Fiscal Motives and Urban Land Allocation: Evidence from China*

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This version November 2024, for presentation at

National Tax Association Conference

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Acknowledgments

Earlier versions of this paper were presented at the China Urban Economics Scholars Forum (2021), Workshop on Spatial Political Economy at Sun Yat-Sen University (2021), Summer Forum of the China Economics Annual Conference (2021), Frontiers of Public Finance Workshop at Xiamen University (2022), Finance and Taxation Forum at Central University of Finance and Economics (2022), Applied Micro Workshop at Shandong University (2022), 2023 AREUEA National Conference (Washington D.C.), the 10th International Workshop on Regional, Urban, and Spatial Economics in China at Peking University (2023) ,and 79th Annual Congress of the International Institute of Public Finance at USU, Logan, USA. We are grateful for the insightful feedback and suggestions from the discussants and participants. Tang and Hou acknowledge the financial support from the National Natural Science Foundation of China (#71973080) and the Lincoln Institute of Land Policy, respectively.

Abstract

This study examines the fiscal motives behind the allocation of land in Chinese cities by municipal governments for commercial and residential use. We focus on the effects of business taxation and land value-based charges on the allocation of land for the two uses. With the universe of land transfer data, we spatially match commercial parcels with residential parcels and uncover significant price discounts for commercial parcels due to their expected tax flows. A stylized structural estimation reveals that while prospective taxes encourage commercial land supply, market price responses and corresponding land value-based charges notably counteract this effect. These results highlight a self-regulatory mechanism in the land market, balancing the fiscal influences of business taxation and land value-based charges.

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

JEL codes： O18, P48, R12, R31, R38

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 theories of fiscal incentives (Weingast 2009) and fiscal federalism (Oates 1972, 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 generates a significant and sustained stream of future taxes while residential land contributes little direct tax revenue, local governments allocate more land for commercial use under the tax maximization motives ("tax incentives" hereafter), aligning with the traditional fiscal theory on land use allocation. This bias towards commercial land 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 discriminatory tax policies favoring commercial land.

There is a substantial empirical 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 cases, revenue sources based on land value play a minor role in local public finance. However, a fast-growing

[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.

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 (LURs) generates significant revenue in the form of land rent or land transfer revenue, which often surpasses general taxation in amount and as a share of total revenue (more so in some years and regions).

Given local governments' concern with both taxes and land transfer revenues, this study considers two fiscal incentives: taxes and land rent. The tax incentive drives local governments to allocate more land with higher tax potential, while the land rent incentive prompts localities to allocate more land with higher rent potential. An increase in the tax potential will lead to more commercial land development. And as more land is supplied for commercial use, the relative rental price of commercial land will fall that results in a weaker rent incentive for commercial land development, which counters 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 the two uses. In equilibrium, whether a locality transfers a land parcel for use A or use B should make no difference to total local 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 nearby 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 cannot identify whether the rental price discounts of commercial land are attributable to differences in the tax potential between the two types of land development.

[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.

Then we exploit the variation in tax potential of commercial land across cities to test the effect of tax potential of land on transfer prices. Our findings show that commercial land is generally transferred at lower prices when compared to adjacent residential land in cities with higher tax potential. To further refine our measurement of the tax potential of land parcels, we use firm-level tax indicators from the *Annual Business Tax Survey of China* as proxies for the tax potential of commercial land within each neighborhood of the city. Our analysis confirms the inverse relationship between the tax potential of commercial land and its rental price relative to adjacent residential land. Furthermore, our investigation reveals that the rent-tax connection is established through two separate stages: First, a local government sets the starting price of a land parcel; then, developers bid for the parcel. The government plays a dominant role in the process.

Finally, we focus on the impact of tax and rent incentives on land allocation, more specifically, on the ratio between local land transfers for commercial versus residential use. We will explore by taking 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 potential tend to transfer more commercial land. However, this result reveals only the net effect of the tax incentive, which includes the reverse corrective effect of the land rent incentive. Put simply, cities where commercial land holds a higher tax potential see 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 the local land-use structure.

Step 2: We develop a model to reveal the aforementioned mechanism, wherein local governments seek to maximize fiscal revenues through both taxes and land rents. By employing structural estimation with the simulated method of moments, we identify key parameters that govern localities' land allocation decisions between residential and commercial uses.

Step 3: With the theoretical model and the identified parameters, 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 changed. We observe that as the local share of land rental income falls, the proportion of land allocated for commercial use rises. This increase is substantial when compared to the average proportion (26%) of commercial land observed across cities.

This study contributes to the literature in three 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 percent 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 properties from localities 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 where the property tax is the primary revenue source of municipal governments and the allowed rate for commercial properties 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 China's land and fiscal systems, 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. Municipalities could retain the lion's share of land transfer revenues, which provides significant extra fiscal incentives in addition to related tax incentives for local 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

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

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 apparatus to rectify distortions from taxation and other public intervention. Therefore, the findings of this study are of general interest and applicable beyond China.

Second, several research streams have explored the factors influencing land price discounts in China, including intergovernmental competition, demand elasticity, and political corruption. One research stream proposes that industrial land price discounts, compared to commercial or residential land, primarily arise from intergovernmental competition strategies aimed at attracting capital (Zhang et al., 2011; Zhao & Cao, 2017; Lu & Wang, 2020). Complementary literature explores land price discrimination by land use through the lens of demand elasticity (Bhatt et al., 2023; Liao et al., 2024). Other studies have also explored land price discounts from the perspective of political corruption. Cai et al. (2013) conducted an investigation into various land transfer methods and their vulnerability to unethical practices. Chen and Kung (2019) empirically demonstrated that politically connected firms secure land at significantly reduced prices using a spatially matched methodology. Furthermore, Chen et al. (2023) uncovered a sophisticated "revolving door" mechanism, which reveals how local officials are subsequently rewarded with board appointments after facilitating discounted land transactions.[4]

[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.

We focus on the price differentials between commercial and residential land that stem from the differences in tax potential across land uses, the fundamental fiscal motives of local governments in land use allocation. 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 flows. They find that industrial land sales in China are not subsidized relative to residential land sales once future taxes are included in the calculation. This study exploits the spatial proximity of land parcels to detect the price difference between commercial and residential land with the spatial matching method. We find evidence that the difference in tax potential between commercial and residential land contributes to their price difference.

Third, the findings of this 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, which 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 valid 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 the evolution of China's land transfer and tax systems that are related to land development. Section 3 describes the data and empirical strategies. We report the empirical results for rent-tax linkage in Section 4, followed by a structural estimation and counterfactual analysis of the fiscal incentive effects on local land use structure in Section 5. Section 6 concludes the paper.

2. Institutional Background

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 (1982 Constitution). 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 were launched in the early 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, Shenzhen municipality, with support of the central government, adopted a local ordinance[7] to separate

[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] It was the "Shenzhen Special Economic Zone Land Management System Reform Program."

land ownership from land-use rights (LURs), 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 rights made heads way. In 1988, the country's *Land Management Law* was amended to allow transfer of land use right.[8] Article 10 of the 1999 Constitution clearly stated that the right to use land may be transferred. Before year 2000, land-use-right transfers were almost all 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 parcels; case-by-case negotiations often bred corruption.[9] To activate the fundamental role of the land market 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 rights be made through bidding, auction, or listing.

Since year 2000, land transfers have been mainly through the land market nationwide.[10] With the introduction of a series of legislation and administrative rules, China's primary market for transferring the use right of state-owned land was established. In addition, land-use rights

[8] "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."

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

[10] 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."

must be registered and publicized in the official *Land Register*.[11] Consequently, information related to land transfer has become increasingly accessible and transparent.

2.2 Taxes Related to Land Development

The taxes involving land and real estate development are complex. Table 1 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 located on commercial land pay taxes through their business 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 can stay clear of tax enforcement because the cost of tax collection is too high in these petty activities. 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 12 percent of the rent or 1.2 percent of the total price based on the residual property value after deducting 10 to 30 percent of the original value.[12] In contrast, residential property holders are exempt from property

[11] 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.

