

Market-oriented reform and land use efficiency: Evidence from a regression discontinuity design

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ABSTRACT

This paper explores the causal effect of market-oriented reform on land use efficiency, by taking a fuzzy regression discontinuity (RD) design based on China's land market reform. The reform in this paper refers to the event that the central government strictly directed city governments to choose market-oriented methods in transferring industrial land since July 1, 2007. Such an institutional background leads to a discontinuity where the probability of land transferred through market-oriented methods significantly jumped up after July 1. The RD results show that market does have a positive impact on land use efficiency, which is indicated by the shortened land development period, relaxing of the constraint on floor area ratio, and superior companies being screened out to become land buyers. These effects are not only statistically significant and economically sizable, but also keep robust facing multiple changes of bandwidth, alternate of the database, and deletion of special samples. However, we also find the positive effect of market is conditional on government-enterprise relationships. If we compare land whose buyers are companies with a close relationship with governments, market will neither increase the intensity of land use nor make superior companies stand out. This paper contributes to the literature on the efficiency of market for two aspects: (1) by using a novel RD design we identify the causal effect of market-oriented reform on land use efficiency; (2) by uncovering the conditional effect of market we prove the limitation of market in a transitional economy, where other factors like networks, political forces still play an important role.

"As every individual...He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it...he is...led by an invisible hand to promote an end which was no part of his intention...By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it. –[The Wealth of Nations]. Adam Smith".

1. Introduction

Since Smith proposed that market working as an invisible hand could unconsciously but effectively improve public interest, many studies have contributed to the validation of this proposition. Beginning at the last 20th century, large quantities of studies had made attempts to explore the effect of market orientation at the micro-level, especially on organizational performance. For example, literature on firm management found that market orientation could effectively lead to innovations in products, procedures, and systems (Atuahene-Gima and Ko, 2001;

Baker and Sinkula, 1999; Grinstein, 2008; Lukas and Ferrell, 2000). As a result, market orientation presents significantly positive effects on firms' profits (Avlonitis and Gounaris, 1997; Langerak, 2001; Narver and Slater, 1990), sales growth (Langerak, 2001; Slater and Narver, 1994), and market share (Avlonitis and Gounaris, 1997; Baker and Sinkula, 1999). More macro evidence testing the effect of market draws support from market-oriented reforms led by transitional economy. With the rise of the global wave of liberalism in the 1980s, the impact of market-oriented reform of public services such as health care, education, has been widely discussed (Reichard, 2002; Whitty and Power, 2000). China's electricity market-oriented reform, for example, is found to substantially contribute to energy efficiency improvement (Fan et al., 2007; Ming et al., 2016). Another case is that plenty of studies have focused on the transitions from publicly-regulated health systems to market orientation happened in European countries, such as Netherlands, Swedish, and the UK, and many of them prove that market does foster efficient and patient-centered health care (Ferrari, 2006;

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Harrison and Calltorp, 2000; Maarse et al., 2016).

As one of the most important production factors, land has been widely discussed about the process of its marketization and the follow-up effects, especially in transition economy like China. In the process of transition from planned economy, marketization is usually intertwined with the state powers. As a result, different understandings of "market" have emerged. For example, Wu (2018) points out that a key feature of land governance in China is "state entrepreneurialism", which combines state engagement and market instruments and shapes the political economic structures in urbanization. In his framework, market is viewed as an instrument adopted by local governors, which is aimed to generate considerable profit and enable local states to rehouse villagers and compensate their interests. In comparison, a large part of the research focuses on the process of separating the land market from state control. Born out of a planned economic system with central controls and the nationalization of economic resources, land market has been created and land use rights entered the market and became tradable after decades of gradual reforms, under the policy of separation of use rights from ownership (Yeh and Wu, 1996; Zhang, 2000; Zhu, 2005).

In this paper, we focus on a specific manifestation of land marketization, i.e., land transfer marketization (LTM). In the last century, the transaction of urban land use rights was mainly achieved by administrative allocation and private negotiation. Since the start of this century, the central government began to emphasize the importance of land transfer marketization for residential and commercial land,² and the transfer marketization of industrial land followed closely. By doing this, market-oriented methods including listing (guapai, in Chinese), bidding (zhaobiao, in Chinese) and auction (paimai, in Chinese) are strongly enforced. According to the data from China Land and Resources Statistical Yearbook, the share of urban land transferred by market-oriented methods raised from 28.88% in 2004 to 92.41% in 2017. With LTM continues to advance, a plenty of studies focusing on the land transfer marketization and its consequent impacts have emerged. For example, Huang et al. (2017) found that along with the land reform comes the transformation and upgrading of the industrial structure. Lu et al. (2020) pointed out that LTM contributes to the rationalization of industrial structure, which consequently has a significant improvement on the green TFP, especially for the western region of China. Xu et al. (2018) argue that LTM can promote the expansion of production scale by increasing the degree of land capitalization and the scale of urban financing, which significantly contribute to the regional economic growth. At the meantime, by measuring land use efficiency based on the city-level inputs and outputs on land, a growing body of studies has discussed the effect of LTM on land use efficiency (Jiang et al., 2021; Wang et al., 2021).

However, most of these studies on LTM and land use efficiency center on a macro-level perspective. To the best of our knowledge, there is still a lack of micro evidence of how LTM affects land use efficiency. Uncovering the micro process of how LTM works could not only supplement the evidence of the effect of LTM, but also, and more importantly, could advance the understanding of the logic behind the positive effect of LTM on city-level land use efficiency. Therefore, we attempt to make up this gap by establishing a multidimensional indicator system of parcel-level land use efficiency and further exploring how LTM affects land use efficiency. Specifically, we establish the causal links between LTM and land use efficiency by novelly taking the market-oriented reform in China's land market in 2007 for causality identification. The reform refers to the No.78 Document issued by the Ministry of Land and Resource in 2007, which stipulated that the transaction of industrial land between governments and land developers will no longer be

allowed to be achieved by private negotiation since July 1, 2007.³ Instead, market-oriented methods should be used to determine the price and the winner of industrial land transaction. Owing to the forceful implementation by the powerful central government, the share of land transactions achieved by market-oriented methods presented a noticeable jump before and after July 1. Such a context provides us with an ideal condition to conduct a regression discontinuity (RD) design to identify the causal effect of market on the efficiency of land use.

By documenting the causal link between land transfer marketization and land use efficiency, this paper provides new evidence supporting the values of market force. Although previous studies has proved land marketization has positive spillover effects on industrial development, structure upgrading, and green economic growth (Lu et al., 2020; Xu et al., 2018), there is still few work discussing how LTM contributes to the land use itself, especially at the micro-level. As the available new construction land resources become more and more scarce, focusing on the land use efficiency might have special significance. The second contribution of this paper lies on the methodology. Recently, a battery of studies have discussed the factors affecting the urban land use efficiency in China (e.g., Yan et al., 2020; Chen et al., 2018; Wang et al., 2021). Most of these studies use basic regressions and successfully discovered the *correlations* between some factors and land use efficiency. Different from these studies, by taking the discontinuity caused by a strictly enforced direction in 2007, this paper adopts the regression discontinuity design and find a *causal relationship* between LTM and land use efficiency, which provides a more solid argument of how marketization matters.

Finally, this paper also makes several contributions to the literature on state-business relations. Studies on state-business relations usually highlight the value of political connections for firms. For example, Fan et al. (2008) documents that firms with political connections are more easily to get access to bank loans. Goldman et al. (2013) finds that politically connected firms have a higher probability of winning governments' procurement contracts. However, our work documents the positive effect of LTM on land use efficiency is diminished in those politically connected firms. That means, political connection might have a negative side for public interest, which well complements the existing literature.

We organize the paper as follows. In Section 2, we introduce the institutional background of land market reform in China. Section 3 describes the data. Section 4 explains the framework of the fuzzy RD specification. Empirical results are presented and interpreted in Section 5. Section 6 concludes.

