure. To attract investment, some government departments have approved the establishment of various types of DZs without authorization, which has led to the arbitrary occupation of cultivated land, illegal transfers of land, and the promulgation of preferential policies beyond their authority. According to a survey conducted by the Ministry of Land and Resources in 2003, 70% of the 6866 DZs in China are idle (Du et al., 2014), covering a planned area of 38,600 square kilometers, which is higher than the national urban construction land area.

Large-scale land transfers in DZs lead to low levels of land-use and allocation efficiency. In order to curb this phenomenon, the General Office of the State Council in China issued an emergency notice in 2003 suspending the examination and approval of various DZs, and a notice on cleaning up and rectifying various DZs and strengthening the management of construction land; these notices clearly stipulated the procedure for the approval of DZs, the collection of construction land, and the area and mode of transfer. The administrative approval, economic coordination, and management functions of the Management Committee of DZs, as the agency of the local government, were gradually clarified at this stage; however, the Committee does not have the power to sign the land-transfer contract. In China, the power to decide the use of land lies with county-level governments (Zhang, 2009), which also have the power to allocate construction land quotas (Yu and Shen, 2019).

3.2. Research hypothesis

Local governments are responsible for the expropriation and transfer of construction land in DZs; accordingly, their land transfer behavior affects the resource allocation efficiency of manufacturing industries through the scale of land transfer and its marketization degree (see Fig. 1).

The DZ is a government-led industrial agglomeration zone formed by attracting firms through a series of preferential policies or subsidies. In the "Several Opinions on Promoting the Further Improvement of the Development Level of National Economic and Technological Development Zones" issued by the State Council in 2005, the development strategy of the DZ in China was set to the following: focusing on improving the quality of foreign investment, developing modern

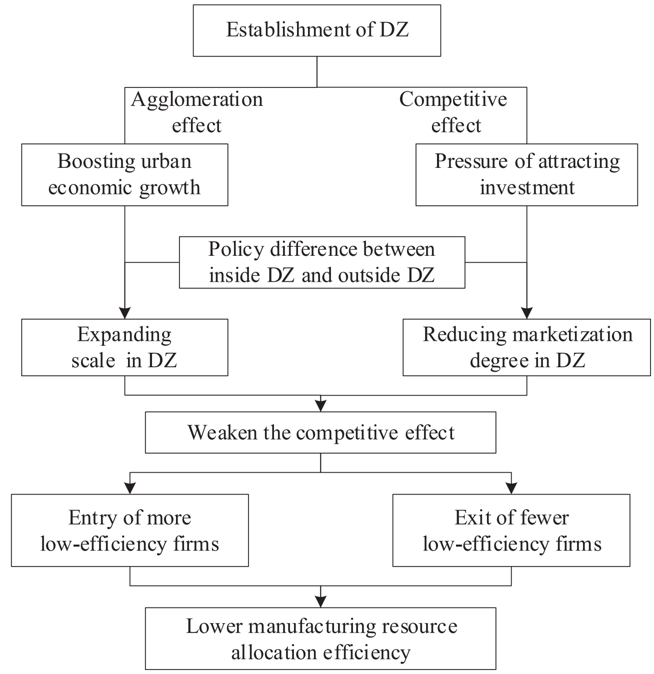

Fig. 1. The mechanism by which DZs influence manufacturing resource allocation efficiency.

manufacturing, and optimizing the export structure; undertaking the development of high-tech industries and high value-added service industries; and promoting the transformation of national economic and technological development zones into multi-functional comprehensive industrial zones. After over 30 years of development, DZs in China have developed into an essential spatial carrier and policy tool to boost urban economic growth, guide industrial agglomeration, and develop an open economy. The main goal of the county government, as the only supplier of land within the jurisdiction, is to allocate construction land-under the constraints of the construction land index-in a way that maximizes financial revenue, while also bringing local economic development (Zhang et al., 2013). Therefore, compared with non-development zones (NDZs), governments provide more policy preferences to expand the scale of land transfer in development zones.

Local governments have the power to plan and transfer land. For instance, according to the "Constitution of the People's Republic of China", all urban land is state-owned, and in rural and suburban areas shall be rural collective-owned, except for those that are state-owned as stipulated by law. City governments can expropriate rural land for public advantages. Development zones were mainly built by city governments on rural land expropriated at below-market prices. Within the zone boundaries, municipalities have acquired large tracts of collectively-owned land following a formal requisitioning procedure. The administration committee of the DZ then develops the now state-owned land by resettling the residents, paying compensation, destroying old construction, and installing new infrastructure. Plots developed in this way were eventually transferred to the zone's firms (Lu et al., 2019).

Outside the development zone, land use restrictions are strict and the approval process is complex. Still, local governments have considerable policy flexibility in expanding the scale of the land transfers within the DZ. The conversion of agricultural land and land expropriation in national economic and technological development zones can be reported to the State Council separately in batches. The provincial government can list the national DZs separately in the land use index, and give priority to the expansion or location adjustment of well-developed national DZs. Taking Lianyungang as an example, in the decomposition scheme of urban land use plan in 2018, the indicators of new construction land in Lianyungang economic-technological development zone and high-tech industrial development zone are listed separately. Furthermore, for DZs with better development and intensive land use, the annual new construction land quota should be given a moderate tilt.

Hypothesis 1. The development zone is an important spatial carrier to guide industrial agglomeration and boost urban economic growth; therefore, compared with NDZs, governments provide more policy preferences for the expansion of land transfer scale in DZs.

At the initial stage of development zone construction, land transfers were based on the agreement mode, which entailed the higher degree of government intervention than auction, bidding and listing. Transfers based on the agreement are often opaque, leading to corruption and rent-seeking, while also causing a serious waste of land resources. A large amount of land were transferred to firms through agreements mode, which means that more land were transferred at a lower price, resulting in the distortion of the market price of land factors and the risk of land mismatch.

However, the transfer of land resources gradually changed from planned allocation to market allocation, owing to the rapid development of market-oriented land transfer reforms. In 2002, 2004, and 2006, the Ministry of Land and Resources issued relevant regulations on the bidding, auction, and listing transfer of state-owned construction land, commercial and residential land, and industrial land. In 2006 and 2007, the relevant documents clearly stipulated that industrial land must be sold by bidding, auction, and listing, and the transfer price shall not be lower than the published lowest price standard, and for the same piece of industrial land, if and only if there is only one intended user, the city and county local governments can transfer it by agreement. This policies limit the government's authority to transfer industrial land by agreement mode. Since then, the proportion of industrial land transferred by agreement decreased significantly (Yang et al., 2014).

At present, there are four ways land can be transferred in DZs in China: bidding, auction, listing, and agreement. Significantly, the agreement mode are heavily regulated following the land market reform, and are applied only to a small proportion of land transfers. Listing has lower requirements regarding the number of bidding units than do auction and bidding, and the land transfer process is more straightforward. The listing mode is divided into two stages. If there are two or more bidders after the bidding at the first stage, the listing will enter the second stage. The government can set the threshold in the first stage to achieve the purpose of land supply. When only one bidder participates in the listing transfer, the agreement mode differs from the listing mode only in aspect: the price in the former mode is finalized through private negotiation, while the price in the latter mode must be quoted publicly on the Internet for transparency. Compared with auction and bidding, the degree of marketization of listing is relatively low.

The governments of all counties are actively establishing provincial-level DZs to attract firms to move in and form industrial agglomerations. The competition between the DZs encourages county governments to use their power to intervene in the market-oriented allocation of land by reducing the marketization degree. The lowered entry threshold enables low-efficiency firms to enter, resulting in the distortion of land allocation among firms. After 2007, the listing mode gradually replaced the agreement mode and became the primary mechanism for industrial land transfer, especially in DZs.

