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Title: Urban land marketization in China: a supply side analysis

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Abstract

The land reforms in China that aim to build an efficient land market have led to the emergence of a dual land supply system composed of market-based leasing and administrative allocation. The use of a market-based leasing approach is deemed to strengthen the land supply efficiency with its superior competitiveness and transparency to administrative allocations. Yet, despite the central mandate requiring urban land to be supplied through public auction and tender in the market track, administrative allocation and negotiated trading remain as the dominant supply approach in China. This has caused concerns over whether the land reforms can achieve the efficiency goal given the limited role of the market instrument. This study attempts to clarify the concerns with the examination of the dynamics of urban land marketization in major Chinese cities and, more importantly, the impact on the efficiency of land supply and new housing supply. By utilizing aggregate prefecture-level residential land supply and new housing supply data during the period 2006-2017 and individual property development data between 2006 and 2015, systematic macro and micro analyses were conducted. The results show that 1) less-developed cities witness significant increases in the level of residential land marketization, while developed cities experience considerable decline, 2) increases in the residential land marketization show a limited role in improving the responsiveness of housing supply to housing price changes at both the aggregate supply and individual development levels, and 3) this limited role is likely to be caused by inefficient residential land supply, which is controlled by the municipal government, regardless of the supply channel. These findings have important implications in understanding the role of government interventions in supporting market-based activities on one hand, while on the other, how successful the land reforms in China are in improving the efficiency of land and new housing supply.

Keywords: Market reform, urban land market, land supply, housing supply, developers, Chinese cities

1. Introduction

The urban land market is imperfect by nature due to the more or less fixed supply of land parcels caused by its heterogeneity in terms of location and quality (Zhu, 2002). This imperfection is viewed as the major reason for the existence of mass government interventions in the land market across countries (Tian and Ma, 2009). Whether government interventions, either taking the form of direct government control on land supply or of various land use regulations, can achieve market efficiency has been frequently discussed in the literature (e.g., Vandergeest, 1997; Zhu, 1997, 2002). The unique dual nature of the Chinese economy can complement this line of research by the examination of government interventions in supporting market-based activities.

Since the market-oriented reforms in the late 1970s, a heightened feature of the Chinese economy has been the coexistence of a command system and the market instrument, which also exists in the urban land market (He and Wu, 2009). As the *de facto* owner of all urban land in China, the government has substantial control over land use and land supply (Lin and Yi, 2011). The establishment of a Land Use Rights (LURs) system in 1988 marked the end of free land use in China with the introduction of land value and an urban land market emerged with a dual land use system composed of market-based land lease and non-market administrative allocation (Yeh, 2005). Different from countries where government interventions were imposed in a free market economy, the market mechanism in China is built upon an administratively controlled land system which has existed for years. Though the Chinese government has restructured the institutional configuration to support the development of the urban land market, the market-track supply approach has coexisted uneasily with administrative allocations (Yeh and Wu, 1996; Yeh, 2005). For example, the difference between the market lease and administrative allocation prices in the dual land use system has led to the emergence of a black market where administratively allocated land is transacted at a price lower than the leased price but high enough to make a profit. The black market has hindered the development of a competitive land market system with fragmented land development and irregularities in urban space formation (Yeh and Wu, 1996). In addition, instead of weakening the role of the government, the land reforms were revealed to strengthen the government interference with complete control on land supply, namely, the quantity, structure, and timing of supply (Liu, Cao, Yan, and Wang, 2016). This casts doubt on the government's determination to comply with the market logic of urban land demand when it is conflicted with their own political and financial goals. Given the threat from the black market and the self-interested government, it remains questionable whether the land reforms in China can achieve an efficient land market with the introduction of market instruments.

The development of China's urban land market since the land reforms has been extensively examined in the literature. A large line of existing studies are focused on reviewing the reform course of the urban land system and documenting the new practices of land development (Ding, 2003; Lin and Ho, 2005; Lin, 2007; Xu, Yeh, and Wu, 2009). Studies in more recent years have primarily been concerned with the strengthened government interference in the process of market reforms (Tian and Ma, 2009; Tao, Su, Liu, and Cao, 2010; Ding and Lichtenberg, 2011; Yan, Ge, and Wu, 2014). Generally, it is found that, instead of making room for the market, the government has transformed itself to make the best of market mechanisms to achieve their own goals. Consistent with the evidence documented in developed markets¹, the

¹ See Vermeulen and Ommereen (2009), Kim and Cho (2010), and Ooi, Sirmans, and Turnbull (2011) for examples.

strengthened government intervention has threatened the adequate supply of housing by reducing the amount of land available for development. The restrictive land supply in China has also led to considerable land price increases, benefiting municipal governments with substantial revenue from granting land use rights (Bertaud, 2012; Du and Peiser, 2014). In addition to the fiscal incentive, municipal governments may fail to accurately forecast the demand for housing which makes land supply insufficiently responsive to demand changes (Cheshire and Sheppard, 2005). Du et al. (2011) and Peng and Thibodeau (2012) suggest that direct government control on land supply dampened the efficiency of the land market with the evidence of a weaker relationship between land prices and property prices in the post-reform period than in the pre-reform period in China. The reduced efficiency also presents in the housing market. Yan et al. (2014) reveal a significant decline in the elasticity of new housing supply in the post-reform period. These evidence may sound counter-intuitive because the land reforms in the early 2000s mandated all residential and commercial land to be supplied through the market mechanism instead of administrative allocation and non-transparent agreement. The increased use of a competitive supply method was expected to motivate the government to be more responsive to demand changes so as to maximize the land revenue. However, according to Haila (2007) who criticized scholars for treating the use of administrative allocation and agreement as indicators of the absence of a market mechanism in land development in China, the use of the market supply system may contribute to little extra efficiency. To clarify the argument, a more detailed investigation on the development of the market supply system in China is needed.

Liu and Lin (2014) and Liu et al. (2016) are two exceptions to examine the marketization dynamics of the land supply system in Chinese cities in the post-reform period. Despite the top-down central policy mandating leasing land through the market mechanism, they find the actual land supply strategy to be shaped through a bottom-up practice, which is determined by municipal governments' dual goals of fiscal expansion and local economic development. Theoretically, the municipal government's reliance on revenue from leasing land could operate as a self-generating force to improve the competitive nature of the land market by complying with the market logics of local land demand (Xu et al., 2009). However, a substantial amount of land was transferred non-transparently via the non-market mechanism to attract manufacturing investment and boost local facility constructions (Lin and Ho, 2005; Yeh, 2005). In this aspect, the progress of urban land marketization has not weakened the power of municipal governments but allows them to take advantage of the market mechanism to achieve their own goals (Liu and Lin, 2014). The result is considerably varied land supply strategies in terms of the extent of using the market track supply approach across cities in various geographical locations and development stages.