2. Institutional background and theoretical framework

2.1. Evolution of industrial land market in China

China has a unique land system, where there is no private ownership of land. Urban land is owned by the state, while rural land is owned by rural collectives (Lu and Wang, 2019a, 2019b). In Maoist China, it was not allowed to merchandise land and there is no land market. Only until Deng Xiaoping came to power and started the economic reform did the land market gradually emerge. Even so, land market is different from market of general merchandises due to the special land ownership system. It is land use right, which is learned from the land leasehold system from Hong Kong, instead of land ownership, being transacted in land

² For example, the State Council Document No. 15 in 2001 highlighted the importance of using market-oriented methods. In the Document No. 11 of the Ministry of Land and Resources, the central state strictly stopped local government from transferring residential and commercial land by negotiation.

³ See the Notice of the Ministry of Land and Resources on the Implementation of the Public Tender, Auction, and Listing of Quotation of Industrial Land, http://www.gov.cn/jzwgk/2007-04/12/content_579830.htm, accessed at Dec. 25, 2019.

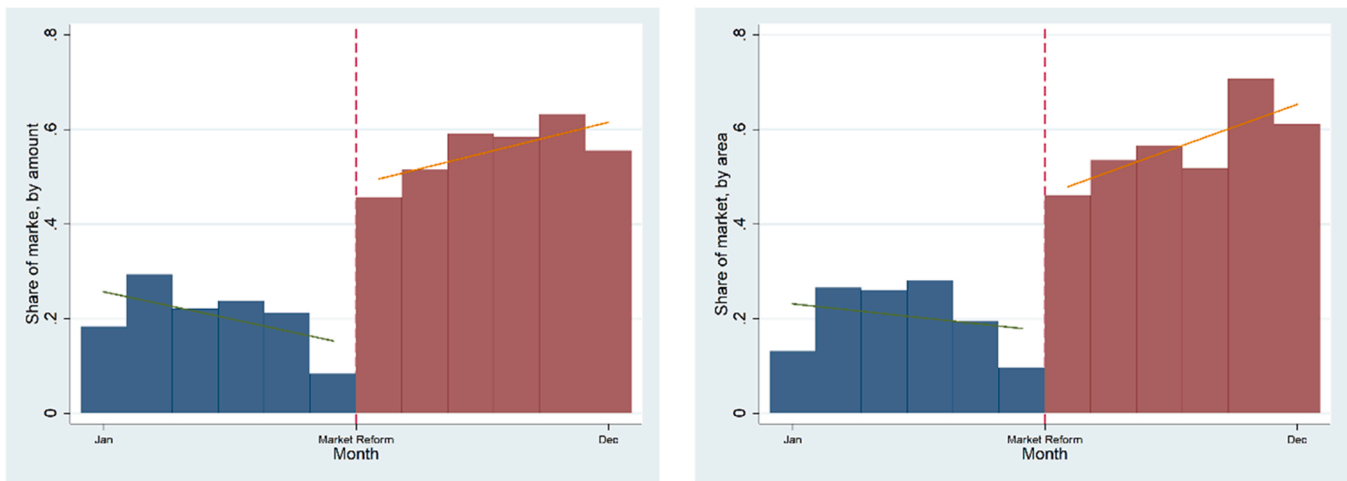


Fig. 1. Discontinuity of the share of market methods before and after July 1, 2007.

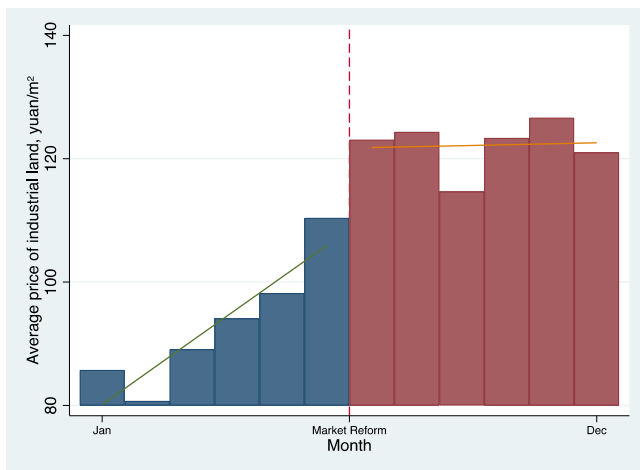


Fig. 2. The distinguished increase of industrial land price.

market.⁴ In general, there are three types of land market: (1) the primary market, which refers to the transaction between government and individual/firm; (2) the secondary market, referring to the transaction between individuals/firms with the permission of government; (3) the tertiary market, referring to the partial transfer of land use right between individuals/firms, such as rental or mortgage (Tian and Ma, 2009).

With the establishment of land bank system at the end of the last century, city government has monopolized the primary land market (Zhu, 2005). City government, on the one hand, is the only subject endowed with the authority to expropriate farmland from rural peasants and convert land to non-agricultural use. On the other hand, city government transfers the use rights of construction land to potential land developers for up-front land conveyance fees (Ding, 2007). By the process of land take and land sale, government reaps abundant profits, which even account as much as 170% of the formal budget in some cities (Wang and Lu, 2019). However, when transferring industrial land, city government's behavior does not merely follow the assumption of maximizing land transfer revenue. As many studies have pointed out,

city government makes a trade-off between revenues generated by land leasing and tax base attracted by low-priced industrial land (Cao et al., 2008; Tao et al., 2010). City government urgently pursues manufacturing firms to its jurisdiction, since these firms not only contribute value-added tax (VAT) and enterprise income tax to local revenues but also generate spillover effects to activate service industry. Given that foot-loose manufacture firms could easily move around to minimize their production costs, city government is motivated to push down the price of industrial land to win the regional competition. As a result, the price of industrial land is extremely low.

Transferring industrial land through private negotiation could exclude potential competitors and deliver land to a specific company that is preferred by government. What's more, since the price of negotiation is not determined by competition, it is in line with government's demand for attracting manufacture firms with low-priced industrial land. Consequently, though there exist several market-oriented methods like tender, listing, and bidding for city government to choose, city government distinctly prefers non-market-oriented one (i.e. private negotiation). Around 80% of industrial land transaction was achieved through private negotiation before 2007 (Lu and Wang, 2019a, 2019b). Under-table negotiation, however, caused a series of problems, such as inefficient use of industrial land and corruption (Gong, 2006; Liu et al., 2014). Facing these problems, the central government issued the Notice of the Ministry of Land and Resources on the Implementation of the Public Tender, Auction, and Listing of Quotation of Industrial Land (or No.78 Document) in April 2007. This notice strictly prohibited city governments to lease industrial land through negotiation since July 1, 2007. Since then, except for some special circumstances,⁵ city governments were required to adopt the market-oriented methods to transfer industrial land.

Owing to the powerful central authority, city governments were forced to follow the No.78 Document immediately after "the deadline of June 30". The share of industrial land transactions achieved by market-oriented methods raised from 9.8% in June to 46.1% in July. The effect of market reform keeps climbing and long-lasting. Lu and Wang (2019b) find the share of industrial land transferred through market-oriented methods further raised to 92.2% in 2013. Here, we focus on the industrial land transaction that happened nearly before and after July 1, 2007. As presented in Fig. 1, there is a distinct jump before and after July

⁴ Land use rights are transacted for a certain period, depending on the usage of land. Generally, the use right of industrial land is transferred for 30 years, that of commercial and residential land are transferred for 50 and 70 years respectively.

⁵ It is still allowed to transfer industrial land through negotiation in some special circumstances. For example, if a parcel of industrial land used by a company is expropriated by government due to city renovation, it is allowed to transfer another parcel of industrial land to the company through negotiation to compensate it. Overall, this situation is very rare.

