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# Tax Streams, Land Rents, and Urban Land Allocation

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**Abstract**

This paper examines the fiscal motives behind municipal governments' decisions to allocate commercial and residential land when two categories of land use are subject to different fiscal revenue alternatives: business-related tax and/or land rent. We use urban parcel-level land transfers during China's peak period of urbanization, match commercial parcels with residential parcels, and find significant price discounts on commercial parcels relative to adjacent residential parcels. The observed discounts arise from the future tax flows from commercial use, i.e., expected taxes from developed commercial land reduce its transfer price. We conduct a structural estimation to examine the implications on land use structure of future taxes lowering land transfer prices. Results show that while prospective taxes increase commercial land supply, a significant portion of the favorable treatment impact is mitigated by market price responses, suggesting that the land market counters commercial land favoritism when local revenues include both business-related taxes and land value-based charges. The results have implications for the design of urban public revenue systems.

**JEL No.:** O18, P48, R12, R31, R38

**Keywords:** Fiscal incentives; Land transfer; Spatial matching; Land use

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## 1. Introduction

This study aims to uncover the fiscal motives behind decisions of land allocation at the municipal level, with a focus on localized trade-offs between residential and commercial land use in the context of fast urbanization and urban expansion.[1] By the theory of fiscal incentives (Weingast 2009) under fiscal federalism (Oates 2005), local governments prefer to have more land developed that yields higher general business taxes through supply-side regulations (Altshuler & Gomez-Ibanez 2000; Cheshire & Hilber 2008; Blöchliger et al. 2017; OECD 2017). In country contexts where commercial land has the potential to generate a significant and sustainable stream of future taxes while residential land use contributes relatively little directly to tax generation, local governments allocate more commercial land driven by its tax revenue maximization motives (tax incentives, hereafter), aligning with the traditional fiscal theory on land use allocation. However, the bias towards commercial land use resulting from tax incentives increases the share of commercial land use and causes a fall in the relative prices (rents) of commercial land compared to residential land. This bias can be mitigated if alternative revenue sources such as land rent or land value-based taxes are considered. In other words, land market-based revenue design serves as a counterforce to the favoritism towards commercial land driven by discriminatory tax policies.

Empirically, there is a substantial amount of literature on tax incentives and their impact on land use allocation; nevertheless, verifying the counterforce to restore equilibrium through the response of the land market is challenging. This difficulty arises from the fact that, in most

[1] Commercial land in this study refers to land designated for commercial and business facilities, excluding land used for industrial, manufacturing, logistics, and other purposes. We use the narrow definition of commercial land to examine the trade-off between residential and commercial land allocation, because commercial and residential land uses are typically competing within close proximity, while industrial land is usually located in suburbs, far away from residential areas.

cases, revenue sources based on land value play a minor role in local public finance. However, a fast-growing economy experiencing rapid urbanization is a natural laboratory to test the aforementioned theoretical conjecture. China is such a case where local governments, especially those in urban areas, have exclusive control over land supply. The transfer of land use rights generates significant revenue in the form of land rent or land transfer revenue, which often surpasses general taxation in amount and share of total revenue (more so in some time periods and specific regions).

Given local governments' concern with both taxes and land transfer revenues, this study considers two types of fiscal incentives: tax incentive and land rent incentive. The tax incentive drives local governments to allocate more land with higher tax potential, while the land rent incentive prompts them to allocate more land with higher rent potential. Assuming an increase in the tax potential for commercial land development, more commercial land will be developed driven by the tax incentive. As more commercial land is supplied, the relative rental price of commercial land will decrease. This decrease results in a weaker rent incentive for commercial land development, which acts as a counterforce to the initial changes in tax incentive for land allocation. Specifically, an increase in the tax potential for commercial land corresponds to a decrease in the relative land rent for commercial use compared to residential use. By the theory of budget maximizing bureaucracy, local governments will weigh the taxes from land development against rental revenues from land transfers when allocating land between different uses. In equilibrium, whether a locality transfers a land parcel for use A or use B should make no difference to total local public revenue. Hence, the sum of the discounted future tax flows derived from the parcel’s development and the corresponding land transfer revenue should be

equal for uses A and B. In the context of this study, if a parcel of land is used for commercial purposes with high tax potential instead of residential use with slim potential for taxes, the land transfer price for commercial purposes should be lower than that for residential use.[2]

This rent-tax linkage highlights the market's response to discriminatory tax policies and indicates how fiscal incentives influence land allocation decisions. When local governments prioritize the development of commercial land with higher tax potential, they may be willing to forgo some of the current rental from commercial land in exchange for the future taxes it will generate. Consequently, the land transfer price for commercial use reflects this trade-off between current rental income and future tax streams, resulting in lower prices relative to residential land.

To examine the existence of the rent-tax linkage and its implications for land allocation between commercial and residential uses, we proceed with the following empirical analysis. First, we test the presence of rent-tax linkage by comparing commercial and residential land transfer prices (rents) with the spatial matching method using transaction data of the primary land market in the top 99 Chinese cities from 2007 to 2019. The baseline empirical results show that the transfer price of commercial land is significantly lower than that of spatially proximate residential land during the same period, suggesting that local governments may forgo some of their current land rental income for future taxes from commercial land transfers. However, we

[2] We can further view this rent-tax linkage in the framework of local governments competing for commercial capital. Local governments compete to attract private investment by offering developers large discounts on land transfer prices, similar to the case in the tax competition model. However, a rational local government will not offer a land price discount larger than the present value of the future tax revenue that they can derive from commercial land development. In a competitive equilibrium, localities with higher tax potential for commercial land will offer larger discounts that for residential land, i.e., higher tax potential for commercial land is associated with lower prices for commercial land relative to residential land prices.

cannot identify whether the rental price discounts of commercial land are attributed to differences in the tax potential between the two types of land development.

Then we exploit the variation in tax potential of commercial land across cities and the gradient of urban land-use tax in Shanghai to further test the effect of tax potential of land on transfer prices. We find that commercial land is transferred at lower prices than adjacent residential land in cities with higher tax potential. Using the urban land-use tax gradient and the corresponding specific tax rates to proxy the tax potential of commercial land across boroughs in Shanghai, we confirm that the higher the tax potential of commercial land, the lower its rental price relative to adjacent residential land. Further analysis reveals that the rent-tax linkage is set up in two moves: Local governments first set the starting price, then developers bid for the parcel, with the former playing a dominant role.

Finally, we focus on the impact of tax and rent incentives on local land allocation, specifically on the ratio between local commercial versus residential land transfers. We will explore by the following three steps.

Step 1: Exploiting cross-city variations in the tax potential of commercial land, we estimate the effect of the tax potential on urban land use structure, i.e., the share of commercial land in total transfers. We find that cities where commercial land has higher tax potentials tend to transfer commercial land more. However, this result reveals only the net effect of tax incentive, which includes the reverse corrective effect of land rent incentive. Put simply, cities where commercial land holds a higher tax potential experience lower commercial land rents in comparison to their residential counterparts due to the rent-tax linkage. Thus, relatively low

commercial land rents will discourage local governments from transferring commercial land, which counteracts the tax incentive on local land use structure.

Step 2: To calculate the effect of rent incentive on land use allocation, we employ China's 2011 "land proceeds distribution reform" as a quasi-experiment and a difference-in-differences (DiD) design with continuous treatment. We find that the more the upper-level governments extract from land transfer proceeds, the higher the proportion of commercial land transfers. The less local governments capture from land transfer proceeds, the more incentive they have to develop commercial land with future tax potential. The results are robust in cities that have high tax potential from commercial land.

Step 3: We conduct a counterfactual analysis to investigate the potential changes in the allocation of local land uses if the incentives for rental income of local governments were removed. To accomplish this, we construct a simple structural estimation model. Our findings indicate that absent of the discipline imposed by land rent incentive, tax incentive alone results in a rise of approximately 5 percentage points in the share of commercial land transfers. This increase is substantial when compared to the average proportion (26%) of commercial land observed across cities.

This study contributes to the literature in four ways. First, it is related to theoretical and empirical studies of fiscal incentives for land development. A large body of literature discusses how local taxation shapes the structure of land use. For example, Quigley and Raphael (2005) find that California's property taxes are constitutionally limited to 1% of acquisition costs, and cities are permitted a share of the local sales tax. This arrangement creates fiscal incentives for localities to favor commercial development over housing construction. Cheshire and Hilber

(2008) examine the impact of the 1990 Uniform Business Rate reform in the United Kingdom, which shifted the tax levy on commercial property from the local to the central government. They document that this fiscal concentration left local governments with no incentive to allow new commercial development and made the supply of office space more inelastic, leading to higher market prices for office space. In Israel, the property tax is the primary revenue source of municipal governments and the allowed rate for commercial property is up to 10 times higher than that for residential units, local authorities have a strong incentive to develop commercial and office space (OECD 2017). However, the obvious fiscal advantages of municipal commercial rates compared to residential rates inhibit local authorities from increasing the population in their jurisdictions and limit the land supply for residential construction. These fiscal advantages lead to a widening land and housing price gap between commercial and residential real estate (Zvi et al. 2014).[3] Zhang et al. (2022) examine the impact of tax incentives on the structure of local land allocation in China. They use China's business tax reform as a shock and their results are consistent with the fiscal incentive theory on land use structure.

Based on the context of China's land and fiscal system, this study advances the research on fiscal incentives for land use. As urban land in China is state-owned, the fiscal incentives guiding urban governments to allocate land use are not only from taxes but also from land transfer revenues. Local governments could retain the lion's share of land transfer revenues, which provides significant extra fiscal incentives in addition to related tax incentives for local

[3] Burnes et al. (2014) and Jacob & McMillen (2015) documented similar findings using data from Florida counties and Cook County (Chicago), Illinois.

governments (Wu et al., 2015; Li & Kung, 2015). We find evidence supporting the existence of rent-tax linkage, and the response of land rent to discriminatory tax policies plays a crucial role in land use allocation. In other country contexts where land is privately owned and local governments cannot directly gain from land development, the same logic may still hold in many cases. For example, if local governments derive revenue from both property taxes on commercial properties and sales taxes on business activities, the distortion in land use from a rise in sales taxes may be corrected, at least in part, by a decrease in commercial property taxes due to a reduced tax base. Thus, the land market is a potential device to rectify distortions imposed by taxation and other public intervention. Therefore, the findings of this study are of general interest and applicable elsewhere.

Second, some studies have focused on China's land price discount between industrial and commercial/residential land caused by intergovernmental competition to attract capital (Zhang et al., 2011; Zhao & Cao, 2017; Lu & Wang, 2020), but these have generated less than credible evidence. The most recent He et al. (2022) study is of special interest, which argues from a public finance perspective, as this paper does, that local governments are willing to sell industrial land at a lower price because of future tax flow. They find that industrial land sales in China are not subsidized relative to residential land sales once future taxes are included in the calculation. However, the location of industrial land is very different from that of commercial and residential land, and it is challenging to construct a counterfactual case in which industrial land may be sold for residential or commercial purposes. This study exploits the spatial proximity of land parcels to detect the price difference between commercial and residential land using the spatial matching method. We generate evidence that the difference

in tax potential between commercial and residential land contributes to their price difference.

Third, several studies use parcel-level data in China to examine specific land price discounts from the perspective of political corruption. For example, Cai et al. (2013) compare the effects of different land transfer methods (bidding, auctioning, and listing) on transfer price. They find that land parcels transferred via two-stage auction (listing) are less expensive than those transferred via an English auction and concluded that listing is more likely to breed corruption. Chen and Kung (2019) classify land parcels into two categories: politically connected and non-politically connected. These categories are based on whether the land-taking entities have connections with the top political elites. Using a spatially matched sample, they find that politically connected firms can acquire land at lower prices, which is evidence of corruption in the land transfer market. Chen et.al (2023) identify a pattern of 'revolving door' exchanges between local officials and land acquisition firms by matching data on land transactions in China's primary land market to detailed curricula vitae of board directors in publicly listed firms. Specifically, they observed a discount of 19.4% when land was sold to these firms, followed by subsequent board appointments for the involved local officials upon retirement.[4] While this study also analyzes price discounts using parcel-level data, we use a different approach and focus on the price differentials between commercial and residential land that stem from the differences in tax potential across land uses. The primary aim of this study is to understand the fundamental fiscal motives of local governments in land use allocation rather than investigating political influence on land sales. This perspective enables us to grasp

[4] Two recent articles focus on potential distortions in China's land market. Fu et al. (2021) argue for the implications of an irrational allocation of land supply quotas among cities, while Henderson et al. (2022) focus on the political manipulation of urban land markets by local officials.

the intricate interactions among fiscal incentives, land use allocation, and the financial decisions by local governments.

Finally, the findings in the study are in line with the well-known Henry George theorem (George 1879; Arnott & Stiglitz 1979) and echo the theoretical claim made by Fujita and Thisse (2002, p. 136) that "A perfectly competitive land market is a powerful device to achieve the first best optimum." China's rapid urbanization provides a natural laboratory for testing these propositions. On the one hand, local governments in China can be perceived as competitive land developers, engaging in fierce competition to attract capital and population inflows by transferring land use rights to the private sector through bidding, auction, and listing. This process largely ensures the effectiveness of the land market. On the other hand, local governments exercise monopoly over land supply in their respective jurisdictions and aim to maximize local tax revenues and land rents. Even in such a mixed land market, we find reliable evidence that the land market response may serve as a means to correct the discriminatory tax incentives on land use allocation, which holds general interest for tax design.

The remainder of this paper is organized as follows: Section 2 introduces the conceptual framework and evolution of China's land transfer and tax systems related to land development. Section 3 describes our data set. Section 4 presents the empirical strategies. We report the empirical results for rent-tax linkage in Section 5, followed by a counterfactual analysis of fiscal incentive effects on local land use structure in Section 6. Finally, Section 7 concludes the paper.

## 2. Institutional Background and Conceptual Framework

## 2.1 China's Land Tenure System since 1980

All land in China is publicly owned by villages collectively in rural areas, and by the state in urban centers. In cities, municipal governments are the *de facto* owners of land within their jurisdiction. Before the early 1980s (under the old political regime), land was allocated only by government with no trades or the market mechanism at play. After the economic reforms in the 1980s, especially with the entry of foreign direct investments, localities were allowed to experiment with the rent-for-use of land.[5] At that time, land transactions were still prohibited;[6] land allocation was mainly through the administrative machinery, excluding the role of market mechanisms. In 1987, with support of the central government, Shenzhen municipal government adopted the *Shenzhen Special Economic Zone Land Management System Reform Program* to separate land ownership from land use rights, which, while maintaining public ownership of land, enables local governments to transfer land-use right to users for a price (though users are not allowed to conduct secondary transfers). This reform laid the foundation for establishing a nationwide system of paid transfers of land-use right. Following Shenzhen, similar programs were piloted in several other coastal cities. Along with the relevant pilot programs, legislation on transferring land-use right made heads way. In 1988, the country's *Land Management Law* was amended to allow transfer of land use right.[7] Article

[5] An often-cited example is the now-famous megacity Shenzhen bordering Hong Kong. When the city was initiated in the early 1980s, the central government's fiscal potential was dwindling fast in the first fifteen years of the reform with decentralization of enterprises and revenue sources. Consequently, Shenzhen Special Economic Zone was established with no cash infusion from the center; instead, the State Council granted Shenzhen the exclusive preferential policy to try fees for land use. In 1981, Guangdong Provincial People's Congress promulgated the *Provisional Regulations on Land Management in the Shenzhen Special Economic Zone*, which specified the guidelines and prices for different types of land.

[6] By Article 10 of the 1982 Constitution of the People's Republic of China: "Urban land belongs to the state; no organization or individual may appropriate, buy, sell, lease, or transfer land illegally."

[7] "The State applies a system of compensated use of State-owned land per the law" and "the right to use state and collective-owned land may be transferred per the law."

10 of the 1999 Constitution clearly stated that the right to use land may be transferred. Before year 2000, land-use-right transfers were by agreement, with local governments and land users (businesses) negotiating the price. The transfer prices did not necessarily reflect the actual market value of land lots; case-by-case negotiations often bred corruption.[8] To improve the land market for it to play a fundamental role in land allocation, Shenzhen promulgated and implemented in 1998 the *Regulations on Bidding and Auctioning of Land Use Right*, requiring the transfer of land use right be made by bidding, auction, or listing.

Since year 2000, land transfers are mainly through the land market nationwide.[9] With the introduction of a series of legislation and rule, China's primary market for transferring the use right of state-owned land was established. In addition, land use rights must be registered and publicized in the official *Land Register*.[10] Consequently, information related to land transfer has become increasingly accessible and transparent.

### 2.2 Central-Local Sharing of Land Transfer Proceeds

How land transfer proceeds are vertically distributed among governments affects the land transfer behavior of local governments. From the 1980s to the mid-1990s, fierce competition occurred between central and local governments over urban land transfer proceeds.

[8] For example, 90% of land transfers from 1987 to 1999in Shenzhen were by agreement, with only 10% transferred via auction or bidding.