The aforementioned two studies, nevertheless, are limited to the extent to which China has established market institutions in land development. Many questions remain unexplored. How well does the land marketization controlled by the municipal government comply with the market logic? Since the implementation of the market supply method enhances the degree of competition on the demand side of the land market by encouraging more firms to enter into the real estate market, will the land marketization improve the efficiency of the urban land market? How have the dynamics of new housing development been shaped by the development of the urban land market? Will land marketization improve the housing supply efficiency with increases in its responsiveness to housing price changes? Will a competitive land supply strategy also affect the real estate developers' development behaviour, such as speculatively hoarding land from development? These questions have significant implications for a better

understanding of the development of the urban land market and the effectiveness of market instruments that are at the hand of the government.

In this study, we attempt to complement the urban land literature by examining if the introduction of the market instrument in the land market can improve the efficiency of land supply and new housing supply. Our focus is placed on the residential sector considering its pivotal role in real estate investment in China². Our purpose is fourfold, namely, (1) to identify the extent of urban land marketization across major Chinese cities; (2) to test the relationship, if any, between the extent of urban land marketization and the efficiency of new housing supply by utilizing a fixed effects panel data analysis; (3) to evaluate the impact of urban land marketization on real estate developers' development decisions with micro-level development data; (4) to compare the land supply efficiency across different supply channels.

The remainder of the paper is organized into four parts. In the subsequent section, we provide the institutional background of the land market development in China. Then, the empirical part of the study examines the extent of urban land marketization in major Chinese cities and identifies its impact on the efficiency of new housing supply and land supply and the development decisions of real estate developers. The important findings of the study are summarized and discussed at the end.

2. The land market reforms of China

2.1 The introduction of an urban land market in the late 1980s

The land market in China was built up in a gradual and dual-track manner, but has experienced significant changes over the years. Before 1987, land was only supplied by the government to users via administrative allocation at a small amount of administrative fees. Due to the lack of market guidance, the administrative allocation system led to over occupation of cultivated agricultural land by urban development, which triggered land reforms to tighten the land supply system (Yeh and Wu, 1996). The paid transfer of land use rights was introduced in 1987. Since land still belongs to the state, the granting of land use rights was recognized as acceptable within the existing socialist regime (Li, 1998). Land users usually obtain land use rights with a lease of 30-70 years for a specified type of use, which could be transferred to other users.

The introduction of the paid transfer of land use rights signalled the establishment of the urban land market in China with a dual land use system composed of market-based leasing and administrative allocation (Yeh, 2005). The non-market administrative allocation mechanism is mainly used for land developments of public services. In this type of allocations, it was the municipal government that initiated the allocation process, and a nominal land use fee, which is relatively low compared with the economic return that the land brings, is charged annually. The market-based mechanism primarily serves for commercial and industrial developments, allowing their land use rights to be transferred via public auction (*pai mai*), tender (*zhao biao*), and agreement (*xie yi*). In public auctions, the highest bidder will get the land use right, while a tender is based on invitation. In one-to-one agreements, the transaction price for the lease is usually negotiated 'under the table', which typically cannot reflect the economic value of the land as in auctions and tenders.

² Between 2005 and 2017, residential investment occupies 69% of investments in real estate in China (NBSC, 2018).

It is natural to expect that the introduction of land leases, in particular, auctions and tenders, would improve the efficiency in allocating land resources with their superior transparency and competitiveness. However, a large proportion of land is either allocated through administrative allocation or non-transparently through one-to-one agreement. Between 1995 and 1999, 447,231 hectares of land were administratively allocated, which accounted for 67% of the total land supplied³. The land supplied through agreement represented nearly 88% of total leased land in the same time period. The dominance of administrative allocations and under-the-table agreements can be attributed to the substantial discretion allowed for the municipal government to determine the price, if any, and other conditions of the land transfer. Due to the embedded non-transparency, local officials can collude with private developers to pursue personal gains or manipulate land prices to appeal to private developers, resulting in misallocation of land resources and land hoarding (Yeh and Wu, 1996; Xu, 2001; Lin and Ho, 2005; Wu and Yeh, 2007; Xu et al., 2009). This contributes to an urgent need to further regulate land supply by changing the land allocation method from administrative allocations to land leases, and from agreements to public auctions and tenders.

2.2 The reinforcement of market instruments in the early 2000s

To strengthen the role of the market mechanism, a new land trading system called auction/tender/listing (the ATL method) was introduced in 1999. Listing (*gua pai*), or two-stage auction, adds an under-the-table stage before auctions. In the first stage, bidders make entry decisions sequentially and the bids will be updated accordingly to the public. In the second stage, if there is only one bidder at the end of the notice period, that bidder is assigned the land use right at the bid price. If there is more than one bidder competing at the end, then the listing is converted to a public auction. Nevertheless, the use of the first stage leaves municipal governments substantial leeway to manipulate the transaction process to be advantageous to the preferred bidder (Cai, Henderson, and Zhang, 2013). Later, the Directory of Allocated Land abolished administrative land allocations to supply land for commercial projects. In March 2002, the Ministry of Land and Resources (MLR) issued Decree No. 11 to mandate all land for commercial developments to be transferred publicly using the ATL method after 1 July 2002. To reiterate the orders contained in Decree No. 11, two more regulations were announced. In March 2004, Decree No. 71 was issued to set 31 August 2004 as the deadline for all cities to abandon negotiated conveyances for commercial developments. Meanwhile, the secondary land market has been criticized for motivating land speculation, such as leaving developable land laying idle, and was thus banned from transferring land use rights after March 2004 (Yan et al., 2014). In other words, urban land can be converted from other uses to residential use in only one way, that is, from municipal governments to developers. Therefore, municipal governments have become the sole supplier of urban land and the market mechanism is mandated as the only way to supply land since then.