Hypothesis 2. Under the influence of fierce competition between DZs to attract investment, local governments intervene in the market-oriented allocation of land to attract firms to settle in a DZ by increasing the ratio of listing transfers, which reduces the marketization degree of land transfers.

The distortion of land transfers in DZs results in the distortion of land allocation among firms, which implies a failure in the flow of resources from inefficient firms to efficient firms and the deviation of location and investment decisions from the optimal level. The increase in productivity differences among firms, which leads to significant differences in land's marginal output between different regions or between different firms in the same area, mainly manifests as underutilized land, and is caused by the expansion of the scale of land transfers on the one hand and inefficient land use because of low-price transfers on the other.

In certain cases, DZs have become the primary way for local governments to occupy land, resulting in a large number of underutilized lands, which include approved but not requisitioned, requisitioned but not supplied, and supplied but not used spaces (Long et al., 2014). Therefore, many expropriated lands cannot be put into industrial production, nor can they be used for crop cultivation, resulting in a waste of resources. By contrast, the effect of marketization of industrial land transfers on the efficiency of manufacturing resource allocation is mainly reflected in the selection effect of industrial land among heterogeneous firms. Industrial land policy plays a vital role in determining the spatial distribution of manufacturing firms (Zheng and Shi, 2018). A reduction in the marketization of land transfer will weaken the screening effect of competitive pricing on firms with varying levels of efficiency, hindering the rational allocation of land among firms. Under the influence of a weakening competition effect, DZs will attract lower-efficiency firms and inhibit the improvement of the resource allocation efficiency of the manufacturing industry.

Hypothesis 3. Expanding the scale and reducing the marketization of land transfers will inhibit the improvement of manufacturing resource allocation efficiency, through a weakened competitive effect.

4. Data and processing

4.1. Data sources

This study utilized data from three sources. First, the *"China Development Zone Audit Bulletin Directory (2018)"* provided information on the time of establishment, approved area of DZs, and the county in which DZs were located, using the longitudinal and latitudinal coordinates of the management committee of the DZs.[3] Second, the China Land Market Network provided data on industrial land transfer.[4] Since 2007, the micro-data of industrial land leases can be obtained from the China Land Market Network. Third, the Annual Survey of Industrial Firms (ASIF) was used to retrieve the relevant data of manufacturing firms.[5] ASIF reports basic information pertaining to production and operational activities of all state-owned and non-state-owned industrial legal person firms above designated size,[6] which was last updated in 2013. Hence, the research period in this study is 2007–2012.

4.2. Measurement of resource allocation efficiency

The method of Olley and Pakes (1996) was used to measure the Total Factor Productivity (TFP) of firms. The traditional panel fixed effects method to estimate the TFP of the production function would have resulted in simultaneity bias and sample selectivity bias. The former is a more serious concern, in that the firm will adjust the input combination of production factors according to the current observable firm productivity status, which will lead to a correlation of the residual term representing the TFP and the regression term in the estimation, causing estimation bias. Further, there is no data on intermediate input in the Chinese industrial firm database after 2008. This study, therefore, uses

[3] Data source: The National Development and Reform Commission, https://www.ndrc.gov.cn/.

[4] Data source: The Ministry of Natural Resources, 2020, https://www.landchina.com.

[5] Data source: The National Bureau of Statistics, http://www.stats.gov.cn/.

[6] During 2007–2010, firms above designated size are defined as firms with annual revenue from principle business over RMB 5 million yuan. Since 2011, the standard was changed to RMB 20 million and above.

the Olley-Pakes method ("OP method") to estimate firms' TFP. The model form is as follows:

$$\mathrm{Ln}Y_{ft} = \varphi_0 + \varphi_k LnK_{ft} + \varphi_l LnL_{ft} + \varphi_a age_{ft} + \chi_{ft} \tag{1}$$

where, *Y, K, L,* and *age* represent output (measured by industrial added value), capital input, labor input, and age of the firm respectively; the subscripts *f* and *t* represent the firm and year, respectively. The proxy variable is the company's investment, *LnI*; the state variables are *LnK* and *age*; the independent variable is *LnL*, and the exit variable is adopted based on the business situation of the firm. The corresponding indicator data come from the ASIF (2007–2012), and the data processing mainly includes the following steps: (a) The present study draws on the methods of Brandt et al. (2012) and Yang (2015) to deal with outliers, and then uses the enterprise legal person code as the main basis, combined with the corporate's name and other information, to match and obtain unbalanced panel data[7]; (b) This study draws on Wang (2017), and uses the median of industrial added value in the total output value at the city-industry level to calculate the industrial added value for observations with missing years.

The present study further refers to Li et al. (2016) and Duranton et al. (2015) to decompose the total factor productivity, TFP_{ci}, into:

$$\begin{aligned} TFP_{ci} &= \sum_f \theta_{cif} tfp_{cif} = \overline{tfp_{ci}} + \sum_f (\theta_{cif} - \overline{\theta_{ci}})(tfp_{cif} - \overline{tfp_{ci}}) \\ &= ave\_tfp_{ci} + cov\_tfp_{ci} \end{aligned} \tag{2}$$

where the subscripts *c, i,* and *f* represent counties, industries, and firms, respectively. TFP_{ci} represents the overall productivity obtained by weighting the market shares of all firms in industry *i* in the county *c*. θ_{cif} is the weighting coefficient, which reflects the allocation of factors such as labor and capital among firms. tfp_{cif} is the productivity level of industry *i* and firm *f* in the county *c*; $\overline{tfp_{ci}}$ represents the average productivity of industry *i* in the county *c*, namely the unweighted part, denoted as ave_tfp_{ci}, which reflects the internal productivity of the firm. $\sum_f (\theta_{cif} - \overline{\theta_{ci}})(tfp_{cif} - \overline{tfp_{ci}})$ is the covariance between firm productivity and market share, denoted as cov_tfp_{ci}; a higher value indicates that high-efficiency firms receive a higher share of factors (Bartelsman et al., 2013). In this situation, counties are more efficient at resource allocation in this industry. Therefore, the equation for measuring the efficiency of resource allocation at the level of county and industry is as follows:

$$Rap_{ci} = \sum_f (\theta_{cif} - \overline{\theta_{ci}})(tfp_{cif} - \overline{tfp_{ci}}) \tag{3}$$

Due to the differences in the elasticity of labor-capital in different industries, the present study uses sub-industry samples to calculate firms' TFP. According to Eq. (3), the efficiency of resource allocation is calculated at county-industry level with the weight of labor share as the weight; the resource allocation efficiency at the county level is calculated based on the weighted share of the added value of each industry in the added value of the manufacturing industry, denoted as *Rap_i*. Furthermore, the present study uses the OP method to estimate the capital and labor elasticity of the whole industry sample, and then calculates the efficiency of resource allocation, *Rap_a*, as a robustness test.

4.3. Statistics of land transfer

In this study, we undertake a descriptive statistical analysis and compare the scale and mode of land transfers between newly established DZs in 2007–2012 and those counties that did not have any DZs before 2012. It can be seen from Table 1 that the average transfer scale (*Sca*) of newly established DZs is significantly higher than that of NDZs .

To compare the differences in land transfer listings between DZs and NDZs in different regions and cities, we calculated the proportional area of industrial land transferred by listing at the city level (*Ulp*) and development zone level (*Udp*) in the sample cities based on industrial land transfer data from 2007 to 2012. Furthermore, we calculated the proportion of individual development zones (*Dzp*) for a more detailed comparison. As shown in Table 2, the proportion of industrial land transferred by listing in DZs was higher than the proportion for the city. This indicates that development zones are more inclined to transfer industrial land by listing than non-development zones are. Individual development zone case data also support this result.