[12] 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.

taxes.[13] Besides, holders of commercial property must pay an "urban land use tax," with its rate dependent on the classification of the land the property sits on; whereas residential properties are free from this tax.[14]

Table 1: **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.

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.

[13] 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".

[14] 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.

2.3 Background to 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 former, 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 latter, 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 their city by allocating land use to maximize the city's value, while also pursuing economic growth, fiscal revenues, and sustainable urban development.

3. Framework, Data, and Empirical Strategies

3.1 Conceptual Framework

We use a toy model to illustrate our conceptual framework. Assume a municipality supplies new land, $\bar{L}$, between commercial and residential developments, 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 $P_c(L_c)$ is an inverse demand function, thereby $P'_c(\cdot) < 0$; 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 also 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:

$$Max_{\{L_c, L_r\}} (R_c + R_r) + T_c = (L_c P_c + L_r P_r) + L_c T, \qquad \text{s.t. } L_c + L_r = \bar{L}.$$

Solving the maximization problem derives:

$$\frac{\partial R_c}{\partial L_c} + \frac{\partial T_c}{\partial L_c} = \frac{\partial R_r}{\partial L_r};$$

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 two propositions:

Proposition 1: *The higher the tax potential of commercial land 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:

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

Proposition 2: *The higher the tax potential of commercial land 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 larger the differential in rent between the two uses, as:

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

By these propositions, higher future tax potential of commercial land use induces 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 as well as an indirect effect on land allocation. The direct effect is higher potential of future taxes 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- use-biased land supply.

3.2 Data

We use three nationwide datasets – parcel-level land transfers, city-level tax potential of commercial parcels for 99 cities from 2007 to 2019,[15] and radius-level tax potential of commercial parcels derived from firm-level tax indicators from the *Annual Business Tax Survey of China*. The parcel-level land transfer data, from the *China Index Academy*, contain

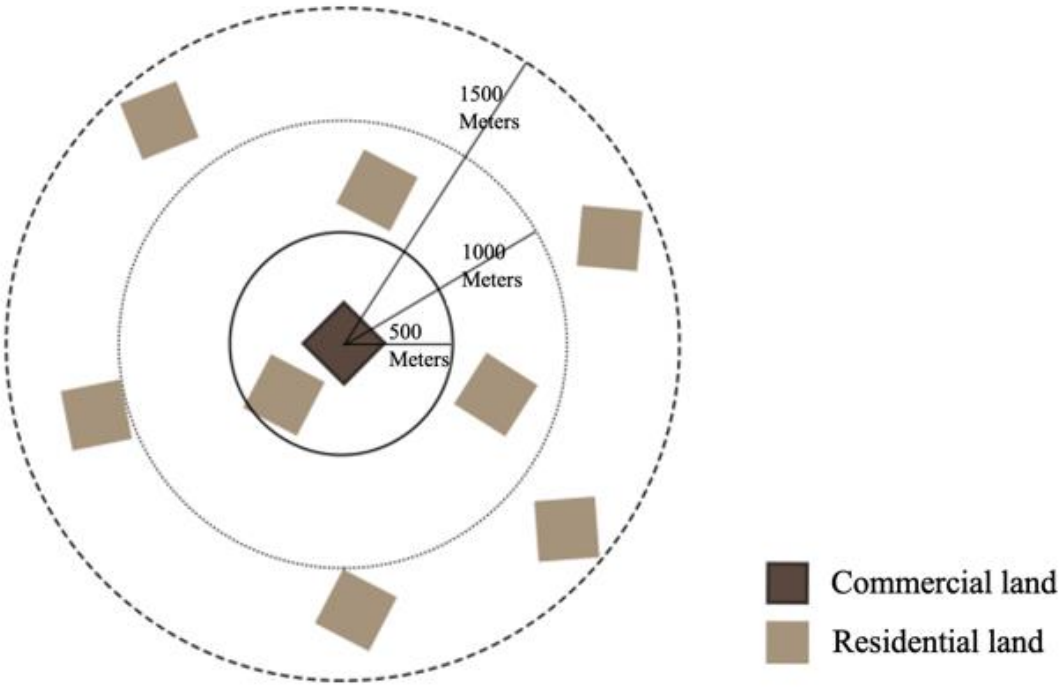
[15] The Land Registration Measures promulgated by the Ministry of Land and Resources (2007) require every land transfer to be registered according to the law. Therefore, rich data on land transactions are available after 2007, which is the main reason why we set the time window of our sample to 2007-2019.

detailed records of all commercial and residential land transfers, with variables including 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 purpose of use among others. To avoid the distortion by extreme values on the estimation results, we removed parcels with floor area ratios of less than 1 or greater than 20.[16]

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 1 illustrates, each commercial parcel is matched with its surrounding residential parcels by radii of 500, 1000, and 1500 meters, respectively. Close to 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 in a cohort that are not located in the same city. The final cleaned data set has 39,238 commercial and 84,946 residential land-transfer records.

[16] 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 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.

Figure 1: **Spatial Matching Method**



Note: Figure 1 illustrates the method of spatial matching which takes each commercial parcel as the center and matches it to residential parcels within three radii.

The tax potential of commercial land compared to residential land is a vital variable in this study. Table 2 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. The table shows significant disparity in tax treatment between commercial and residential land, particularly during the operation and property-holding period following land development. Therefore, we reasonably assume, based on China's current tax laws, that local governments expect to collect future taxes solely through commercial land development. 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 2: **Descriptive Statistics of Land Parcels**

Panel A	Commercial Parcel			Residential Parcel		
	Mean	SD	Obs	Mean	SD	Obs
Transaction price (floor area) (CNY per m^2)	1,851	3,256	38,319	1,869	3,104	84,695
Land parcel area (in m^2)	27,589	44,090	38,309	43,397	47,447	84,677
Floor area ratio	2.62	1.74	38,319	2.55	1.30	84,695
Starting price (floor area) (CNY per m^2)	1,531	2,464	36,550	1,586	2,341	79,723
Premium rate (%)	12.36	45.93	36,550	14.05	39.79	79,723
Panel B	Commercial Parcel			Residential Parcel		
Transfer by auction (%)	16.09			21.71		
Transfer by bidding (%)	1.71			0.02		
Transfer by listing (%)	82.20			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.

We construct two city-level indicators of tax potential. The first is the average ratio of tertiary industry output to the city's built-up area for each year from 2007–2019 to measure the tax potential of commercial land in each city. The second is the average ratio of local business tax to the built-up area for each year from 2007 to 2015 as a proxy for tax potential.[17] Additionally, we average these ratios over the sample period in each city to measure tax potential, regardless of its temporal variability. This choice is motivated by the belief that the average of the ratios can more precisely represent the tax potential of commercial land use in a city, free of noise from macroeconomic fluctuations and that in allocating land between the two uses, municipal governments prioritize long-term benefits over short-term variations when they develop a land parcel. Data on tertiary industry output are from the *China Research Data*

[17] Full implementation in 2016 of the business-to-VAT reform in China led to drastic decline in the amount of business tax. The change of business tax to VAT made the indicator of business tax no longer a good proxy for the tax revenue generated by land. Therefore, we only use business tax data up to 2015.

Service Platform (CNRDS) and business taxes data are from the *Annual Statistical Yearbook* of each city. The built-up area of each city is from the *China Urban Construction Statistical Yearbook*. Panel A in Table 3 shows descriptive statistics of city-level tax potential indicators of commercial land, and the variables used to construct them.