2.3 The bottom-up practice of urban land marketization

New land policies promoting marketization have not led to the end of dualism, but were enforced with difficulty (Hsing, 2010). For example, Xu et al. (2009) document the ignorance of the Beijing Municipal Government in the capital city regarding the implementation of Decree No.11. A local Circular No. 33 in Beijing was issued just before Decree No. 11 came into effect to allow land use rights to be transferred through agreement in selected areas (e.g.,

³ Data are collected from statistical yearbooks published by the China State Land Administration Bureau (1996-1997) and the China Ministry of Land and Resources (1999-2000). According to Lin and Ho (2005), data for 1997 are missing because of the merger of the Land Administration Bureau into the China Ministry of Land and Resources.

small towns, green belts, and urban renewal schemes) and then treated as the main guidance for the local land supply strategy. This emphasizes the pivotal role played by the municipal government in the progress of China's land marketization. As the monopoly land supplier and the local land manager responsible for the formulation of local land policies, municipal governments can implement central policies selectively depending on their own interests (Ran, 2013). Diverging from the central government's objective of improving land use efficiency, the interest of the municipal government mainly lies in the expansion of local finance and the growth of the local economy. Due to the increasing fiscal pressure since the tax-sharing reform in the mid-1990s, collecting sufficient budgetary and extra-budgetary revenue has been prioritized by most municipal governments. Urban land marketization, which can increase the average price of leased land through competitive biddings, has then become a critical means to generate extra-budgetary revenue. In this aspect, the central policy aiming at promoting land marketization should be effectively implemented by municipal governments. The statistics show that the conveyance fee⁴ collected from urban land supply has increased dramatically from 51.4 billion yuan in 1999 to 3.46 trillion yuan in 2016, and its ratio to local budgetary revenue has increased from 9.2% to 49.7% during the same time period (MLRC, 2000, 2017; NBSC, 2017). This land revenue fund has been at municipal governments' full disposal and can be used in any manner to support local government expenditure (Du and Peiser, 2014).

Urban land marketization can alleviate municipal governments' fiscal pressure with immediate land revenue but hinder their goal to promote local economic growth in the longer run (Liu and Lin, 2014). For example, a non-market mechanism should be preferred over market mechanisms to lease land for manufacturing factories. Given fierce regional competition, municipal governments usually rely on supplying lower-priced land through under-the-table agreement to attract manufacturing investment. If it succeeded, the local economy would enjoy the benefits generated by the manufacturing investment, including a sustainable stream of tax revenue and the spill-over effect on the development of the local service sector and the agglomeration of urban population (Liu et al., 2016). In comparison, because commercial activities are in general local and do not provide additional taxes in addition to the lump sum land conveyance fee, land for such uses was preferred to be supplied through market mechanisms (Wu, Li, and Yan, 2008). There are exceptions, however. It is also common for municipal governments to appeal to the developer with low-price land leased through agreement in commercial developments, while in return, the developer will build affordable housing or other public facilities for the city (Wu, 1999). As a result, the optimal land supply strategy should reflect municipal governments' balance between the short-term fiscal revenue of land marketization and long-term benefit from urban prosperity (Xu et al., 2009; Tao et al., 2010). It is reasonable to expect varied land supply strategies across cities with different geographical locations, economic structures, and development stages. That is to say, though land marketization is a central policy, its implementation should be understood as a bottom-up practice, depending on municipal governments' strategy to achieve its dual goals of fiscal expansion and local economic development (Liu et al., 2016).

3. Methodology

3.1 Residential land marketization

⁴The land conveyance fee refers to the gross traded price of land conveyance instead of the net profits made by the municipal governments. Liu et al. (2016) estimated that the profit margin of land sales was around 40% of the gross traded price, with the remaining 60% spent on land expropriation and land developments.

We first identify the dynamics of urban residential land marketization between 2002 and 2017. In this period, though the central policy mandated residential and commercial land to be supplied via the ATL method, administrative allocations and closed-door agreements could be used locally but to different extents. We employ a weighted average approach introduced by Liu and Lin (2014) to measure the degree of land marketization, that is, the extent of using the market-track land supply method, in different cities. Based on the assumption that different means of land supply are characterized by different degrees of transparency and competitiveness, the land marketization equation is expressed as follows:

$$MAR_{i,t} = \frac{\sum S_{i,t,k} W_k}{\sum S_{i,t,k}}, \quad (1)$$

where $MAR_{i,t}$ is the marketization level of urban land supply in city i and year t , k denotes the type of land supply, S indicates the total number/area of land parcels transferred in a city, and W is the marketization level of each type of land supply. The marketization level is defined by Liu and Lin (2014) as the average price of urban land conveyed in a particular way in comparison with the highest price level among the five supply types. Since the average prices of land conveyance through auctions and tenders were similar and the highest, their marketization levels are defined as 1. Accordingly, the marketization levels of listings and agreements are defined as 0.5 and 0.15, respectively. Though listing is categorized as one of the market-track lease methods, it can serve as a tool of manipulating the land auction process due to its non-transparent first stage (Cai et al., 2013; Wang and Hui, 2017). In agreements, it was often the local government that initiated the process and set the transaction price, if any, for the lease. This price typically did not reflect the economic value of the land, making it reasonable to assign it a low marketization weight. For land allocation, its marketization level is defined as 0, indicating the least transparency and competitiveness and the lowest price (Ding, 2003; Lin and Ho, 2005).

We calculated the residential land supply marketization level based on Eq.(1) for the 40 major Chinese cities, including four 1st-tier cities, fourteen New 1st-tier cities, sixteen 2nd-tier cities, and six 3rd- and 4th-tier cities. China has undergone a relatively sustained process of urban land marketization since 2002. As shown in Figure 1, between 2002 and 2017, the residential land marketization level calculated in land area increased from 27.7% to 59.3%, whereas only 5% increase is observed in the marketization level calculated in the number of land plots. Given the fact that land supplied through different methods differs substantially in size, land area should be a better measure than the parcel number to represent the amount of land supplied in each way. Since 2002, the share of residential land area supplied through the ATL method has achieved dramatic increases (see Figure 2), peaking in 2005 when the marketization level by area reached 68.3%. This supports the effect of the central land policy proposed in 2002 that required commercial and residential land to be supplied via the market mechanism. However, the increasing trend stopped after 2005. The residential land marketization level measured based on either the land area or plot declined abruptly in the following two years and has remained relatively stable between 2007 and 2017. This might be interpreted by the structural change of land supply as shown in Figure 2. Since 2005, the increased share of land supply via the market track has been exclusively contributed by listing, of which transparency and competitiveness were relatively limited, whereas the shares of land supply through auctions and tenders have declined considerably. During more than two decades of land market reforms, public auctions and tenders have not become popular ways to supply residential land. It is interesting to note that, as shown in Figure 3, the share of residential land supply leased through agreements has rebounded in terms of plots since 2005, though its share measured in land area

shows no substantial change. This suggests that the majority of residential land of large size has been conveyed through the ATL method as mandated by the central state.