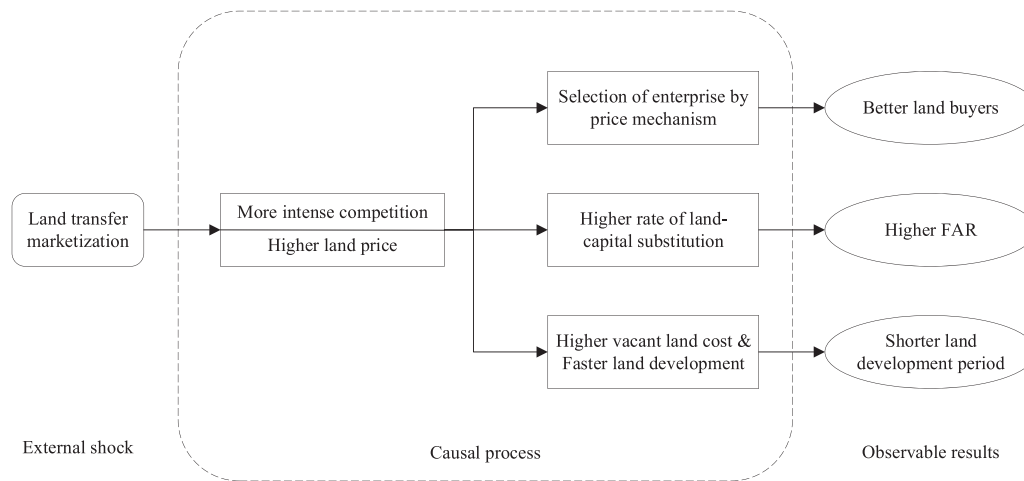


Fig. 3. Effect of LTM on land use efficiency: theoretical framework.

Table 1
Indicators for land use efficiency.

Object	Sub-object	Indicator	Abbreviation
Land use intensity	Time perspective	Period from signing contract to delivering land	Prd_deliver
		Period from signing contract to starting construction	Prd_start
		Period from signing contract to completing construction	Prd_finish
Buyer of land	Spatial perspective	Lower limit for FAR	Far_down
		Upper limit for FAR	Far_up
	Buyer information from NECIPS	Register capital of buyer company	Reg_capital
		Staff of buyer company	Staff
		Duration of live of buyer company	Live
	Buyer information from CIED	Main income of buyer company	Income
		Return on capital of buyer company	Profit_rate
		Tax payment of buyer company	Tax
		Total factor productivity ^a	TFP

^a The calculation of TFP is followed by the OP method developed by Giannetti et al. (2015) and Lu and Lian (2012). The indicators in CIED used to calculate TFP include the main income, total asset, the number of employees, and the costs of purchasing products for every firm in a single year. More detailed calculation process could be available upon request.

1, which provides us with an ideal condition to validate the causal effect of market-oriented reform by an RD design.

2.2. Effect of LTM on land use efficiency: theoretical consideration

One of the most distinguished effects of LTM is returning the price of industrial land to its market value (Li et al., 2020). Due to the lack of transparency and competition, the price of the land transferred by negotiation is relatively low. On the contrary, bidding, auction and listing, with the principle of "the higher bidder gets" (Lian et al., 2019), are supposed to elicit more sufficient competition among the potential

buyers and to push up the land price. Recent empirical studies have also proved that the market-oriented methods of allocating land achieve a price premium compared with negotiation methods as a result of more fierce competition and higher level of transparency (Qin et al., 2016; Yuan et al., 2019).

With the LTM and the subsequent increase of industrial land price, land use efficiency is supposed to be affected through three mechanisms. The first is the threshold effect, that is, the market competition will push up the price of industrial land price, which in turn will set a price barrier to potential investment from entering the land market. Only firms willing to pay higher price and having such an ability can win the industrial land, while those with lower added value and inferior production capacity will be excluded (Lu et al., 2020). As a result, better companies will be selected out to be land buyers. Fig. 2 presenting the distinguished increase of industrial land price provides an indirect evidence that the threshold effect may exist. The second mechanism is the substitution effect. Classical literature on land economy has pointed out there is a substitution relationship between land and capital (Dowall and Alan Treffeisen, 1991). That means, with the increase of land price, firms will increase the average investment on land (Batisani and Yarnal, 2011; McDonald, 1981). At the meanwhile, the increase of land price may also drive local government take a more market-oriented way of managing land and lessen the limits on floor area ratio (FAR). Under the combined influence of the two mechanisms, the FAR are supposed to go up. The last one is the idle cost effect. With the rising price of industrial land, leaving land idle means higher capital costs. Therefore, land buyers will be motivated to speed up land development so as to put land into production as soon as possible. Presenting in Fig. 3, to sum up the three effects, we suppose that land transfer marketization will result in higher industrial land use efficiency, which is indicated by better land buyers, higher FAR and shortened land development period.

3. Data

We build up a unique database to test the effect of market on industrial land use efficiency, which mainly comes from three sources. The data of industrial land comes from the China Land Market website (www.landchina.com). This website was set up by the Ministry of Land

and Resource, and it publicizes all land transferring records from 1998 to now. Recently, this dataset has been more and more widely used in research (Chen and Kung, 2016; Fei, 2019; Huang and Du, 2018). All detailed information about land transaction is included, such as land area, price, usage, buyer, transaction methods, transaction date, land deliver date, construction start date and construction completion date. We only use the transaction of industrial land that happened in 2007 for discontinuity regression design, which accounts for 37,430 records.

The former dataset of land transactions includes the name of land buyers. To acquire detailed information of company, we use the second source of data, which comes from the National Enterprise Credit Information Publicity System (NECIPS). This system is set up by the State Administration for Market Regulation and publicizes detailed information on each company registered in China, including register capital, amounts of staff, establishment date and so on. We search the NECIPS by using the name of land buyer as keywords and 16,289 companies are being matched.⁶ In order to be consistent with the land dataset, the historical information of a company in 2007, which could be tracked by NECIPS, is used in this study.⁷

Although the NECIPS provides us with a window to judge the quality of a company by its scale and duration time, it lacks more precise information on the performance of a company. Therefore, we also attempt to match the land buyer with the company information from China Industrial Enterprise Database (CIED). This database investigates detailed performance information of the company whose annual sales are more than 5 million yuan. Consequently, we will inevitably miss some data due to match failure (plenty of land buyers have yearly sales of less than 5 million yuan). There are 4203 land buyers being identified by CIED. Even with data attrition, we still adopt it as the third source of data since the comprehensive company information from CIED does provide another way to validate our hypothesis.

With data from the above three sources, we could now define the indicators for land use efficiency. We learn from the criterion developed by the Ministry of Land and Resource in 2010 to define the efficiency of industrial land. The criterion includes 4 objectives and 16 indicators that evaluate land use efficiency, such as building density, floor area ratio, capital output intensity (Tu et al., 2014). For the consideration of data attributes,⁸ this paper defines land use efficiency from two perspectives.⁹ The first perspective is the intensity of land use, including intensity from time dimension and intensity from spatial dimension. If a parcel of industrial land is contracted to put into use in a shorter period (time dimension), or built with higher floor area ratio (spatial dimension), such a parcel of land is supposed to be more intensively used.¹⁰

⁶ It is noticeable that individuals could also be land buyers. But the information of individuals could not be tracked through NECIPS.

⁷ NECIPS records every change of business information of a company. Therefore, although we did the search work in 2019, it's still practicable to get the information of a company in 2007.

⁸ The data we use is the parcel-level of industrial land. Differently, the criterion developed by the MLR is based on a whole industrial park. For example, to calculate the capital output intensity, one should divide the total capital output by the total area of industrial land of an industrial park. Obviously, such a method is not applicable for our data. Therefore, we modify it based on the characteristics of our data.

⁹ This evaluation system is the result of comprehensive consideration of theoretical importance and data availability. We have to acknowledge that there exist other important indicators measuring land use efficiency such as the input and output of industrial land. However, due to the data is government confidential data, we have no access to it even with requirement. Therefore, such a evaluation system might be the second best choice for our research.