5. Empirical estimation

5.1. The impact of the establishment of DZs on land transfer

DZs in the sample period were established in batches, thus this study draws on the method of Beck et al. (2010) and uses staggered difference in difference method for estimation. The treatment group and the control group in the model are counties that have approved the establishment of DZs during the period 2007–2012 and those that have not yet approved the establishment of DZs before 2012[8], respectively.

5.1.1. Baseline model

The baseline model is as follows:

$$Sca_{ct} = \alpha Zont_{ct} + \omega X + \lambda_c + \nu_t + \varepsilon_{ct} \tag{4}$$

where, the explanatory variable, Sca_{ct}, measures the scale of land transfer of county *c* in year *t*; $Zont_{ct}$ is whether the county approved the establishment of DZs at the provincial-level or above in the current year. The value of $Zont_{ct}$ is 1 in the current year and subsequent years is approved, and the value of $Zont_{ct}$ is 0 before approval. The coefficient α of $Zont_{ct}$ is a core coefficient of particular importance here; it measures the average change in the scale before and after DZ establishment. λ_c and ν_t represent the fixed effect of county and time respectively, and ε_{ct}

Table 1
Comparison of the scale and mode of industrial land transfers between newly established DZs and NDZs (2007–2012).

Variable	Sample	N	Mean	Std	Min	Max
Sca	DZs	1147	3.353	1.452	-2.659	7.734
	NDZs	5957	2.744	1.669	-4.962	7.007
Sca1	DZs	511	1.337	1.894	-5.635	7.187
	NDZs	2780	1.368	1.889	-5.547	6.568
Sca2	DZs	164	1.520	1.736	-2.807	6.152
	NDZs	870	1.203	1.545	-3.477	6.734
Sca3	DZs	1072	3.247	1.459	-3.471	6.710
	NDZs	5014	2.691	1.612	-4.646	7.007
Lis	DZs	1099	0.948	0.189	0.000	1.000
	NDZs	5191	0.931	0.221	0.000	1.000
Lis_n	DZs	1099	0.947	0.186	0.000	1.000
	NDZs	5191	0.929	0.213	0.000	1.000

Note: *Sca* is the logarithm of the transferred area of industrial land; *Sca1*, *Sca2*, & *Sca3* represent the logarithm of the area of the land transferred by agreement, bidding and auction, and listing, respectively; *Lis* and *Lis_n* respectively measure the proportion of the area and number of listed lands in land transfer.

[7] Observations with missing, negative, and zero key indicators are deleted; observations with abnormal business operations are deleted; observations with less than eight employees are deleted; observations with abnormal important financial indicators are deleted.

[8] During the period 2007–2012, 158 approved national DZs were upgraded from provincial DZs. In order to estimate the net effect of the approval of DZs (at the provincial level and above) on land transfer, these 158 national DZs are not considered in the treatment group.

Table 2
Comparison of the proportion (by area) of industrial land transfers by listing between different spatial scales: The case of four cities (2007–2012).

Region	City	*Ulp* (%)	*Udp* (%)	Development Zone	*Dzp* (%)
East	Ningbo	66.57	76.37	Ningbo Economic & Technological Development Zone	97.69
West	Chengdu	98.60	98.99	Chengdu Economic & Technological Development Zone	98.97
Central	Anqin	93.75	97.87	Anqin Economic & Technological Development Zone	97.34
Northeast	Ha'erbin	73.27	84.15	Harbin-Limin Economic & Technological Development Zone	79.23

Note: *Udp* is calculated using the data of all national development zones within the sample city.
Source: Land transfer data from the Ministry of Natural Resources (https://www.landchina.com); The relationship between regions and cities is based on "Division Method of Eastern, Western, Central and Northeast Regions" published by the National Bureau of Statistics, (http://www.stats.gov.cn/).

represents the random disturbance term. *X* represents a series of control variables that affect the behavior of land transfer (Tian et al., 2019). *X* in this model includes characteristic variables at the city level and the county level. The variables at the city level are the logarithm of the per capita regional GDP, *Pgd* (which reflects the level of urban economic development); the proportion of the secondary industry in GDP, *Sec* (which measures the urban industrial structure); the ratio of fiscal expenditure to income in the local general budget, *Fipr* (which measure the financial pressure of the local government); and *Lasu,* the proportion of the urban construction land area to the land area of the municipal district (which represents the pressure of urban land supply). The characteristic variables at the county level are the degree of marketization, *Mar* (which is measured by the proportion of the output value of state-owned firms in the total output value of the county manufacturing industry); and the burden of the firm, *Tax* (which is measured by the proportion of the value-added tax payable by the firm in the main business income). In order to alleviate the endogeneity, the above control variables are all delayed for one period. The descriptive statistics of the variables are shown in Table 3.

In order to eliminate the estimation bias caused by the self-selection effect of DZs, this study adopts the propensity score matching method (PSM) to control the unobservable and time-invariant differences between the treatment group and the control group (Heckman et al., 1999). According to the research of Abadie (2010), the X_{ci} used to estimate the propensity score should not only affect the land transfer behavior, but also affect the decision-making of the DZs selection, thereby reducing the influence of sample self-selection effect on the empirical results.

Therefore, according to the principle of maximizing the goodness of fit, the matching vector includes the degree of marketization in the county last year, *Mar*. The higher the level of marketization in an area, the better the market environment it enjoys, which facilitates the process of approving the establishment of DZs. For the corporate tax, *Tax*, high firm tax burden that will cause operational risks, such as low capital liquidity and profit margins. It is more difficult to receive approval for establishing DZs in areas with high tax burdens. For the logarithm of the per capita GDP of the city where the county is located, *Pgd*, cities with economic solid tend to have a higher administrative level and the establishment of DZs is more likely to be approved. For the proportion of the secondary industry in GDP, *Sec*, DZs in China seek to attract manufacturing agglomeration; the higher the value of Sec in a city, the easier it is to set up a DZ there. The urban construction land area accounts for a proportion of the total land area in the municipal district, *Lasu*; cities with higher *Lasu* show greater economic potential, and it is easier receive approval to establish DZs in such cities.

Table 3
Descriptive statistics.

Variable	Sample size	Mean	Std	Min	Max
Rap_i	7914	0.193	0.206	-0.317	1.722
Rap_a	7914	0.167	0.174	-0.014	1.584
Pgd	8648	9.772	0.580	4.356	11.613
Sec	8644	0.502	0.102	0.159	0.910
Fipr	8664	0.456	0.219	0.054	1.256
Lasu	8664	0.107	0.132	0.000	0.972
Mar	8444	0.161	0.253	0.000	1.000
Tax	8438	0.031	0.021	-0.397	0.186

This study uses the staggered difference in difference method from the method of Heyman et al. (2007), and use the year-by-year matching method to find the corresponding control group for each year's treatment group. Using 2010 as an example, the present study uses matching variables to estimate the probability value of the selection, and then uses kernel matching to match propensity scores. Table 4 reports the logistic regression results and propensity score matching balance test. After matching, the standard deviation of all variables is significantly reduced, and the difference between the treatment group and the control group is insignificant, which means that the comparability of the two groups of samples after matching is greatly enhanced. This ensures the randomness of sample processing and improves the explanatory power of the estimated results.

Based on the PSM estimation, the staggered difference in difference method is used to regress the benchmark model. The results are shown in Table 5. The explained variables are the logarithms of the scale of land transfer. The regression results all show that the regression coefficient of the variable *Zont* is positive, and all have passed the significance test, indicating that the approval of DZs has expanded the scale of industrial land transfer. After adding control variables, the sign and significance of the regression coefficient did not change. The regression coefficient of the item of time trend is significantly positive, which indicates that during the sample period, as the time for the establishment of DZs to be approved increases, the extent of the expansion of the scale of land transfer by the local government also increases.