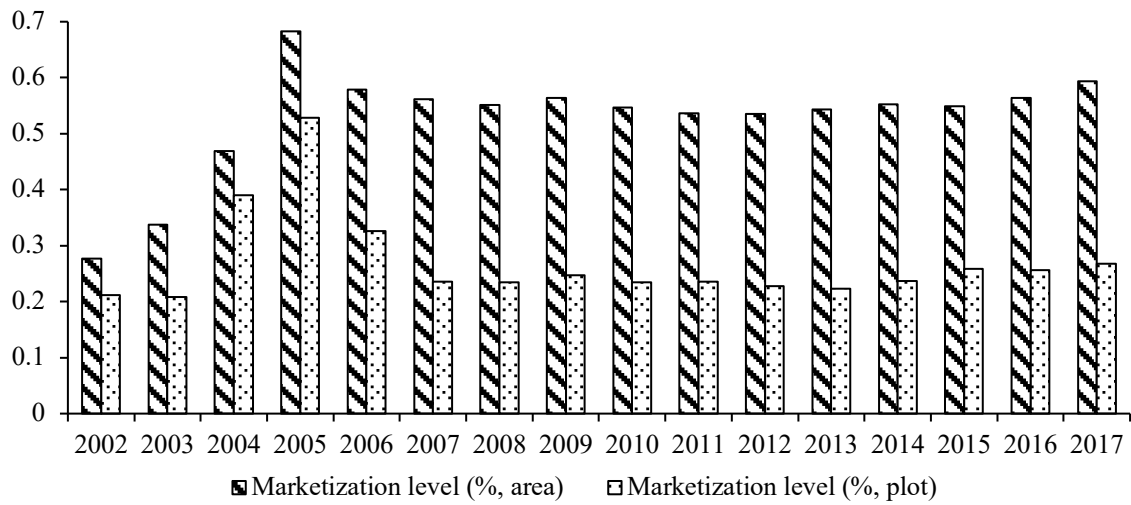


Figure 1: The marketization level of residential land supply in 40 major Chinese cities, 2002-2017

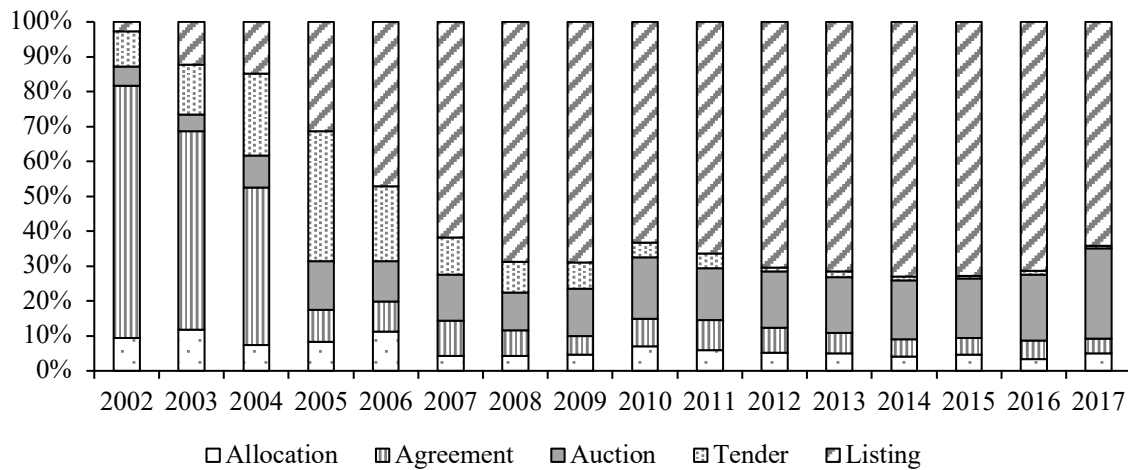


Figure 2: The structure of residential land supply in 40 major Chinese cities, 2002-2017: land area

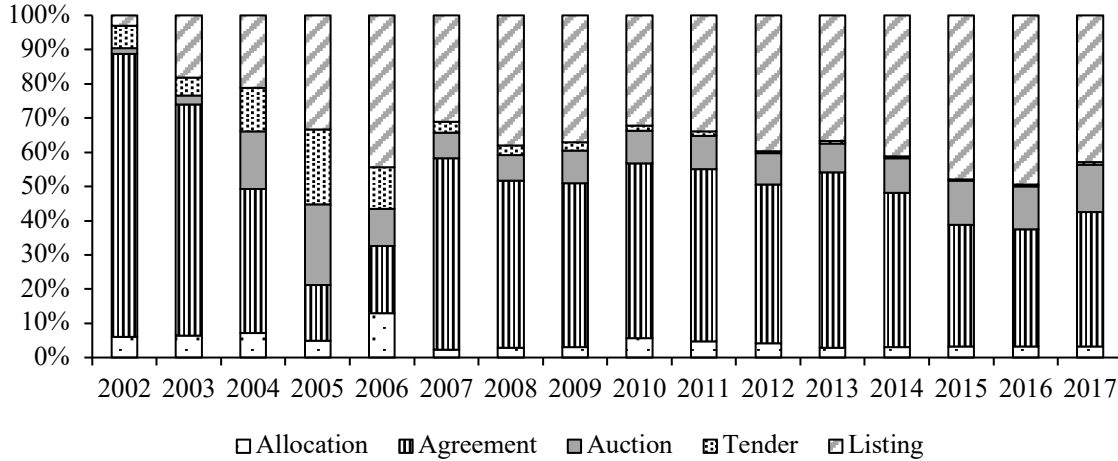


Figure 3: The structure of residential land supply in 40 major Chinese cities, 2002-2017: land plot

Benefited from the central policy, the residential sector achieved greater success in marketization than other sectors (i.e., industrial) in land supply. The average marketization level for the entire urban land market increased from approximately 22% in 2002 to 33% in 2010 as documented by Liu et al. (2016), while the residential sector achieved a 21-percentage points increase in the same time period, increasing from 34% to 55%. Expectedly, the land supply strategies vary across cities. For example, Table 1 shows a very uneven landscape of land marketization based on city tiers, which are used to differentiate cities with different development stages. Generally, the higher the tier, the more developed the city is. According to Table 1, there seems to be a gradual transition of residential land marketization from developed cities to less-developed cities. The marketization level in 1st-tier cities, the most developed cities in China, was highest in 2002, but it declined to the lowest in 2017. In the same time period, the residential land marketization level in New 1st-tier and 2nd-tier cities doubled. In comparison, 3rd- and 4th-Tier cities achieved substantial increase between 2002 and 2010, but then started to decrease. However, this trend may not be representative for 3rd- and 4th-tier cities due to the limited number of 3rd- and 4th-tier cities included in our sample.

Table 1: Residential land supply marketization by city tiers, 2002, 2010 & 2017

City tiers	Cities	2002	2010	2017
1 st Tier	Beijing, Guangzhou, Shanghai, Shenzhen	0.730	0.524	0.337
New 1 st Tier	Changsha, Chengdu, Chongqing, Hangzhou, Kunming, Nanjing, Ningbo, Qingdao, Shenyang, Suzhou, Tianjin, Wuhan, Xi'an, Zhengzhou	0.284	0.521	0.616
2 nd Tier	Changchun, Dalian, Fuzhou, Guiyang, Haikou, Harbin, Hefei, Jinan, Lanzhou, Nanchang, Nanning, Shijiazhuang, Taiyuan, Wenzhou, Wuxi, Xiamen	0.314	0.531	0.585
3 rd & 4 th Tier	Beihai, Hohhot, Sanya, Urumqi, Xining, Yinchuan	0.278	0.514	0.344

Note: 1st-Tier cities are the most developed in terms of per capita GDP, while 3rd- and 4th-Tier cities are the least developed. New 1st-Tier cities are more developed than 2nd-Tier cities.