¹⁰ The contents written in contracts have institutional constraints on both the government and the land buyers. For example, if governments have delay in land delivery, the government has to pay liquidated damages to the buyer for every day of delay. That means, the information of contracts could be well reflected the actual land use and development plan in the real world.

Table 2
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Covariates					
Area	37,425	3.79	14.88	0.00	1781.86
distance	17,951	30.49	10.88	0.00	64.49
Import & export	25,066	107.80	164.14	0.33	608.47
Steel production	22,865	208.01	192.06	0.03	988.29
Sales of consume goods	22,865	384.63	245.30	13.80	956.90
Intensity of land use					
Prd_deliver	20,761	49.69	172.35	0.00	3653.00
Prd_start	22,328	237.11	370.20	0.00	4114.00
Prd_finish	22,757	709.28	484.18	0.00	5622.00
Far_down	21,879	0.55	0.49	0.00	8.70
Far_up	18,665	0.48	0.64	0.00	7.48
Quality of land buyer (NECIPS)					
Reg_capital	16,265	14,310.83	94,775.65	0.00	567,1302.00
Staff	13,344	1.58	1.10	1.00	5.00
Live	14,211	1430.22	1516.67	0.00	13,610.00
Quality of land buyer (CIED)					
log(income)	4074	10.97	1.66	4.14	19.01
Profit_rate	4171	0.09	0.17	-1.24	2.49
log(tax)	3511	5.52	2.32	0.00	16.30
State_capital	4203	35,523.54	379,423.90	0.00	10,900,000.00
Local_firm	4203	0.20	0.40	0.00	1.00
TFP	3767	7.04	1.01	1.53	11.19

The second perspective is to differentiate the buyers of industrial land. If a parcel of industrial land is won by a superior company, we suppose this land can achieve more effective development. More detailed division of the two objects and their respective indicators are listed in the following Table 1.

We also add a series of covariates, including characteristics both of province and land. We control the two most important characteristics of land, the area, and location of land. The land dataset includes the detailed location of land, and we transform it into precise longitude and latitude of land through Baidu Map.¹¹ As we also have the geocode of the central business district (CBD) of a city, we could calculate the distance from the land to CBD as the proxy of the location of land. For the characteristics of province, we include some available monthly economic indicators of a province (i.e., import and export volume, steel production, sales of consumer goods).¹² The descriptive statistics of all variables are listed in Table 2.

4. Identify strategy

4.1. Fuzzy regression discontinuity design

The regression discontinuity (RD) design relies on that researchers have precise knowledge on institution rules about what assignment or forcing variable will determine the treatment. Once the forcing variable

¹¹ Baidu Map is one of the biggest company providing map services in China. The coordinate system Baidu Map use is a transformation from WGS84. In the process of geocoding, Baidu Map will return a variable called "confidence", which representing the accuracy of geocode results. This variable provides us with a condition to check whether the regression results are sensitive to the accuracy of geocoding. More detailed introduction of the coordinate system and geocode accuracy of Baidu Map could be found in <http://lbsyun.baidu.com/index.php?title=coordinate>.

¹² In general, economic statistics in China are publicized yearly. Using yearly variables is meaningless in our research since the samples are all from 2007. Given that only a few indicators of provinces are publicized monthly in China, we can only use the monthly indicators of provinces as covariates to capture macro-economic characteristics.

Table 3
Effect of market on the period of land development.

Dep. Var.	(1) Prd_deliver	(2) Prd_start	(3) Prd_finish	(4) Prd_start	(5) Prd_deliver	(6) Prd_finish
Market	-43.07 * ** (11.04)	-149.8 * ** (22.36)	-316.8 * ** (34.41)	-224.6 * ** (31.75)	-48.21 * ** (13.70)	-311.8 * ** (49.08)
Constant	140.6 * ** (10.24)	373.4 * ** (20.41)	1142 * ** (31.58)	371.2 * ** (20.70)	140.7 * ** (10.23)	1142 * ** (31.54)
Land characteristic	Y	Y	Y	Y	Y	Y
City characteristic	Y	Y	Y	Y	Y	Y
Observations	10,717	11,389	11,583	11,389	10,717	11,583

Note: We choose ± 50 days as bandwidth in all columns. The first three columns correspond to first polynomial of $f_s(Days_t)$ and the last three columns correspond to second order polynomial of $f_s(Days_t)$. * ** $p < 0.01$, * * $p < 0.05$, * $p < 0.1$.

goes cross the cutoff, treatment is supposed to turn on/off. In this paper, we take July 1, 2007, as the value of cut off, since if a parcel of land is transacted after July 1, it will have a significantly greater possibility of achieving it through market-oriented methods (as discussed in Section 3). However, one thing having to be aware of is, coming across cut off does not necessarily imply that land is transferred through market-oriented methods. Thus, the discontinuity in the probability of transferring through market-oriented methods is smaller than 100% at the deadline fixed by the central government. This “imperfect compliance” naturally leads to a fuzzy RD where the date of transaction happens is the forcing variable that partially determines the methods of transaction. Therefore, we apply two-stage least square (2SLS), where the discontinuity and the date of transaction as the instrumental variables of whether the transaction is achieved by market-oriented methods, to identify the causal effect of market on land use efficiency:

$$Market_{ijt} = \gamma_0 + \gamma_1 UpCutoff_{ijt} + f_s(Days_t) + \gamma_2 X_i + \gamma_3 \Psi_j + \mu_{ijt} \quad (1)$$

$$Outcome_{ijt} = \beta_0 + \beta_1 Market_{ijt} + f_s(Days_t) + \beta_2 X_i + \beta_3 \Psi_j + \varepsilon_{ijt} \quad (2)$$

where i indexes land i , j indexes land transaction happens in city j , and t indexes land transaction happened in date t . *Market* is a dummy variable that is assigned 1 if a parcel of land is transferred through market-oriented methods, including public tender, listing, and bidding and 0 otherwise. *UpCutoff_{ijt}* is the forcing variable assigned 1 if a transaction happened after July 1 and 0 otherwise. $f_s(Days_t)$ includes a polynomial function of $Days_t$, which refers to the distance in days from the transaction to July 1. Gelman and Imbens (2019) suggest that using high-order polynomials of $f_s(Days_t)$ could lead to misleading results. Thus, we only use linear and quadric function of $f_s(Days_t)$ throughout this paper. With the institutional background we introduced above, we use the fitted value of *Market_{ijt}* from Eq. (1) as the key explanatory variable to estimate Eq. (2). *Outcome_{ijt}* are series of indicators of land use efficiency as we defined in Section 4.1. β_1 captures the causal effect of market on the economic outcomes. X_i and Ψ_j , which refer to control variables for land i and city j respectively, are included in both two equations. μ_{ijt} and ε_{ijt} are robust error terms.

4.2. RD validation checks

The identification assumption is local continuity of other covariates, which implies that land transaction around the cutoff is comparable. If treatment is locally randomized, then the characteristics of land and city around July 1 should not differ substantially. Fig. A1 in the Appendix shows the scatter plots of covariates with local polynomial smooth plots in a window of ± 6 months around the cutoff caused by market-oriented reform. And Table A1 in Appendix further uses parametric estimation to test the discontinuity of predetermined characteristics. Both the figures and table indicate no significant discontinuity in any of the baseline covariates at the threshold pointing towards local random assignment. The RD validity checks support our identification strategy and provide no evidence for violations of the key underlying assumptions.

Table 4
The effect of market on floor area ratio (FAR).

Dep. Var.	(1) Far_down	(2) Far_up	(3) Far_down	(4) Far_up
Market	0.123 * ** (0.0375)	0.476 * ** (0.0525)	0.245 * ** (0.0557)	0.411 * ** (0.0753)
Constant	0.465 * ** (0.0289)	0.815 * ** (0.0410)	0.468 * ** (0.0288)	0.814 * ** (0.0403)
Land characteristic	Y	Y	Y	Y
City characteristic	Y	Y	Y	Y
Observations	10,707	8920	10,707	8920

Note: We choose ± 50 days as bandwidth in all columns. The first two columns correspond to the first polynomial of $f_s(Days_t)$ and the last two columns correspond to second-order polynomial of $f_s(Days_t)$. Robust standard errors in parentheses. * ** $p < 0.01$, * * $p < 0.05$, * $p < 0.1$.