To measure the tax potential more precisely within city, we leverage Annual Tax Survey data from 2007 to 2016, constructing tax potential indicators for commercial land use within discrete spatial boundaries in each city. Specifically, we extract actual tax payments from companies' cash flow statements and normalize these values using the respective city's Consumer Price Index (CPI) to account for inflation. Focusing on individual commercial parcels as centroids, we identify surrounding observation points within a 500-meter radius. The inflation-adjusted tax payment data is then aggregated and averaged across observation points within this defined radius, yielding a localized tax potential indicator. Subsequently, with a specific commercial land parcel as the centroid, we identify observation points within a 500-meter radius. We then aggregate the inflation-adjusted actual tax payment data and divide the total by the number of observation points within the 500-meter radius, yielding the average tax potential indicator for businesses within that defined area. To address possible tax refunds from authorities, we perform robustness checks based on companies' net tax outlays. Summary statistics for these radius-level indicators are detailed in Panel B, Table 3.

Table 3: **Tax potential indicators**

	Mean	SD	Min	Max	Obs
Panel A: City-level					
Tertiary industry output (million CNY)	161,028	222,599	4,954	2,196,117	1,181
Business tax (million CNY)	7,405	12,878	136	97,348	786
Urban built-up area (km2)	254	261	20	1,515	1284
Tertiary industry output / urban built-up area	607.14	300.50	136.34	2,068.20	1,176
Business tax / urban built-up area	27.01	17.73	2.93	124.99	783
Tax potential I: Ave(tertiary industry output / urban built-up area)	605.18	257.07	241.27	1408.29	99
Tax potential II: Ave(business tax / urban built-up area)	23.73	14.59	4.23	83.33	99
Panel B: Radius-level					
Tax potential III: (average of all taxes and fees paid)	6.65	2.33	-8.06	15.50	17351
Tax potential IV: average of net taxes and fees paid [Paid – Tax Returns])	6.42	2.37	-8.06	15.61	15524

Notes: The business tax was replaced by VAT in 2016, so the indicator of business tax revenue is only for 2007-2015. Nominal variables, which are valued in current monetary terms, are adjusted for inflation on a city-by-city basis using their respective Consumer Price Index (CPI). For cities with missing CPI data, the CPI of the province where the city is located is used.

Table 4 shows 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.

Table 4: **Descriptive Statistics of City-Level Variables**

	Mean	SD	Min	Max	Obs
# Commercial land transfers	45.76	49.63	0	427	1287
# Residential land transfers	83.66	81.37	0	551	1287
Land use structure I: # Parcels (Commercial/Total)	0.34	0.16	0	1	1218
Area of commercial land transfers (km^2)	1.16	1.33	0	12.33	1287
Area of residential land transfers (km^2)	3.35	3.53	0	33.32	1287
Land use structure II: Area (Commercial/Total)	0.26	0.17	0	1	1218

Notes： Total number (area) of land transfers = number (area) of commercial land transfer + number (area) of residential land transfer. Due to zero land sales in specific years for certain cities, the effective sample size for analyzing land use structure is reduced by 69 observations, from a potential 1287 to 1218.

By China's current laws, commercial and residential land use rights can be 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 *SP* is the sale price per square meter, P is the annual rent (per square meter) of land area, and *r* is the discount rate (chosen as 8%, 10%, and 12% [18]), $PVIFA(r,n)$ 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.

3.3 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 square meter) by floor area of parcel i in city *c* and year *t*. $Commerical_i$ is the key explanatory variable, which takes the value of 1 when a parcel is for commercial purposes and 0 for residential purposes, and β_1 denotes the difference between the annual rents of commercial and residential land. λ_t is year fixed effect; δ_{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 control the effect of land transfer

[18] 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%.

methods on the results (Cai et al., 2013), we include a vector, ρ_i, of binaries for bidding, auction, or listing as control variables.

However, even if β_1 is significantly negative, we cannot attribute it solely to the tax differences associated with land development for two different 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 is the magnitude of tax potential of a city's average commercial property or the tax potential derived from firm-level tax indicators within a ring-like neighborhood.[19] The other variables are the same as in Equation 2. The economic implication of β_1 is that for a 1%

[19] Since commercial land development generates significantly more tax revenue than residential land, we can reasonably assume that residential land development does not directly contribute to tax revenue although the tax contribution of the two types of land use can be hardly separated clearly.

increase in tax potential, the rent of commercial parcels decreases by β_1% relative to adjacent residential parcels.

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 to account for land-use variation across cities – the number of commercial versus residential parcels transferred). The model is Equation 4:

$$Composiiton_{ct} = \beta_0 + \beta_1 \log(tax_c) + \lambda_t + \epsilon_{ct} \quad (4)$$

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 of each city, as defined in Equation 3; λ_t is time-fixed effect; and ϵ_{ct} is the residual term. The coefficient of interest, β_1, indicates that for a 1% increase in tax potential, $Composition_{ct}$ rises by β_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. These 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 conduct a simulated method of moments (SMM) estimation to recover the true parameters of a structural model that demonstrates the theoretical mechanism governing the influence of the rent-tax relationship on land use composition.

Step 3: To evaluate the impact of rent incentives on land use allocation, we compare the actual share of commercial land with counterfactual results under various degrees of rent incentives for local governments. The analysis allows us to assess the response of the land market to changes in tax potential and the effectiveness of rent incentives in rectifying the allocation of land use.

4. Empirical Results on Rent-Tax Linkage

4.1. Rent Differential between Commercial and Residential Parcels

Table 5 shows the results of 500-, 1000-, and 1500-meter radiuses matching, estimated from Equation (2). To remove the confounding effects of different lease terms for commercial and residential land, we compare the annualized rent instead of transfer price, as discussed earlier. To annualize the land rent, we use 8% as discount rate.[20] 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%. Translated into Chinese yuan (CNY), the unit rental price of commercial land would be 200-300 CNY lower than that of residential land. Regarding the effect of land transfer methods on

[20] We have also used 10% and 12% discount rates as robustness tests, with results reported in Tables A1 and A2 of the Appendixes.

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.

Table 5: **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.

4.2. Rent-Tax Linkage: Tax Potential Measured by City-Level Data

Next, we use the variation in the tax potential of commercial land across cities to identify the rent-tax linkage. Table 6 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.[21]

Table 6: **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 Method 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.

[21] One caveat about our identification is the possible dual causality. As an example, a municipality may opt to allocate more land for commercial use when the local tax potential is high and commercial land rent is low, which helps attract more business investment but may suppress the running average tax potential. For this reason, our identification may under-estimate the exogenous tax potential. We will address this endogeneity in a subsequent section on structural estimation.

4.3. Rent-Tax Linkage: Tax Potential Measured by Firm-level Indicators

Notwithstanding the analysis in the previous section, measures of tax potential derived from city-level data are embedded with confounding factors that cannot be cleanly solved with aggregate data, because the output volume of the third industry and the volume of aggregate business tax are both proxies to tax potential, with marked measurement errors. In this section, we apply a more direct measure constructed with data from an annual survey of nationwide business taxpayers. The data of annual taxes paid at the firm level enables us to align tightly each business taxpayer with each commercial land parcel, thereby we can minimize any confounding effects with more strict fixed effects.

The regression is the same as in the previous section except that the variables are the new measure of tax potential. Results, shown in Table 7, are consistent with city-level measures in sign and statistical significance but much smaller in magnitude, about one-tenth of those from aggregates data.

Table 7: **Tax Potential Elasticity of Commercial Land Discount across Circle**

	Taxes & Fees Paid		Net Taxes Paid	
	(1)	(2)	(3)	(4)
Commercial * log (Tax Potential)	-0.0221***	-0.0263***	-0.0248***	-0.0278***
	(0.00370)	(0.00365)	(0.00378)	(0.00377)
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 method fixed effects	Y	Y	Y	Y
Year * City fixed effects	N	Y	N	Y
Year * Land use fixed effects	N	Y	N	Y
Observations	64,820	64,762	57,957	57,897
R-squared	0.734	0.778	0.729	0.772

Notes: 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 Tax potential III; columns 3 and 4 correspond to Tax potential IV. 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.