3.2 The efficiency of new housing supply

In this section, we build models of new housing supply and determine whether urban land marketization has any impact on the efficiency of the housing market. Previous studies that examine the dynamics of new housing production agree on the variables that affect new housing production, such as housing price, construction cost, and constraints that affect the availability of development inputs, but differ on the construction of the model (Mayer and Somerville, 2000; Mayo and Sheppard, 2001; Ball, Meen, and Nygaard, 2010). The main issue is whether new housing construction should be modelled as a response to housing price levels or changes (Deng and Chen, 2019). According to Dipasquale and Wheaton (1994), housing price is a stock variable which equilibrates total housing supply with total housing demand in the long run, while new housing construction is a flow variable that adjusts the housing stock toward this long-run equilibrium. Therefore, new housing construction should be induced by housing price changes rather than price levels. Moreover, given that new housing production is a stationary variable and housing price level tends to be trended, a function of housing price changes fits better with the properties of time series variables (Mayer and Somerville, 2000; Deng and Chen, 2019). Following this line of literature, we specify that new housing supply is induced by housing price changes and changes in the cost of development inputs. If the land supply strategies comply well with the market logics of urban land demand, we expect new housing supply to be responsive to changes of one-period housing price changes. Our basic model of new housing supply thus takes the following form:

$$\ln HS_{i,t} = \beta_0 + \beta_1 \Delta \ln HP_{i,t-1} + \beta_2 \Delta \ln PGDP_{i,t} + \beta_3 \Delta \ln LAC_{i,t} + \beta_4 \Delta \ln COC_{i,t} + \beta_5 \ln LS_{i,t-1} + \beta_6 \ln LS_{i,t-2} + \theta_i + \zeta_t + \epsilon_{i,t}, \quad (2)$$

where subscripts i and t refer to city i and year t , respectively; \ln denotes the natural logarithm; Δ denotes the first difference of relevant variables; θ_i is the city-specific fixed effects, ζ_t is a vector of year-specific fixed effects, and $\epsilon_{i,t}$ is the idiosyncratic error. HS is new housing supply, measured by the floor area of housing starts, and HP is a residential price index.

To avoid the simultaneity problem, Eq.(2) is performed with lagged housing price changes. In Eq.(2), the coefficient β_1 represents the estimate of the flow housing supply elasticity, which measures the responsiveness of housing supply to changes in housing price. If the flow housing supply elasticity is relatively high, new housing starts will increase accordingly to meet the increased demand. If the flow housing supply elasticity is relatively low, new housing supply will not respond adequately to the demand changes, contributing to substantial housing price appreciation. We also follow Ooi and Le (2012) to include an exogenous demand variable, i.e., changes in the local per capita GDP ($PGDP$), as control in case the housing market is not efficient and housing prices may not capture all general macroeconomic conditions.

Housing production will become less profitable as land cost and construction cost increase. We use the annual residential land price to measure land cost (LAC) and add the annual average construction cost (COC) which includes the cost of building materials, equipment, and labour. However, land price may insufficiently capture the land constraints for housing development, which is even serious in China because the land supply is controlled by the government (Saiz, 2010). That is, land price increases may not lead to an expanded land supply. We follow Deng and Chen (2019) to include the residential land supply (LS). Land supply should be positively related to new housing supply in a well-functioning market, unless developers speculatively hold land vacant. Because it is necessary for developers to go through various administrative

formalities before starting construction, land supply tends to affect new housing supply with a time lag. We follow Yan et al. (2014) to include the 1-year and 2-year lags of land supply (i.e., $LS_{i,t-1}$ and $LS_{i,t-2}$) as independent variables in Eq.(2).

To maximize the revenue, we expect new housing supply to be more responsive to market changes if they were supplied via the market track with a more competitive land price than the non-market track. That is, a competitive land market should strengthen the efficiency in the new housing supply. Ideally, we need a specific land marketization measure indicating the extent of new housing developed on land supplied via the market track to model such effect. However, constrained by data availability, we rely on the overall residential land marketization level as a proxy. We include the lagged residential land marketization ($MAR_{i,t-1}$) and its interaction with housing price changes in Eq.(2) to test the impact of land marketization on the elasticity of new housing supply. A positive coefficient estimate is expected on the interaction term to confirm the strengthening impact.

3.3 The responses of individual development

In this section, we complement the macro analysis of new housing supply in Section 3.2 by examining the impact of urban land marketization on the supply of individual development. Du and Peiser (2014) document the evidence of land hoarding by municipal governments in the progress of land marketization. This leads to the question that whether land marketization will also incentivize development delays by the developer so as to capture higher sales price in the future. To model such impact, we estimate the developer's decision of development with a parametric hazard model and include the measure of residential land marketization to proxy the likelihood that the development is built on the land supplied via the market track. Unlike the use of aggregate data in a reduced form supply equation (i.e., Eq.(2)), this approach enables microdata analysis of development timing for each single project in a duration model and both property characteristics and developer features can be well captured.

Specifically, we estimate Eq.(3) and Eq.(4) using the parametric hazard model as follows:

$$h(t) = \exp(Z'\omega)h_0(t), \quad (3)$$

and

$$Z'\omega = \gamma_1 MAR_{i,t-12} + \gamma_2 MAR_{i,t-12} * PC_{i,t-1} + controls, \quad (4)$$

where $h(t)$ measures the conditional probability of development occurring at time t (at month level), which is routinely called the hazard rate; Z consists of the residential land marketization level at a 1-year lag ($MAR_{i,t-12}$), and its interaction term with the lagged housing price change ($MAR_{i,t-12} * PC_{i,t-1}$), and control variables defined below; ω is a vector of coefficients to be estimated, and $h_0(t)$ is the baseline hazard⁵ that defines the hazard rate when all explanatory variables are equal to 0. Developments that remain unlisted on the market at the end of our sample period are treated as right censored.

The coefficient γ_1 denotes the impact of land marketization on development timing and of particular interest is the coefficient γ_2 on the interaction term between the land marketization level and the housing price change. It is to capture the potential differences in the developer's

⁵We assume a Weibull baseline hazard with the function form of $h_0(t) = \lambda p(pt)^{p-1}$, where p is the shape parameter to be estimated.

responses to housing price changes if the land for development was supplied via different channels. We add control variables based on the work of Wang, Tang, and Jia (2016) in Eq.(4), which include hedonic variables for the development project, firm characteristics, and variables on market characteristics representing both the local supply and demand.