5. Effect of market on land use efficiency

5.1. Main results

First, we present and discuss the results of the effect of market on the period of land development. Our main specification is a local parametric regression estimated on a 50 days bandwidth. The first three columns of Table 3 use first-order polynomial of $f_s(Days_t)$ and the last three columns use second order. As seen in both specifications, we find a negative effect of market on the period of land development which is significant at 1% level. The estimated effect suggests that transferring land through market-oriented methods causes the period from signing a contract to delivering land, starting construction, and finishing construction decrease by around 43, 150, 317 days respectively. Given that the average periods for the three are 50, 237, 709 days (see Table 2), such a decrease is not only statistically significant but also economically considerable. That means, market-oriented methods could reduce the period of land development by 86%, 63%, 45% respectively. The first-stage effects are highly significant pointing towards instrument relevance as the first stage F-statistics of 865.7 clearly exceed the Stock-Yogo critical values at any common significance level, which excludes the possibility of a weak instrumental variable.

Second, we test the effect of market on the spatial intensity of land use. That is, whether market-oriented reform will contribute to the increase of floor area ratio (FAR). Although we don't have exact FAR data on each parcel of land, we adopt the limit on FAR formulated in land transaction contract. We suppose land will be more intensively used if its contract sets both higher values on the lower and upper limit of FAR, since such a condition implies government prevents land buyer from using land at low density and encourages higher-intensity land development. Similar with Table 3, we try to estimate Eqs. (1) and (2) with both first and second-order polynomial. The results are shown in Table 4. Market-oriented methods have a positive and sizeable effect on the FAR. The lower limit and upper limit on FAR for land transferred through market-oriented method will increase by 0.123 and 0.476

Table 5

The effect of market on land buyer.

Dep. Var.	(1) Reg.capital	(2) Staff	(3) Live	(4) Reg.capital	(5) Staff	(6) Live
Market	23,230 *** (6011)	0.470 *** (0.122)	1094 *** (159.9)	34,712 *** (9814)	0.328 ** (0.163)	883.2 *** (229.0)
Constant	25,444 *** (5168)	1.433 *** (0.0993)	1058 *** (116.4)	25,102 *** (5273)	1.435 *** (0.0982)	1061 *** (113.8)
Land characteristic	Y	Y	Y	Y	Y	Y
City characteristic	Y	Y	Y	Y	Y	Y
Observations	8375	6905	7157	8375	6905	7157

Note: We choose ± 50 days as bandwidth in all columns. The first three columns correspond to the first polynomial of $f_s(Days_t)$ and the last three columns correspond to second-order polynomial of $f_s(Days_t)$. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6

Robustness with the change of bandwidth.

Bandwidth	(1) [- 30, 30]	(2) [- 70,70]	(3) [- 100, 100]	(4) MSERD	(5) MSETWO	(6) MSESUM
Prd_deliver	-92.24 *** (19.53)	-42.10 *** (12.67)	-40.90 *** (11.10)	-109.5 *** (23.01)	-106.4 *** (19.50)	-105.4 *** (22.32)
Prd_start	-245.1 *** (39.89)	-184.2 *** (27.02)	-101.9 *** (24.48)	-266.3 *** (50.46)	-294.7 *** (48.52)	-301.6 *** (59.94)
Prd_finish	-384.6 *** (64.61)	-346.1 *** (43.37)	-256.8 *** (37.42)	-398.4 *** (68.92)	-542.8 *** (87.75)	-470.2 *** (109.5)
Far_down	0.291 *** (0.0739)	0.157 *** (0.0508)	0.0899 *** (0.0456)	0.534 *** (0.0946)	0.379 *** (0.0776)	0.280 *** (0.0684)
Far_up	0.344 *** (0.0908)	0.507 *** (0.0680)	0.621 *** (0.0625)	0.444 *** (0.0998)	0.405 *** (0.0971)	0.431 *** (0.0989)
Reg_capital	32,210 *** (10,754)	35,871 *** (8478)	29,443 *** (7999)	28,165 *** (10,870)	17,987 (11,596)	21,208 *** (10,292)
Staff	0.377 * (0.213)	0.469 *** (0.152)	0.252 * (0.133)	0.230 (0.186)	0.253 (0.186)	0.320 * (0.163)
Live	636.4 * (272.6)	1406 *** (221.6)	1284 *** (199.6)	660.7 * (290.5)	445.4 (282.9)	513.3 * (246.5)

Note: All columns in this Table are used second-order polynomial of $f_s(Days_t)$. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7

The effect of market on land buyer, based on CIED.

Dep. Var.	(1) log (income)	(2) ROC	(3) log (tax)	(4) log (income)	(5) ROC	(6) log (tax)	(7) TFP
Market	0.847 ** (0.335)	0.0910 ** (0.0359)	1.059 ** (0.507)	0.869 * (0.520)	0.103 * (0.0550)	1.370 * (0.781)	0.768 ** (0.320)
Constant	10.36 *** (0.298)	-0.0100 (0.0278)	4.682 *** (0.479)	10.36 *** (0.311)	-0.0120 (0.0297)	4.614 *** (0.506)	6.405 *** (0.203)
Land characteristic	Y	Y	Y	Y	Y	Y	Y
City characteristic	Y	Y	Y	Y	Y	Y	Y
Observations	1976	2064	1740	1976	2064	1740	1832

Note: We choose ± 50 days as bandwidth in all columns. The first three columns correspond to the first polynomial of $f_s(Days_t)$ and the last four columns correspond to second-order polynomial of $f_s(Days_t)$. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

respectively (or 22.36% and 99.17% as their average).

Finally, we turn to validate the hypothesis that market could screen out superior companies to become land buyers. Table 5 presents the effect of market on land buyers' scales, which are captured by the registered capital and the amounts of staff and their duration since establishment. An assumption here is that, companies with larger scale and more prolonged periods of life are more likely to be superior.¹³ As shown in Table 5, we find that if a parcel of land is transferred through market-oriented methods, its land buyer would have higher registered capital, more employees, and longer survival time. These effects confirm that market could make superior companies stand out in land market.

¹³ Of course, such an assumption might be incorrect. Therefore, we following use more detailed performance indicators of a company from CIED to conduct further check.

5.2. Robustness check

In the previous specifications, we use a window of 50 days before and after July 1. Therefore, we first test whether the results are robust facing the change of bandwidth. We turn to use the bandwidth both larger and less than 50 days, that is, 30, 70, 100 days to conduct the 2SLS analysis. As shown in the first three columns of Table 6, although with the change of the size of coefficients, all estimations remain expected impacts and statistical significance. We also use three MSE-optimal data-driven bandwidth that developed by (Calónico et al., 2014, 2018), and the results are presented in the last three columns. Once again, most the results keep statistically significant, proving the baseline results are not sensitive to the change of bandwidth.

The second robustness check targets to test whether baseline results are sensitive to the alternative database. In the baseline, we use the NECIPS database and take scale and live period as the proxy variables of the quality of a company. However, due to the lack of detailed

Table 8

Robustness check: exclude cities seeing change of leadership.