4.4 Rent-Tax Linkage: Starting Rent vs. Rent Premium

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

Table 8 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. The results suggest that the higher the tax potential, the larger the starting price differential.

Column 2 reports the differences in the premium between commercial and residential land uses. 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. 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.

Table 8: **Tax Potential Elasticity of Commercial Land Discount by Starting Price/ Premium Rate**

Regression	Starting price	Premium rate
	(1)	(2)
Commercial land rent discount	-0.0803*** (0.00592)	-0.0413*** (0.00373)
Land rent discount by tax potential (I or II?) at city level	-0.176*** (0.0108)	-0.0457*** (0.00703)
Land rent discount by tax potential at radius level	-0.0257*** (0.00364)	-0.00733*** (0.00208)

Notes: The results in this table are obtained from estimating Equation 4 with the starting price(Column 1) and the premium rate(Column 2) as the dependent variables. The matching radius is 500 meters, with any commercial land parcel as the center of the circle. The discount rate is 8%. For the first-line regressions, fixed effects for the radius, the land transfer method, and city-by-year are incorporated. In the second and third-line regressions, we include radius fixed effects, city by year fixed effects, year by land use fixed effects, and land transfer method fixed effects.

4.5 Robust 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 Table 11) 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 Table 12) 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.

Table 11: **Coefficients in different matching radiuses**

Regression	500m	1000m	1500m
Commercial land rent discount	-0.107*** (0.00611)	-0.139*** (0.00509)	-0.154*** (0.00476)
Land rent discount by tax potential at city level	-0.199*** (0.0113)	-0.207*** (0.00944)	-0.204*** (0.00876)
Land rent discount by tax potential at radius level	-0.0278*** (0.00377)	-0.0297*** (0.00330)	-0.0317*** (0.00315)

Note: Price differentials are estimated with controls of fixed effects of radius, year-city, and method of transfer. Elasticity is estimated with fixed effects of radius, year-city, year-land use, and method of transfer.

Table 12: **Robustness and placebo tests**

Regression	Benchmark	Robust	Placebo
Commercial land rent discount	-0.107*** (0.00611)	-0.0753*** (0.00504)	0.00133 (0.00372)
Land rent discount by tax potential at city level	-0.199*** (0.0113)	-0.172*** (0.00942)	-4.82e-05 (0.00668)
Land rent discount by tax potential at radius level	-0.0278*** (0.00377)	-0.0186*** (0.00301)	0.000717 (0.00264)

Note: Price differentials are estimated with controls of fixed effects of radius, year-city, and method of transfer. Elasticity is estimated with fixed effects of radius, year-city, year-land use, and method of transfer.

Another possible source of the rental price differential is the positive spillover from commercial development to housing construction that pushes up the price of residential land. If the price differential is solely from this spillover and the future tax stream does not contribute to the differential, then the above tests should not have captured any rental price elasticity from measures of tax potential by the above methods. Our approach is to estimate the price elasticity in three steps while controlling for the spillover effect. First, we use the

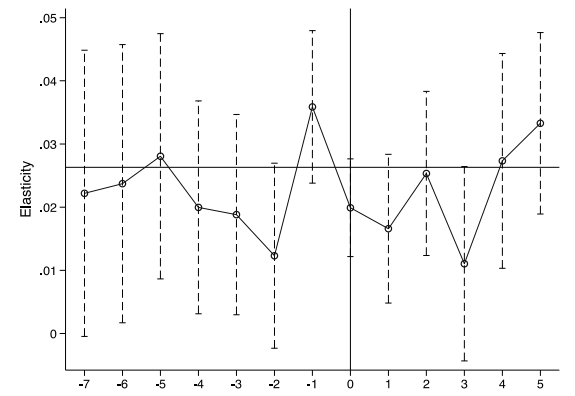
matched distance circles of commercial and residential parcels and take a major commercial complex in each 500-meter circle as a shock to examine the impact of such shocks on our main results obtained above. It is common sense that there exists rarely more than one major commercial complex within 500 meters; recall from our summary statistics (Table 1) that the mean size of commercial land parcels is 27,589 square meters, larger than 500x500.

$$log(P_{ict}) = \sum_{i=-7}^{5} \beta_i \, Gap_i * Residential_i \times \log(tax_r) + \sum_{j=-7}^{5} \beta_j \, Gap_i * Residential_i + \beta_c Commerical_i + \lambda_t + \delta_{ic} + \rho_i + \varepsilon_{ict} \quad (6)$$

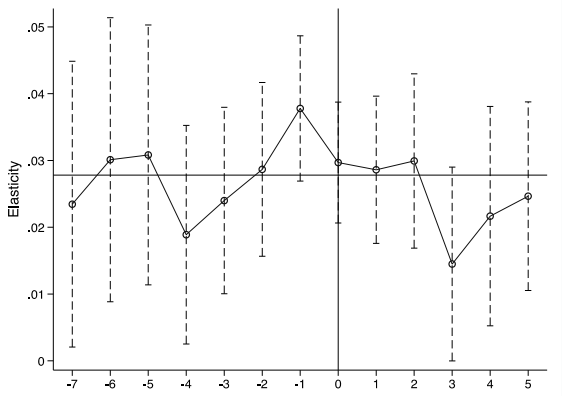
Second, we calculate the gap in rental price of each residential parcel relative to the major commercial complex in the circle for each year. These are generated as binary Gap_i. Finally, if the above approach is valid and exerts real impacts on the core results of this study, then where Gap<0 the real price of residential land would not have been influenced by the commercial complex shock; therefore, the results we have obtained are reliable and valid. Since spillover is not the focus in this study, we simply control for the effects of spillovers on the price of residential land with $Gap_i * Residential_i$ fixed effects. Figure 2 visually depicts the results from this exercise: Regardless of which year's Gap, the estimated price elasticity hangs around the coefficients we obtained previously. Thus, we conclude that even if spillover from commercial development does impact the price differential between the two land uses, our elasticity estimates are not materially affected.

Figure 2: **Rental Price Gap between the Two Land Uses**

Panel A: Tax Potential from Taxes Paid



Panel B: Tax Potential from Net Taxes



Notes: The horizontal solid line indicates estimated elasticity reported in Table 7. Where the year of transfer is the same for commercial and residential parcels, gap=0; when the commercial parcel was transferred before residential parcels, gap>0; otherwise, gap<0. The left figure represents the results of a regression using the tax potential indicator based on the business's actual tax paid (Tax Potential III), while the right figure displays the outcomes of a regression utilizing the tax potential derived from the difference between the business's actual tax paid and the tax refund received (Tax Potential IV). The model controls for fixed effects of land parcel, year-city, year-land use, and method of transfer.

5. Fiscal Motives on Local Land Use

Section 4 has presented evidence of rent-tax linkage. In this section, we examine how fiscal incentives (i.e., current-year rents and future tax streams) 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 be generated from commercial land development induces municipalities to transfer more land for commercial use. Nevertheless, an increase in the supply of commercial land can potentially suppress the rental price of commercial parcels, thereby mitigating the motivation of localities to transfer commercial land and ultimately offsetting the impact of tax incentives on land allocation.