In the above regression, the PSM makes no significant difference in the scale of land transfer between counties with the DZs and counties without the DZs in the regression sample before the establishment of DZs, but the possibility that the change rate of the scale of land transfer in DZs is faster cannot be ruled out. Therefore, to test whether there is an overestimation of the policy effect brought about by the faster rate of change in the scale of land transfer in the counties with the DZs, a parallel trend hypothesis test is needed, and at the same time the dynamic effect of the establishment of the DZs on the scale of land transfer is estimated. This study sets the following estimation model, as shown in Eq. (5):

$$Sca_{ct} = \sum_{m=1}^{5} \beta_{-m} Zdi_{ct}^{-m} + \sum_{n=1}^{5} \gamma_n Zdi_{ct}^{n} + \omega X + \lambda_c + \nu_t + \varepsilon_{ct} \tag{5}$$

In the above Equation, the first two items on the right side represent the dummy variables before and after the DZs are set. The first item represents the dummy variables *m* years before the DZs are set. When *t-set_year* (time approved by the DZs) is equal to *m*, Zdi_{ct}^{-m} is 1, otherwise, Zdi_{ct}^{-m} is 0; the second item is the dummy variable for the *n*th year after DZ is set. When *t-set_year* is equal to *n*, Zdi_{ct}^{n} is 1, otherwise, Zdi_{ct}^{n} is 0. In the sample time period, the earliest approval time of the DZs is 2007, and the latest is 2012. Therefore, the data for the 5 years before and 5 years after the approval of DZs can be obtained. β_{-m} 、 γ_n respectively measure whether there is a significant difference in the scale of land transfer between the counties of the DZs and the counties of the NDZs before and after the establishment of DZs. They mainly concern coefficient for parallel trend hypothesis testing, where the dynamic changes of the impact of the establishment of DZs on the scale of land transfer can

Table 4
Test results of propensity score matching balance in 2010.

Variable	Sample	Mean		Std (%)	Absolute value reduction of standard deviation (%)	T statistic	P-value
		Treatment group	Control group				
Pgd	*Before matching*	9.712	9.822	-22.9	88.6	-2.21	0.028
	After matching	9.712	9.699	2.6		0.21	0.834
Sec	*Before matching*	0.538	0.510	28.6	93.2	2.97	0.003
	After matching	0.536	0.534	1.9		0.16	0.876
Lasu	*Before matching*	0.158	0.097	44.1	96.7	4.88	0.000
	After matching	0.147	0.145	1.5		0.09	0.926
Mar	*Before matching*	0.136	0.178	-18.1	86.3	-1.70	0.089
	After matching	0.139	0.133	2.5		0.21	0.833
Tax	*Before matching*	0.041	0.024	79.2	92.5	9.90	0.000
	After matching	0.039	0.038	5.9		0.42	0.675

Note: It is generally required that the standard deviation after matching does not exceed 10%.

Table 5
Regression results of the impact of the DZs establishment on land transfer scale.

Variables	(1) *Sca*	(2) *Sca*	(3) *Sca*	(4) *Sca*
Zont	0.167**	0.619***	0.170**	0.163**
	(0.066)	(0.062)	(0.066)	(0.066)
Pgd		0.534**	0.054	0.037
		(0.248)	(0.127)	(0.125)
Sec		4.900***	1.278	1.487*
		(0.974)	(0.910)	(0.891)
Fipr		0.229	0.667*	0.485
		(0.345)	(0.344)	(0.330)
Lasu		0.802***	-0.018	0.030
		(0.310)	(0.320)	(0.318)
Mar		0.329*	0.339**	0.359**
		(0.175)	(0.170)	(0.168)
Tax		-4.865***	-0.180	-0.690
		(1.639)	(1.203)	(1.226)
County FE	YES	YES	YES	YES
Time FE	YES	NO	YES	NO
Time trend				0.207***
				(0.014)
Observations	6858	6761	6761	6761
R-squared	0.109	0.058	0.111	0.105
Number of counties	1387	1387	1387	1387
F	91.030	36.890	46.230	64.230

Note: In Column 1, only *Sca* is used as the explained variable in the regression, and the county and time fixed effects are controlled; in columns 2–4, control variables at the county and city levels are added; in Column 2, only the county fixed effects are controlled; in Column 3, both county and time fixed effects are controlled; in Column 4, the county fixed effect is controlled, and an item for time trend is added. The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively.

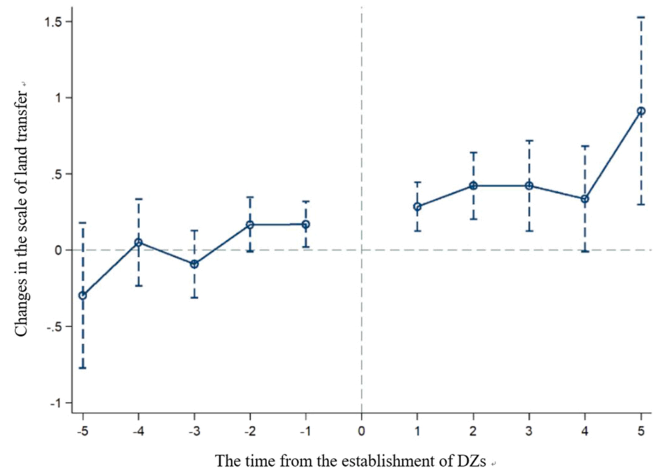

Fig. 2. Parallel trend test.

be observed. Based on the results shown in Fig. 2, the estimated coefficient fluctuates around 0 before the establishment of DZs, but is significantly positive after the establishment of the DZs, which indicates that the scale of land transfer between the county with special economic zone and the county with NDZs has no significant difference before the DZs are set. Therefore, the possibility that the hypothesis of parallel trends holds cannot be rejected. After the establishment, the impact on the expansion of the scale of land transfer gradually increased, which is consistent with the results shown in the item of time trend in column 4 of Table 5.

This study also uses PSM and the staggered difference in difference method to estimate the impact of the establishment of the DZs on land listing. Based on the results are shown in Table 6, *Zont*'s regression coefficient is positive, and all have passed the significance test, indicating that the establishment of the DZs increases the proportion of industrial land listed and reduces the degree of marketization of land transfer.

Table 6
Regression results of the impact of the DZs establishment on land transfer methods.

Variables	(1) *Lis*	(2) *Lis*	(3) *Lis*
Zont	0.027**	0.026**	0.022*
	(0.012)	(0.012)	(0.012)
County FE	YES	YES	YES
Time FE	YES	YES	NO
Control variables of cities and counties	NO	YES	YES
Time trend			0.016***
			(0.002)
Observations	6068	5987	5987
R-squared	0.035	0.037	0.028
Number of counties	1364	1361	1361
F	13.280	6.812	8.838

Note: The explanatory variable in columns 1–3 is the proportion of listed area for sale, *Lis*. In Column 1, only *Lis* is used as the explained variable for the regression, and the county and time fixed effects are controlled. Then, the control variables at the county and city levels are added in columns 2 and 3; the county and time fixed effects are controlled in Column 2 and the item of time trend is added in Column 3. The space is limited, only the regression results of key explanatory variables are reported, the same below.

5.1.2. *Heterogeneity analysis*

5.1.2.1. Heterogeneity of the DZs. The treatment group was divided into sub-samples at the province level according to the type of DZs. The propensity score matching and the staggered difference in difference method are performed on the sub-samples. The results are shown in Table 7. The analysis shows that by comparing the regression

Table 7
Regression results of the heterogeneity of the development zones (DZs).

