Land Financing and Economic Growth: Evidence from Chinese Counties

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Abstract

How does land institution affect economic growth? This paper proposes a simple model showing that, in an institution that land is owned and supplied by the state, local governments tend to increase investment in infrastructure when holding a larger share of land conveyance revenue in the total revenue. The main channel is that land conveyance revenue serves as a signal of credit quality of local governments. To test the model of land financing, this paper employs an exogenous event of the deregulation of local government debt in China in 2009. Using county-level data in China, empirical results suggest that counties with a higher initial share of land conveyance revenue were growing faster after 2009. The land-financing effect was persistent and even stronger during 2009 to 2014. Results are robust using geographic plainness as the instrumental variable measuring the amount of developable land resources. There is also consistent evidence on the growth of night light intensity.

JEL classification: O43, H81.

Keywords: land institution, local government debt, economic growth, China.

The rent of land is naturally a monopoly price.
—— Adam Smith, *The Wealth of Nations*

1. Introduction

The importance of land in economic growth has long been recognized by economic researchers. For example, in the seminal work *"The Wealth of Nations"* in 1776, Adam Smith argued that land improvement for food production could raise demand for non-food production.[1] Recent influential research on land has focused on the improvement of land rights and its impact on migration (De Janvry, Emerick, Gonzalez-Navarro and Sadoulet, 2015), consumption (Kemper, Ha and Klump, 2015), investment (Nizalov, Thornsbury, Loveridge, Woods and Zadorozhna, 2016), real income (Aragn, 2015) and poverty reduction (Besley and Burgess, 2000). Most of these studies, however, are related to rural land and few pay attention to the role of urban land expansion or land reallocation in economic growth. It is generally believed that urban land development is the outcome of economic growth rather than its cause. While this may be true when land is privately owned and land owners set the profit-maximization rent, it may not be the case when land is owned by the state. In an institution where urban land is owned by the state, local governments may have incentives to set low rents for land to compete for firm investment, or to allocate land conveyance revenue as collateral to finance infrastructure projects.[2] The latter is often referred to as "land financing". China in this regard provides a possible model of catalyzing economic growth by land financing, though its long-term effect remains uncertain.

This paper proposes a simple model of land financing through which local governments stimulate economic growth under the institution that land is owned and supplied by the state. The model builds on Cai and Treisman (2005) with the extension of inter-temporal decision on external financing. The model shows that local governments with a higher share of land conveyance revenue in total fiscal revenue (hereafter, *the share of land revenue*) can obtain a lower cost of debt, which induces more investment in infrastructures.[3] The critical

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[1] See Smith (1976) Chapter XI "Of the Rent of Land", page 160.

[2] Land conveyance revenue refers to the income of transferring land-use rights by local governments. It does not include tax incomes based on the land use. In China's land institution, the ownership and the use right of land is separated. Local government only transfers land-use rights and receives a lump-sum rent of land use for 40 to 70 years, depending on the type of land use. The buyer (or the tenant) can renew the contract after the expiry date of land-use right. I call this initial transfer of land-use right as land conveyance. Some studies call it land leasing. In China, the means of land conveyance include allocation (almost at zero price) and leasing through negotiation, bid, auction or listing.

[3] Local government debt refers to both direct and indirect liability of local governments, including debts

assumption is that the probability of getting liquidation from land conveyance revenue is higher than that from tax revenue, which is plausible in the context of China. In China, tax revenue is strictly regulated and highly shared by the upper government. Land conveyance revenue, on the other hand, is more flexible and less shared by the upper government (Han and Kung, 2015).[4] In the eyes of the lenders, therefore, land conveyance revenue is regarded as the collateral of better quality because it is more likely to be used for debt repayment compared to the regulated tax revenue. In addition, infrastructure investment can increase the value of land in the future which also strengthens the confidence in repaying the debt by future land conveyance revenue. Consistent with studies on collateral pricing (Benmelech and Bergman, 2009; Jimenez, Salas and Saurina, 2006), a higher share of land revenue serves as an important signal of better credit quality of the borrowers to whom lenders are willing to offer a lower interest rate .

To test the land-financing mechanism, the ideal way is to test the relation between the share of land revenue and infrastructure investment. Unfortunately, neither infrastructure investment nor the cost of local government debt is fully available in the public data.[5] Alternatively, this paper tests the relation between the share of land revenue and economic growth, given all else being equal. The main challenge is that both tax revenue and land conveyance revenue are moving together with economic growth. To deal with this problem, this paper employs a quasi-experiment event in China in late 2008 when the central government launched a "Four Trillion Yuan" stimulus package in response to the global financial crisis. An important but less discussed part of the 'Four Trillion Yuan' policy was the deregulation of local government debt in which local governments were the first time in recent decades being encouraged to set up local government financing vehicles (LGFVs) to borrow money for public investment projects. In addition, much more rural lands were permitted

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taken by local government financing vehicles.