Dep. Var.	Prd_start (1)	Prd_deliver (2)	Prd_finish (3)	Far_down (4)	Far_up (5)	Reg_capital (6)	Staff (7)	Live (8)
Change of party secretary								
Market	-140.9 *** (23.35)	-40.92 *** (11.58)	-339.0 *** (36.41)	0.127 *** (0.0393)	0.467 *** (0.0553)	23,784 *** (6267)	0.538 *** (0.130)	1170 *** (168.5)
Constant	377.3 *** (20.96)	147.9 *** (10.75)	1167 *** (32.57)	0.449 *** (0.0298)	0.791 *** (0.0421)	23,920 *** (5279)	1.424 *** (0.104)	952.7 *** (122.2)
Observations	10,785	10,103	10,968	9832	8472	7906	6512	6724
Change of mayor								
Market	-151.6 *** (22.95)	-41.59 *** (11.29)	-325.1 *** (35.47)	0.118 *** (0.0381)	0.471 *** (0.0533)	25,067 *** (6169)	0.524 *** (0.126)	1093 *** (162.3)
Constant	381.4 *** (21.04)	141.4 *** (10.44)	1153 *** (32.63)	0.444 *** (0.0296)	0.782 *** (0.0418)	23,509 *** (5240)	1.368 *** (0.0999)	949.8 *** (119.5)
Land Characteristic	Y	Y	Y	Y	Y	Y	Y	Y
City Characteristic	Y	Y	Y	Y	Y	Y	Y	Y
Observations	10,951	10,298	11,143	10,033	8671	8100	6667	6872

Note: We choose ± 50 days as bandwidth in all columns. The first three columns correspond to the first polynomial of $f_s(Days_t)$ and the last three columns correspond to second-order polynomial of $f_s(Days_t)$. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9

Robustness check: exclude chengtou companies.

Dep. Var.	Prd_start (1)	Prd_deliver (2)	Prd_finish (3)	Far_down (4)	Far_up (5)	Reg_capital (6)	Staff (7)	Live (8)
Market	-150.5 *** (22.33)	-42.47 *** (11.03)	-314.8 *** (34.35)	0.127 *** (0.0374)	0.478 *** (0.0525)	23,307 *** (5975)	0.458 *** (0.122)	1079 *** (159.4)
Constant	374.7 *** (20.51)	138.5 *** (10.25)	1140 *** (31.68)	0.430 *** (0.0291)	0.813 *** (0.0412)	24,641 *** (5170)	1.434 *** (0.0998)	1039 *** (116.3)
Land characteristic	Y	Y	Y	Y	Y	Y	Y	Y
City characteristic	Y	Y	Y	Y	Y	Y	Y	Y
Observations	11,331	10,661	11,525	10,360	8878	8315	6846	7101

Note: We choose ± 50 days as bandwidth in all columns. The first three columns correspond to the first polynomial of $f_s(Days_t)$ and the last three columns correspond to second-order polynomial of $f_s(Days_t)$. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

information on company performance, such a narrow definition is limited by some defects. Therefore, we use more comprehensive indicators of company performance from CIED to re-estimate the effect of market on land buyers. Regression results in Table 7 suggest that, if a parcel of land is transferred through a market-oriented method, its buyer is supposed to have larger operation income, more excellent ROC, more taxes contributing to governments, and higher TFP. This result solidly supports the baseline results, that market screens superior companies to become land buyers.

The third robustness check we intend to conduct is based on such a fact that the discontinuity might be caused by the change of city leaders. In China, the core leadership in a city is constituted by party secretary of Communist Party and mayor. The former one usually takes responsibility of decision making and the latter is responsible for implementation. Their appointments are determined by a higher-hierarchical organization department, and their positions might be changed at any time of a year (Kou and Tsai, 2014). If the leadership of a city was changed, the new leaders themselves might prefer and adopt different land use policies, which can also lead to a discontinuity of land use efficiency. Therefore, we exclude land transaction samples that occurred in cities that saw the change of party secretary and mayor from January to July,¹⁴ which corresponds to 130 and 113 cities respectively. The estimation results using leftover samples are shown in Table 8. The results are only slightly changed but still consistent with the baseline results.

The final robustness check is based on the existence of a special type

¹⁴ As a new leadership may change policies immediately after he takes office or wait a while, we allow a respectively wide time window to observe whether there is change of leadership. Actually, the results are little changed even if we use other time windows.

of firms in China, i.e., city-owned urban investment (chengtong) companies.¹⁵ The priority of these companies is pursuing policy goals, instead of contributing economic efficiency. In land market, a prevalent practice is that local governments require the chengtong companies they control to purchase industrial land to enlarge the companies' assets for financing purposes. After the conveyance, the local government would send back the conveyance fees to the chengtong company as a capital injection. The land conveyance is only a nominal market behaviour. Besides, there is also a practice that the chengtong companies' holding of industrial land as a measure for implementing industrial policies. In this practice, industrial land is actually hold by local governments with the camouflage of chengtong companies. Therefore, we conduct the robustness check by excluding chengtong companies from the sample.¹⁶ The results, which are shown in Table 9, imply that the baseline results are unlikely to be biased by chengtong companies.

5.3. Extension

Although the empirical results show that market does improve efficiency, one thing must be acknowledged is that the market itself sometimes falls into a problem of failure (Bator, 1958). Market failure is usually caused by externalities, information asymmetry, and other

¹⁵ We appreciate the reviewer for his/her reminder of the special role of chengtong companies.

¹⁶ If a company meets one of the following conditions, we will regard it as a city investment company: (1) a company once issued an urban investment bonds; (2) The actual controller of the company is the local government or government agency. Meanwhile, the business scope of the company is about helping local governments complete a certain function, such as infrastructure construction, land development.