[9] By the Regulations on the Bidding, Auction, and Listing of State-owned Land Use Rights issued by the Ministry of Land and Resources in 2002, "commercial, tourism, entertainment, and residential land must be transferred by bidding, auction or listing." In 2003, the State Council issued the Urgent Notice on Further Strengthening Efforts to Regulate and Consolidate the Order of the Land Market, requiring full implementation of the "bidding, auction, and listing" procedure for business-purpose land transfers. The *Property Rights Law* of China (March 2007) stipulates that "industrial, commercial, tourism, entertainment and commercial residential land, as well as the land with more than two intended land developers, shall be transferred by bidding, auction or listing."

[10] See the "Measures on Land Registration" promulgated by the Ministry of Land and Resources (2007) which required that state-owned land use rights, collective land use rights, land mortgages, easements, and other land rights that are to be registered under laws and regulations must be registered and publicized in the land register.

Finally, the 1994 Tax-Sharing Reform initiated by the State Council specified the intergovernmental distribution of land transfer proceeds.[11] That reform centralized major taxes but gave up the central share of land transfer revenue. As a result, urban state-owned land transfer fees became permanent, exclusive local revenue earmarked for urban construction and land development.

Into the 21st century, urbanization advancements dramatically increased the scale of land transfer revenues. The central government introduced a series of new regulations within the framework of the 1994 tax-sharing system on the distribution and use of land transfer proceeds. Consequently, land transfer proceeds have been incrementally centralized to central and provincial treasuries.[12]

A recent policy change, since 2011, was a mandate to set aside 10% of land transfer proceeds as the "Funds for Irrigation and Water Conservancy Construction and Education," of which the central government controls 20%; the share for provincial governments varies.[13] The sum of the central and provincial shares are limited to 50% of the total so as to ensure that localities retain adequate amounts for irrigation and water conservancy construction.[14] We will use this 2011 policy as a shock for empirical tests.

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[11] See the "Decision of the State Council on the Implementation of the Tax-Sharing System of Fiscal Management" (Document [1993] No. 85).

[12] These regulations are reflected mainly in stipulations after 2004 that central and local finances must set aside a portion from the proceeds of local land transfers as agricultural land development funds, and after 2011, irrigation and water conservancy construction and education funds. See the "Notice of the Ministry of Finance and Water Resources on Issues Related to the Withdrawal of Funds from Land Transfer Proceeds for Farmland Water Conservancy Construction (Finance Document [2011] No. 48) and the "Notice of the Ministry of Finance and Ministry of Education on Issues Relating to the Withdrawal of Education Funds from Land Transfer Proceeds (Finance Document [2011] No. 62).

[13] Refer to the online data description for details.

[14] See the Notice of the Ministry of Finance and the Ministry of Water Resources on issues related to the central share of the land transfer proceeds for the construction of farmland water conservancy funds (Cai Zong [2012] No. 43).

Finally, it is worth noting that local budgetary management of land transfer revenues has been increasingly regulated. For example, starting from 2007 the inflow and expenditure of land transfers are fully integrated into local government Annual Budgets. That is, land transfer revenues must be placed into the local treasury and public expenditure on land development be financed by the local Fund Budget.

### 2.3 Taxes Related to Land Development

The taxes involving land and real estate development are complex. Table I lists the taxes involved in each stage and step of land and real estate development. Note that the taxes applicable to commercial and residential properties are the same during land acquisition and development as well as property sales, with similar levels of tax burden. We focus on the differences between taxes on commercial and residential land development. First, businesses on commercial land pay taxes through commercial operations; these include business tax, value-added tax, corporate income tax, and personal income tax (by employees) among others. In contrast, residential properties do not generate future tax streams directly. Second, homeowners or non-business entities who rent out their houses and receive rental income are theoretically subject to a property tax, but in practice these rental activities stay outside of tax enforcement because the cost of tax collection is too high. Third, the tax burden of holding properties is markedly different between commercial and residential uses. Commercial property holders are subject to a property tax at a rate of 12% of the rent or 1.2% of the total price based on the residual property value after deducting 10% to 30% of the original value.[15]

[15] For details, see the "Provisional Regulations of the People's Republic of China on Property Tax," available at http://www.gov.cn/zhengce/2020-12/25/content_5574127.htm.

In contrast, residential property holders are exempt from property taxes.[16] Besides, holders of commercial property are to pay the urban land use tax, its rate dependent on the classification of the land the property sits on; whereas residential properties held are free from this tax.[17]

In summary, commercial land and residential land both pay one-shot taxes to municipalities during development and transaction. Businesses on commercial land pay taxes to stay in operation, while homeowners do not pay taxes for holding property. Such differences cast a long-term impact on local employment and economic growth.

### 2.4 Background on Land Use Planning

Urban land use in China is subject to two long-term blueprints of each city – an overall land-use plan and an urban plan. The overall land-use plan, which is developed in accordance with the Land Management Law, determines the scale and layout of construction land, permanent basic farmland, and cultivated land within each jurisdiction and time frame. The urban plan, regulated by the Urban and Rural Planning Law, aims to strike a balance between residential, commercial, industrial, transportation, environmental, and public facility land use within a given scale of construction land. Local governments play a pivotal role in managing the city by allocating land use to maximize the city's value, while also pursuing economic growth, fiscal revenues, and sustainable urban development.

### 2.5 Conceptual Framework

[16] Article 13 of the Interpretation and Provisional Provisions of the Ministry of Finance and the General Administration of Taxation on Certain Specific Issues of Property Tax (Cai Shui Di Zi [1986] No. 008) states that "[a]ccording to the Provisional Regulations on Property Tax, properties owned by individuals for non-business purposes are exempt from property tax".

[17] Article 18 of the “Interpretation of and Provisional Provisions on Certain Specific Issues of Land Use Tax” (Tax Adm Document [1988] No. 015) stipulates that the exemption of land use tax for residential houses and yards owned by individuals shall be determined by the taxation bureaus of provinces and municipalities directly under the central government.

This section begins by developing a toy model to illustrate our concept framework. Assume a municipality disposes new land supply, $\bar{L}$, between commercial and residential development, of which $L_c$ is for commercial use and $L_r$ for residential use. The annual rent for each unit of commercial land, denoted as $P_c(L_c)$, is calculated by discounting the sale price of land at an appropriate rate. Suppose $P'_c(\cdot) < 0$ and $P_c(L_c)$ is the inverse demand function, then the larger the land supply, the smaller the rent from per unit of land. Further, the municipal government can derive not only land rent of the current period from commercial development, $R_c = L_c P_c$, but also the present value of taxes, $T_c = L_c T$, where $T > 0$ depicts the annual tax potential of commercial land use.

The municipality provides $L_r$ for residential use, with annual unit land rent $P_r(L_r)$ and an assumed $P'_r(\cdot) < 0$. Where property tax is not levied, there is no revenue stream from residential land use (as is the current case in China) and $R_r = L_r P_r$ is all the municipality can obtain from residential land. Since the development cost is close between commercial and residential use, this paper treats both types of development cost as 0. The gap in revenue potential between the two uses of land affects government's allocation of land for either use. To focus on the revenue structure of the two uses, we assume municipalities maximize their revenue from land allocation. Set total land revenue as $R$, then optimality is:

$$Max_{\{L_c, L_r\}} (1-\tau)(R_c + R_r) + T_c = (1-\tau)(L_c P_c + L_r P_r) + L_c T$$

$$\text{s.t. } L_c + L_r = \bar{L}.$$

where $\tau$ is the share of land transfer proceeds extracted by higher-level governments. Solving the maximization problem derives

$$(1-\tau)\frac{\partial R_c}{\partial L_c} + \frac{\partial T_c}{\partial L_c} = (1-\tau)\frac{\partial R_r}{\partial L_r};$$

namely, optimal land allocation by a municipality is the sum of the marginal land rent of a unit of commercial land and the marginal future taxes from the unit equals the marginal land rent of a unit of residential land. That is, the two types of land use generate the same marginal total revenue. Dissecting the equilibrium obtains three propositions:

*Proposition 1: The higher tax potential of commercial land use in the future, the more land will be allocated for commercial use by municipal governments and the less land will be allocated for residential use, which is:*

$$\frac{\partial L_C^*}{\partial T} > 0, \frac{\partial L_T^*}{\partial T} < 0.$$

*Proposition 2: The higher tax potential of commercial land use in the future, the lower the annual unit rent of commercial land use and the higher the annual unit rent of residential land use, and the differential between the two uses increases, which is:*

$$\frac{\partial P_C^*}{\partial T} < 0, \frac{\partial P_r^*}{\partial T} > 0, \frac{\partial (P_r^* - P_C^*)}{\partial T} > 0.$$

*Proposition 3: Given the tax system and tax sharing between municipality and upper level governments, the larger the share of land rent extracted by upper level governments, $\tau$, the more land will be allocated by municipal governments for commercial use and the less land will be allocated for residential use, which is:*

$$\frac{\partial L_C^*}{\partial \tau} > 0, \ \frac{\partial L_r^*}{\partial \tau} < 0$$

By the above propositions, higher future tax potential of commercial land use will lead municipal governments to supply more land for commercial use and less for residential use. As a result, the land-supply structure is more oriented toward commercial use which reduces the rent of commercial land and raises the rent of residential land. Thus, the future tax stream of commercial land use has a direct effect and an indirect effect on land allocation. The direct

effect is higher future tax potential for the municipal government, for which the municipality increases land supply for commercial use. The indirect effect is lower land rent of commercial land use, for which municipalities may reduce commercial land supply. The latter effect is opposite to the former: The lower commercial land rent may work to reduce land supply that can increase future tax revenue, which partly offsets the direct impact of future tax streams on commercial-biased land use.

## 3. Data and Summary Statistics

### 3.1 Data Sources and Cleaning

We use three datasets – parcel-level land transfers, city-level tax potential of commercial parcels for 99 cities from 2007 to 2019,[18] and tax potential indicators of commercial parcels by urban-land-use tax classification in the urban areas of Shanghai. The parcel-level land transfer data, from the *China Index Academy*, contain detailed records of all commercial and residential land transfers. Its variables include location (latitude and longitude coordinates), land area, price of transaction floor area, price of starting floor area, methods of transfer (bidding, auction, and listing), premium ratio, plot ratio, and land use purpose among others. To avoid the influence of extreme values on the estimation results, we removed parcels with floor area ratios of less than 1 or greater than 20.[19]

[18] The Land Registration Measures promulgated by the Ministry of Land and Resources (2007) require every land transfer to be registered according to the law. Therefore, rich data on land transactions are available after 2007, which is the main reason why we set the time window of our sample to 2007-2019.

[19] According to the "Notice of the Ministry of Land and Resources, the Ministry of Housing and Urban-Rural Development on Further Strengthening the Regulation and Control of Real Estate Land Use and Construction Management" (MoHURD document, No. 151 [2010]), the plot ratio of ordinary residential land must be greater than 1. There are two cases where the plot ratio is less than 1, one is villa land and the other is commercial land such as gas stations and scenic spots, and these special sites are not the ones examined in this paper, so we delete the observation of floor area ratio less than 1. In addition, the floor area ratio of skyscrapers with more

To minimize the effect of unobservable factors on commercial and residential land prices, we use a spatial matching strategy similar to that of Chen and Kung (2019). As Figure I illustrates, each commercial parcel is matched with its surrounding residential parcels by radii of 500, 1000, and 1500 meters. On city boundaries, spatial radius matching may result in land parcels (cohorts) straddling jurisdictions. Since land transfer prices are influenced heavily by local governments, we remove observations that do not belong to the same city in a cohort. The final cleaned data set has 39,238 commercial and 84,946 residential land-transfer records.

The tax potential of commercial land compared to residential land is a vital variable in this study. Table I demonstrates a significant disparity in tax treatment between commercial and residential land, particularly during operation and holding following land development. Therefore, we make the approximate assumption that according to China's tax law, local governments expect to collect future taxes solely through commercial land development. Thus, we define the tax potential indicators in two ways. First, we use the average ratio of a city's tertiary industry output to the built-up area for each year from 2007–2019 to measure the tax potential of commercial land in a city. Then we use the average ratio of local business tax to the built-up area for each year from 2007 to 2015 as another proxy for tax potential.[20] Additionally, we employ the average ratio over time in a city to measure the tax potential, regardless of its temporal variability. This choice is motivated by the belief that the average ratio more precisely represents a city's tax potential, not affected by macroeconomic

than 100 floors does not exceed 20, so observations with too high floor area ratios may have measurement errors, and we remove observations with floor area ratios higher than 20 as well.

[20] Due to the full implementation of the business to VAT reform in China in 2016, the amount of business tax declined significantly after 2016. Business tax was changed to VAT, making the indicator of business tax no longer a good proxy for the tax revenue generated by land. Therefore, we only use business tax data for 2015 and previous years.

fluctuations. In allocating land among various uses, the government may prioritize long-term factors over short-term fluctuations. Data on tertiary industry output come from the China Research Data Service Platform (CNRDS). Data on business taxes are from the *Annual Statistical Yearbook* of each city. The built-up area of each city is from the *China Urban Construction Statistical Yearbook*.

Chinese local taxation authorities classify urban land and levy urban land-use taxes at rates that differ by land class. Determination of land class in urban areas is based on the tax potential of business activities. We use this land classification system to define the business vitality and tax potential of commercial parcels within a city. Land classification data are not available for all sample cities but available for Shanghai. The *Shanghai Urban Land Use Tax Implementation Regulations*, promulgated in 2007, publicized specific tax rates for the first-to-sixth-class areas. As the numerical designation of land class increase（from Class I to Class VI）the distance to the city center increases, and the tax rate decreases.[21] In addition, the accompanying document to the above *Regulations* uses textual descriptions such as streets and borough boundaries to determine the specific division of land classes.[22] Accordingly, we manually mapped land classification of Shanghai and identified the land class of each commercial parcel. Since the above *Regulations* expired in January 2019, only land transfer data of 2007–2018 are used for analysis in this study. Finally, when we examine the impact of fiscal incentives on the composition of urban land supply, we obtained diverse structural

[21] The urban land use tax rates for Class I to Class VI areas are 30, 20, 12, 6, 3 and 1.5 yuan per square meter, respectively.

[22] It is in the "Notice on the Announcement of the Specific Scope of Urban Land Use Tax Grades in the City."

indicators by summing up the number or area of various types of parcels. Relevant data are described in the Appendix.

### 3.2 Summary Statistics

Panel A of Table II reports the descriptive statistics of the main variables obtained from 500-meter-radius matching with any commercial parcel as the center. The average transaction price of floor area, starting price of floor area, and premium ratio for residential land parcels are higher than those of commercial ones, showing a price difference between commercial and residential parcels. Panel B reports the shares by transfer method, namely bidding, auction, and listing. Listing is the apparent dominant method of land transfer, especially for commercial land.

Table III shows descriptive statistics of the variables used to construct city-level indicators of the tax potential of commercial land and the composition of land use. Panel A includes two tax potential indicators. Indicator I is defined as the logarithm of the output value of the tertiary industry divided by the urban built-up area; indicator II is the logarithm of business tax revenue divided by the urban built-up area. Panel B includes two indicators of land use composition. The first is the ratio of the number of commercial land transfers to the total number of commercial and residential land transfers. The second is the ratio of the area of commercial land transfers to the total area of commercial and residential land transfers.

By China's current laws, commercial and residential land use rights are transferred for terms up to 40 and 70 years, respectively. Therefore, commercial and residential land transfer prices are not directly comparable. To facilitate comparison, we convert transfer prices into *annual rents*. Consider the current land transfer price of a parcel as a summation of the present

discounted value of future rent payments through the lease term, then the unit price of floor area and the annual rent satisfy the following equation:

$$SP = \sum_{i=0}^{n} \frac{P}{(1+r)^i} = P \times PVIFA(r, n) \qquad (1)$$

where S$P$ is the sale price per square meter, $P$ is the annual rent (per square meter) of land floor area, and $r$ is the discount rate (chosen as 8%, 10%, and 12% [23]), $PVIFA(r, n)$ is the present value coefficient of annuity, a constant value for a given $r$, and $n$. We use the present-value coefficient of annuity to calculate the annual rent of the parcel and take it as the explained variable.

## 4. Empirical Strategies

First, we apply a semi-logarithmic model to the radius-matched dataset and test whether there exists a stable difference between the annual rents of commercial and residential parcels. The model is:

$$log(P_{ict}) = \beta_0 + \beta_1 Commerical_i + \lambda_t + \delta_{ic} + \rho_i + \varepsilon_{ict} \qquad (2)$$

where $P_{ict}$ is the annual rent (per sqm) by floor area of parcel $i$ in city $c$ and year $t$. $Commerical_i$ is the key explanatory variable in this study, which takes the value of 1 when a parcel is for commercial purposes and 0 when it is for residential purposes, and $\beta_1$ denotes the difference between the annual rents of commercial and residential land. $\lambda_t$ is year fixed effect; $\delta_{ic}$ is spatial proximity fixed effect, which indicates that the matched commercial and residential parcels fall into the same circle with a radius of 500, 1000, or 1500 meters. To

[23] The discount rates are selected with reference to the *Notice on Issuance of Methods and Parameters for Economic Evaluation of Construction Projects* issued by the State Planning Commission and the Ministry of Construction (SPC Document [2006] No. 1325), which stipulates the maximum discount rate as 12% and the minimum discount rate as 8%.

control the effect of land transfer methods on the results (Cai et al., 2013), we include a vector, $\rho_i$, of binaries for bidding, auction, or listing as control variables.