	National DZ		Provincial DZ		Considering the size of the DZ	
	(1)*Sca*	(2)*Lis*	(3)*Sca*	(4)*Lis*	(5)*Sca*	(6)*Lis*
Zont	0.140	-0.025	0.182**	0.030**	0.293***	0.026**
	(0.145)	(0.032)	(0.071)	(0.013)	(0.071)	(0.013)
*Zont * Zsc*					-7.930***	0.012
					(1.171)	(0.261)
Observations	4246	3734	6538	5775	6749	5975
R-squared	0.088	0.029	0.111	0.040	0.114	0.037
Number of counties	867	848	1350	1323	1385	1359
F	23.620	4.007	44.320	6.774	45.020	6.248

Note: The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively. The fixed effects of counties and times are controlled in the model.

coefficients of the two sub-samples, the establishment of provincial DZs has a greater effect on the scale of industrial land transfer and the degree of marketization of industrial land transfer than national DZs. A possible reason for this is that the establishment of DZs at the national level reflects the national-level regional development strategy, and its policies are formulated by the central government. By contrast, provincial DZs cover all types of DZs approved by the provincial government, whose policies are mainly formulated by local governments. They are more affected by the policy intentions of local governments. Driven by the "competition"-style promotion mechanism, fierce competition among provincial DZs drives the city and county governments to continuously expand the scale of industrial land transfer in provincial DZs and reduce the degree of marketization of land transfer to achieve the purpose of attracting investment.

This study also uses the area approved by the DZs to account for the administrative area of the county, *Zsc,* to indicate the scale of the DZs, and incorporates the intersection term with the core explanatory variable *Zdi* into the measurement model. The results in column 5 and 6 of Table 7, find that as the proportion of the approved area of the DZs in the administrative area of counties increases, the impact of the establishment of the DZs on the expansion of land transfer scale significantly weakens. The reason may be related to the land transfer structure. Wang and Cui (2003) pointed out that the operating expenses and land development fees of the DZs depend on the income from commercial and residential land transfer, and county finances also need to make up for the loss of low-priced industrial land transfer through high-priced commercial and residential land transfer (Tao et al., 2009). When the newly established DZs occupies a larger administrative area of the county, the preferential land price policy in the DZ will increase, however, with the higher price, the scale of the DZ will have a "crowding effect" on the land resources of NDZs in the counties. The county government expands the proportion of commercial and residential land transfer within the DZ to obtain the corresponding fiscal revenue, thereby weakening the incentives for industrial land transfer in the zone.

5.1.2.2. Heterogeneity of city size. Table 8 reports the impact of the establishment of DZs on local land transfer under different urban scales. This study categorizes the sample cities into three categories on the basis of the "Notice on Adjusting the Standards for Urban Size Classification" issued by the State Council in 2014. Small-sized cities are defined as cities with a permanent population of less than 500,000 in urban areas; medium-sized cities with a population of 500,000–1 million; and large-sized cities with a population of more than 1 million.[9] The estimation results show that the impact of the establishment of the three types of urban DZs on land transfer is consistent with the benchmark regression, but only in the sub-sample regression of the medium-sized cities; all have passed the significance test.

The urban economy is affected by the agglomeration effect and congestion costs (Krugman, 1991). For DZs in large cities, the selection effect created by firms' competition is an important way to improve productivity (Combes et al., 2012) and big cities are mainly service-oriented, which weakens local governments' motivation to attract industrial firms by intervening in land transfer. Compared with DZs in medium-sized cities, DZs in small cities have poorer development endowments and weaker firm competition, so the price of industrial land is relatively lower. Small city governments do not need to transfer industrial land at a disguised low price through intervention. Since most DZs in medium-level cities are in the stage of rapid industrial development, land prices are relatively high. This promotes local governments to adopt more listing transfers to reduce firms' entry costs.

Furthermore, column 7 and 8 in Table 8 report the results of re-estimation after adding the intersection term between the establishment of the DZs, *Zont*, and the urban population logarithms, *Cpop*. The coefficient of the intersection term on the scale of land transfer is significantly negative at 1% confidence level, indicating that the strength of the DZs establishment to expand the scale of land transfer weakens with the increase of the city scale. A possible reason is that, compared with small and medium-sized cities, large cities have relatively small amounts of construction land for use. For example, Beijing has been at the stage of intensive development for volume reduction, and the proportion of production space in the land supply will decrease, leading to a weaker effect of the establishment of the DZs on the expansion of land transfer.

5.1.2.3. Heterogeneity of the region. Different regions have different natural endowments, historical accumulations, and policy systems, which are likely to affect the intensity of the DZs' policies on land transfer behavior of local governments. This study further divides the sample counties into sub-sample regression. According to the common Chinese regional division standard, the sample of this article should be divided into four regions: east, mid, west and northeast for regression. However, the sample size is not enough to meet the matching requirements when matching the northeast sub-samples year-by-year. Therefore, this section divides the sample into two sub-samples, the eastern coastal region, and the mid-western and the northeastern region, to perform propensity score matching and staggered difference in difference method results. The estimation results are shown in Table 9.

The establishment of DZs in the central, mid-western, and the northeastern region expanded the scale of land transfer and increased the ratio of listed transfers. The regression coefficient is significant at the 1% confidence level, while the establishment of the DZs in the eastern coastal areas had no significant impact on land transfer behavior. There are some possible reasons for this occurrence. First, the central government implemented a land use policy favoring the mid-western and

[9] Large-sized cities include large-sized cities, very large-sized cities, and super large-sized cities. Since the number of very large-sized cities and super large-sized cities are small, they are classified as large-sized cities and discussed together. The number of permanent residents in the urban area comes from "China Urban Construction Statistical Yearbook (2010)" published by The National Bureau of Statistics.

Table 8
Regression results of different city size.

	Small-sized city		Medium-sized city		Large-sized city		Considering the size of the city	
	(1)*Sca*	(2)*Lis*	(3)*Sca*	(4)*Lis*	(5)*Sca*	(6)*Lis*	(7)*Sca*	(8)*Lis*
Zont	0.223*	0.021	0.243**	0.042*	0.132	0.009	1.020***	0.036
	(0.133)	(0.018)	(0.108)	(0.022)	(0.111)	(0.025)	(0.307)	(0.044)
*Zont * Cpop*							-0.193***	-0.002
							(0.065)	(0.010)
Observations	2493	2249	2239	1998	1942	1663	6761	5987
R-squared	0.143	0.035	0.147	0.054	0.060	0.030	0.113	0.037
Number of counties	524	518	455	446	387	374	1387	1361
F	23.860	3.046	20.130	2.774	7.415	2.277	43.050	6.292

Note: The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively. The fixed effects of counties and times are controlled in the model.

Table 9
Regression results of different regions.

	Eastern region		Mid-western and Northeastern regions	
	(1)*Sca*	(2)*Lis*	(3)*Sca*	(4)*Lis*
Zont	0.009	-0.004	0.252***	0.043***
	(0.109)	(0.025)	(0.082)	(0.014)
Observations	1784	1578	4935	4374
R-squared	0.111	0.042	0.115	0.039
Number of counties	345	338	1032	1012
F	10.110	2.367	38.470	6.011

Note: The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively. The fixed effects of counties and times are controlled in the model.

Table 10
Robustness test.