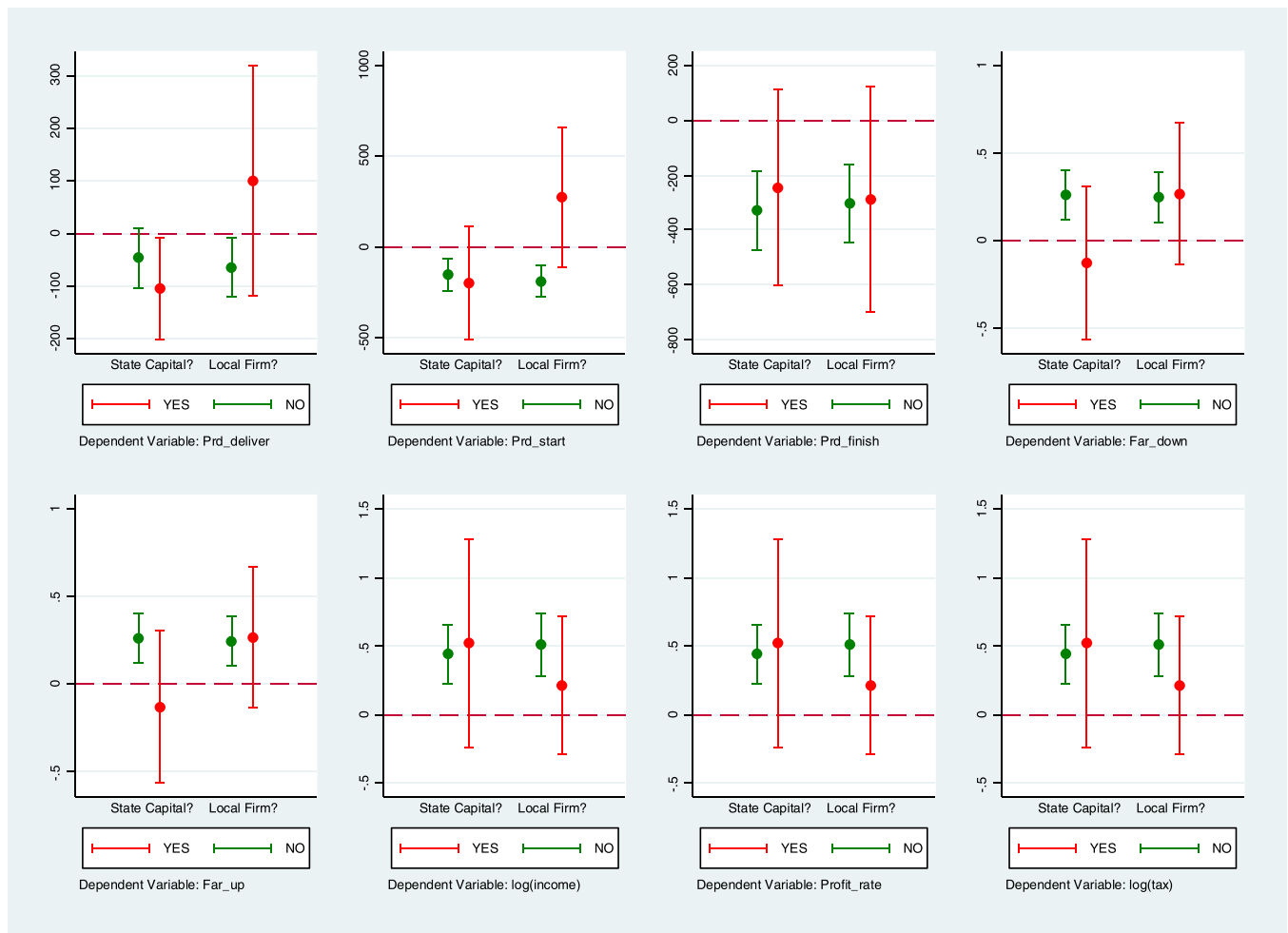


Fig. 4. The heterogeneous effect of market. Note: All figures are estimated by 2SLS with quadric function of $f_s(Days_t)$. We use 50 days before and after July 1 as bandwidth. 95% confidence intervals are presented.

reasons (Mankiw, 2014). Considering informal norms still plays a critical role in China's society and economy (Mattingly, 2016; Peng, 2004), here we focus on whether networks (guanxi, in Chinese) between government and enterprises, one of the most important informal institution, will impair the positive effect of market. To complete this work, we first need to distinguish companies that are "close" with government from those not. We leverage companies' information on capital structure and administrative affiliation covered in CIED.¹⁷ If a company has state capital participation or is directly affiliated to city government,¹⁸ we then suppose it has a close relationship with government. In 4203 companies that match successfully between CIED and land buyers, there are 270 and 860 companies being identified to have a close relationship with government according to the criteria of capital and affiliation respectively.

Using the samples from the four subgroups (i.e., has state capital, does not have state capital; affiliate to city government, does not affiliate to city government), we replicate the estimation with quadric function

of $f_s(Days_t)$ and 50 days as bandwidth. The results are shown in Fig. 4. The dots in the graph refers to the estimated coefficients and their 95% confidence intervals are also presented. Green symbols are results using companies with "long" distance from government, either defined by the criteria of capital or affiliation. Obviously, the positive effects of market on land use efficiency, including the intensity of land use and the quality of land buyers, become statistically insignificant for companies with a close relationship with governments. That means, if a parcel of land is won by a company closely related to government, even though the transaction is achieved by market-oriented competition, it still will not be intensively used. Meanwhile, market is also failed to screen out superior companies to become land buyers if we limit the sample to companies that are closely tied to government. These results imply that the positive effects of market are impaired by informal norms.

6. Conclusion and policy implication

6.1. Conclusion

The role of market is a long-lasting and core issue in economic. However, due to marketization is generally a nation-wide and gradual process, it is hard to find a proper "natural experiment" to establish causal links between market and economic outcomes. This paper attempts to contribute to this issue by novelly using the case of land market reform in China in 2007, which refers to that the central government strictly prohibited city government from transferring industrial

¹⁷ Each company in China has a certain administrative affiliation to different levels of government, i.e., central, province, city, county and town government. The affiliated government is responsible for administrative supervision and tax collection. Such an affiliation relationship will shape more close relationship between company and its affiliated government.

¹⁸ Every company in China corresponds to a specific level of government who supervises it. It could be government up to central government to township government.

land through private negotiation. Instead, city government is required to transfer industrial land through market-oriented methods. Due to the powerful central government and unique land system in China, market order of industrial land was founded almost over a night. Therefore, we could observe a significant jump up of the share of industrial land transactions achieved by market-oriented methods before and after July 1, 2007. This institutional background provides us with an ideal condition to conduct a fuzzy regression discontinuity design to identify the causal effect of market-oriented reform on land use efficiency.

The results show solid evidence supporting that market contributes to the improvement of land use efficiency. We find market not only improves the intensity of land use, which is indicated by the period of land development and floor area ratio of land, but also screens out superior companies to become land buyers. These results are statistically significant, economically sizable, and robust facing the change of bandwidth, alternate of the dataset, and deletion of special samples. However, we also find the positive effects of market are conditional on informal norms. If we compare land whose buyers are companies with close relationships with governments, market will neither increase the intensity of land use, nor make superior companies stand out. In short, our conclusions are two-sided: market has its positive effect, but the existence of market failure also should not be neglected.

One discussion worth specially noting is that how the conclusions speak to the race-to-bottom pricing issue among different jurisdictions. Although we find the evidence that market-oriented reform could effectively improve the land use efficiency, which is mainly achieved by the increase of industrial land price after reform, we lack the confidence to draw the conclusion that such a reform could effectively eliminate the phenomenon of race-to-bottom. With the political centralization and economic decentralization, regional competition for capital would be a long-lasting work for local governments. Regardless of the increasing industrial land price after reform, local governments could turn to other methods to attract those exceptional enterprises, such as providing industrial support funds, loan discounts, and tax returns. In this case, how should we understand this contradiction between the ongoing race-to-bottom and the market-oriented reform happened in industrial land? We argue that the main significance of market-oriented reform is that it screens out companies that have a higher evaluation of the value of the land and have the ability to pay a correspondingly higher price for the land. Owing to the bidding process and the increase of land price, industrial land is more likely to be won by admirable companies and used more intensively and efficiently. In a word, we believe the market-oriented reform could promote the *partial equilibrium* of the land market and significantly improve the land use efficiency, but the *general equilibrium* which takes other economic resources into account is hard to be achieved by the market reform happened in a single production factor like industrial land.

6.2. Policy implication

The above conclusions have important guiding significance for improving industrial land use efficiency and promoting the market-oriented reform of industrial land transfer. Therefore, we provide the following two policy recommendations:

- (1) Promoting the market-oriented allocation of land resource is an important task that local governments need to adhere to in the future. Land transfer marketization effectively promote the price of industrial land to its authentic market value. By taking full advantage of market mechanism in optimizing the allocation of industrial land, local governments could not only reap more considerable land revenue, but also could attract high-quality

investment projects and encourage industrial land to be more intensively used. To advance the land transfer marketization, we propose three concrete policy recommendations: First, from the side of government, we believe local governments should limit the application of negotiation transfer and increase the use of bidding, auction and listing. Second, a vigorous market requires the active participation of firms. However, due to the stipulated period of industrial land use right is 50 years, large quantities of firms are actually excluded from the primary land market due to the huge payment pressure. Middle-sized and small firms would rather to rent industrial land in the secondary land market, which not only causes the problem of unfairness but also severely weakens the competition in the primary market. More flexible years of land use rights should be adopted to encourage more firms to engage in the land primary market. Cities like Guangzhou are experimenting such a policy innovation and has achieved desired consequences. Third, smooth information flow will effectively promote the development of market. As a public goods, local governments should take the responsibility of establishing a timely and transparent land transfer information and transaction platform. Some developed provinces like Zhejiang and Jiangsu have made very successful demonstrations in this field and their experiences are worthy of national adoption.

- (2) The informal connections between government and enterprises might be obstacle for achieving the "authentic" land transfer marketization. Currently, although industrial land has been required to transfer through bidding, auction or listing, local governments are still equipped with the ability to choose land buyers. For example, Wang and Yang (2016) points out that local governments use the method of directional listing, which essentially has little difference from negotiation, to transfer land to their preferred enterprises. Their argument is well echoed with our finding that firms with close relationships to local governments are unlikely to be affected by land transfer marketization. These preferred enterprises (usually state-owned enterprises and large enterprises), which are not always more economically efficient than their counterparts, may crowd other disadvantaged companies out of the industrial land market. Therefore, it is important for local governments to take some measures to ensure that private enterprises and small enterprises can compete on an equal footing in the industrial land market. For example, recently the central government's policy of allowing small and medium-sized private enterprises to jointly participate in the auction of industrial land might be an important breakthrough for the achieving of a fully competitive industrial land market.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.landusepol.2022.106006](https://doi.org/10.1016/j.landusepol.2022.106006).