However, even if $\beta_1$ is significantly negative, we cannot attribute it solely to the tax differences associated with the development of the two land uses because developers of commercial and residential land may have different willingness to pay for the convenience of access to public facilities. For example, developers of commercial land may be ambivalent to facilities such as schools, hospitals, and parks, whereas developers of residential land value these as amenities. Therefore, we test the tax-rent linkage by exploiting the spatial variations in the tax potential differential between commercial and residential land. If the rent-tax linkage holds, the price difference between commercial and residential land should be related to the tax potential of commercial land relative to residential land (which is assumed to be zero in the absence of a real property tax). Where commercial land has higher tax potential, the annual rent differential between commercial and residential land in that area should be larger. The model for this test is Equation 3, which identifies the difference in land rent due to the difference in tax potential.

$$log(P_{ict}) = \beta_0 + \beta_1 Commerical_i \times \log(tax_c) + \beta_2 Commerical_i + \lambda_t + \delta_{ic} + \rho_i + \varepsilon_{ict} \quad (3)$$

where $tax_c$ denotes the magnitude of each city's average tax potential of commercial land.[24] The other variables are the same as in Equation 2. The economic implication of $\beta_1$ is that for

[24] As shown in Table I, commercial land development generates significantly more tax revenue than residential land development, and we approximatively assume that residential land development does not contribute to tax revenue directly, although the tax contribution of the two types of land development can hardly be separated sharply.

a 1% increase in tax potential, the rent of commercial parcels increases by $\beta_1$% relative to adjacent residential parcels.

We further examine whether the price difference between commercial and residential land varies with the tax potential differential of land within a city, using data of the gradient of urban land use tax in Shanghai. Although not large in amount, the urban land use tax is a good indicator of commercial land's tax potential within a neighborhood. The model is shown in Equation 4:

$$P_{izt} = \beta_0 + \beta_1 Commerical_i \times level_z + \beta_2 Commerical_i + \lambda_t + \delta_i + \varepsilon_{it} \quad (4)$$

where $level_z$ denotes the designated land class of a parcel or the corresponding urban land-use tax rate by business zones in Shanghai. The other variables are defined in the same way as in Equation 2. The economic implication of $\beta_1$ is that the higher the land class (lower in numerical designation), the higher the land use tax rate, and the lower or higher the price of commercial parcels relative to residential ones. This model does not contain fixed effects of land transfer methods because all land transfers in Shanghai, whether commercial or residential, are conducted via listing.

Subsequently, we turn to empirical strategies to test the impact of fiscal incentives on the composition of land use. The research question is: How would the rent-tax linkage affect the composition of land use if the linkage holds? We provide an approximate answer using a three-step procedure.

Step 1：we exploit variations in the tax potential of commercial land across cities to account for land-use variation across cities (the number of commercial versus residential parcel transfers). The model is Equation 5:

$$Composiiton_{ct} = \beta_0 + \beta_1 \log(tax_c) + \lambda_t + \epsilon_{ct} \quad (5)$$

where $Composition_{ct}$ is the land-use composition by city by year, measured as the ratio of commercial land transfers to the total number of commercial and residential land transfers; $tax_c$ is the average tax potential within each city, as defined in Equation 3; $\lambda_t$ is time-fixed effect; and $\epsilon_{ct}$ is the residual term. The coefficient of interest, $\beta_1$, indicates that for a 1% increase in tax potential, $Composition_{ct}$ rises by $\beta_1$ percentage points, which incorporates the land rent corrective effect in land use, due to the rent-tax linkage and represents the net effect of tax changes on land transfer. We use the instrumental variables method to handle the endogeneity caused by omitted variables. We choose the shortest distance from the city to the coast and the distance from the nearest major port as the instrumental variables. The distance variables are exogenous. That said, the convenience and low cost of ocean transportation may affect a city's tax potential of land, but they seem to have no direct relationship with a city's land use; therefore, these two distance variables appear to be good instruments.

Step 2: We use the 2011 mandate for central and provincial shares in land transfer proceeds as a quasi-experiment to identify the effect of exogenous changes in land rent incentives on land allocation. We design a continuous treatment DID model for this test, as shown in Equation 6:

$$Composition_{ct} = \beta_0 + \beta_1 post_{2011} * \tau_c + \lambda_t + \mu_c + \epsilon_{ct} \quad (6)$$

where $post_{2011}$ captures the land transfer scheme before or after the proceeds centralization mandate in 2011. It takes one if the year is after 2011 and is zero otherwise. $\tau_c$ denotes the city specific share of land transfer proceeds taken by the central and provincial governments through the irrigation and water conservancy construction fund. $\beta_1$ is the effect of the changes

in the land-transfer-proceeds centralization rate on local government land allocation, which is the fiscal incentive effect of land transfer revenue on local land use, the focus of this study.

Step 3: We conduct a counterfactual analysis with a simple model-based structural estimation, utilizing the parameters obtained from the reduced form estimations. By comparing the actual share of commercial land with the counterfactual results of land use after the removal of rent revenue incentives for local governments, we can evaluate the response of the land market to changes in tax potential and the role of rent incentives in rectifying the allocation of land use. The specifics of model construction and counterfactual analysis are in Section 6.3.

## 5. Empirical Results on Rent-Tax Linkage

### 5.1. Rent Differential between Commercial and Residential Parcels

Table IV presents the results of the regression on Equation (2). To remove the confounding effects of different lease terms for commercial and residential land, we compare the annual rent instead of transfer price. To calculate the annual rent, we use 8% as discount rate. We also use 10% and 12% discount rates as robustness tests, which are reported in Tables A1 and A2 of the Appendixes.

Table IV reports the results from 500-, 1000-, and 1500-meter radiuses matching. The estimates, all negative and statistically significant at high confidence levels, are consistent across three radiuses. The rent of commercial land is markedly lower than that of residential land, from 10.7% to 15.8%. Translating these percentages into Chinese yuan (CNY) reveals that the rental price per square meter for commercial land would be approximately 200-300 CNY lower than that for residential land. Regarding the effect of land transfer methods on rents,

the results show that land rents are significantly lower under the listing and bidding methods than under the default auction method, which is consistent with findings in previous research (Cai et al., 2013). In addition, as the matching radius expands, the estimated rental price differential increases. This increase indicates that commercial development may have a negative spillover effect on nearby neighborhoods such as traffic congestion and noise pollution.

### 5.2. Rent-Tax Linkage: Evidence across Cities

Next, we use the variation in the tax potential of commercial land across cities to identify the rent-tax linkage. Table V reports the results with two measures of the tax potential of land parcels: The first is the ratio of tertiary industry output to the size of the urban built-up area and the second is the ratio of business tax to the size of the urban built-up area. The estimated coefficient of the interaction term is of our interest. Under the first measure, the rents of commercial land fall by 0.21% (Column 1) to 0.25% (Column 2) relative to that of residential land for a 1% increase of the tax potential of commercial land. Under the second measure, the rents of commercial land fall by 0.18% (Column 3) to 0.20% (Column 4) relative to residential land for a 1% increase of the tax potential of commercial land. These findings suggest that the rent differential between urban commercial and residential land can be explained by the tax potential of commercial land in each city. The higher the tax potential, the lower the rent of commercial land relative to residential land.

### 5.3. Rent-Tax Linkage: Evidence within Shanghai City

Now we use the variation in the tax potential of commercial land inside Shanghai but located in different land class zones to further examine the rent-tax linkage. The results in Table

VI are estimated from Equation 4. Columns 1 and 2 use land class to measure tax potential; for Columns 3 and 4, tax potential is measured with rates of the land-use tax. As the land class rises (with lower designation numbers), both the land-use tax rate and the tax potential of land parcels increase. For each step up in the land classification (designation numbers go down) or the increased tax potential, the annual rent of commercial land relative to residential land decreases by approximately 168-202 CNY per square meter. Alternatively, for each unit increase in the urban land-use tax rate (specific tax), the annual rent of commercial land relative to residential land decreases by about 54-62 CNY per square meter. This evidence suggests that the rent-tax linkage also holds within a city.

**5.4. Rent-Tax Linkage: Starting Rent vs. Rent Premium**

In this section, we decompose the land transfer price into a starting price set by the government and a premium from competition among developers. Our research question is: Does the rent-tax linkage occur in the government-set starting price or in the bidding process of land acquisition firms? The final transaction price of land, $P_f$, is expressed as a function of the starting (asking) price, $P_s$, and the premium rate, $r_m$: $P_f = P_s * (1 + r_m)$, where $(1 + r_m)$ is a multiplier.

Table VII reports the results. Columns 1 and 2 show the difference in starting prices (rents) between commercial and residential parcels, and that the starting prices of commercial land transfers are approximately 8% lower than those of their adjacent residential parcels. Columns 3 to 6 report how the tax potential of land affects the starting price differential for commercial and residential uses under the two tax potential indicators. The results suggest that the higher the tax potential, the larger the starting price differential.

Table VIII reports the differences in the premium between commercial and residential land uses. Columns 1 and 2 show that the rental price premium of commercial land transfers is about 4% to 5% lower than that of their adjacent residential parcels, the magnitude of the effect being about half of those starting rents (Columns 1 and 2, Table VII). Columns 3-6 reveal how the tax potential of land affects the premium multipliers for commercial and residential uses under two tax potential indicators. The results indicate that effect of tax potential on the premium multiplier is only one-fifth of that on the starting price of land transfer in Table VII.

In summary, the formation of the rent-tax linkage occurs mainly in the process of local governments setting the starting prices of land transfer, which suggests that rent-tax linkage is driven by the behavior of local governments that prefer to relinquish some current rental revenue in exchange for more future taxes.

**5.5. Robustness Tests**

Up to the previous subsection, we have matched each commercial parcel with their surrounding residential parcels. Here we design and run robustness tests of the findings. First, we match each residential parcel with the surrounding commercial parcels, the results (in Appendix B tables) show no change to our basic findings after changing the matching method, which suggests that the results of the previous baseline regression are robust. Second, we conduct radius matching for parcels with the same type of use. It would pose a great challenge to our previous findings if we could find a significant price difference between the central and surrounding parcels. Therefore, we conduct a placebo test using each commercial parcel to match the surrounding parcels of the same type within a radius of 500-, 1000-, and 1500-meters. The other settings remain the same as those in the baseline regression. The results (in Appendix

C) demonstrate that the price differences between the central and surrounding parcels are no longer statistically significant, either in an economic or statistical sense, which largely excludes potential confounders associated with spatial proximity. Finally, we perform spatial matching within a one-year time horizon. In order to eliminate the possibility of spillover effects from a commercial parcel to its nearby residential parcels, we further match with residential parcels prior to the transfer of the commercial parcel within a one-year period. The results can be found in Appendix D, and they align with the previous findings.

## 6. Fiscal Incentives on Local Land Use

Section 5 has presented evidence of rent-tax linkage. In this section, we examine how fiscal incentives (i.e., current-year rents and future taxes) affect land allocation by municipal governments, with a focus on the shares of commercial and residential land transfers in the total. The potential tax flow that will generate from commercial land development induces municipalities to transfer more land for commercial use. Nevertheless, an increase in the supply of commercial land can potentially decrease the rental prices of commercial parcels, thereby diminishing the motivation to transfer commercial land and ultimately mitigating the impact of tax incentives on land allocation.

We proceed in three steps to quantify the impact of tax and rent incentives on land allocation and evaluate the role of the rent-tax linkage in this process. First, we estimate the net effect of the tax potential of commercial land on the composition of land transfers, which is the *direct effect* of the tax incentive minus the *indirect effect* from rent-tax linkage. Then, we use the 2011 policy shock (mandate on shares of land transfer proceeds for central and provincial

governments) to estimate the effect of changes in the municipal share of land rents revenue on the composition of land use. Finally, using all the parameters we have obtained from our reduced-form empirical analyses in the earlier sections, we conduct a model-based structural estimation and a counterfactual analysis to disentangle the effects of two fiscal incentives on land use allocation.

### 6.1. Tax Potential of Commercial Land and Local Land Use

In scatterplots, we visualize the correlation between the tax potential of commercial land and the share of commercial land by the number of parcels and by the area in total transfers. Figures II and III reveal that these two variables are positively correlated – the higher the tax potential of commercial land in a city, the higher the proportion of commercial land transfers in the number and area of commercial parcels.

To further examine the quantitative relationship between the two variables, Table IX reports the 2SLS estimation results based on Equation 5 using the shortest distance between the city center and the coastline as an instrumental variable. Again, we use two indicators to measure the tax potential of commercial land, as in the previous sections. Results show that a 1% increase in tax potential I is associated with 0.135 percentage points increase in the share of commercial parcels and 0.073 percentage points increase in the area of commercial parcels, and the estimates of these two variables for tax potential II are 0.096 and 0.052, respectively. The regression results using a city's distance to the nearest major seaport as instrument are in Appendix E1; the first-stage regression results for both instruments are in Appendix E2. A comparison of the differences between the IV and the OLS estimates is in Appendix E3.

### 6.2. Centralization of Land Transfer Proceeds and Local Land Use

This section estimates the effect of changes in land rents (the share of land transfer proceeds retained by local governments) on land use. As the share of land transfer proceeds retained by local governments decreases (after the 2011 mandate), the strength of the land rent incentive diminishes. Considering the tax potentials of commercial land, municipalities prioritize taxes rather than land rents, leading to an increase in commercial land transfers.

We use the 2011 change in intergovernmental distribution of land transfer proceeds as a shock to gauge the impact of a decline in the local share of land transfer proceeds on land use. First, we plot a histogram of the average land transfer composition as an indicator of the share of commercial land for all cities before and after the change. Figure IV measures land use composition using the number of commercial and residential parcels, whereas Figure V utilizes the areas of parcels. Figures IV and V illustrate that the share of commercial land transfers increased significantly after the central and provincial governments took a share of land transfer proceeds, as local governments strategically became more interested in future tax revenues to be generated from commercial land development.

We estimated Equation 6 with a continuous treatment difference-in-differences framework to more precisely identify the response of land use to rent incentives. The results are reported in Table X. Columns 1 and 2 correspond to the composition of land use as measured by the number of transferred parcels and columns 3 and 4 correspond to land use as measured by the size of transferred land. The results show that the policy change cast a strong and positive effect on the share of commercial land in cities with tax potentials above the $50^{th}$ percentile: The higher the extraction ratio by upper-level government (the lower the local share) in land transfer proceeds, the more commercial land the localities transfer since future taxes

become more important to them. Conversely, for cities with tax potential below the 50th percentile, the effect is opposite and not statistically significant. This could be attributed to fact that these cities are the main beneficiaries of this centralized reform, as the land transfer proceeds collected by upper-level governments are redistributed to these areas with lower tax potential.

Further, we estimated the dynamic effects of the continuous treatment DID model (Nunn and Qian 2011), using a sample with tax potential above the 50% percentile. Figures VI and VII depict the results. The pre-reform parallel trends are satisfied with indication of a significant anticipatory effect, however.

**6.3. Structural Estimation and Counterfactual analysis**

To facilitate further quantitative analysis, this section first expands the conceptual framework introduced in Section 2, then proceeds to conduct a structural estimation and counterfactual analysis.

Consistent with the settings in section 2, we replace $T_c$ with $L_c\gamma T(L_c)$ where $\gamma$ represents the city-specific non-time-varying tax potential of commercial land related to urban features, corresponding to the tax potential indicators in the above sections of empirical analysis. $T(L_c)$ represents the variation in tax potential resulting from changes in the supply of commercial land in a city. The optimality can be rewritten as:

$$Max_{\{L_c,L_r\}}\ (1-\tau)(R_c+R_r)+T_c=(1-\tau)(L_cP_c+L_rP_r)+L_c\gamma T(L_c)$$

$$\text{s.t. } L_c+L_r=\bar{L}$$

where again $\tau$ represents the share of land transfer proceeds extracted by the central and provincial governments and $\bar{L}$ is normalized to 1.

Analyzing this optimization problem yields F.O.C as follows:

$$(1-\tau)\frac{\partial R_c}{\partial L_c}+\gamma\frac{\partial T_c}{\partial L_c}=(1-\tau)\frac{\partial R_r}{\partial L_r}.$$

And we revise the three propositions:

$$\frac{\partial P_c^*}{\partial \gamma}<0,\frac{\partial P_r^*}{\partial \gamma}>0,\frac{\partial (P_r^*-P_c^*)}{\partial \gamma}>0.$$

$$\frac{\partial L_c^*}{\partial \gamma}>0,\frac{\partial L_r^*}{\partial \gamma}<0.$$

$$\frac{\partial L_c^*}{\partial \tau}>0,\ \frac{\partial L_r^*}{\partial \tau}<0$$

To facilitate the structural estimation, we set up the reverse demand functions and tax function as follows:

$$P_c(L_c)=\beta_1+{L_c}^{\alpha_1}$$

$$P_r(L_c)=\beta_2+(1-L_c)^{\alpha_2}$$

$$T(L_c)=\beta_3+{L_c}^{\alpha_3}$$

$\alpha_1,\alpha_2,\alpha_3,\beta_1,\beta_2,\beta_3$ are the parameters to be estimated.