	Changes in the study period		The sample includes the provincial development zone upgrading to a national development zone		Changes in indicators
Variables	(1)*Sca*	(2)*Lis*	(3)*Sca*	(4)*Lis*	(5)*Lis_n*
Zont	0.195**	0.034**	0.119**	0.012	0.023*
	(0.079)	(0.015)	(0.057)	(0.010)	(0.012)
Observations	5107	4429	7534	6718	5987
R-squared	0.101	0.043	0.114	0.037	0.047
Number of counties	1273	1237	1526	1497	1361
F	37.330	7.226	52.380	6.955	7.816

Note: The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively. The fixed effects of counties and times are controlled in the model.

the northeastern region in terms of the spatial distribution of land for regional balanced development (Lu et al., 2015), resulting in a tense relationship between land supply and demand in the eastern coastal areas, generally facing embarrassing situations of "no land available", giving rise to gray and even illegal land use (Tan, 2014). Further, the establishment of the DZs has no significant impact on land supply of local government. Second, from the perspective of industrial demand, the central and western regions have a greater degree of deviation from their own comparative advantages in their industrial policy choices than the eastern regions, and are inclined to follow key industrial policies of the central government (Zhao and Chen, 2019); consequently, land demand corresponding to the industries in eastern DZs are more stable.

5.1.3. Robustness test

We conducted a robustness test of the benchmark regression results from different perspectives, including changing the research period, increasing the sample of the DZs, replacing the measurement indicators of the land transfer method, and re-testing the model. The results are shown in Table 10. The selection of the research period will have an impact on the sample size of the DZs, which in turn may affect the estimation results.

Firstly, this section adjusts the research period to 2007–2011 to investigate whether the adjustment of the research period affects the empirical results and improve the robustness of the conclusions. We use propensity score matching and staggered difference in difference method and the results are shown in Table 10, column 1 and 2. The adjustment of the research period did not affect the conclusion, and the establishment of DZs significantly expanded the scale of land transfer and increased the proportion of listed transfers.

Secondly, in the benchmark regression, the treatment group did not consider the 158 national DZs that were upgraded from provincial DZs during 2007–2012, to estimate the net effect of the approval of provincial and above DZs on land transfer. However, an upgrade from provincial-level DZ to a national-level DZ, will increase significantly the preferential policies enjoyed, impacting land transfer behavior. In the robustness test, we add the 158 national-level DZs formed by provincial-level upgrades to the sample of the treatment group and re-estimate. The results show that although the estimated coefficient of the proportion of listed sales is not significant, the signs of the core explanatory variables are consistent with the benchmark regression results, and the conclusions are relatively robust. In addition, this study also replaces *Lis*, the proportion of the listed area for transfer, with the proportion of the number of listed transfers, *Lis_n*, to measure the land transfer method, and the estimated coefficient is still significantly positive.

5.2. The impact of land transfer on the efficiency of manufacturing resource allocation

The above analysis has examined the impact of the establishment of the DZs on the scale and method of industrial land transfer. Under the incentive of investment promotion, local governments will expand the scale of land transfer and increase the proportion of listed transfers. However, the effects of expansion of the scale of land transfer and the reduction of marketization have not been assessed. In particular, how do these two factors affect the efficiency of resource allocation in manufacturing?

To this end, this section discusses the impact of the scale and method of land transfer on the efficiency of manufacturing resource allocation. Considering that there is a strong correlation between the scale of land transfer and the degree of marketization of land transfer, the two variables are applied to the regression model. After obtaining the right to use industrial land, most projects require about two years to complete factory construction and officially enter production and operation (Yang et al., 2014). Therefore, the return of land transfer indicators lags two phases. The estimated model is as follows:

$$Rap_{ct} = \beta_1 L2.Sca_{ct} + \omega X + \lambda_c + \nu_t + \varepsilon_{ct} \quad (6)$$

$$Rap_{ct} = \beta_2 L2.Lis_{ct} + \omega X + \lambda_c + \nu_t + \varepsilon_{ct} \tag{7}$$

where X represents a series of control variables that affect the efficiency of resource allocation in the manufacturing industry, including the degree of marketization of the county in the previous year, *Mar*; the proportion of foreign-funded firms' output value, *For*; the corporate asset-liability ratio, *Lev*; corporate tax burden, *Tax;* corporate management burden, *Man*; the degree of the optimization of manufacturing structure, *Tec*; the logarithm of the per capita GDP of the city where the county is located, *Pgd*; the proportion of the secondary industry in GDP, *Sec*; and whether the administrative approval center has been established that year, *Gov*. Changes in the scale and method of land transfer will affect the efficiency of manufacturing resource allocation through its impact on resource allocation, whereas the differences in the efficiency of the allocation of manufacturing resources in counties will affect the land transfer behavior of local government, which will cause simultaneous biases. Two-period lagging processing of independent variables can alleviate the simultaneous bias problem. Nonetheless, some variables that are difficult to observe accurately are omitted in Eqs. (6) and (7), which may cause endogenous problems. Therefore, it needs to be controlled by instrumental variables. A suitable instrument variable (IV) must meet two conditions: (a) related to the scale and method of land transfer; (b) not related to the random error term.

This study selects the proportion of flat land in counties, *Gen*, as the instrumental variable of the scale of land transfer (*Sca*). To measure Gen, we first use ArcGIS to calculate the number of grids with a slope of less than 15° in the city and the total number of grids, and obtain the proportion of flat land in each county. The flatter the counties, the easier it is to increase the land transfer scale.

In addition, we use the geographic conditions, *Gco*, as the instrumental variable of ratio of land listing (*Lis*). *Gco* is measured by the logarithm of the shortest distance between counties and national central cities.[10] According to Harris (1954), national central cities have a higher market potential. The spillover effect of the national central city is attenuation with geographical distance (Anselin and Getis, 1992; Moreno et al., 2005), resulting in a development disadvantage for the region which is far away from the national central city, and it's further affecting the local government's land transfer strategy. As argued by Wang and Yang (2016), local governments with poor locations are more motivated to achieve targeted supply at low prices by intervening in land transfer, which lead to a relatively high listing proportion. Consequently, the city has a higher listing proportion with a higher *Gco*.

Gen and *Gco* do not change with time. To reflect the dynamic characteristics, we use the lagged period of the per capita disposable income index of urban households to adjust to obtain the instrumental variable, *Genct* and *Gocct*, which is strictly exogenous and is not affected by the efficiency level of manufacturing resource allocation.

This study uses the *underidentification test* (Angrist and Pischke, 2009) and *weak identification test* (Stock and Wright, 2000) to test the validity of instrumental variables. Table 11 reports the regression results of the two-stage least square (2SLS) method after using instrumental variables, showing that *Genct* passed the test, and is statistically valid. In Table 11, panel A is the regression result of the first stage, and panel B is the regression result of the second stage. The explained variables of panel A are the scale of land transfer and the listing ratio. It is observed that the proportion of flat land is highly correlated with the scale of land transfer and the proportion of listing. Combining the results of the *weak identification test* can eliminate the possibility of weak instrumental variables. The *p-value* of the *LM statistic* of the *underidentification test* is 0, which effectively rejects the hypothesis of insufficient identification of the instrumental variable. The second-stage regression results reported on panel B show that expanding the scale of land transfer and increasing the proportion of listed transfers will reduce the efficiency of manufacturing resource allocation; the significance test is successful at 1% confidence level.

Table 11
2SLS regression results.

	(1)	(2)
Panel A: Phase 1	*L2.* Sca_{ct}	*L2.* Lis_{ct}
Genct	0.024***	
	(0.006)	
Gcoct		0.018***
		0.000
F statistics	16.08	59.25
Panel B: Phase 2	Rap_i_{ct}	Rap_i_{ct}
$L2.Sca_{ct}$	-0.122***	
	(0.037)	
$L2.Lis_{ct}$		-0.354***
		(0.090)
Underidentification test (LM statistics)	16.046	58.001
p-value	0.000	0.000
Weak identification test	16.080	59.251
Observations	4184	3361
Number of counties	1317	1076

Note: limited space, the table only reports the regression results of key explanatory variables, the same below.