3.4 The efficiency of residential land supply

Land supply is an essential determinant of the efficiency of the new housing market (Goodman, 2005). Given adequate supply of land, developers can respond quickly to housing price increases by constructing more. By contrast, the responsiveness of new housing supply to housing price changes will be limited when the land supply is inadequate. Peng and Thibodeau (2012) rely on the explanatory power of property prices on residential land prices to interpret the efficiency change in the urban land market caused by the land reforms in China. Given the inaccurate land price information, we use the relationship between residential land supply and housing price changes to examine the efficiency of land supply across different channels. If the land market is efficient, then land supply should respond positively to housing price changes. The basic specification of the model of land supply is expressed as follows:

$$\ln LS_{i,t} = \alpha_0 + \alpha_1 \Delta \ln HP_{i,t} + \alpha_2 \Delta \ln PGDP_{i,t} + \alpha_3 \ln DES_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}, \quad (5)$$

where subscripts i and t refer to city i and year t , respectively; \ln denotes the natural logarithm; Δ denotes the first difference of relevant variables; μ_i is the city-specific fixed effects, δ_t is a vector of year-specific fixed effects, and $\varepsilon_{i,t}$ is the idiosyncratic error. LS is residential land supply, which is measured by site area of land sold to the developer for housing development. Similar to Eq.(2), we add the housing price changes ($\Delta \ln HP_{i,t}$). Considering the potential inefficiency of housing price changes in capturing demand changes, we employ changes in local per capita GDP ($PGDP$) to control the exogenous local demand for properties (Du et al., 2011). City density (DES) is also included to control the geographical supply constraints (Green, Malpezzi, and Mayo, 2005).

The coefficient α_1 represents the estimate of the average responsiveness of residential land supply to housing price changes and is expected to be positive if housing price changes help determine the demand for land and, thus, land supply. It might be concerned that the coefficient α_1 will capture the causation from land supply to housing prices. However, considering the time lag between purchasing land and selling properties, housing prices should be determined by previous land supply instead of future land supply. Therefore, it is plausible that the coefficient α_1 captures the effect of housing price changes on future land supply.

The motive behind the mandate requiring the adoption of the ATL method to grant land use rights is to enhance transparency and competition on the demand side. Therefore, we expect that land supply via the market track would be more responsive to housing price changes than government-oriented land supply. To test such difference, we divide land supply into through tender/auction, through listing, and through agreement/allocation and repeat Eq.(5) using the three categories of land supply as the dependent variable, respectively.

4. Data

We rely on multiple sets of data to conduct our empirical analysis. First, to model the dynamics of urban land marketization, we compiled land supply data based on detailed land transaction records including transaction date, supply channel, the parcel's address, size, designated usage

(i.e., residential, office, retail, etc.), and major planning indicators such as floor area ratio, which are available from the official land market website. This dataset starts from 2002 when the municipal governments were required to transfer land via public channels and to publicly report the land transaction information. Due to its rarity, the land transaction dataset has been increasingly employed to produce high-quality research on China's housing and land markets (e.g., Wu, Gyourko, and Deng, 2015).

Second, a reliable housing price index is of particular importance to identify housing market efficiency. We employed the multi-city housing price index built by the Real Estate Institute in Tsinghua University. Another two official housing price indices are the average selling price of newly built residential buildings and the price index for real estate in 70 large- and medium-sized cities, both of which are calculated and reported by the National Bureau of Statistics of China. However, the former price index can be criticized for not adjusting for quality differences, while the latter one fails to account for developers' pricing behaviour. Wu, Deng, and Liu (2014) sorted out these methodological issues in the establishment of a new housing price index by using the hedonic pricing method based on the newly built housing market. In the rest, data on the floor area of housing starts were generated from the Wind database; urban and regional statistics, such as population, per capita GDP, construction cost, and municipal fiscal revenue, were derived from the China Statistical Yearbook for Regional Economy.

Subject to data availability, our panel data only cover the period between 2006 and 2017 from 40 major Chinese cities. Due to missing values for some years of some cities, the panel data are unbalanced. The descriptive statistics of the panel variables in Eq.(2) and Eq.(5) are listed in Table 2. Comparing land supply via different tracks, listing was the dominant way to supply residential land for housing development, which is two times more than the respective amount of land supplied through auction/tender and agreement/allocation.

Before running the panel model, we tested whether or not the panel variables have a unit root. We employed the panel unit root test for the unbalanced panel data proposed by Im, Pesaran, and Shin (2003), and the results are reported in the last two columns of Table 2. The null hypothesis of the existence of a unit root is rejected for all variables in their transformations.

Table 2: Summary statistics and panel unit root test

Variable	Obs.	Mean	Std.Dev.	Min	Max	Transformation	Im, Pesaran, and Shin (2003)
HP	466	228.74	113.37	96.40	1002.35	$\Delta \ln$	-5.252***
HS	401	1141.11	792.59	119.09	5387.6	\ln	-4.557***
LS	466	638.85	847.35	0.939	10391.41	\ln	-3.217***
LS (auction/tender)	466	115.58	242.03	0.00	2579.19	\ln	-3.465***
LS (listing)	466	394.51	486.43	0.00	3391.34	\ln	-4.366***
LS (negotiation/allocation)	466	47.18	103.95	0.00	1104.41	\ln	-6.582***
MAR	466	0.53	0.16	0	1	/	-6.290***
PGDP	466	8.17	6.35	0.85	49.31	$\Delta \ln$	-3.238***
DEN	428	691.47	409.12	128.22	2275.67	$\Delta \ln$	-2.251**
LAC	463	3070.99	3837.35	204.11	31413.35	$\Delta \ln$	-12.324***
COC	465	2235.03	830.36	804.25	5761.69	$\Delta \ln$	-4.330***

Note: * denotes significance at the 10% level, ** denotes significance at the 5% level, and *** denotes significance at the 1% level.

The individual development data for Eq.(4) came principally from the CREIS database which contains detailed records of parcels and developments that occurred across China. The development sample consists of a total of 1,355 newly built residential projects that are developed on land parcels transacted between 2006 and 2015. These developments come from 17 Chinese cities by 90 listed real estate firms. We used the trackable records to identify the start and the end of each land parcel as undeveloped. In theory, developers can start the development once completing the purchase of a parcel from local government. Yet, around a one-year lag is needed to allow developers to go through the necessary administrative approvals (Wang et al., 2016). Therefore, we measured the start of the duration by one year after the parcel transaction date recorded and the duration end by the construction start. The duration of undeveloped time is then calculated from the date when a parcel is bought by a real estate developer postponed by one year until the construction start and majority projects were developed within 40 months. In total, the 1,355 residential projects are transformed into over 40,000 observations with the time-span records of a single project split into monthly records.