The F.O.C can be rewritten as:

$$(1-\tau)(\beta_1+(\alpha_1+1){L_c}^{\alpha_1})+\gamma(\beta_3+(\alpha_3+1){L_c}^{\alpha_3})=(1-\tau)(\beta_2+(\alpha_2+1)(1-L_c)^{\alpha_2}).$$

Then we total-differentiate the F.O.C. to facilitate a comparative static analysis, as follows:

$$\{(1-\tau)[\alpha_1(\alpha_1+1){L_c}^{\alpha_1-1}+\alpha_2(\alpha_2+1)(1-L)^{\alpha_2-1}]+\gamma\alpha_3(\alpha_3+1){L_c}^{\alpha_3-1}\}dL_c\ +$$

$$[\beta_3+(\alpha_3+1){L_c}^{\alpha_3}]d\gamma=[(\beta_1+(\alpha_1+1){L_c}^{\alpha 1})-(\beta_2+(\alpha_2+1)(1-L_c)^{\alpha_2})]d\tau.$$

All the known parameters that are used to solve the six moment conditions are listed in Table XI (details in Appendix F). By solving the six equations together, we obtained the coefficients, as shown in Table XII.

Given the average land proceeds extraction ratio τ = 0.04 and the normalized average tax potential γ = 6, the relationship between $\frac{P_c(Lc)}{P_r(Lc)}$ and $L_c$ can be predicted using the

theoretical model, as illustrated with the blue line in Figure VIII. The theoretical prediction line indicates that the price ratio $\frac{P_c(Lc)}{P_r(Lc)}$ decreases as $L_c$ increases, which is in accordance with the underlying economic rationale.

Given $\tau = 0.04$, the theoretical relationship between $L_c$ and $\gamma$ can be obtained as the blue line in Figure IX. The theoretical prediction aligns well with the data, indicating that the model setups are largely reasonable.

Finally, we perform a counterfactual analysis; the result is presented in Figure X. If the central and provincial governments take all the land transfer proceeds, meaning that the land rent incentive disappears, the proportion of commercial land in total transfers would rise from 26% to 31%. This change signifies a substantive shift in land allocation, which is evidence of the magnitude of the counterforce propelled by the rent-tax linkage.

## 7. Conclusion

This study has examined the nexus between the tax potential and rental price of land and explored the impact of the rent-tax linkage on land allocation by municipal governments in the framework of fiscal incentives. The results of empirical analyses based on parcel-level transaction data in China's primary land transfer market show that the rents of commercial land with strong tax potential are lower than those of residential land with relatively weak tax potential. For example, a 1% increase in commercial land's tax potential is associated with an approximately 0.2% decrease in the rent for commercial land relative to residential land. The findings remain robust under different spatial-matching radii, discount rates, and robustness

tests. Further evidence suggests that the rent-tax linkage is shaped by local governments setting the starting price of land transfers and the land bidding process by developers.

When fiscal incentives for local land development are derived from taxes and land rents, as in China, the structural bias in local land development due to tax incentives may be fully or partially offset by the inverse change in land rent revenue incentives. This study estimates the net effect of tax potential on local land use structure using the variation in the tax potential of commercial land across Chinese cities. We find that a 1% increase in the tax potential of commercial land increases the share of commercial land supply by approximately 0.05-0.1 percentage points. We designed a continuous treatment DID model using China's land transfer proceeds sharing reform in 2011 as a natural experiment and found that the decrease in the local retention ratio of land transfer proceeds increases the share of local commercial land supply, especially for regions with a high tax potential. Subsequently, based on the results of the reduced-form estimation, we conducted a structural estimation and reached the conclusion that if the land rent channel were switched off, the expansion of commercial land use driven solely by tax incentives would be substantially increased.

The economic implications of the findings in this study are twofold. On the one hand, when local governments have both general taxing power and land ownership (or land value-based taxation), a rent-tax linkage implies that excessive taxation will lead to a decline in land rents. This decline indicates that local governments' taxing power will be subject to constraints from the land market. On the other hand, the effectiveness of this mechanism depends on many critical factors shaping the rent-tax linkage, such as the degree of marketization of land factors, capital mobility, and the intergovernmental revenue allocation system for taxes and rents.

Nonetheless, the rent-tax linkage explored in this study suggests that preferential tax incentives for commercial land development may lead to a bias in the local government land supply structure, but the reverse incentive from land rents may dampen it. These observations establish that resource allocation can be restored to an efficient equilibrium when local governments derive their revenues from land rents or land-based taxation, which is in line with the Henry George Theorem (Arnott & Stiglitz, 1979) and has tremendous implications for the design of local public finance.

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**Table I**

**Taxes for Commercial and Residential Property**

| Stages in Development | | Tax | Commercial property | Residential property |
|---|---|---|---|---|
| Transaction | Land acquisition | Deed tax | Yes | Yes |
| | | Farmland occupation tax | Yes | Yes |
| | | Stamp duty | Yes | Yes |
| | | Urban land use tax | Yes | Yes |
| | Sale of property | Business tax (before 2016) | Yes | Yes |
| | | VAT (after 2016) | Yes | Yes |
| | | Land value-added tax | Yes | Yes |
| | | Corporate income tax | Yes | Yes |
| | | Deed tax | Yes | Yes |
| | | Stamp duty | Yes | Yes |
| | | Personal income tax | Yes | Yes |
| Holding & operation of property | Business operation | Business tax (before 2016) | Yes | No |
| | | VAT (after 2016) | Yes | No |
| | | Corporate income tax | Yes | No |
| | | Personal income tax | Yes | No |
| | | Urban maintenance & construction tax | Yes | No |
| | Holding property | Property tax | Yes | No |
| | | Urban land use tax | Yes | No |

Notes: Authors' summary.

## Table II

## Descriptive Statistics of Land Parcels

Panel A: **Matched sample within 500-meter radius from 2007 to 2019**

| | Commercial Parcel | | | Residential Parcel | | |
|---|---|---|---|---|---|---|
| | Mean | SD | Obs | Mean | SD | Obs |
| Transaction price (floor area) (CNY per $m^2$) | 1,850.65 | 3,255.80 | 38,319 | 1,869.13 | 3,104.31 | 84,695 |
| Land parcel area (in $m^2$) | 27,589.03 | 44,089.93 | 38,309 | 43,396.77 | 47,447.23 | 84,677 |
| Floor area/plot ratio | 2.62 | 1.74 | 38,319 | 2.55 | 1.30 | 84,695 |
| Starting price (floor area) (CNY per $m^2$) | 1,530.84 | 2,464.04 | 36,550 | 1,585.87 | 2,341.14 | 79,723 |
| Premium rate (%) | 12.36 | 45.93 | 36,550 | 14.05 | 39.79 | 79,723 |

Panel B: **Share by land transfer method**

| | Commercial | Residential |
|---|---|---|
| Transfer by auction | 0.16 | 0.21 |
| Transfer by bidding | 0.02 | 0.02 |
| Transfer by listing | 0.82 | 0.77 |

Notes: The observations are *land transfers* in 99 large- and medium-sized cities in China. *Transaction price by floor area* equals the land transfer price divided by the product of the land parcel area and floor area ratio. *Starting price* refers to the initial price set by local governments before developers bid for the parcels. *Premium rate* equals the transaction price (by floor area) minus the starting price and then divided by the starting area price. In Panel A, we allow duplicate matching. Data source: China Index Academy.

## Table III

## Descriptive Statistics of City-Level Variables

| | Mean | SD | Min | Max | Obs |
|---|---|---|---|---|---|
| **Panel A：City-level tax potential indicators** | | | | | |
| Tertiary industry output (million CNY) | 161,028.20 | 222,598.90 | 4,954.39 | 2,196,117 | 1,181 |
| Business tax (million CNY) | 7,404.52 | 12,878.03 | 135.50 | 97,348.14 | 786 |
| Urban built-up area ($km^2$) | 250.38 | 257.79 | 20.00 | 1,515.41 | 1,179 |
| Tax potential I, by city (average tertiary industry output / urban built-up area over sample period) | 607.14 | 300.50 | 136.34 | 2,068.20 | 1,176 |
| Tax potential II, by city (average business tax / urban built-up area over sample period) | 27.13 | 17.74 | 2.93 | 124.99 | 777 |
| **Panel B：City-level land use indicators** | | | | | |
| # Commercial land transfers | 48.36 | 49.78 | 0 | 427.00 | 1218 |
| # Residential land transfers | 88.40 | 81.10 | 0 | 551.00 | 1218 |
| Land use structure I: # Parcels (Commercial/Total) | 0.34 | 0.16 | 0 | 1 | 1218 |
| Area of commercial land transfer（$km^2$） | 1.23 | 1.34 | 0 | 12.33 | 1218 |
| Area of residential land transfer（$km^2$） | 3.54 | 3.54 | 0 | 33.32 | 1218 |
| Land use structure II: Area (Commercial/Total) | 0.26 | 0.17 | 0 | 1 | 1218 |

Notes: The data include 99 large and medium-sized cities in China. Observations vary across variables due to data missing. The business tax was replaced by VAT in 2016, so for the indicator of business tax revenue, the time window is 2007-2015. Both tertiary industry output value and business tax revenue have been deflated using the CPI of each city. For cities with missing CPI data, the CPI of the province where the city is located in the same year is used. Total number(area) of land transfer = number(area) of commercial land transfer + number (area) of residential land transfer. Data sources: Chinese Research Data Services (CNRDS); CEIC; China Urban Construction Statistical Yearbook.

## Table IV

### Commercial Land Discount (Residential Land as Default)

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.107*** | -0.107*** | -0.142*** | -0.140*** | -0.158*** | -0.155*** |
| | (0.00611) | (0.00611) | (0.00513) | (0.00509) | (0.00479) | (0.00476) |
| Bidding | -0.167*** | -0.236*** | -0.178*** | -0.251*** | -0.186*** | -0.259*** |
| | (0.0267) | (0.0269) | (0.0162) | (0.0163) | (0.0135) | (0.0130) |
| Listing | -0.298*** | -0.311*** | -0.297*** | -0.336*** | -0.291*** | -0.344*** |
| | (0.0114) | (0.0114) | (0.00795) | (0.00790) | (0.00625) | (0.00638) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year*City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 105,432 | 105,401 | 230,990 | 230,975 | 395,106 | 395,101 |
| R-squared | 0.750 | 0.784 | 0.731 | 0.763 | 0.715 | 0.748 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 8%. See the Appendix A1 and A2 for results under other alternative discount rates. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Ring Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Table V

### Tax Potential Elasticity of Commercial Land Discount across Cities

| | Tax：Tertiary industry output / Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax Potential) | -0.213*** | -0.246*** | -0.182*** | -0.201*** |
| | (0.0162) | (0.0162) | (0.0112) | (0.0114) |
| Land Use Fixed Effects | Y | N | Y | N |
| Radius Matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land Transfer Methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 105,432 | 105,401 | 105,071 | 105,040 |
| R-squared | 0.751 | 0.786 | 0.751 | 0.786 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price(log) as the dependent variable. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. The discount rate is 8%. See Appendix A3 and A4 for results under other alternative discount rates and matching radii. Columns 1 and 2 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Land Use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Ring Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia，2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

## Table VI

**Impact of Tax Potential on Commercial Land Discount, Shanghai City**

| | Tax Potential by Land Classification | | Tax Potential by Tax Rate | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial ∗ Tax Potential | 167.6*** | 202.7*** | -54.39*** | -61.61*** |
| | (52.85) | (56.92) | (17.64) | (18.03) |
| Land Use Fixed Effects | Y | N | Y | N |
| Radius Matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Year * Land Use Fixed Effects | N | Y | N | Y |
| Observation | 2,170 | 2,170 | 2,170 | 2,170 |
| R-squared | 0.786 | 0.799 | 0.789 | 0.802 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price(log) as the dependent variable. The matching radius is 500 meters with any commercial land parcel as the center of the circle. The discount rate is 8%. See the Appendix A6 and A7 for results under other alternative discount rates and matching radius. Columns 1 and 2 correspond to regression results based on land classification within Shanghai; Columns 3 and 4 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. The higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; therefore, we do not introduce any Land Transfer Method fixed effects in the model. Land Use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Ring Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. ∗ $p<0.1$, ∗∗ $p<0.05$, and ∗∗∗ $p<0.01$.

## Table VII

### Tax Potential Elasticity of Commercial Land Discount by Starting Price across Cities

| | Average difference | | Tax：Tertiary industry output / Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial * log (Tax Potential) | | | -0.188*** | -0.219*** | -0.166*** | -0.177*** |
| | | | (0.0159) | (0.0160) | (0.0107) | (0.0109) |
| Commercial | -0.0788*** | -0.0805*** | Y | | Y | |
| | (0.00590) | (0.00592) | | | | |
| Radius Matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Land Transfer Method Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Year * Commercial Fixed Effects | N | N | N | Y | N | Y |
| Observation | 99,101 | 99,070 | 99,101 | 99,070 | 98,740 | 98,709 |
| R-squared | 0.752 | 0.786 | 0.753 | 0.788 | 0.753 | 0.789 |

Note: The results in this table are obtained from estimating Equation 4 with the starting price by floor area（log）as the dependent variable. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. The discount rate is 8%. See the Appendix A8 for results under other alternative discount rates and matching radii. Columns 1 and 2 report the average difference between commercial and residential land rental prices. Columns 3 and 4 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 5 and 6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Ring Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Table VIII

### Tax Potential Elasticity of Commercial Land Discount, by premium rate, across Cities

| | Average difference | | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial * log (Tax Potential) | | | -0.0293*** | -0.0358*** | -0.0394*** | -0.0465*** |
| | | | (0.0105) | (0.0105) | (0.00725) | (0.00711) |
| Commercial | -0.0466*** | -0.0415*** | Y | | Y | |
| | (0.00366) | (0.00373) | | | | |
| Radius Matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Land Transfer Method Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Year * Commercial Fixed Effects | N | N | N | Y | N | Y |
| Observation | 99,101 | 99,070 | 99,101 | 99,070 | 98,740 | 98,709 |
| R-squared | 0.421 | 0.481 | 0.421 | 0.483 | 0.421 | 0.483 |

Note: The results in this table are obtained from estimating Equation 4 with the $Multiplier_{premium}$ (log) as the dependent variable. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. The discount rate is 8%. See the Appendix A9 for results under other alternative discount rates and matching radii. Columns 1 and 2 report the average difference between commercial and residential land rental prices. Columns 3 and 4 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 5 and 6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Ring Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia， 2015). Robust standard errors in parentheses are clustered at the neighborhood level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Table IX

## Share of Commercial Land by Tax Potential（2SLS）

| | Land use structure by number of parcels | | Land use structure by total area of parcels | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Tax potential I) | 0.135*** | | 0.0733** | |
| | (0.0265) | | (0.0301) | |
| Log(Tax potential II) | | 0.0959*** | | 0.0522** |
| | | (0.0180) | | (0.0209) |
| IV | Y | Y | Y | Y |
| Year Fixed Effects | Y | Y | Y | Y |
| Observations | 1,196 | 1,183 | 1,196 | 1,183 |
| R-squared | -0.071 | 0.028 | -0.030 | 0.015 |

Note: The results reported in this table are obtained from Equation 5 using the Two-Stage Least Squares (2SLS) method with the shortest distance between the city center and the coastline as the instrument variable. Tax potential I is the logarithm of the output value of tertiary industry/urban built-up area. Tax potential II is the logarithm of the business tax revenue/urban built-up area. The dependent variables in columns 1 and 2 are the share of commercial land, which is the ratio of the number of commercial land sales to the sum of the number of commercial and residential land sales. The dependent variables in columns 3 and 4 are the share of commercial land, which is the ratio of the area of commercial land sales to the sum of the area of commercial and residential land sales. First stage results are reported in Appendix. Robust standard errors in parentheses. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

## Table X

### Change in Share of Commercial Land by Land Proceeds Centralization

| | Land transfer by number of parcels | | Land transfer by area of parcels | |
|---|---|---|---|---|
| **Tax potential** | **Above 50$^{th}$ percentile** | **Below 50$^{th}$ percentile** | **Above 50th percentile** | **Below 50th percentile** |
| | (1) | (2) | (3) | (4) |
| post_2010*rate | 2.087** | -1.870* | 1.965** | -1.458 |
| | (0.916) | (1.060) | (0.975) | (1.459) |
| Year effects | Y | Y | Y | Y |
| City effects | Y | Y | Y | Y |
| Observations | 396 | 390 | 396 | 390 |
| R-squared | 0.573 | 0.522 | 0.478 | 0.378 |

Note: The results in this table are obtained from estimating Equation 6. The dependent variable corresponding to columns 1 and 2 is the share of commercial land measured by the number of parcels. The dependent variable corresponding to columns 3 and 4 is the share of commercial land measured by the area of parcels. Tax Potential II is used to sort the sample. Robust standard errors in parentheses are clustered at the city level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