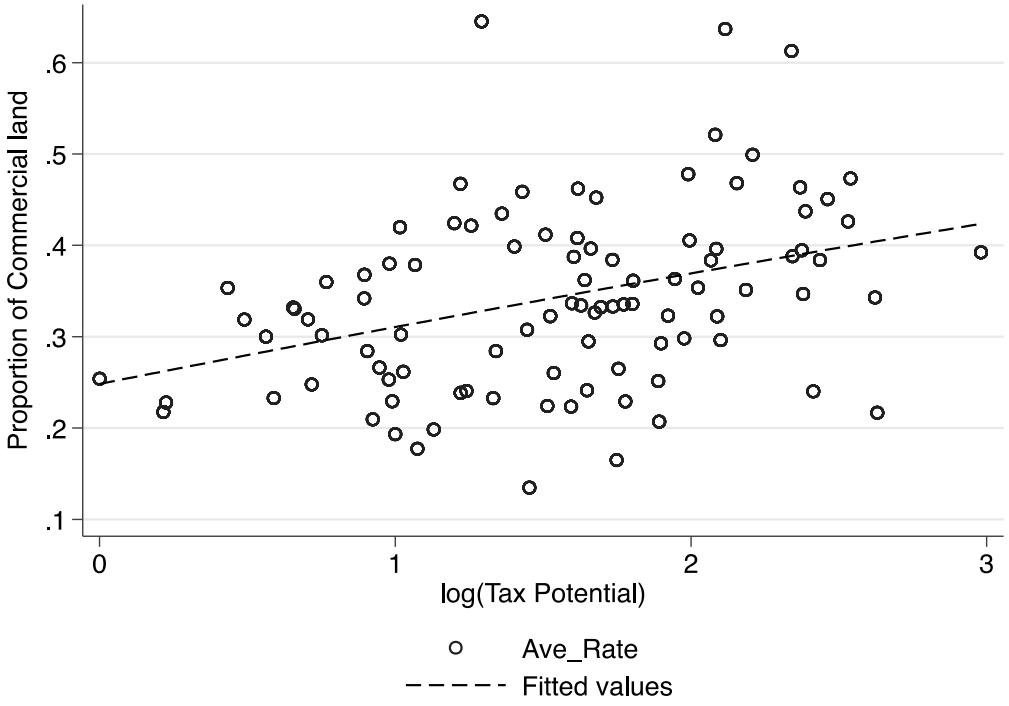
We proceed in three steps to quantify the impact of tax and rent incentives on land allocation and evaluate the role of the rent-tax linkage in this process. First, we estimate the net

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 the rent-tax linkage. Then, we develop a simple model to illustrate how local governments allocate land between commercial and residential uses, aiming to maximize revenue from land. Using the SMM structural estimation technique, we identify the key parameters that drive these decisions. Finally, we introduce a land rent revenue-sharing parameter to proxy the strength of local governments' incentives from land rents and conduct a counterfactual analysis to disentangle the effects of the two distinct fiscal incentives on land use allocation.

5.1. Tax Potential of Commercial Land and Local Land Use

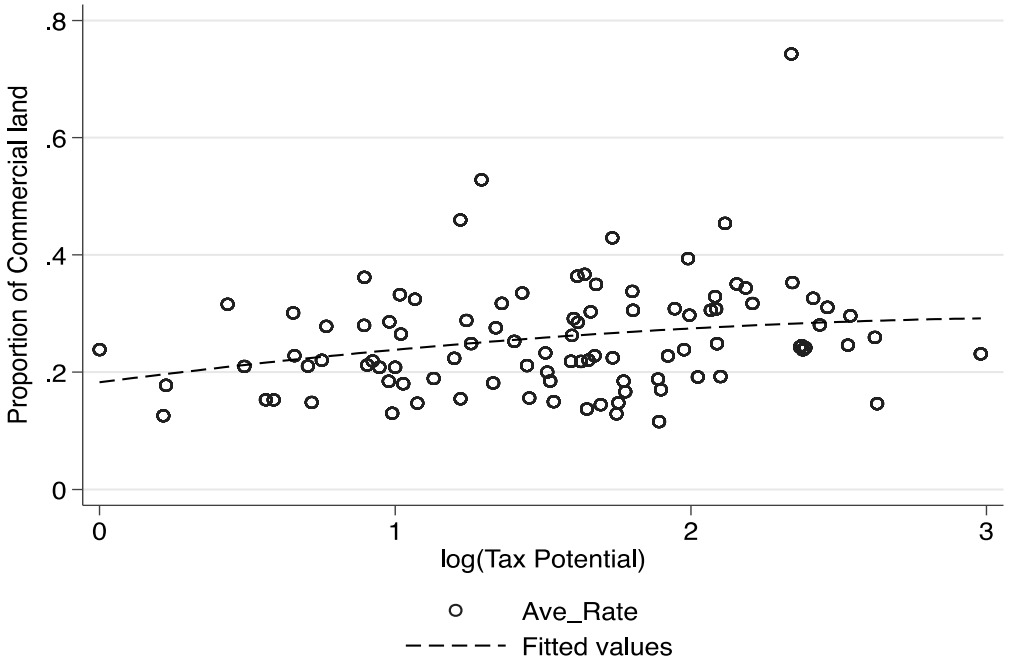
In scatterplots, we visualize the correlation between the tax potential of commercial land and the share of commercial land by the number of parcels and by the area in total transfers. Figures 3 and 4 reveal that these two variables are positively correlated – the higher the tax potential of commercial land in a city, the higher the proportion of commercial land transfers in the number and area of commercial parcels.

Figure 3: **Tax Potential and Land Transfer by Use – Number of Parcels**



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 4: **Tax Potential and Land Transfer by Use – Area of Parcels**



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.

To further examine the quantitative relationship between the two variables, Table 13 reports the 2SLS estimation results based on Equation 5 using the shortest distance between the city center and the coastline as an instrumental variable.[22] 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.

Table 13: **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 2SLS method with the shortest distance to a major seaport 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 the Appendix. Robust standard errors in parentheses. $*$ p<0.1, $**$ p<0.05, and $***$ p<0.01.

[22] We choose 2SLS is because neither measure of tax potential is directly aligned with the total taxes paid by businesses, rather they are merely proxies, with marked measurement errors that lead to attenuation bias. For this reasons, estimates obtained from 2SLS are more credible.

5.2 Structural Modeling

Model setup. We develop a structural model to estimate how fiscal incentives affect municipal governments' land allocation decisions. Drawing upon the conceptual framework introduced in Section 2, we construct a model where local governments maximize their total revenue from land transfers that comprises immediate land rents and discounted future tax revenues. The local government's optimization problem can be expressed as:

$$Max_{\{L_c,L_r\}}\ R_c + R_r + \varepsilon_T T_c = L_c P_c(L_c) + L_r P_r(L_r) + \varepsilon_T L_c \gamma T(L_c)$$

$$\text{s.t. } L_c + L_r = \bar{L} \qquad (7)$$

where land supply, $\bar{L}$, is normalized to 1. The terms remain the same as in Section 2. In this model, we introduce an idiosyncratic shock and specify the configuration of the tax function and the inverse demand functions.

Idiosyncratic shock ε_T. We introduce a random disturbance ε_T that follows a log-normal distribution (i.e., $log(\varepsilon_T) \sim N(\mu, \sigma)$), to capture heterogeneity in how municipalities weight current land rents versus future tax revenues. This disturbance encompasses both preference heterogeneity and institutional variation across localities.

The heterogeneity operates through two distinct channels:

(1) **Preference Heterogeneity**: Municipalities differ in their subjective valuation of immediate land revenues versus future tax flows, which can result from variations in local officials' time preferences, fiscal constraints, and borrowing capacity, as well as development priorities, and strategic planning horizons.

(2) **Institutional Variation**: The relative value of land rents versus taxes is influenced by exogenous policy parameters that differ across jurisdictions and time, including revenue retention rates between different levels of government, restrictions on local governments' use of land transfer revenues, and the efficiency of local tax administration systems.

This disturbance enhances the model's flexibility to accommodate diverse local contexts and unobserved factors that may impact municipalities' land allocation decisions.

Tax function T_c. The tax revenue generated from commercial land is modeled as:

$$T_c = L_c \gamma T(L_c) = L_c \gamma {L_c}^{-1/a_T}$$

This specification decomposes tax generation into three components:

(1) **Scale Effect** (L_c): The direct effect of the quantity of commercial land on tax generation, which represents the proportional relationship between the amount of commercial land and tax revenue.