5. Estimation results

5.1 New housing supply and land marketization

Table 3 shows the regression results for the fixed panel model of new housing supply. Column (1) reports regression results for Eq.(2) when the lagged change in housing prices ($\Delta \ln HP_{i,t-1}$), change in per capita GDP ($\ln PGDP_{i,t}$), change in land price ($\Delta \ln LAC_{i,t}$), change in construction cost ($\ln COC_{i,t}$), and 1-year and 2-year lags of land supply ($\ln LS_{t-1}$ and $\ln LS_{t-2}$) are included as explanatory variables. The coefficient estimate on $\Delta \ln HP_{i,t-1}$ registers a positive and significant sign, showing that housing supply has positively responded to changes in the first difference of housing price, as one would expect in a functioning housing market. Because we take logs for both the dependent and independent variables, the coefficient estimate on $\Delta \ln HP_{i,t-1}$ is a direct measurement of the elasticity of new housing supply. The magnitude of the new housing supply elasticity is close to that documented by Yan et al. (2014) using national data between 2006 and 2011 (i.e., 0.515). An elasticity smaller than 1 suggests limited responsiveness of new housing supply to housing price changes. As a positive response to demand changes, new housing supply increases with per capital GDP growth in the city. Consistent with previous studies (e.g., Yan et al., 2014), coefficient estimates on construction cost and land price are not statistically significant. Expectedly, coefficient estimates on the 1-year and 2-year lags of land supply are positive and statistically significant. A 1% increase in 1-year lag of land supply will result in 0.158% increase in new housing supply, and a 1% increase in 2-year lag of land supply will result in a 0.074% increase in new housing supply. Because new housing supply is positively related to land supply, it is reasonable to argue that the efficiency in land supply will affect the efficiency in new housing supply.

Of primary interest are estimated coefficients on the lagged land marketization level and its interaction term with the lagged housing price changes. In column (2) of Table 3, the coefficient estimate on the lagged land marketization level registers a positive and significant sign, which suggests that a competitive land market can bring an increase in new housing supply. However, as shown in column (3), the insignificant interaction estimate implies that land marketization fails to improve the responsiveness of new housing supply to housing price changes. In column (4), other variables remaining the same, we replace $MAR_{i,t-1}$ with a dummy variable, which is equal to 1 if the residential land marketization level is larger than its median value and 0 otherwise. The coefficient estimate on the interaction term reports to be positive and

statistically significant at the 10% significance level. This could provide weak evidence showing that a great level of land marketization can improve the flow housing supply elasticity. In other words, new housing supply supplied via the market track would be more responsive to changes of one-period housing price changes.

Table 3: Regression results for models of new housing supply

Dependent variable: $\ln HS_{i,t}$	(1)	(2)	(3)	(4)
Independent variables				
$\Delta \ln HP_{i,t-1}$	0.533*** (0.166)	0.488*** (0.164)	0.395 (0.493)	0.468 (0.166)
$\Delta \ln HP_{i,t-1} \times MAR_{i,t-1}$			0.304 (0.206)	0.338* (0.204)
$MAR_{i,t-1}$		0.326** (0.154)	0.193 (0.963)	-0.001 (0.033)
$\Delta \ln PGDP_{i,t}$	0.318** (0.153)	0.295* (0.153)	0.293* (0.153)	0.313** (0.153)
$\Delta \ln LAC_{i,t}$	0.057 (0.045)	0.056 (0.045)	0.055 (0.045)	0.054 (0.044)
$\Delta \ln COC_{i,t-1}$	-0.083 (0.186)	-0.065 (0.182)	-0.067 (0.182)	-0.075 (0.186)
$\ln LS_{t-1}$	0.158*** (0.032)	0.155*** (0.031)	0.155*** (0.031)	0.158*** (0.032)
$\ln LS_{t-2}$	0.074*** (0.027)	0.078*** (0.026)	0.078*** (0.026)	0.073* (0.027)
Constant	5.443*** (0.274)	5.174*** (0.284)	5.193*** (0.303)	5.459*** (0.273)
Year fixed effects	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
Observation	366	366	366	366
R^2	0.887	0.889	0.889	0.887

Notes: (1) The model is a fixed panel model; (2) Robust standard errors are reported in parentheses; (3) * denotes significance at the 10% level, ** denotes significance at the 5% level and *** denotes significance at the 1% level; (4) In column (4), $MAR_{i,t-1}$ is replaced with a dummy variable, equal to 1 if $MAR_{i,t-1}$ is larger than its median value and 0 otherwise.

5.2 Development delays and land marketization

Table 4 reports the regression results for the hazard model of individual development decision. First of all, the hazard model is statistically significant, as indicated by the value of the Weibull parameter estimate, p . Specifically, $p > 1$ at all standard significance levels. This outcome suggests a strongly increasing hazard of development over time that is consistent with theories and empirical observations.

Our interest lies on the variable of land marketization level and its interaction with the housing price change. As shown in column (1) without the interaction term, the coefficient estimate on the land marketization variable registers a significantly negative sign, suggesting considerable delaying impact. Specifically, a 1% increase in land marketization level is associated with a decrease in the likelihood of development equivalent to 0.46% of the average development rate in the sample. This longer holding period may result from the typically large size for the

market-track supplied land as found comparing Figure 2 and Figure 3, which requires considerable preparation work. The coefficient estimate on the housing price change is positive and significant, suggesting that developers respond to housing price increases with acceleration of development. When the interaction term between the land marketization level and the housing price change is included in column (2), it reports a positive coefficient estimate which is significant at the 10% significance level. In line with the macro analysis results in the last section, competition in the land market can strengthen the developer's responsiveness to housing price changes (at least) to some extent.

Table 4: Regression results for models of development timing

	(1)	(2)
<i>Dependent variable: the hazard rate at time t for property i</i>		
MAR	-0.610*** (-3.31)	-0.837*** (-3.75)
MAR×AVGP		2.825* (1.85)
AVGP	0.964*** (5.68)	-0.457 (-0.58)
Weibull parameter ρ [standard error]	1.502 [0.023]	1.502 [0.023]
Log likelihood	-8713	-8711
No. of Events	1,207	1,207
Observation	42,045	42,045
Control variables	Yes	Yes
Firm fixed effects	Yes	Yes
Quarter fixed effects	Yes	Yes

The estimated hazard model is $h(t)=\lambda\rho(\lambda t)^{\rho-1}\exp(X'\beta)$. Coefficients are reported in real form (β) and a standard deviation change in X leads to a $[\exp(1*\beta*\rho)]-1$ percent change in the hazard rate $h(t)$. Z-statistics are reported in parenthesis (except for where noted).