**Table XI**

**List of Estimated Coefficients**

| Definitions of coefficients | Coefficient | Source | Value of coefficient |
|---|---|---|---|
| Commercial land discount | $log(P_c/P_r)$ | Table IV | -0.1 |
| Land discount by tax potential | $\frac{\partial[log(P_c/P_r)]}{\partial[log\gamma]}$ | Table V | -0.2 |
| Commercial land share by tax potential | $\frac{\partial[(L_c)]}{\partial[log\gamma]}$ | Table IX | 0.05-0.1 |
| Commercial land share by rate of land proceeds centralization | $\frac{\partial[(L_c)]}{\partial\tau}$ | Table X | 2* |
| Mean of Commercial land share | | Summary Statistics | 0.26 |
| Minimum of Commercial land share | | Summary Statistics | 0.11 |
| Mean rate of land proceeds centralization | | Summary Statistics | 0.04 |

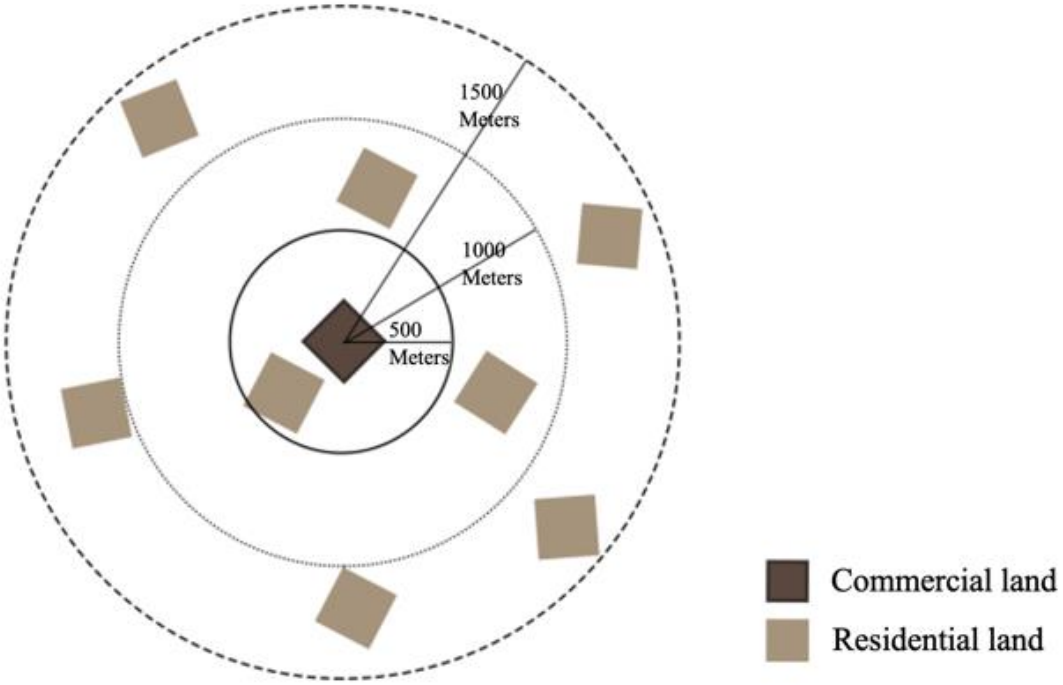
Notes: * The coefficient is estimated from data for cities in the top 50% quantile of tax potential. In order to enhance comparability, we only present the estimated coefficients where business tax is used as a measure of land tax potential.

**Table XII**

| Parameters | Theoretical value for the parameters |
|---|---|
| $\beta_1$ | -0.9894 |
| $\alpha 1$ | -0.0100 |
| $\beta_2$ | -0.9870 |
| $\alpha 2$ | -0.0469 |
| $\beta_3$ | 0.0268 |
| $\alpha 3$ | -1.0082 |

**Figure I**

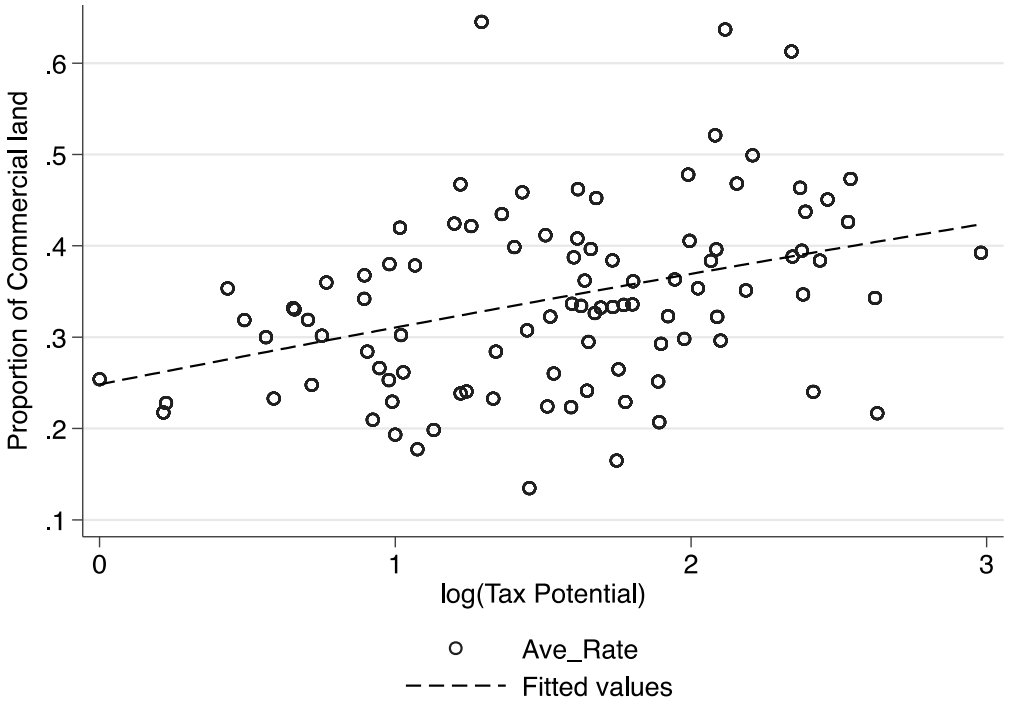
**Spatial Matching Method**




Note: Figure 1 illustrates the method of spatial matching which is to take each commercial parcel as the center and match it to residential parcels within different radii.

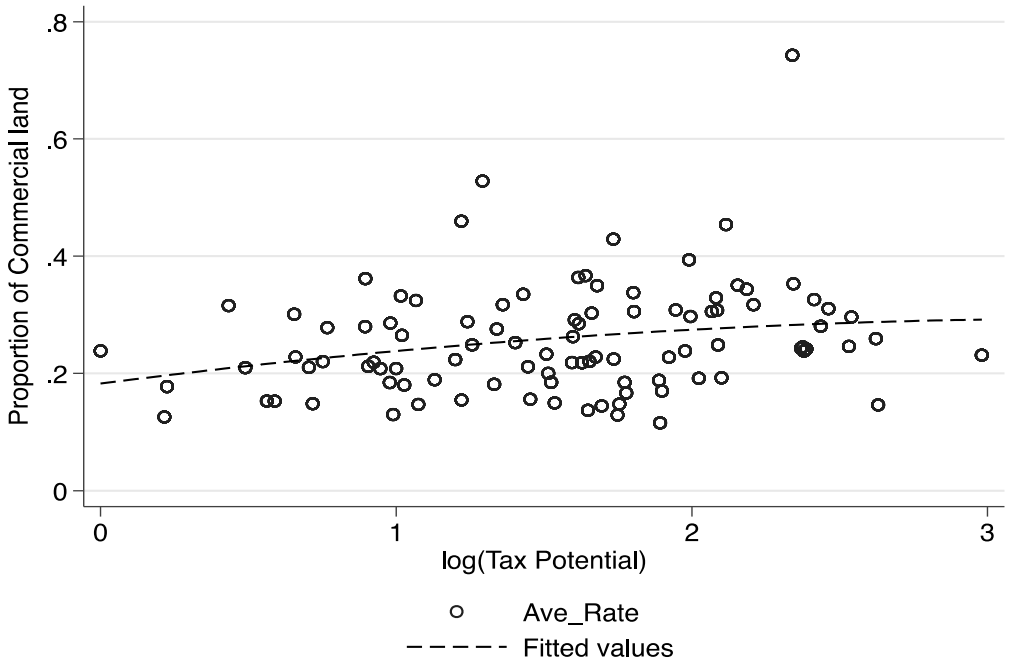
**Figure II**

**Tax Potential and Land Transfer by Use**




Note: The land transfer structure is measured by the numbers of parcels for commercial and residential purposes. Tax potential is standardized by its minimum value, i.e., minimum value of tax potential is set at 1.

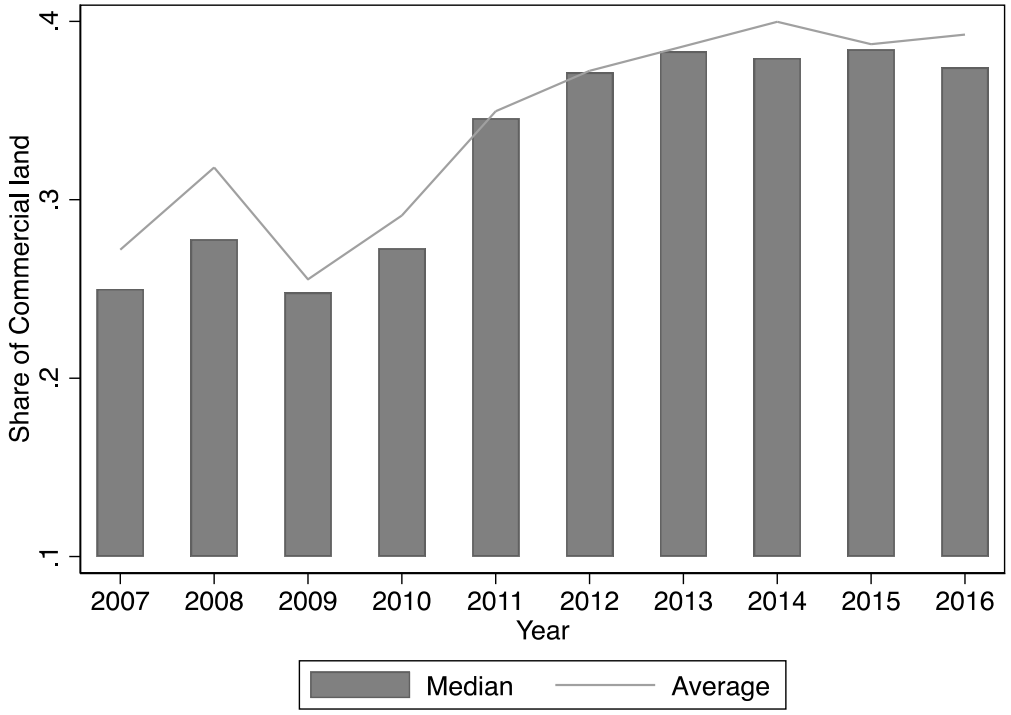
**Figure III**
**Tax Potential and Land Transfer by Use**




Note: The land transfer by use is measured by the area of parcels for commercial and residential purposes. Tax potential is standardized by its minimum value, i.e., minimum value of tax potential is set at 1.

**Figure IV**

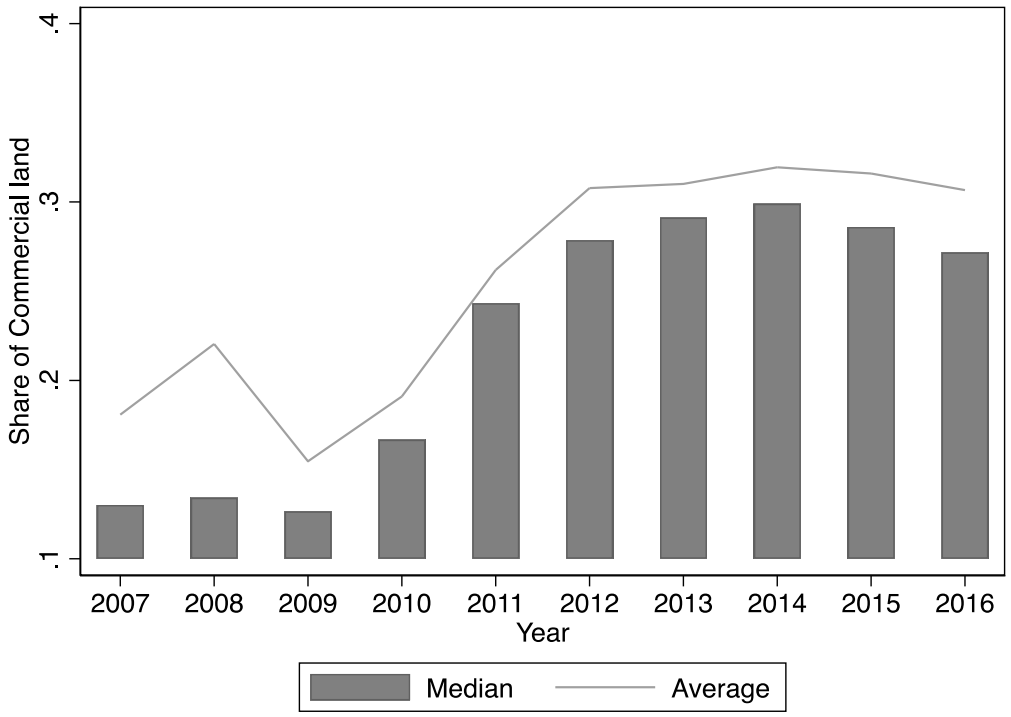
**Share of Commercial Land by Total Number of Parcels**




Note: The dashed line represents the average share of commercial land transfers across all cities over the years. The bar chart represents the median share of commercial land transfers across all cities over the years.

**Figure V**

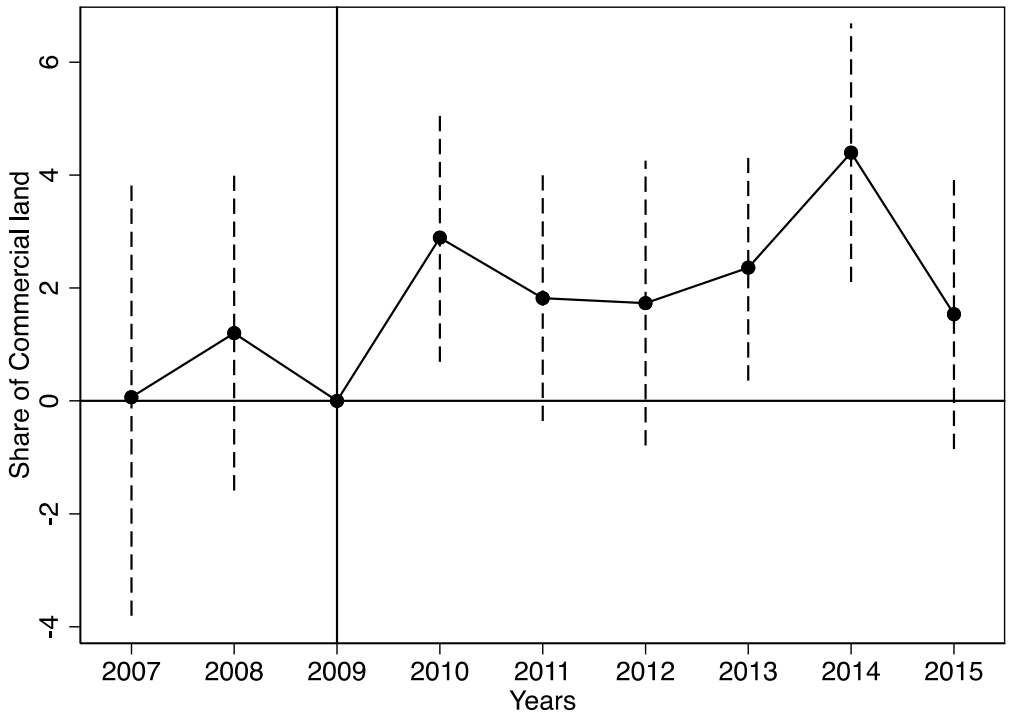
**Share of Commercial Land by Total Area of Parcels**




Note: The dashed line represents the average share of commercial land transfers across all cities over the years. The bar chart represents the median share of commercial land transfers across all cities over the years.