(2) **Location-Specific Potential** (γ): A city-specific, time-invariant parameter that captures fundamental determinants of tax potential. These determinants include geographic advantages, market access, infrastructure quality, and historical agglomeration economies. This component highlights the role of location-specific factors in shaping the tax generation capacity.

(3) **Intensity Effect** ($T(L_c) = {L_c}^{-1/a_T}$): An endogenous component that captures how marginal tax productivity varies with commercial land supply. This specification implies that as the share of commercial land increases, its marginal tax productivity decreases. Areas with concentrated commercial activity may face congestion effects that

lead to diminishing returns and a decline in tax productivity. The declining marginal tax productivity, embodied in the intensity effect also serves to ensure interior solutions by preventing corner solutions where all land is allocated to commercial use.

Reverse demand functions : $P_c(L_c)$ and $P_r(L_r)$.

In our framework, municipal governments act as monopolistic suppliers in the land market, facing inverse demand functions from competitive developers. The inverse demand functions for commercial and residential land are specified as:

$$P_c(L_c) = b_c {L_c}^{-1/a_c}$$

$$P_r(L_c) = b_r(1 - L_c)^{-1/a_r}$$

where b_c, b_r are scaling parameters for the demand for commercial and residential land, respectively, and we normalize $b_r = 1$. a_c, a_r are elasticity parameters; L_c is the share of commercial land; and $1 - L_c$ is the residual share allocated to residential use

5.3 Structural Estimation

SMM estimation. We employ the Simulated Method of Moments (SMM) to estimate the structural parameters in the model. This section details our estimation strategy, identification approach, and results.

We estimate the parameter vector $\theta \equiv (a_c, a_r, a_T, b_c, \mu, \sigma)$, where (a_c, a_r) govern price elasticities of the demand for commercial and residential land; a_T determines the curvature of the tax generation function; b_c scales commercial land demand; and (μ, σ) characterize the

distribution of **idiosyncratic** shocks, capturing both preference heterogeneity and institutional differences across jurisdictions.

For a candidate value of θ, the model is solved to simulate municipal land allocation decisions. Specifically, the SMM estimation seeks to minimize the discrepancy between observed sample moments and model-generated moments, using an identity weighting matrix. The objective is to find the parameter vector θ that best matches the empirical data by iteratively updating candidate values over 500 iterations. The moments used for estimation include the following:[23]

Average Share of Commercial Land in Four Bins: Cities in our sample are put into four bins according to their tax potential (in CNY 0-15, 15-25, 25-40, and 40+ per square meter). The average share of commercial land within each bin serves as a moment condition that is a measure of spatial differentiation in land use structure.

Discount Rate for Commercial Land Rent in the Four Bins: The average discount rate for commercial land rent within the four bins is also included to capture the differences in commercial land rent discounts relative to residential land rent among the different bins.

The SMM estimator minimizes the following criterion function:

$$\widehat{\theta_N} = \arg\min_{\theta} \left[\widehat{S_N} - \tilde{S}(\theta)\right]' \Sigma \left[\widehat{S_N} - \tilde{S}(\theta)\right]$$

where $\widehat{\theta_N}$ is the estimated parameter vector, $\widehat{S_N}$ is the vector of observed sample moments, $\tilde{S}(\theta)$ is the vector of model-generated moments given θ, and Σ is the identity weighting matrix. The estimation procedure involves selecting six parameters to match eight sample moments. The SMM estimation chooses the model parameters θ such that the model

[23] See the calculation of empirical moments in Appendix.

moments $\tilde{S}(\theta)$ fit the observed moments $\widehat{S_N}$ as closely as possible in a quadratic form with the weighting matrix, over 500 iterations.[24]

Our estimation yields price elasticities of 1.59 for residential land (a_r) and 1.52 for commercial land (a_c), consistent with elastic demand under monopolistic supply.

Verification of the SMM Estimation

Table 14 demonstrates that our structural model successfully captures the key patterns in both the allocation of commercial land and the pricing behavior across cities. The close alignment between the simulated and observed moments is a strong validation of our model's ability to replicate real-world land allocation decisions.

Table 14：**Simulated vs. Data Moments**

Moments	Tax Potential Group (Bin)	Data	Model
Share of Commercial Land	Low	0.2332	0.2312
	Mid-low	0.2510	0.2485
	Mid-high	0.2757	0.2683
	High	0.2971	0.3090
Commercial Land Rent Discount	Low	0.0166	0.0171
	Mid-low	-0.0552	-0.0568
	Mid-high	-0.1307	-0.1375
	High	-0.3280	-0.2922

Notes: This table compares the moments generated by our simulations with those from the data. The data moment "Share of Commercial Land" is represented by the average value across cities and years within each bin. The data moment "Commercial Land Rent Discount" is calculated by regressing within each bin, with the regression equations and details provided in the appendix. The table shows our model does a remarkable job of matching 8 moments from the data using relatively parsimonious model based on 6 parameters.

Look at the commercial land share patterns. The model closely tracks the monotonic increase in commercial land allocation as we move from low to high tax potential cities (in

[24] See the Appendix for the derivation of moments $\tilde{S}(\theta)$ and data for moments $\widehat{S_N}$.

four bins). For instance, in low tax potential cities, the model predicts a commercial land share of 23.12%, very close to the observed 23.32%. This accuracy persists across the four groups, with the model capturing the gradual increase in commercial land share from low to high tax potential areas (23.12% to 30.90%), matching the empirical pattern (23.32% to 29.71%). The slight overestimation in the high tax potential group (30.90% vs 29.71%) suggests that while our model captures the main economic forces driving land allocation, there might be additional constraints in high tax potential cities that somehow moderately limit commercial development.

The model also effectively replicates the pattern of commercial land rent discounts across the four groups. Notably, it captures the systematic deepening of commercial land discounts as tax potential increases – from a small premium of 1.71% in low tax potential cities (1.66% in the data) to a substantial discount of -29.22% in high tax potential cities (-32.80% in the data). This pattern aligns with our theoretical prediction that city governments with high tax potential are more willing to offer larger commercial land discounts in order to attract businesses that generate future taxes.

The close fit between our model and data is particularly remarkable given that we are matching eight distinct moments with only six structural parameters. This parsimony suggests that our model captures the fundamental economic mechanisms driving both land allocation decisions and pricing strategies of local governments. The slight deviations between the model and data, such as the moderately smaller predicted discount in high tax potential cities (-29.22% vs -32.80%), likely reflect additional institutional or market factors not explicitly included in our streamlined theoretical framework.

To further validate our estimation results, we employ a comprehensive set of untargeted moments derived from our earlier regression analyses. This validation approach is powerful as it tests our model's ability to match empirical patterns that were not explicitly targeted in the estimation process, thereby providing a test of the model's external validity. Table 15 outlines four key untargeted moments used for validation: β_1 directly measures the percentage discount/premium for commercial land; β_2 captures the elasticity of the discount with respect to tax potential, at both the city and radius levels; and β_3 measures the semi-elasticity of commercial land share with respect to tax potential.

Table 15: **Untargeted Moments and Their Sources**

Untargeted Moments	**Regression Equation**
Commercial land rent discount β_1	$log(\widehat{P_{ict}}) = \beta_0 + \beta_1 Commerical_i + \delta_{ic} + \varepsilon_{ict}$
Land rent discount by tax potential (city level) β_2	$log(\widehat{P_{ict}}) = \beta_0 + \beta_1 Commerical_i + \beta_2 Commerical_i \times log\ (tax_c) + \delta_{ic} + \varepsilon_{ict}$
Land rent discount by tax potential (radius level) β_2	$log(\widehat{P_{ict}}) = \beta_0 + \beta_1 Commerical_i + \beta_2 Commerical_i \times log\ (tax_c) + \delta_{ic} + \varepsilon_{ict}$
Commercial land share by tax potential (IV) β_3	$\widehat{Lc_{ct}} = \beta_0 + \beta_3\, log(tax_c) + \epsilon_{ct}$

Notes: $\beta_1\ represents$ Commercial Land Rent Discount, $\beta_2\ represents$ the Tax Potential Elasticity with respect to Commercial Land Rent Discount, and $\beta_3\ represents$ the Tax Potential Semi-Elasticity with respect to the Share of Commercial Land. The empirical moments are obtained from corresponding regressions in the table.