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Control variables:

soe: 1 if the project is developed by a state-owned developer; otherwise, 0

firmsize: the natural logarithm of the total asset value of the developer lagged by one year

firmgrowth: the year-on-year percentage change in asset value

lp_hp: the ratio of the average land price to the average housing price in the city

cpolulation: the year-on-year population change in the city

cincome: the year-on-year income change in the city

shibor: the 9-month Shanghai Interbank Offered Rate

supply: the amount of total projects (in terms of building area) supplied in the city

phasing: 1 if the project has multiple phases; otherwise, 0

skeydis: 1 if the project is located in the main district of the city; otherwise, 0

fBuildArea: the building floor area within the project

luxury: 1 if the project is a villa; otherwise, 0

5.3 Land supply and land marketization

A fixed panel model was estimated for the model of residential land supply in Eq.(5), with results displayed in Table 5. Columns (1) to (4) report regression results without the lagged land supply. As shown in column (1), changes in housing price exert a positive but insignificant impact on the entire residential land supply. This insignificance holds in the next three columns when the dependent variable is replaced with residential land supply through auction/tender, listing, and agreement/allocation, respectively. When the lagged land supply variable is

included as in the last four columns, it is interesting to note that land supply through auction, tender, and listing rely heavily on the respective land supply in the previous year, whereas land supply through agreement and administrative allocation shows no reliance on previous records. Considering the lack of competitiveness and transparency in administrative allocation and agreement, it is not surprising to find that the land supplied via these two channels fails to respond to housing price changes or previous supply records. However, it is unexpected that the market-track land supply shows similar ignorance of housing price changes but only follows what was supplied in the previous year. Given that new housing supply positively correlates with land supply (as shown in Table 3), the inefficiency in land supply may be one of the causes for the limited elasticity in new housing supply. If housing price changes are efficient signals for market changes, these could be the evidence for either the municipal government's failure to accurately predict the demand change in leasing land or intentional ignorance of the market logic for their own interests.

Despite the unresponsiveness to housing price changes, we find that residential land supply through listing increases with local per capital GDP growth. Meanwhile, in dense cities with limited land supply, there is more land supplied through auctions and tenders, while less land is supplied through listing. The pressure of limited land available for development forces the government to maximize the land leasing revenue through competitive bids.

Table 5: Regression results for the models of residential land supply

Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln LS_{i,t}$	Total	Auction/ Tender	Listing	Agreement/ Allocation	Total	Auction/ Tender	Listing	Agreement/ Allocation
$\Delta \ln HP_{i,t}$	0.109 (0.337)	2.006 (2.690)	-2.235 (1.792)	-0.445 (2.976)	0.199 (0.333)	1.341 (2.669)	-1.593 (1.679)	-0.210 (3.040)
$\ln LS_{t-1}$					0.243 ^{***} (0.053)	0.289 ^{***} (0.077)	0.312 ^{***} (0.104)	0.123 (0.093)
$\Delta \ln PGDP_{i,t}$	0.592 [*] (0.302)	-1.090 (2.734)	6.236 ^{***} (2.253)	1.254 (1.989)	0.524 ^{**} (0.260)	-0.570 (2.440)	5.884 ^{**} (2.342)	1.108 (1.950)
$\ln DEN_{i,t}$	0.357 (0.584)	8.107 ^{**} (4.053)	-4.858 ^{**} (2.044)	1.992 (2.315)	0.456 (0.562)	8.700 ^{**} (4.031)	-5.270 ^{**} (2.319)	1.927 (2.320)
Constant	4.709 (3.890)	-41.85 (27.08)	36.57 ^{***} (13.52)	-5.829 (15.46)	2.186 (3.770)	-49.45 (27.00)	43.13 ^{***} (15.44)	-6.227 (16.22)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	359	359	359	359	359	359	359	359
R ²	0.775	0.499	0.579	0.424	0.795	0.536	0.632	0.432

Notes: (1) The model is a fixed panel model; (2) Robust standard errors are reported in parentheses; (3) * denotes significance at the 10% level, ** denotes significance at the 5% level and *** denotes significance at the 1% level.

6. Conclusion and discussion

This study examines the dynamics of urban land marketization and its impact on the efficiency of land supply and new housing supply in 40 major Chinese cities from 2006 to 2017, a period during which private housing markets flourished in China. Though it was mandated that land for commercial developments have to be supplied via the market-track, the implementation

varies significantly across cities. Since the mandate, less developed (i.e., 2nd- and 3rd-tier) cities have realized stable increases in residential land marketization by employing the market-track land leasing method frequently, whereas developed (i.e., 1st-tier) cities have experienced substantial decline. It is also found that, despite the central government's effort to speed up the development of the urban land market, auctions and tenders have not won dominance with their superior competitiveness and transparency. Instead, the majority of municipal governments choose the listing approach which allows them to meet the central government's mandate, while maintaining discretion to manipulate the transaction process.

The existing literature shows that the choice of land supply methods makes a significant difference in the conveyance revenues earned by municipal governments (Liu and Lin, 2014). This study extends this line of literature by investigating the impact of the land supply strategy on the efficiency of new housing and land markets. The main results show that three decades of housing and land reforms in China have produced a supply system with limited responsiveness to market changes and the progress of urban land marketization is of little help to improve such responsiveness. In other words, the increased use of the market-track supply method fails to improve the efficiency of land supply, and consequently, shows limited impact on the efficiency of new housing supply.

What does our study imply for our understanding of the Chinese real estate market? First of all, the findings by measuring the land and housing supply elasticities that capture how residential land and new housing production have responded to housing price changes can facilitate our understanding of housing price movements. This is particularly useful when the Chinese real estate market has undergone substantial price increases, which has caused serious social dissatisfaction for non-homeowners. According to this study, inelastic new housing supply, which is partly caused by inefficient land supply, can be held responsible for the rapid housing price appreciations. Secondly, the analysis on the impact of the residential land marketization can extend our understanding of whether the development of the urban land market has improved the land and housing market efficiency. The results that residential land marketization plays little role in improving the elasticity of land and housing supply cast doubt on the success of urban land marketization. The dominant use of listing, which is of limited transparency and competitiveness compared with auctions and tenders, might be the cause. Therefore, beyond the mandate requiring commercial developments to be supplied through the ATL method, further guidance should be directed toward the use of auctions and tenders to improve the land supply and housing supply efficiency. Since land marketization is a bottom-up practice determined by municipal governments, how to incentivise local officials in building a competitive land market needs further consideration. Nevertheless, the municipal government has a long and arduous way to make land supply respond to market demand and city development more effectively and efficiently.

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