**Figure VI**

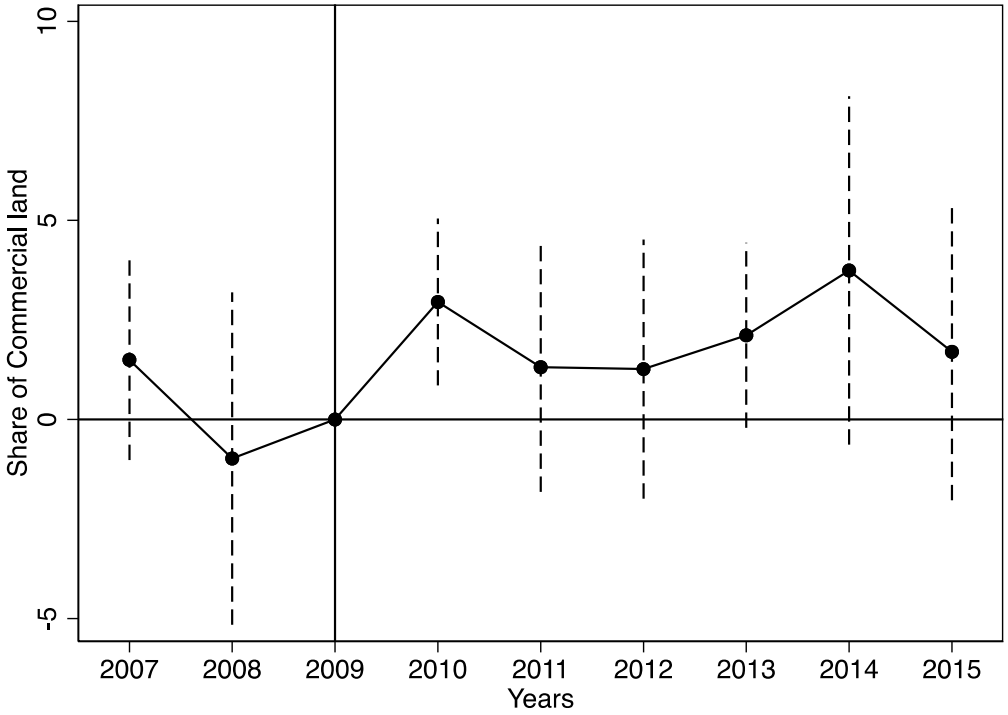
**Event Study Analysis of Land Transfer by Use**




Note: The graph is plotted using cities with a tax potential (measure II) above the 50th percentile. The share of commercial land transfer is measured by the number of parcels. 95% confidence interval.

**Figure VII**

**Event Study for Land Transfer by Use**




Note: The graph is plotted using cities with a tax potential (measure II) above the 50th percentile. The share of commercial land transfer is measured by the area of parcels. 95% confidence interval.

## Figure VIII

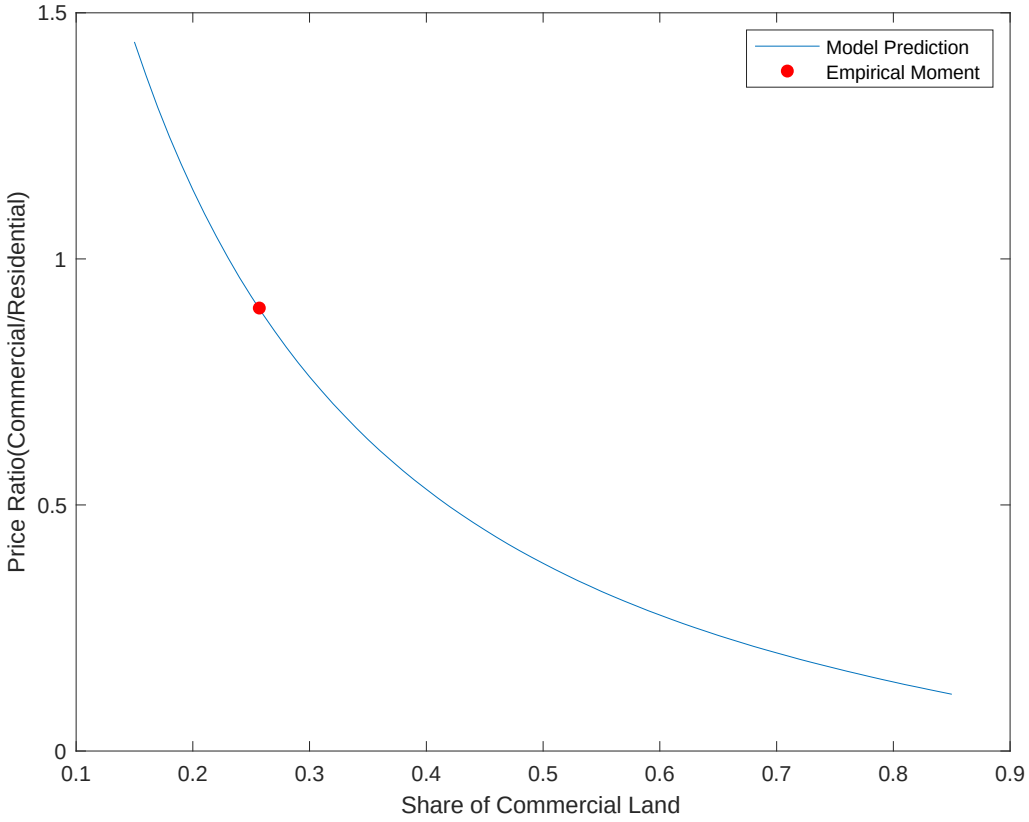

Model Prediction
Empirical Moment
Price Ratio(Commercial/Residential)
Share of Commercial Land
1.5
1
0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

**Figure IX**

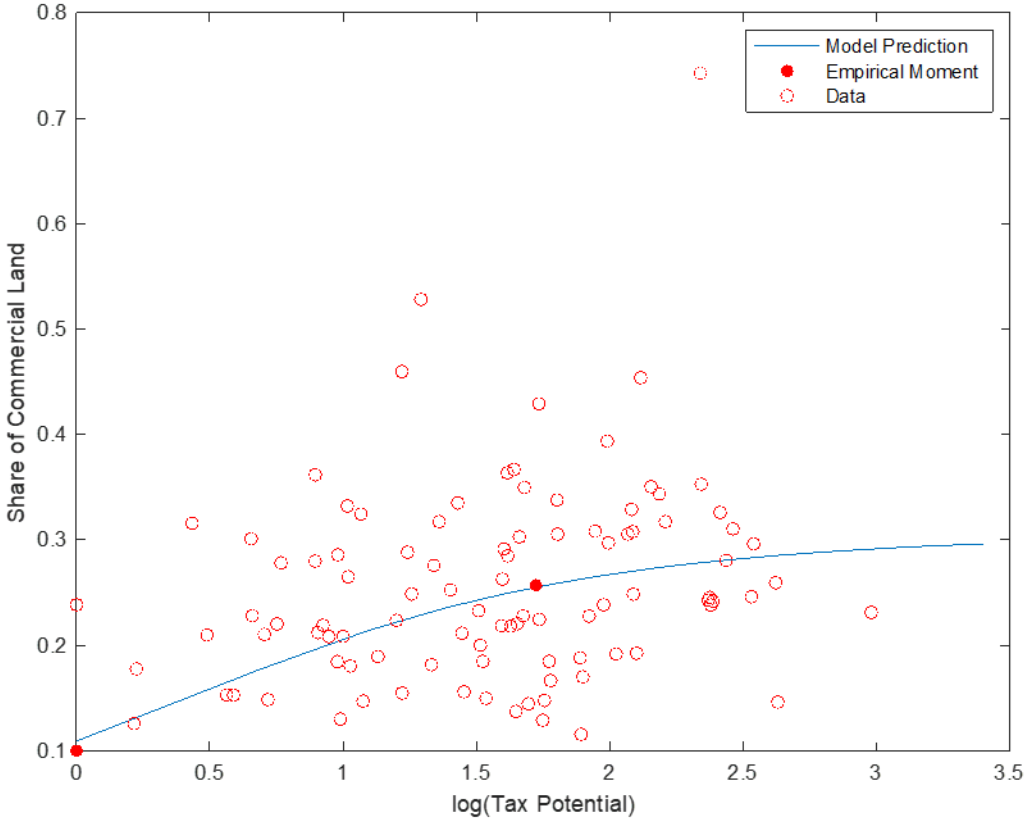
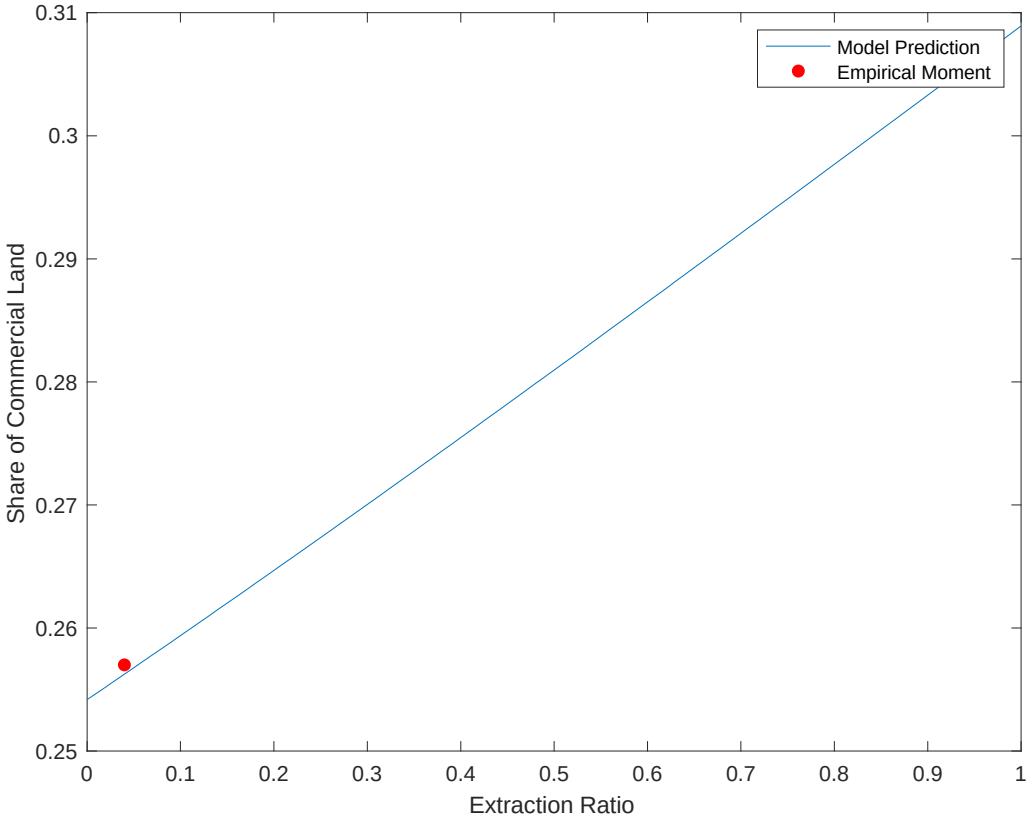

Model Prediction
Empirical Moment
Data
Share of Commercial Land
log(Tax Potential)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.5
1
1.5
2
2.5
3
3.5

**Figure X**


Model Prediction
Empirical Moment
Share of Commercial Land
Extraction Ratio
0.31
0.3
0.29
0.28
0.27
0.26
0.25
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

# Appendix A

Table A1. Commercial Land Discount with Residential Land as Default, discount rate=10%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.126*** | -0.125*** | -0.158*** | -0.160*** | -0.173*** | -0.177*** |
| | (0.00611) | (0.00611) | (0.00509) | (0.00513) | (0.00476) | (0.00479) |
| Bidding | -0.235*** | -0.166*** | -0.250*** | -0.177*** | -0.259*** | -0.185*** |
| | (0.0269) | (0.0267) | (0.0163) | (0.0162) | (0.0130) | (0.0135) |
| Listing | -0.311*** | -0.298*** | -0.336*** | -0.297*** | -0.344*** | -0.291*** |
| | (0.0114) | (0.0114) | (0.00789) | (0.00795) | (0.00638) | (0.00625) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 105,401 | 105,432 | 230,975 | 230,990 | 395,101 | 395,106 |
| R-squared | 0.784 | 0.750 | 0.763 | 0.731 | 0.748 | 0.715 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 10%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A2. Commercial Land Discount with Residential Land as Default, discount rate=12%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.135*** | -0.134*** | -0.167*** | -0.169*** | -0.183*** | -0.186*** |
| | (0.00611) | (0.00611) | (0.00509) | (0.00513) | (0.00476) | (0.00478) |
| Bidding | -0.235*** | -0.165*** | -0.250*** | -0.177*** | -0.259*** | -0.185*** |
| | (0.0269) | (0.0267) | (0.0163) | (0.0162) | (0.0130) | (0.0135) |
| Listing | -0.310*** | -0.298*** | -0.336*** | -0.297*** | -0.344*** | -0.291*** |
| | (0.0113) | (0.0114) | (0.00789) | (0.00794) | (0.00638) | (0.00625) |
| Neighborhood Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year x City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 105,401 | 105,432 | 230,975 | 230,990 | 395,101 | 395,106 |
| R-squared | 0.784 | 0.750 | 0.763 | 0.731 | 0.748 | 0.715 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 12%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matches Fixed Effects, which corresponds to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A3 Elasticity of Commercial Land Discount from Across-City Tax Potential, radius=1000 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log(Tax potential) | -0.223*** | -0.255*** | -0.195*** | -0.208*** |
| | (0.0138) | (0.0138) | (0.00950) | (0.00952) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 230,990 | 230,975 | 230,332 | 230,317 |
| R-squared | 0.732 | 0.765 | 0.732 | 0.765 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1000 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia，2015). Robust standard errors in parentheses are clustered at the neighborhood level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A4. Elasticity of Commercial Land Discount from Across-City Tax Potential, radius=1500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax Potential) | -0.218*** | -0.247*** | -0.194*** | -0.205*** |
| | (0.0128) | (0.0129) | (0.00873) | (0.00884) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 395,106 | 395,101 | 394,053 | 394,048 |
| R-squared | 0.716 | 0.749 | 0.716 | 0.749 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1500 meters, with any commercial land parcel as the center of the circle Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A5. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=8%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potential | 202.7*** | 71.85* | 144.2*** | -61.61*** | -19.65* | -35.62*** |
| | (56.92) | (42.82) | (39.24) | (18.03) | (11.51) | (10.08) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,170 | 4,673 | 6,788 | 2,170 | 4,673 | 6,788 |
| R-squared | 0.799 | 0.693 | 0.646 | 0.802 | 0.693 | 0.646 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 8%. Columns 1-3 correspond to regression results based on land classification within Shanghai, while columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. Thus, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; therefore, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A6. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=10%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potential | 262.0*** | 102.6* | 194.0*** | -79.26*** | -27.62* | -47.70*** |
| | (70.32) | (52.82) | (48.50) | (22.20) | (14.17) | (12.44) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,170 | 4,673 | 6,788 | 2,170 | 4,673 | 6,788 |
| R-squared | 0.798 | 0.692 | 0.645 | 0.801 | 0.692 | 0.645 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 10%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. Therefore, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A7. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=12%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potential | 319.7*** | 130.7** | 241.1*** | -96.51*** | -34.96** | -59.14*** |
| | (83.97) | (63.03) | (57.93) | (26.46) | (16.89) | (14.85) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,170 | 4,673 | 6,788 | 2,170 | 4,673 | 6,788 |
| R-squared | 0.798 | 0.691 | 0.644 | 0.801 | 0.692 | 0.645 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 12%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding, so we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table A8. Tax Potential Elasticity of Commercial Land Discount, by starting price, across Cities

| | Tax：Output value of tertiary industry/ Urban built-up area | | | Tax：Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * log(Tax Potential) | -0.219*** | -0.235*** | -0.225*** | -0.177*** | -0.200*** | -0.200*** |
| | (0.0160) | (0.0136) | (0.0127) | (0.0109) | (0.00910) | (0.00847) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 99,070 | 218,999 | 377,008 | 98,709 | 218,341 | 375,955 |
| R-squared | 0.788 | 0.767 | 0.750 | 0.789 | 0.768 | 0.750 |

Note: The results in this table are obtained from estimating Equation 4 with the starting floor area rental price (log) as the dependent variable. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia，2015). Robust standard errors in parentheses are clustered at the ring level. * p<0.1, ** p<0.05, and *** p<0.01.