The model successfully replicates these untargeted moments, as shown in Table 16. The predicted commercial land rent discount (-0.116) closely matches the empirical estimate (-0.107). The model captures both the city-level (-0.2042 vs. -0.180) and radius-level (-0.0225 vs. -0.0248) tax potential elasticities. The commercial land share response to tax potential (0.0557) aligns well with the IV estimate (0.0522). Standard errors in parentheses indicate

high statistical precision in both the empirical and model-generated estimates, though the model-generated standard errors are naturally smaller due to the absence of measurement error in the simulated data. Notably, the model's ability to match these untargeted moments, particularly the distinct city-level and radius-level elasticities, provides extra evidence of its robustness and structural validity. This success in matching moments that were not used in the estimation process suggests that our model can capture the fundamental economic mechanisms driving both land allocation decisions and pricing strategies of local governments.

Table 16: **SMM Estimation with Untargeted Moments**

Moments	Empirical Moments	Model Moments
Commercial land rent discount	-0.107*** (0.00611)	-0.116*** (0.00033)
Land rent discount by tax potential in city level	-0.180*** (0.0111)	-0.2042*** (0.0003)
Land rent discount by tax potential in radius level	-0.0248*** (0.00378)	-0.0225*** (0.00022)
Commercial land share by tax potential (IV)	0.0522** (0.0209)	0.0557*** (0.0009)

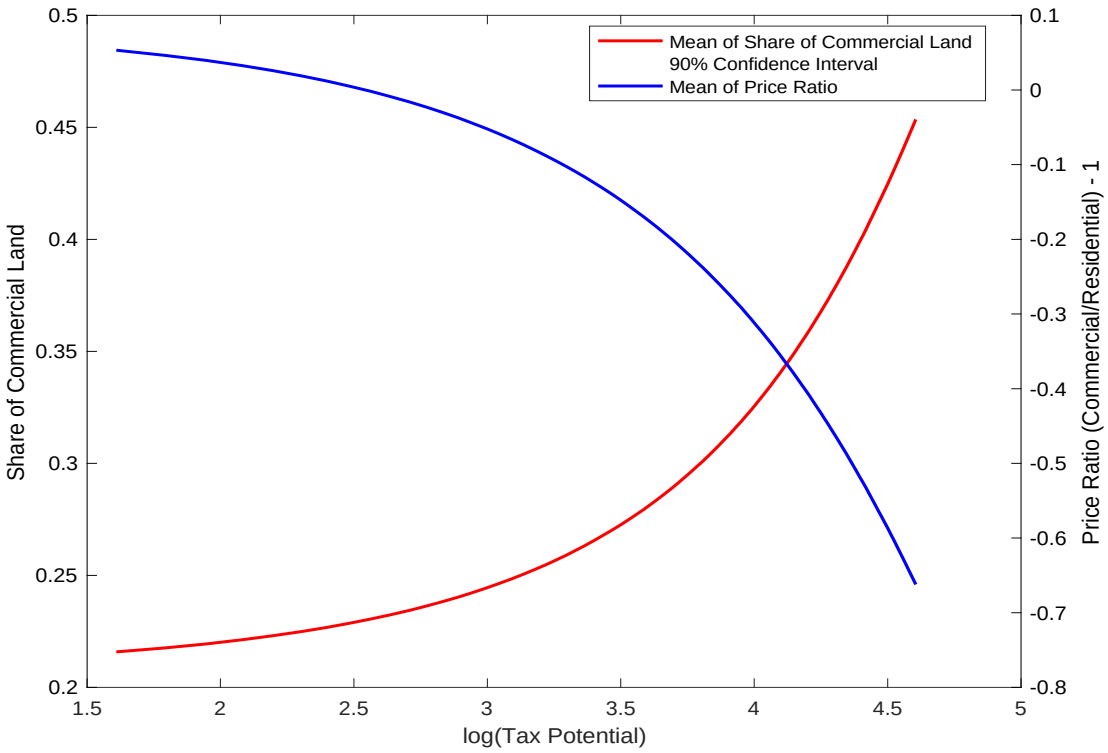
Notes: This table presents the estimated results of the model for the Commercial Land Rent Discount, the Tax Potential Elasticity of the Commercial Land Rent Discount, and the Tax Potential Semi-Elasticity of the Share of Commercial Land. The results indicate that our model effectively calculates these price differentials and elasticities, showing strong alignment with the reduced-form estimation.

5.4 Model Prediction

Having verified that our structural model effectively captures the key features of the empirical data, we proceed to utilize the model to generalize the relationships between tax potential, land use structure, and commercial land rent discount. Figure 5 presents the simulated outcomes derived from the model, revealing that as tax potential increases, both the commercial land rent discount and the share of land allocated to commercial use increase.

Specifically, the red curve is aligned with the left y-axis and depicts the positive relationship between tax potential and the share of commercial land, which indicates that cities with higher tax potentials tend to allocate a larger proportion of land for commercial uses. The blue curve, aligned with the right y-axis, illustrates the negative relationship between tax potential and the commercial land rent discount, suggesting that higher tax potential is associated with greater discounts on commercial land rents. The shaded areas around the curves represent the 90% confidence intervals, reflecting the uncertainty inherent in the model's predictions. These findings underscore the model's ability to capture and generalize key economic relationships, providing insights into how tax potential influences land use decisions and land pricing.

Figure 5: **Relationship between Tax Potential, Land Use, and Land Price Differential**



5.4 **Counterfactual Experiments**

Returning to the opening question posed at the beginning of this study, municipal land development decisions are shaped by both tax incentives and land rent income. These incentives are connected through the land market, prompting us to ask how municipal land use decisions might change if local governments could not obtain revenue from land rents, or if these rent-based incentives were partially or fully removed. To examine this, we introduce a policy instrument in our model: a central government levy on local land rents, represented by the parameter τ, where $\tau \in (0,1)$. This adjustment modifies the local government's revenue maximization problem as follows:

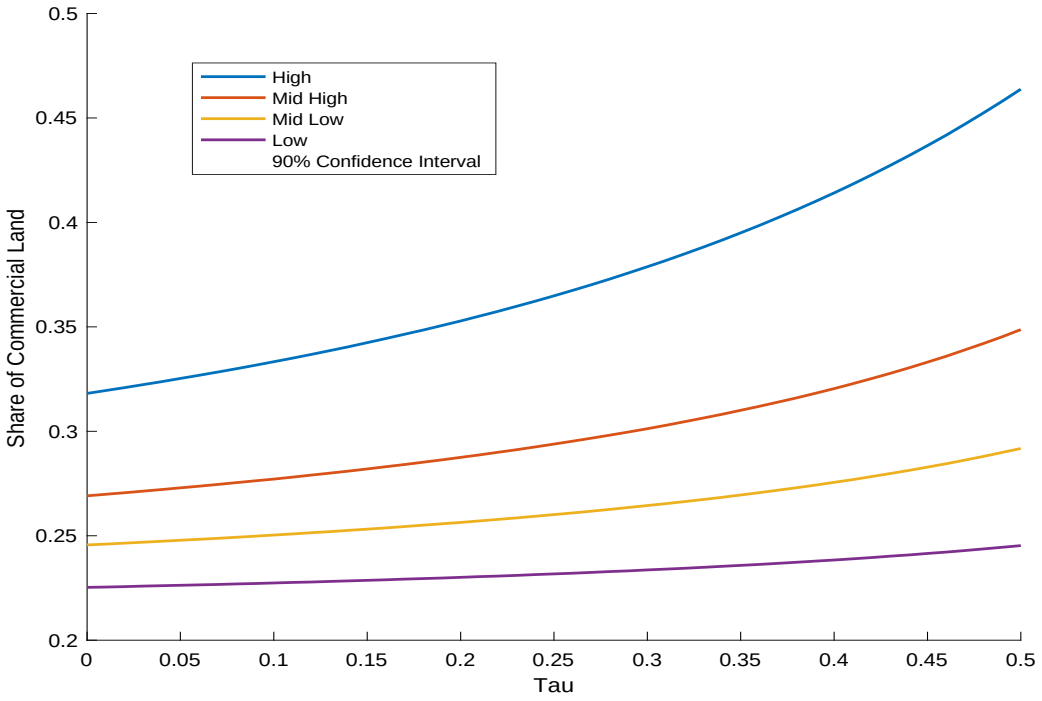
$$Max_{\{L_c,L_r\}}\ (1-\tau)(R_c+R_r)+T_c=(1-\tau)[L_cP_c(L_c)+L_rP_r(L_c)]+\varepsilon_T L_c\gamma T(L_c)$$