Appendix

(See here Appendix Figs. A1, A2 and Table A1).

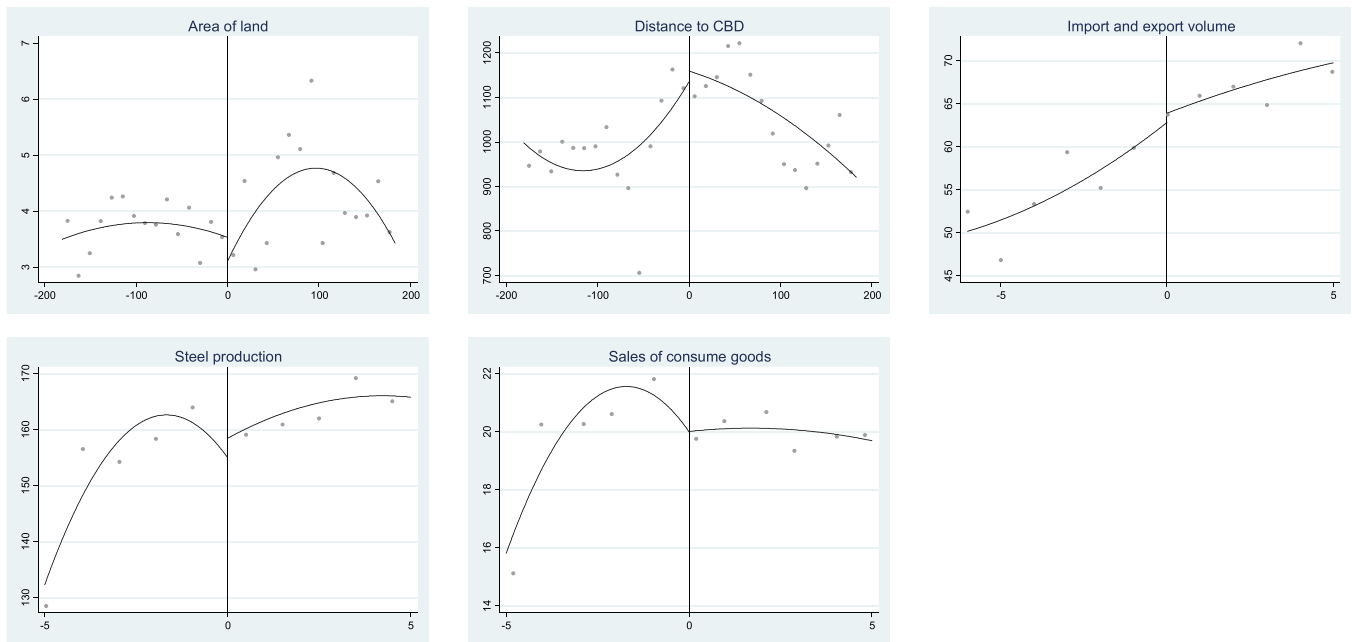


Fig. A1. No discontinuity of covariates.

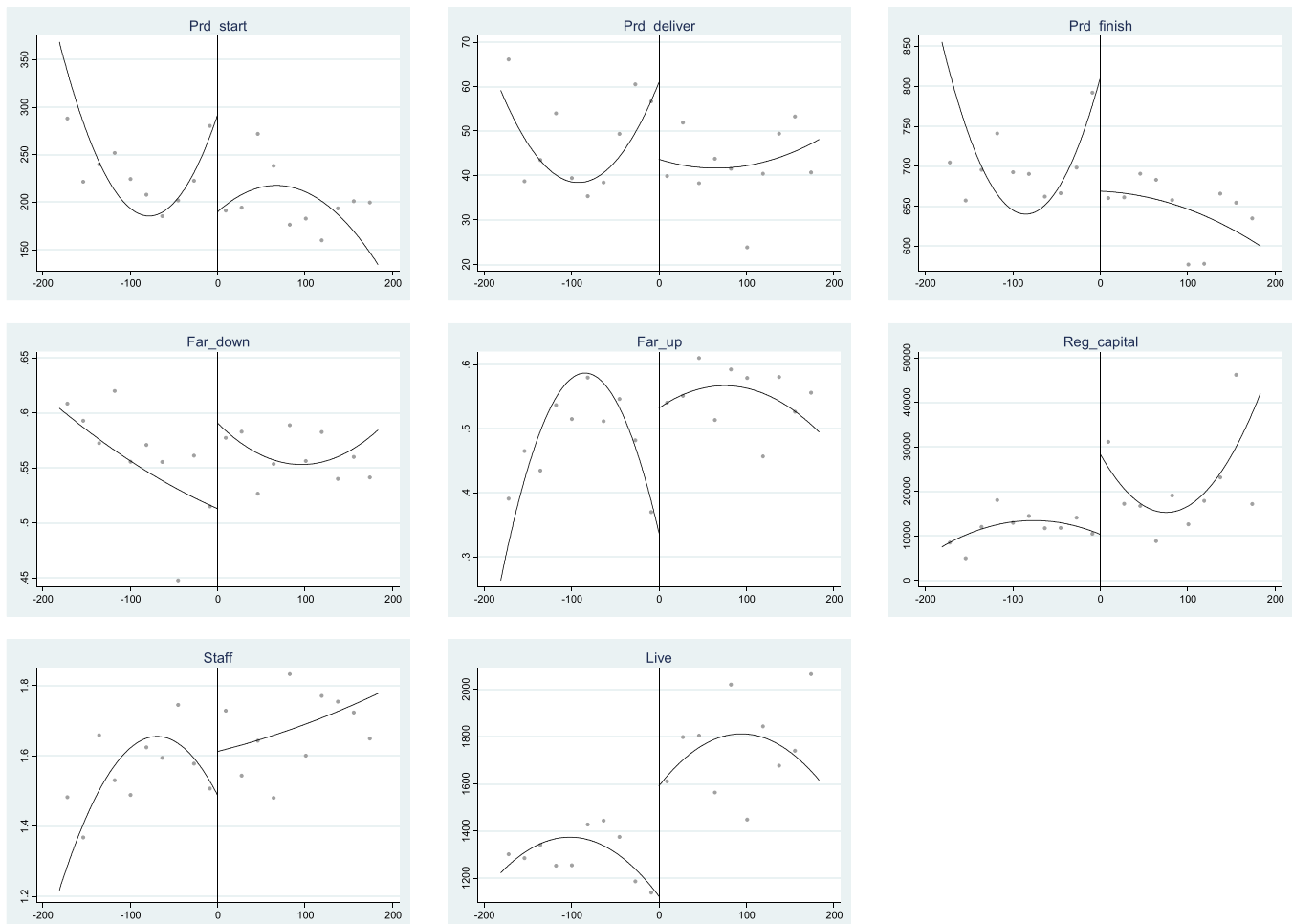


Fig. A2. Discontinuity of indicators of land use efficiency.

Table A1
Estimated Discontinuities in Predetermined Characteristics.

Dep. Var.	(1)	(2)	Observations
Area	-0.00276 (0.424)	-0.101 (0.497)	18,520
Distance	-64.15 * (26.58)	-31.41 (32.65)	11,781
Import & Export Volume	3.152 (24.51)	3.154 (24.55)	358
Steel production	-8.471 (43.08)	-12.56 (43.99)	328
Sales of consume goods	-15.26 (44.60)	-7.408 (45.19)	328
Days/Months polynomial controls	Linear	Quadric	

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