The robustness of the conclusions is verified from three aspects, changing the lag order of land transfer, adopting different resource allocation efficiency estimation methods, and replacing the measurement indicators of the scale and method of land transfer (see Table 12). The choice of the lagging order of the land transfer index may have an important impact on the empirical conclusion, as such, this study selects the lagging one and three lagging periods of *Sca* and *Lis* to re-estimate. The estimation results show that the signs of the estimated values of β_1 and β_2 obtained by the above two lag orders are consistent with the baseline estimation, and both have passed the significance test. Secondly, *Rap_a* is used to replace *Rap_i* to re-estimate; the result is consistent with the baseline estimation result, and the conclusion is robust. In addition, this study replaces the core explanatory variables representing the scale and method of land transfer with the area of listed land *Sca3* and the ratio of the number of listed transfers to the land transfer *Lis_n*. After re-estimating the model, the results are still consistent with the benchmark estimation results, indicating that the benchmark regression results are robust.

6. Mechanism inspection

This study further uses micro-firm samples to reveal the mechanism underlying the effect of land transfer scale and the degree of marketization in counties with DZs on resource allocation efficiency from the perspective of heterogeneous firm entries and exits.

6.1. The perspective of firm entry

This study considers the impact of the establishment of the DZs in counties of land transfer scale and the degree of marketization of land transfer on the number of new firms. We use the year of establishment, as the standard to identify industrial firms formed that year, as new firms, and divide the sample into high-efficiency firm samples and low-efficiency firm samples according to the firm median (P50), and then respectively count the number of high-efficiency firms, *Fnh*; the number of new firms and the number of inefficient new firms *Fnl*. Since the number of new firms with different efficiency is a non-negative integer, it has the significance of ranking, and the sample variance is much larger than the mean, which is characterized by excessive dispersion. This study adopts a negative binomial regression model to estimate the

[10] According to the "National Urban System Planning (2010–2020)" document issued by the Ministry of Housing and Urban Rural Development, the national central cities include Beijing, Tianjin, Shanghai, Guangzhou, and Chongqing.

Table 12
Robustness test.

	Changes in the lag order of land transfer				Replacement of resource allocation efficiency		Replacement of transfer area	Replacement of listing ratio
	Rap_i	*Rap_i*	*Rap_i*	*Rap_i*	*Rap_a*	*Rap_a*	*Rap_i*	*Rap_i*
L1.Sca	-0.064*** (0.015)							
L1.Lis	*L1.lis*		-0.169** (0.070)					
L3.Sca			-0.124** (0.052)					
L3.Lis				-0.442*** (0.149)				
L2.Sca					-0.112*** (0.033)			
L2.Lis						-0.336*** (0.078)		
L2.Sca3							-0.063*** (0.013)	
L2.Lis_n								-0.347*** (0.086)
N	5315	4574	2788	2130	4072	3361	3200	3361
Number of counties	1279	1195	1043	851	1205	1076	1046	1076
F	5.794	5.050	2.047	3.807	2.722	4.893	5.061	3.940

Note: The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively.

impact of the scale of land transfer and the degree of marketization on the number of new firms with different efficiency in the DZs. The model is as follows:

$$Fnh_{ct} = exp(\alpha_0 + \alpha L2.T_{ct} + \omega L.X_{ct}) + \zeta_{ct} \tag{8}$$

$$Fnl_{ct} = exp(\varphi_0 + \varphi L2.T_{ct} + \varnothing L.X_{ct}) + \tau_{ct} \tag{9}$$

where, the subscript *c* represent the city, *t* represent the year, α_0、 φ_0 are constant terms, and, ζ_{ct}、 τ_{ct} are random error terms. The explained variable is the number of newly formed firms with different efficiency levels in the counties of the DZs; T_{ct} is the core explanatory variable, which includes the scale of land transfer, *Sca*, and the degree of marketization in the counties of the DZs, *Lis*; *X* is the corresponding control variables, which specifically includes the logarithm of per capita regional GDP, *Pgd*, whether the administrative approval center was established that year, *Gov*, the degree of marketization, *Mar*, and the degree of openness, *For*. The control variables were processed with a one-period lag.

Considering the errors caused by the division standard of firm efficiency, a comprehensive negative binomial regression model is used to estimate the impact of the number of new firms sampled in different efficiency quantile intervals to improve the robustness of the regression results. The results are shown in Table 13. Columns 1–4 are the regression results of the number of new firms considering the scale of sample land transfer in the DZs and the corresponding control variables. From the results in column 1, the regression coefficient of *L2. Sca* is significantly 0.024 at the 1% confidence level, indicating that the scale of land transfer can be expanded by 1% and 0.024 low-efficiency firms can be established. For the sample of high-efficiency firms in the [P50, P100] interval indicated by the results in column 2, the effect of land transfer scale is not significantly negative, indicating that increasing the scale of land transfer has a certain deterring effect on the establishment of high-efficiency firms. The results of the samples of firms in the interval of [0, P25] and [P75, P100] are robust. Therefore, results show that the expansion of the scale of land transfer in the counties of the DZs will significantly increase the number of low-efficiency firms established in the counties.

The regression results of the number of new firms in counties (Column 5 and 8, Table 13), considering the degree of marketization of land transfer in the DZs samples, show that the regression coefficient of *L2. Lis* is significant (0.129) at the 1% confidence level, indicating that an increase in the proportion of listed land for sale by one percentage point will bring in 0.129 low-efficiency companies. For the sample of high-

Table 13
Estimation results of the negative binomial model for the number of new firms.

Variables	(1) < P50 *Fnl*	(2) > P50 *Fnh*	(3) < P25 *Fnl*	(4) > P75 *Fnh*	(5) < P50 *Fnl*	(6) > P50 *Fnh*	(7) < P25 *Fnl*	(8) > P75 *Fnh*
L2.Sca	0.024** (0.011)	-0.002 (0.013)	0.048*** (0.016)	0.009 (0.013)				
L2.Lis					0.129** (0.065)	0.099 (0.071)	0.164* (0.092)	0.115 (0.082)
L1.Mar	0.159 (0.115)	0.163 (0.138)	0.285* (0.161)	0.010 (0.135)	0.169 (0.120)	-0.134 (0.126)	0.391** (0.172)	-0.124 (0.143)
L1.For	-0.620** (0.270)	-0.318 (0.311)	-0.662* (0.363)	-0.007 (0.273)	-0.786*** (0.275)	0.074 (0.242)	-0.765** (0.372)	-0.070 (0.272)
L1.Pgd	0.058 (0.151)	0.048 (0.181)	0.416*** (0.158)	0.533*** (0.176)	-0.050 (0.152)	0.505*** (0.155)	0.350** (0.160)	0.423** (0.196)
L1.Gov	0.001 (0.098)	0.049 (0.120)	0.064 (0.130)	0.184* (0.111)	-0.060 (0.114)	0.040 (0.111)	0.067 (0.147)	0.178 (0.128)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
County FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1322	1309	1294	1335	1135	1145	1106	1145

Note: The standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively.

efficiency firms in the interval of [P50, P100], the effect of land transfer scale is not significantly positive, and the value is smaller than the regression result of low-efficiency firms. The results of the samples of firms in the interval of [0, P25] and [P75, P100] are robust. Therefore, the reduction in the degree of marketization of land transfer in the DZs will significantly promote the entry of low-efficiency firms.