By adjusting τ, we can estimate the resulting allocation L_c, the share of land designated for commercial purposes. $\tau = 1$ implies that the municipal government cannot retain any revenue from land sales, that is, its incentives to allocate land for commercial uses are gone. At the other end, $\tau = 0$ denotes a scenario where the city government fully retains land sale revenue. Even in country contexts where land is privately owned, municipalities still generate revenue from land-related taxes, meaning that land allocation decisions are still relevant in these cases. Therefore, to examine a more realistic set of policy alternatives for countries like China, we focus on the range $\tau \in [0,0.5]$, where both local and higher-level governments share the revenues from land sale.

Our results, as shown in Figure 6, indicate that as τ increases, the share of land allocated to commercial use rises across all subgroups, with the most pronounced effects observed in high-tax-potential cities. This acts as a counterbalance to the tax incentives for commercial

land development, revealing that as the local share of land sale revenue diminishes, municipalities are increasingly incentivized to designate land for commercial purposes. For example, in a low land revenue retention scenario (τ=0.5), the commercial land share in high-tax potential cities is higher by approximately 10% compared to the full retention scenario (τ=0). This outcome aligns with our hypothesis that cities with higher tax potential are more responsive to shifts in fiscal incentives tied to land sales revenue. In contrast, lower-tax-potential cities exhibit a more moderate reduction in commercial land allocation, reflecting the comparatively weaker influence of revenue-sharing arrangements on land use decisions in these cities.

Figure 6: **Simulated Counterfactual Policies**



Notes: This figure illustrates the share of commercial land across subgroups with different tax potential. We calculate the counterfactual share of commercial land for each subgroup, with model predictions shown as solid lines in various colors. The shaded areas represent the 90% confidence intervals for our predicted share of commercial land. The figure demonstrates that as τ increases, the share of commercial land rises, particularly in "High" tax-potential cities.

6. 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 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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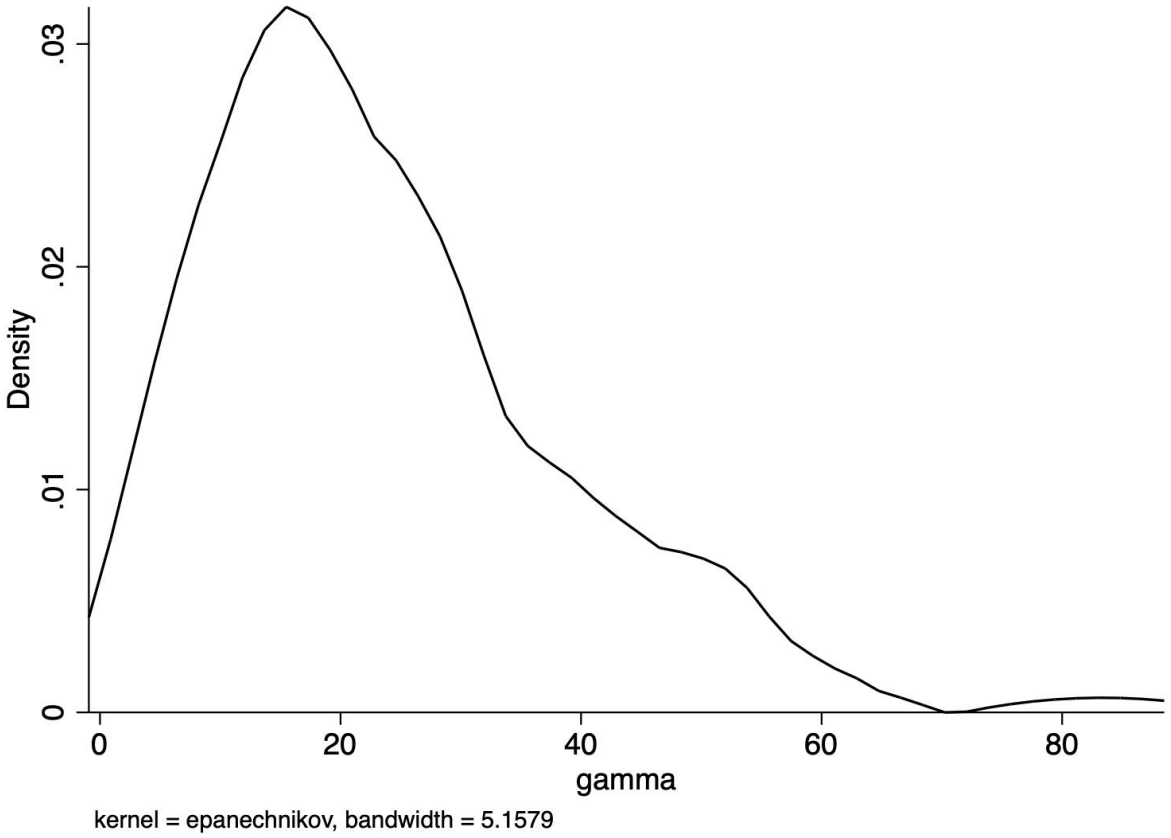
Appendix to Structural Estimation

Distribution of Tax Potential



Descriptive Statistics of Tax Potential

	Mean	SD	Min	Max	Obs
Tax potential in Low Tax potential cities	10.22	2.77	4.23	14.86	422
Tax potential in Mid-low Tax potential cities	20.58	2.71	15.39	24.89	390
Tax potential in Mid-high Tax potential cities	31.50	3.86	25.03	38.49	273
Tax potential in High Tax potential cities	51.61	10.03	43.90	83.33	182

Descriptive Statistics of City-Level Variables

	Mean	SD	Min	Max	Obs
Ave Land use structure II in Low Tax potential cities	0.233	0.073	0.126	0.460	442
Ave Land use structure II in Mid-low Tax potential cities	0.251	0.092	0.129	0.528	390
Ave Land use structure II in Mid-high Tax potential cities	0.276	0.083	0.116	0.454	273
Ave Land use structure II in High Tax potential cities	0.297	0.133	0.146	0.743	182

Commercial Land Discount

	Discount heterogeneity	
Commercial	0.017	
	(0.0136)	
Commercial * Mid-low	-0.055***	-0.070***
	(0.0167)	(0.0167)
Commercial * Mid-high	-0.131***	-0.137***
	(0.0183)	(0.0182)
Commercial * High	-0.328***	-0.345***
	(0.0195)	(0.0196)
Radius matching Fixed Effects	Y	Y
Year Fixed Effects	Y	N
Year*City Fixed Effects	N	Y
Land Transfer Method Fixed Effects	Y	Y
Observations	106,130	106,099
R-squared	0.753	0.788

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.