Table A9. Tax Potential Elasticity of Commercial Land Discount, by premium rate, across Cities

| | Tax: Output value of tertiary industry/ Urban built-up area | | | Tax: Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * log(Tax Potential) | -0.036*** | -0.046*** | -0.050*** | -0.047*** | -0.042*** | -0.041*** |
| | (0.011) | (0.009) | (0.009) | (0.00711) | (0.00614) | (0.00592) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 99,070 | 218,999 | 377,008 | 98,709 | 218,341 | 375,955 |
| R-squared | 0.483 | 0.394 | 0.336 | 0.483 | 0.394 | 0.336 |

Note: The results in this table are obtained from estimating Equation 4 with the $Multiplier_{premium}$ (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Appendix B. Robustness Tests

Table B1. Commercial Land Discount with Residential Land as Default, discount rate=8%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.0753*** | -0.0886*** | -0.104*** | -0.121*** | -0.115*** | -0.128*** |
| | (0.00504) | (0.00504) | (0.00385) | (0.00387) | (0.00345) | (0.00345) |
| Bidding | -0.279*** | -0.222*** | -0.287*** | -0.223*** | -0.300*** | -0.239*** |
| | (0.0303) | (0.0284) | (0.0172) | (0.0157) | (0.0121) | (0.0111) |
| Listing | -0.294*** | -0.254*** | -0.295*** | -0.238*** | -0.306*** | -0.241*** |
| | (0.0124) | (0.0132) | (0.00791) | (0.00809) | (0.00619) | (0.00621) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 116,611 | 116,655 | 258,885 | 258,908 | 437,573 | 437,583 |
| R-squared | 0.749 | 0.710 | 0.711 | 0.673 | 0.676 | 0.634 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 8%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table B2. Commercial Land Discount with Residential Land as Default, discount rate=10%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.0940*** | -0.107*** | -0.123*** | -0.139*** | -0.134*** | -0.147*** |
| | (0.00503) | (0.00504) | (0.00385) | (0.00387) | (0.00345) | (0.00345) |
| Bidding | -0.279*** | -0.221*** | -0.287*** | -0.223*** | -0.299*** | -0.239*** |
| | (0.0303) | (0.0284) | (0.0172) | (0.0157) | (0.0121) | (0.0111) |
| Listing | -0.294*** | -0.254*** | -0.295*** | -0.237*** | -0.306*** | -0.241*** |
| | (0.0124) | (0.0132) | (0.00791) | (0.00809) | (0.00619) | (0.00621) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 116,611 | 116,655 | 258,885 | 258,908 | 437,573 | 437,583 |
| R-squared | 0.749 | 0.711 | 0.711 | 0.673 | 0.676 | 0.634 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 10%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table B3. Commercial Land Discount with Residential Land as Default, discount rate=12%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.103*** | -0.117*** | -0.132*** | -0.148*** | -0.143*** | -0.156*** |
| | (0.00503) | (0.00504) | (0.00385) | (0.00387) | (0.00345) | (0.00345) |
| Bidding | -0.279*** | -0.221*** | -0.287*** | -0.223*** | -0.299*** | -0.239*** |
| | (0.0303) | (0.0284) | (0.0172) | (0.0157) | (0.0121) | (0.0111) |
| Listing | -0.294*** | -0.254*** | -0.295*** | -0.237*** | -0.306*** | -0.241*** |
| | (0.0124) | (0.0132) | (0.00790) | (0.00809) | (0.00619) | (0.00621) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 116,611 | 116,655 | 258,885 | 258,908 | 437,573 | 437,583 |
| R-squared | 0.749 | 0.711 | 0.712 | 0.673 | 0.676 | 0.634 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 12%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table B4. Elasticity of Commercial Land Discount from Across-City Tax Potential, matching radius=500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax Potential) | -0.253*** | -0.222*** | -0.184*** | -0.174*** |
| | (0.0134) | (0.0133) | (0.00942) | (0.00949) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 116,655 | 116,611 | 116,230 | 116,186 |
| R-squared | 0.712 | 0.751 | 0.712 | 0.751 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table B5. Elasticity of Commercial Land Discount from Across-City Tax Potential, matching radius=1000 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax Potential) | -0.314*** | -0.281*** | -0.232*** | -0.220*** |
| | (0.0106) | (0.0103) | (0.00733) | (0.00734) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 258,908 | 258,885 | 258,101 | 258,078 |
| R-squared | 0.675 | 0.714 | 0.675 | 0.714 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1000 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table B6. Elasticity of Commercial Land Discount from Across-City Tax Potential, matching radius=1500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax Potential) | -0.309*** | -0.280*** | -0.231*** | -0.221*** |
| | (0.00957) | (0.00938) | (0.00654) | (0.00660) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 437,583 | 437,573 | 436,335 | 436,325 |
| R-squared | 0.635 | 0.678 | 0.635 | 0.679 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1500 meters, with any commercial land parcel as the center of the circle Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table B7. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate =8%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potential | 129.6*** | 94.55*** | 63.41** | -46.48*** | -24.74** | -11.14 |
| | (41.35) | (32.69) | (29.57) | (16.24) | (10.91) | (8.657) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,354 | 5,313 | 8,060 | 2,354 | 5,313 | 8,060 |
| R-squared | 0.795 | 0.752 | 0.736 | 0.799 | 0.752 | 0.735 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 8%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding, so we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table B8. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=10%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potential | 170.3*** | 127.2*** | 87.79** | -60.66*** | -33.45** | -16.10 |
| | (51.22) | (40.58) | (36.75) | (20.06) | (13.54) | (10.74) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,354 | 5,313 | 8,060 | 2,354 | 5,313 | 8,060 |
| R-squared | 0.794 | 0.750 | 0.734 | 0.798 | 0.750 | 0.734 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 10%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding, so we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table B9. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=12%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potential | 209.4*** | 157.9*** | 110.4** | -74.35*** | -41.64** | -20.61 |
| | (61.25) | (48.57) | (44.02) | (23.96) | (16.20) | (12.85) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,354 | 5,313 | 8,060 | 2,354 | 5,313 | 8,060 |
| R-squared | 0.794 | 0.750 | 0.733 | 0.797 | 0.750 | 0.733 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 12%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding, so we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table B10. Tax Potential Elasticity of Commercial Land Discount, by starting price, across Cities

| | Tax：Output value of tertiary industry/ Urban built-up area | | | Tax：Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * log (Tax Potential) | -0.179*** | -0.244*** | -0.251*** | -0.148*** | -0.199*** | -0.208*** |
| | (0.0132) | (0.0103) | (0.00936) | (0.00904) | (0.00699) | (0.00629) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 108,683 | 242,560 | 411,827 | 108,258 | 241,753 | 410,579 |
| R-squared | 0.768 | 0.725 | 0.688 | 0.768 | 0.726 | 0.688 |

Note: The results in this table are obtained from estimating Equation 4 with the starting price by floor area (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table B11 Tax Potential Elasticity of Commercial Land Discount, by premium rate, across Cities

| | Tax：Output value of tertiary industry/ Urban built-up area | | | Tax：Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * log (Tax Potential) | -0.045*** | -0.053*** | -0.048*** | -0.048*** | -0.052*** | -0.047*** |
| | (0.008) | (0.007) | (0.006) | (0.006) | (0.005) | (0.004) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 108,683 | 242,560 | 411,827 | 108,258 | 241,753 | 410,579 |
| R-squared | 0.534 | 0.415 | 0.345 | 0.534 | 0.415 | 0.345 |

Note: The results in this table are obtained from estimating Equation 4 with the $Multiplier_{premium}$ (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Appendix C. Placebo Tests

Table C1. Placebo Tests of Commercial Land Discount with Residential Land as Default

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Central | 0.00134 | 0.00156 | 0.00130 | 0.00104 | -0.00186 | -0.00236 |
| | (0.00372) | (0.00395) | (0.00349) | (0.00368) | (0.00339) | (0.00356) |
| Bidding | -0.0676* | -0.119*** | -0.187*** | -0.188*** | -0.221*** | -0.194*** |
| | (0.0346) | (0.0318) | (0.0216) | (0.0200) | (0.0158) | (0.0150) |
| Listing | -0.0724*** | -0.0792*** | -0.136*** | -0.113*** | -0.188*** | -0.144*** |
| | (0.0155) | (0.0128) | 0.00130 | 0.00104 | -0.00186 | -0.00236 |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 142,856 | 142,856 | 246,944 | 246,944 | 355,365 | 355,365 |
| R-squared | 0.870 | 0.837 | 0.829 | 0.798 | 0.794 | 0.760 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table C2. Placebo Tests of Elasticity of Commercial Land Discount from Across-City Tax Potential, matching radius=500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Central * log (Tax Potential) | 0.000774 | -0.00103 | 0.00214 | 2.56e-05 |
| | (0.0109) | (0.0102) | (0.00716) | (0.00675) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 142,856 | 142,856 | 142,457 | 142,457 |
| R-squared | 0.837 | 0.870 | 0.837 | 0.870 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table C3. Placebo Tests of Elasticity of Commercial Land Discount from Across-City Tax Potential, matching radius=1000 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Central * log (Tax Potential) | 0.00414 | 0.00409 | 0.00326 | 0.00198 |
| | (0.0102) | (0.00968) | (0.00669) | (0.00636) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 246,944 | 246,944 | 246,419 | 246,419 |
| R-squared | 0.798 | 0.829 | 0.798 | 0.829 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1000 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table C4. Placebo Tests of Elasticity of Commercial Land Discount from Across-City Tax Potential, matching radius=1500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Central * log (Tax Potential) | -0.00273 | -0.00378 | -0.000779 | -0.00151 |
| | (0.00985) | (0.00936) | (0.00649) | (0.00616) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 355,365 | 355,365 | 354,733 | 354,733 |
| R-squared | 0.760 | 0.794 | 0.760 | 0.794 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1500 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table C5. Placebo test of Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=8%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Central * Tax Potential | 9.978 | -3.977 | -7.842 | -3.623 | -0.00395 | 2.120 |
| | (27.83) | (26.09) | (27.60) | (7.573) | (6.548) | (6.867) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,119 | 4,087 | 6,178 | 2,119 | 4,087 | 6,178 |
| R-squared | 0.905 | 0.854 | 0.813 | 0.905 | 0.854 | 0.813 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 8%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. The higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table C6. Placebo test of Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=10%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Central * Tax Potential | 12.17 | -4.849 | -9.563 | -4.418 | -0.00482 | 2.585 |
| | (33.94) | (31.82) | (33.65) | (9.234) | (7.984) | (8.373) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,119 | 4,087 | 6,178 | 2,119 | 4,087 | 6,178 |
| R-squared | 0.905 | 0.854 | 0.813 | 0.905 | 0.854 | 0.813 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 10%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table C7. Placebo test of Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=12%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Central * Tax Potential | 14.43 | -5.752 | -11.34 | -5.241 | -0.00572 | 3.066 |
| | (40.26) | (37.74) | (39.92) | (10.95) | (9.471) | (9.933) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 2,119 | 4,087 | 6,178 | 2,119 | 4,087 | 6,178 |
| R-squared | 0.905 | 0.854 | 0.813 | 0.905 | 0.854 | 0.813 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 12%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table C8. Placebo test of Tax Potential Elasticity of Commercial Land Discount, by starting price

| | Tax：Output value of tertiary industry/ Urban built-up area | | | Tax：Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Central * log (Tax Potential) | 0.000103 | 0.00192 | -0.00333 | 0.000317 | 0.000455 | -0.00173 |
| | (0.00996) | (0.00950) | (0.00921) | (0.00654) | (0.00613) | (0.00598) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 137,041 | 237,337 | 341,798 | 136,642 | 236,812 | 341,166 |
| R-squared | 0.876 | 0.836 | 0.800 | 0.876 | 0.835 | 0.800 |

Note: The results in this table are obtained from estimating Equation 4 with the starting floor area rental price (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table C9. Placebo test of Tax Potential Elasticity of Commercial Land Discount, by premium rate, across Cities

| | Tax: Output value of tertiary industry/ Urban built-up area | | | Tax: Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Central * log (Tax Potential) | 0.001 | 0.004 | 0.001 | -0.000 | 0.002 | 0.001 |
| | (0.008) | (0.007) | (0.007) | (0.005) | (0.005) | (0.005) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 137,041 | 237,337 | 341,798 | 136,642 | 236,812 | 341,166 |
| R-squared | 0.447 | 0.369 | 0.301 | 0.447 | 0.369 | 0.301 |

Note: The results are obtained from estimating Equation 4 with $Multiplier_{premium}$ (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Appendix D. Matching with residential parcels prior to the transfer of the central parcel within 12 months

Table D1. Commercial Land Discount with Residential Land as Default, discount rate=8%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.0665*** | -0.0667*** | -0.0986*** | -0.0992*** | -0.111*** | -0.112*** |
| | (0.0107) | (0.0104) | (0.00929) | (0.00909) | (0.00857) | (0.00842) |
| Bidding | -0.244*** | -0.182*** | -0.164*** | -0.154*** | -0.260*** | -0.244*** |
| | (0.0677) | (0.0656) | (0.0505) | (0.0494) | (0.0525) | (0.0502) |
| Listing | -0.221*** | -0.223*** | -0.237*** | -0.236*** | -0.292*** | -0.289*** |
| | (0.0534) | (0.0514) | (0.0392) | (0.0376) | (0.0342) | (0.0328) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 14,795 | 14,815 | 22,784 | 22,806 | 30,168 | 30,188 |
| R-squared | 0.886 | 0.885 | 0.871 | 0.869 | 0.853 | 0.850 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 8%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table D2. Commercial Land Discount with Residential Land as Default, discount rate=10%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.0858*** | -0.0860*** | -0.118*** | -0.118*** | -0.130*** | -0.131*** |
| | (0.0107) | (0.0104) | (0.00929) | (0.00909) | (0.00857) | (0.00842) |
| Bidding | -0.243*** | -0.181*** | -0.164*** | -0.154*** | -0.260*** | -0.244*** |
| | (0.0678) | (0.0657) | (0.0505) | (0.0494) | (0.0525) | (0.0502) |
| Listing | -0.221*** | -0.223*** | -0.237*** | -0.235*** | -0.292*** | -0.289*** |
| | (0.0534) | (0.0514) | (0.0392) | (0.0376) | (0.0342) | (0.0328) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 14,795 | 14,815 | 22,784 | 22,806 | 30,168 | 30,188 |
| R-squared | 0.886 | 0.885 | 0.871 | 0.869 | 0.853 | 0.850 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 10%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table D3. Commercial Land Discount with Residential Land as Default, discount rate=12%

| Matching radius | 500 meters | | 1000 meters | | 1500 meters | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Commercial | -0.0955*** | -0.0957*** | -0.127*** | -0.128*** | -0.140*** | -0.141*** |
| | (0.0107) | (0.0104) | (0.00929) | (0.00909) | (0.00857) | (0.00842) |
| Bidding | -0.243*** | -0.181*** | -0.164*** | -0.154*** | -0.259*** | -0.243*** |
| | (0.0678) | (0.0657) | (0.0505) | (0.0494) | (0.0525) | (0.0502) |
| Listing | -0.220*** | -0.222*** | -0.237*** | -0.235*** | -0.292*** | -0.289*** |
| | (0.0534) | (0.0514) | (0.0392) | (0.0376) | (0.0342) | (0.0328) |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N | Y | N |
| Year * City Fixed Effects | N | Y | N | Y | N | Y |
| Observations | 14,795 | 14,815 | 22,784 | 22,806 | 30,168 | 30,188 |
| R-squared | 0.886 | 0.885 | 0.871 | 0.869 | 0.853 | 0.850 |

Note: The results in this table are obtained from estimating Equation 2 with the floor area rental price (log) as the dependent variable. The discount rate is 12%. The coefficients of Bidding and Listing represent the floor area rent difference compared with auction. Radius matching Fixed Effects correspond to the spatial proximity under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table D4 Tax Potential Elasticity of Commercial Land Discount by premium rate across Cities, matching radius=500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax potential) | -0.146*** | -0.157*** | -0.0773*** | -0.0783*** |
| | (0.0288) | (0.0301) | (0.0218) | (0.0227) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 14,815 | 14,795 | 14,725 | 14,705 |
| R-squared | 0.885 | 0.888 | 0.886 | 0.888 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. * p<0.1, ** p<0.05, and *** p<0.01.

Table D5. Tax Potential Elasticity of Commercial Land Discount by premium rate across Cities, matching radius=1000 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax potential) | -0.177*** | -0.185*** | -0.130*** | -0.131*** |
| | (0.0252) | (0.0262) | (0.0186) | (0.0194) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 22,806 | 22,784 | 22,703 | 22,681 |
| R-squared | 0.869 | 0.873 | 0.870 | 0.874 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1000 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table D6. Tax Potential Elasticity of Commercial Land Discount by premium rate across Cities, matching radius=1500 meters

| | Tax：Output value of tertiary industry/ Urban built-up area | | Tax：Business tax/ Urban built-up area | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Commercial * log (Tax potential) | -0.189*** | -0.198*** | -0.164*** | -0.169*** |
| | (0.0231) | (0.0241) | (0.0170) | (0.0177) |
| Land use Fixed Effects | Y | N | Y | N |
| Radius matching Fixed Effects | Y | Y | Y | Y |
| Year Fixed Effects | Y | N | Y | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y |
| Year * City Fixed Effects | N | Y | N | Y |
| Year * Land use Fixed Effects | N | Y | N | Y |
| Observations | 30,188 | 30,168 | 30,069 | 30,049 |
| R-squared | 0.851 | 0.856 | 0.852 | 0.857 |

Note: The results in this table are obtained from estimating Equation 3 with the floor area rental price (log) as the dependent variable. The matching radius is 1500 meters, with any commercial land parcel as the center of the circle. Columns 1 and 2 correspond to the first measure of tax potential of land by city: average output of tertiary industry divided by urban built-up area; columns 3 and 4 correspond to the second measure of tax potential of land by city: average business tax revenue divided by urban built-up area. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table D7. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=8%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potenial | 581.4*** | 344.0*** | 316.8* | -180.3*** | -111.0*** | -103.2** |
| | (129.5) | (103.3) | (171.0) | (29.25) | (32.15) | (51.22) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 150 | 257 | 345 | 150 | 257 | 345 |
| R-squared | 0.977 | 0.918 | 0.804 | 0.982 | 0.923 | 0.807 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 8%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table D8. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=10%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potenial | 733.7*** | 437.5*** | 407.1* | -227.4*** | -141.2*** | -132.4** |
| | (161.8) | (128.6) | (212.8) | (36.50) | (39.84) | (63.63) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 150 | 257 | 345 | 150 | 257 | 345 |
| R-squared | 0.977 | 0.919 | 0.803 | 0.982 | 0.923 | 0.806 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 10%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table D9. Impact of Tax Potential on Commercial Land Discount, Shanghai City, discount rate=12%

| | Tax Potential by Land classification | | | Tax Potential by Tax rate | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * Tax Potenial | 885.2*** | 529.7*** | 495.4* | -274.3*** | -170.9*** | -160.9** |
| | (194.2) | (154.2) | (255.1) | (43.79) | (47.64) | (76.18) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 150 | 257 | 345 | 150 | 257 | 345 |
| R-squared | 0.977 | 0.919 | 0.802 | 0.982 | 0.923 | 0.806 |