6.2. The perspective of firm exit

This section explores the elimination mechanism of incumbent firms by the establishment of the scale of land transfer in the DZs in counties from the perspective of firm exit. First, the sequential identification method is adopted to identify the exit of sample firms in the DZs in counties within the research period. The failure of the firm or the size of the firm under the standard scale of the ASIF is regarded as a failure. Since it is not possible to know the specific time of failure in the future, for companies that have not failed up until 2012 (the study period), the sample has the characteristic of "right censoring." Drawing lessons from the relevant research of Huang and Gan (2010), the Cox proportional hazard model is selected to estimate the survival probability of firms in different regions. The model assumes that the explanatory variable can be multiplied by the baseline risk function, and the death risk function of the observation value i is:

$$h(t|x_i) = h_0(t)\exp\boxed{f_0}(x_i\beta) \tag{10}$$

where, β is a vector with estimated coefficient, and the basic hazard rate function when other variables represented by $h_0(t)$ are 0 at the same time. Since there is no special requirement for the relationship between the hazard function and time t, it can be in any form, which is the advantage of the semi-parametric Cox model compared with the parametric survival analysis model. $\exp\boxed{f_0}(x_i\beta)$ is the relative risk. The lagging two phases of land transfer scale are divided into low transfer scale samples as the control group, according to the median level, and the high transfer scale samples as the treatment group, denoted as *Scag*. Similarly, according to the median level, the lagging two phases of the marketization of land transfer are divided into samples with a high degree of marketization as a control group, and samples with low degree of marketization as the treatment group, denoted as *Lisg*. Considering the impact of key variables on the model estimation results, the control variables at the firm level are selected including: management expense burden *Manf,* tax burden *Taxf,* debt burden *Levf,* firm size type *Sizf,* firm ownership *Typf,* and control the industry fixed effect of the firm. In addition, the urban per capita GDP level *Pgd* is selected as the control variable at the city level to control further the differences at the city level.

The regression results of the Cox risk estimation model are shown in Table 14. Columns 1–4 are the regression results considering the scale of sample land transfer in the DZs and the corresponding control variables on the risk of firm elimination. The results listed in column 1 and column 2, show that increasing the scale of land transfer can reduce the risk of the firm sample in the [0, P50] interval at the 1% confidence level, which is $\exp(-0.1577) = 0.8541$ times than it should be in the interval. The risk of firm elimination is reduced by 14.59%. For the sample of high-efficiency firms in the range of [P50, P100], the effect of the scale of land transfer at the 10% confidence level can reduce the risk of firm elimination by 4.83%, indicating that increasing the scale of land transfer has a stronger effect on reducing the risk of firm elimination for low-efficiency firms. To enhance the robustness of the results, the samples of firms in the interval of [0, P25] and [P75, P100] are respectively considered, and the conclusions are consistent. Therefore, the expansion of land transfer in the DZs will significantly increase the survival probability of low-efficiency firms.

7. Conclusions

DZs are an essential channel for urban economic agglomeration, which have grown popular and have been pursued by many governments worldwide over the past several decades. It is necessary to acknowledge the leading role of DZs in improving the quality and efficiency of the manufacturing industry. Land transfer is an important policy tool for DZs to guide the allocation of industrial resources. The immovability of land and its high cost of reallocation render it challenging to remedy any efficiency loss caused by the misallocation of land resources. This study used propensity score matching, the staggered difference in difference method, and the instrument variable regression model to investigate the impact of land transfer in DZs on the efficiency of resource allocation among manufacturing firms. The research found

Table 14
Cox model estimation results of firm elimination risk.

Variables	(1) < P50 Sample of low-efficiency companies	(2) > P50 Sample of high-efficiency companies	(3) < P25 Sample of low-efficiency companies	(4) > P75 Sample of high-efficiency companies	(5) < P50 Sample of low-efficiency companies	(6) > P50 Sample of high-efficiency companies	(7) < P25 Sample of low-efficiency companies	(8) > P75 Sample of high-efficiency companies
L2.Scag	-0.158***	-0.050*	-0.137***	-0.040				
	(− 7.425)	(− 1.675)	(− 4.990)	(− 1.017)				
L2.Lisg					-0.062***	-0.020	-0.115***	-0.018
					(− 2.591)	(− 0.598)	(− 3.740)	(− 0.392)
L.Manf	-1.340***	-2.112***	-1.329***	-2.098***	-1.090***	-1.852***	-1.074***	-1.588***
	(− 5.670)	(− 7.173)	(− 4.261)	(− 5.451)	(− 4.681)	(− 6.363)	(− 3.518)	(− 4.080)
L.Taxf	1.499***	0.665	3.107***	0.622	1.448***	0.798	3.013***	0.431
	(3.430)	(1.133)	(5.449)	(0.776)	(3.371)	(1.373)	(5.349)	(0.544)
L.Levf	-0.047***	0.003	-0.078***	-0.005	-0.043***	0.005	-0.077***	0.004
	(− 5.297)	(0.314)	(− 4.873)	(−0.398)	(− 4.875)	(0.508)	(− 4.985)	(0.312)
L.Sizf	0.233***	0.333***	0.039	0.303***	0.207***	0.345***	0.009	0.323***
	(5.715)	(11.544)	(0.706)	(8.143)	(5.251)	(11.965)	(0.171)	(8.627)
Typf	-0.136***	-0.344***	-0.105	-0.378***	-0.144***	-0.300***	-0.107*	-0.322***
	(− 2.864)	(− 8.190)	(− 1.584)	(−7.346)	(− 3.144)	(− 7.126)	(− 1.686)	(− 6.135)
L.Pgd	0.122***	0.208***	0.092***	0.286***	0.066***	0.137***	0.056***	0.219***
	(6.577)	(8.230)	(3.891)	(8.648)	(3.929)	(5.905)	(2.605)	(7.021)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Constant	1.541***	0.978***	1.888***	0.405	1.922***	1.502***	2.212***	0.890***
	(8.286)	(3.940)	(7.8976)	(1.222)	(10.777)	(6.246)	(9.532)	(2.735)
Observations	25,335	29,279	12,420	14,872	22,273	26,696	10,740	13,519

Note: The coefficients in the table are estimated elastic coefficients of semi-parametric Cox proportional hazards model; the standard errors in brackets are after robust adjustment; *, **, *** indicate significant at the significance level of 10%, 5%, and 1%, respectively.

that, first, the establishment of DZs will encourage county governments facing the pressure of attracting investment to expand the area of industrial land available for transfer, and to adopt the approach of listing land for sale, thereby reducing the degree of marketization of land transfer. Second, the expansion in the scale of land transfer and the reduction in marketization will distort the allocation of land resources by weakening the selection effect, and also hinder the efficiency of resource allocation in the manufacturing industry.

From the point of view of the scale and marketization of land resource allocation, this study provides evidence on the causal effect of the establishment of DZs on land resource allocation behavior and its resource allocation effect, which expands the perspective of existing related research. And it reveals the internal mechanism of resource allocation effect from the perspective of firm entry and exit, which can provide a reference for the optimization of land resource allocation policies of national and local governments worldwide. Specifically, there are two revelations.

First, it is necessary to strengthen the role of market mechanisms of land resource allocation in the DZs. It should be implementing smart-growth land use policies rather than extensive expansion strategies (McCauley and Murphy, 2013). The land-use planning requires knowledge of how firms use land (Needham et al., 2013). The land allocation should conform to the principle of productivity, that is, land should be allocated to firms with higher marginal output. Second, the heterogeneity of DZ attributes and of the cities and regions in which they are located will affect the intensity of DZs' impact on land transfer behavior. Consequently, it is necessary to adopt differentiated land control policies for DZs of different types, in different regions, and at different stages of development.

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