Note: The results in this table are obtained from estimating Equation 4 with the floor rental price as the dependent variable. The discount rate is 12%. Columns 1-3 correspond to regression results based on land classification within Shanghai; columns 4-6 correspond to regression results based on urban land use tax rate associated with land classification within Shanghai. In this case, the higher the land classification, the lower the urban land use tax rate. Land transfers in Shanghai are conducted only by listing, but not by auction or bidding; thus, we do not introduce any land transfer method fixed effects in the model. Land use Fixed Effects refer to the effects of two categories of uses: commercial and residential. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table D10. Tax potential Elasticity of Commercial Land Discount, by starting price, across Cites

| | Tax：Output value of tertiary industry/ Urban built-up area | | | Tax：Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * log (Tax Potential) | -0.124*** | -0.147*** | -0.162*** | -0.0709*** | -0.113*** | -0.150*** |
| | (0.0295) | (0.0258) | (0.0237) | (0.0213) | (0.0183) | (0.0168) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 13,898 | 21,578 | 28,687 | 13,808 | 21,475 | 28,568 |
| R-squared | 0.896 | 0.879 | 0.860 | 0.897 | 0.880 | 0.861 |

Note: The results in this table are obtained from estimating Equation 4 with the starting price by floor area (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table D11 Tax Potential Elasticity of Commercial Land Discount, by premium rate, across Cities

| | Tax：Output value of tertiary industry/ Urban built-up area | | | Tax：Business tax/ Urban built-up area | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | 500m | 1000m | 1500m | 500m | 1000m | 1500m |
| Commercial * log (Tax Potential) | -0.003 | -0.025 | -0.034** | 0.001 | -0.020* | -0.024** |
| | (0.018) | (0.016) | (0.015) | (0.012) | (0.011) | (0.010) |
| Land use Fixed Effects | N | N | N | N | N | N |
| Radius matching Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year Fixed Effects | N | N | N | N | N | N |
| Land transfer methods Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * City Fixed Effects | Y | Y | Y | Y | Y | Y |
| Year * Land use Fixed Effects | Y | Y | Y | Y | Y | Y |
| Observations | 13,898 | 21,578 | 28,687 | 13,808 | 21,475 | 28,568 |
| R-squared | 0.652 | 0.641 | 0.613 | 0.652 | 0.641 | 0.613 |

Note: The results in this table are obtained from estimating Equation 4 with the $Multiplier_{premium}$ (log) as the dependent variable. Columns 1-3 correspond to the first measure of tax potential of land: output of tertiary industry divided by urban built-up area. Columns 4-6 correspond to the second measure of tax potential of land: business tax revenue divided by urban built-up area. Radius matching Fixed Effects correspond to the spatial proximity effects under different matching radii. The number of observations varies slightly for different fixed-effects settings because the Reghdfe package automatically drops singletons (Correia, 2015). Robust standard errors in parentheses are clustered at the ring level. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

## Appendix E.

Table E1. Share of Commercial Land by Tax Potential (2SLS)

| | Land use by number of parcels | | Land use by area of parcels | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Tax Potential I | 0.132*** | | 0.0555* | |
| | (0.0258) | | (0.0290) | |
| Tax Potential II | | 0.0962*** | | 0.0405* |
| | | (0.0180) | | (0.0207) |
| IV | Y | Y | Y | Y |
| Year Fixed Effects | Y | Y | Y | Y |
| Observations | 1,196 | 1,183 | 1,196 | 1,183 |
| R-squared | -0.067 | 0.027 | -0.016 | 0.018 |

Note: The results reported in this table are obtained from Equation 5 using the two-stage least squares (2SLS) method with the city's distance to the nearest major port as an instrumental variable. Tax potential I is the logarithm of the output value of tertiary industry/urban built-up area. Tax potential II is the logarithm of the business tax revenue/urban built-up area. The dependent variables in columns 1 and 2 are the share of commercial land, which is the ratio of the number of commercial land sales to the sum of the number of commercial and residential land sales. The dependent variables in columns 3 and 4 are the share of commercial land, which is the ratio of the area of commercial land sales to the sum of the area of commercial and residential land sales. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

Table E2. Share of Commercial Land by Tax Potential (2SLS, first stage)

| | Tax Potential I | | Tax Potential II | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Distance to port | -5.32*** | | -7.46*** | |
| | (0.298) | | (0.448) | |
| Distance to sea shore | | -5.27*** | | -7.62*** |
| | | (0.304) | | (0.463) |
| Year Fixed Effects | Y | Y | Y | Y |
| Observations | 1196 | 1196 | 1,183 | 1,183 |
| R-squared | 0.170 | 0.170 | 0.154 | 0.162 |

Note: The findings presented in this table are the outcomes of the first stage estimation derived from Equation 5. Tax Potential I is the logarithm of the output value of tertiary industry/urban built-up area. Tax Potential II is the logarithm of the business tax revenue/urban built-up area. The dependent variables in columns 1 and 2 are the share of commercial land, which is the ratio of the number of commercial land sales to the sum of the number of commercial and residential land sales. The dependent variables in columns 3 and 4 are the share of commercial land, which is the ratio of the area of commercial land sales to the sum of the area of commercial and residential land sales. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

Table E3. Share of Commercial Land by Tax Potential (OLS)

| | Land use by number of parcels | | Land use by area of parcels | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Tax Potential I | 0.0326 | | 0.00599 | |
| | (0.0218) | | (0.0222) | |
| Tax Potential II | | 0.0564*** | | 0.0357** |
| | | (0.0133) | | (0.0156) |
| Year Fixed Effects | Y | Y | Y | Y |
| Observations | 1,196 | 1,183 | 1,196 | 1,183 |
| R-squared | 0.073 | 0.115 | 0.089 | 0.104 |

Note: The results in this table are obtained from estimating Equation 5. Tax Potential I is the logarithm of the output value of tertiary industry/urban built-up area. Tax Potential II is the logarithm of the business tax revenue/urban built-up area. The dependent variables in columns 1 and 2 are the share of commercial land, which is the ratio of the number of commercial land sales to the sum of the number of commercial and residential land sales. The dependent variable in columns 3 and 4 is the logarithm of the absolute number of residential land sales; the dependent variable in columns 5 and 6 is the logarithm of the absolute number of commercial land sales. Robust standard errors in parentheses are clustered at the city level. $*$ $p<0.1$, $**$ $p<0.05$, and $***$ $p<0.01$.

**Appendix J**

*We want to prove that*

$$\frac{\partial L_c^*}{\partial \gamma} > 0, \frac{\partial L_c^*}{\partial \tau} < 0$$

$$\frac{\partial \frac{P_c^*}{P_r^*}}{\partial \gamma} = \frac{\partial L_c^*}{\partial \gamma} \frac{\partial \frac{P_c^*}{P_r^*}}{\partial L_c^*} < 0$$

*Which is equal to prove*

$$\frac{\partial \frac{P_c^*}{P_r^*}}{\partial L_c^*} = \frac{P_r^* \frac{\partial P_c^*}{\partial L_c^*} - P_c^* \frac{\partial P_r^*}{\partial L_c^*}}{{P_r^*}^2} < 0$$

*As we know that*

$$P_r^* > 0, P_c^* > 0.$$

*Based on our inverse demand function assumption, for every* $L_c$

$$\frac{\partial P_c}{\partial L_c} < 0, \frac{\partial P_r}{\partial L_c} > 0$$

*If* $\frac{\partial L_c^*}{\partial \gamma} > 0$*, then* $\frac{\partial \frac{P_c^*}{P_r^*}}{\partial \gamma} < 0$*. Therefore, all we need to prove is that* $\boldsymbol{\frac{\partial L_c^*}{\partial \gamma} > 0}$ ***and*** $\boldsymbol{\frac{\partial L_c^*}{\partial \tau} < 0}$**.**

***Prove:***

*Target function*

$$Max_{\{L_c\}} R_c + R_r + T_c = (1-\tau)(L_c P_c + (1-L_c)P_r) + L_c \gamma T(L_c)$$

*F.O.C*

$$(1-\tau)\left(P_c + L_c \frac{\partial P_c}{\partial L_c} - P_r + (1-L_c)\frac{\partial P_r}{\partial L_c}\right) + \gamma\left(T + L_c \frac{\partial T}{\partial L_c}\right) = 0$$

$$(1-\tau)\left(P_c + L_c \frac{\partial P_c}{\partial L_c}\right) + \gamma\left(T + L_c \frac{\partial T}{\partial L_c}\right) = (1-\tau)\left[P_r - (1-L_c)\frac{\partial P_r}{\partial L_c}\right]$$

*S.O.C*

$$(1-\tau)\left(2P_c' + L_c P_c'' - 2P_r' + (1-L_c)P_r''\right) + \gamma(2T'(L_c) + L_c T''(L_c)) > 0$$

*According to the assumption*

$$\frac{\partial P_c}{\partial L_c} < 0, \frac{\partial P_r}{\partial L_c} > 0, \frac{\partial T}{\partial L_c} < 0$$

*We could calculate the total differential result based on F.O.C*

$$-[P_c + L_c \frac{\partial P_c}{\partial L_c} - P_r + (1 - L_c) \frac{\partial P_r}{\partial L_c}] d\tau + [(T + L_c \frac{\partial T}{\partial L_c})] d\gamma + [(1 - \tau)\,(2 \frac{\partial P_c}{\partial L_c} + L_c \frac{\partial^2 P_c}{\partial L_c \partial L_c} -$$
$$2 \frac{\partial P_r}{\partial L_c} + (1 - L_c) \frac{\partial^2 P_r}{\partial L_c \partial L_c}) + \gamma (2 \frac{\partial T}{\partial L_c} + L_c \frac{\partial^2 T}{\partial L_c \partial L_c})] dL_c = 0$$

*Then we could know that*

$$\frac{dL_c}{d\gamma} = \frac{-T\left(1 + \frac{L_c}{T} \frac{\partial T}{\partial L_c}\right)}{(1 - \tau)\,(2 \frac{\partial P_c}{\partial L_c} + L_c \frac{\partial^2 P_c}{\partial L_c \partial L_c} - 2 \frac{\partial P_r}{\partial L_c} + (1 - L_c) \frac{\partial^2 P_r}{\partial L_c \partial L_c}) + \gamma (2 \frac{\partial T}{\partial L_c} + L_c \frac{\partial^2 T}{\partial L_c \partial L_c})}$$

$$\frac{dL_c}{d\tau} = \frac{P_c + L_c \frac{\partial P_c}{\partial L_c} - P_r + (1 - L_c) \frac{\partial P_r}{\partial L_c}}{(1 - \tau)\,(2 \frac{\partial P_c}{\partial L_c} + L_c \frac{\partial^2 P_c}{\partial L_c \partial L_c} - 2 \frac{\partial P_r}{\partial L_c} + (1 - L_c) \frac{\partial^2 P_r}{\partial L_c \partial L_c}) + \gamma (2 \frac{\partial T}{\partial L_c} + L_c \frac{\partial^2 T}{\partial L_c \partial L_c})}$$

*S.O.C granted that denominator is lesser than 0.*

*By using the F.O.C, we could know that*

$$(P_c + L_c \frac{\partial P_c}{\partial L_c} - P_r + (1 - L_c) \frac{\partial P_r}{\partial L_c}) = -\frac{\gamma}{1 - \tau} (T + L_c \frac{\partial T}{\partial L_c})$$

$P_c < P_r$ *and* $(P_c + L_c \frac{\partial P_c}{\partial L_c} - P_r + (1 - L_c) \frac{\partial P_r}{\partial L_c}) < 0$. *Accordingly,*

$$\left(T + L_c \frac{\partial T}{\partial L_c}\right) > 0$$

*Therefore, the conclusion is that*

$$\frac{dL_c}{d\gamma} > 0, \frac{dL_c}{d\tau} < 0$$

*Q.E.D*

## Appendix F

**Descriptive Statistics of City-Level Variables for Moment Estimation**

| | Mean | SD | Min | Max | Observation |
|---|---|---|---|---|---|
| **Panel A：tax potential by city** | | | | | |
| Tax potential | 23.87 | 14.59 | 4.23 | 83.33 | 98 |
| Top 50% Tax potential | 34.80 | 12.82 | 21.32 | 83.33 | 49 |
| **Panel B：land use by city** | | | | | |
| Share of Commercial land | 0.257 | 0.095 | 0.116 | 0.742 | 1218 |
| Share of Commercial land in Top 50% city by Tax potential | 0.265 | 0.169 | 0 | 1 | 604 |
| **Panel C：land rent extraction by city** | | | | | |
| Extraction rate | 0.041 | 0.018 | 0.02 | 0.08 | **1192** |

Note: Tax potential in this table is calculated by the average business tax revenue divided by urban built-up area.

***moment condition 1：average tax potential of commercial land on land use structure***

$$\frac{dL_c}{d\log\gamma} = \frac{dL_c}{d\gamma}\gamma$$

$$= \frac{-(\beta_3 + (\alpha 3 + 1){L_c}^{\alpha 3})\gamma}{(1-\tau)\left[\alpha 1(\alpha 1+1){L_c}^{\alpha 1-1} + \alpha 2(\alpha 2+1)(1-L)^{\alpha 2-1}\right] + \gamma\alpha 3(\alpha 3+1){L_c}^{\alpha 3-1}} = 0.05$$

The parameter values are: γ=6, Lc=0.257, and τ=0.04. The value of γ depends on the measurement of tax potential for each city in the empirical analysis, with a minimum value of 4.2 that has been standardized to be equal to 1. Its mean value is 23.87, hence the average value of γ is 5.6 in this sense. Lc and τ are both mean values of their respective variables listed in Table III.

***moment condition 2：average land rental price differential***

$$\frac{P_c(Lc)}{P_r(Lc)} = \frac{\beta_1 + {L_c}^{\alpha 1}}{\beta_2 + (1-L_c)^{\alpha 2}} = 0.9$$

The parameter value： $\mathrm{Lc} = 0.257$

***moment condition 3：***

We know： $\frac{\partial \mathrm{Lc}}{\partial \log\gamma} = 0.05$， $\frac{\partial \log\left(\frac{\mathrm{Pc}}{Pr}\right)}{\partial \log\gamma} = \frac{\partial \mathrm{Lc}}{\partial \log\gamma}\frac{\partial \log\frac{\mathrm{Pc}}{Pr}}{\partial \mathrm{Lc}} = -0.2$

$$\text{then} \quad \frac{\partial log\frac{Pc}{Pr}}{\partial Lc} = -4$$

$$\frac{\partial log\frac{Pc}{Pr}}{\partial Lc} = \frac{\partial\frac{Pc}{Pr}}{\partial Lc} * \frac{Pr}{Pc} = \frac{a1L_c^{a1-1}(\beta_2 + (1-L_c)^{\alpha 2}) + a2(1-L_c)^{\alpha 2-1}(\beta_1 + L_c{}^{\alpha 1})}{(\beta_2 + (1-L_c)^{\alpha 2})^2} * \frac{Pr}{Pc} = -4$$

The parameter values are: $\boldsymbol{Pr/Pc}$ = 1/0.9 and Lc = 0.257.

***moment condition 4：land sales revenue extraction by upper governments on land use structure***

$$\frac{\partial Lc}{\partial \tau} = \frac{(\beta_1 + (\alpha 1+1)L_c{}^{\alpha 1}) - (\beta_2 + (\alpha 2+1)(1-L_c)^{\alpha 2})}{(1-\tau)[\alpha 1(\alpha 1+1)L_c{}^{\alpha 1-1} + \alpha 2(\alpha 2+1)(1-L_c)^{\alpha 2-1}] + \gamma\alpha 3(\alpha 3+1)L_c{}^{\alpha 3-1}} = 2$$

The parameter values are: γ=8.3, Lc=0.265, and τ=0.04. Since the sample used here consists of cities of the top 50% in tax potential. the average tax potential is 34.80, hence γ=8.3. Meanwhile, this sub-sample has a higher average proportion of commercial land use, which is 0.265.

***moment condition 5:*** F.O.C for average tax potential of commercial land

$$(1-\tau)(\beta_1 + (\alpha 1+1)L_c{}^{\alpha 1}) + \gamma(\beta_3 + (\alpha 3+1)L_c{}^{\alpha 3}) = (1-\tau)(\beta_2 + (\alpha 2+1)(1-L_c)^{\alpha 2})$$

The parameter values are: $\gamma = 5.6$，$Lc = 0.257$，$\tau = 0.04$

***moment condition 6：*** F.O.C for least tax potential of commercial land

$$(1-\tau)(\beta_1 + (\alpha 1+1)L_c{}^{\alpha 1}) + \gamma(\beta_3 + (\alpha 3+1)L_c{}^{\alpha 3}) = (1-\tau)(\beta_2 + (\alpha 2+1)(1-L_c)^{\alpha 2})$$

The parameter values are: $\gamma = 1$，$Lc = 0.11$，$\tau = 0.04$。