[4]In China, total fiscal revenue of local governments can be divided into three categories: budgetary revenue, extra-budgetary revenue and off-budgetary revenue. The budgetary revenue mainly refers to the value-added tax, enterprise tax and business tax. The extra-budgetary revenue includes fees and funds from other governmental departments. The third category, off-budgetary revenue, is any other income sources of local government other than the budgetary and extra-budgetary revenue. Land conveyance revenue is generally regarded as off-budgetary revenue. In most cases, local governments only report the first two categories in the name of fiscal revenue. In this paper, total fiscal revenue refers to the summation of reported fiscal revenue and the land conveyance revenue. See Han and Kung (2015) for more detailed description of China's fiscal revenue sharing system.

[5]Note that Gao, Ru and Tang (2016) provide a comprehensive study on China's local government debt based on a unique proprietary loan-level data. Huang, Pagano and Panizza (2017), Zhang and Barnett (2014) offer reliable estimation of local government debt in the whole country and in the prefecture-level cities. Ambrose, Deng and Wu (2015) also test the relation between the expected housing price growth and the risk premium of local government debt using municipal corporate bond (MCBs) data. This paper also provides additional evidence on the relation between the share of land revenue and the cost of local government debt based on the less comprehensive MCBs data.

by the central government to be transferred as urban lands to support investment projects. Therefore, there was a change of cost of debt after the policy shock. Before the 'Four Trillion Yuan" policy, the cost of debt (include cost of regulation) was much higher than the risk-free rate which makes it difficult for local governments to raise debt. After the policy in 2009, however, the cost of debt for local governments was decreasing. Local governments with a higher initial share of land revenue benefited more from the deregulation. Therefore, it is possible to identify the effects of land revenue on economic growth among different regions by adopting the difference-in-differences identification strategy.

Using county-level macro-economic data and transaction-level land-supply data in China, this paper finds that counties with a higher initial share of land revenue were growing faster by 1.6 to 3.5 percentage points on average after 2009, compared to those with zero land conveyance revenue. The land-financing effect was persistent and even stronger during the sample period from 2009 to 2014. There are two reasons why counties are chosen as the basic unit of analysis.[6] First, the primary decisions of land supply are made in the county-level governments, subject to the restriction of an annual supply plan set by the upper level governments. There are more variation of local government's behavior in the counties compared to the provincial and prefectural governments. Second, it is more comparable across regions using county-level data than using prefecture-level city. The political impacts of some super big cities can also be ruled out. For the endogeneity concern, this paper uses the share of land revenue before the policy shock. The distribution of the share of land revenue among counties was persistent from year to year. The pre-policy trends of two groups (high share of land revenue v.s low share one) were similar before 2009 but changed after 2009. Given that the share of land revenue is highly and positively correlative with the amount of developable land, this paper also use the geographic plainness as instrumental variable measuring the amount of developable land and the results are robust. There is also consistent evidence on the growth of night light intensity. To further support the channel of land financing, additional evidence suggests that local governments with a higher share of land revenue were indeed receiving lower interest rate when issuing bonds.

This paper is related to several strands of literature on Chinese economy. The first strand highlights the importance of productivity growth in explaining economic growth in China. In fact, a consensus has gradually emerged that the growth of total factor productivity (TFP) contributed to a large part of China's economic growth since its economic reform in 1978. Before 1978, most of the growth came from forced increase in government investment. The fast growth from 1978 to 2007, however, was driven by productivity growth rather than capital investment (Zhu, 2012). The emergence of entrepreneurship in private business in

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[6]Results are robust when using prefecture-level city data.

late 1990s played an important role in the early growth of China (Li, Yang, Yao, Zhang and Zhang, 2012). The state-owned enterprise (SOE) reform and trade liberalization greatly reduced barriers of entry and exit for manufacturing firms, which contributed to more than two-thirds of total TFP growth (Brandt, Biesebroeck and Zhang, 2012). The input and output tariff reductions can also explain more than half of the productivity growth in China (Brandt, Van Biesebroeck, Wang and Zhang, 2017). China's TFP growth can further be decomposed as labor and capital reallocation between and within regions, sectors and firms. Labor reallocation from agriculture to manufacturing sector increased agricultural TFP growth which accounted for as least as much of total TFP growth as non-agricultural TFP growth did (Cao and Birchenall, 2013). Labor and capital reallocation across manufacturing firms with different productivity was also responsible for an annual two percentage points increase in total TFP from 1998 to 2005 (Hsieh and Klenow, 2009).

This paper adds to this line of literature by considering land reallocation and infrastructure improvement as part of the source of productivity growth. There are two ways to increase investment by land reallocation in China. The first approach is to set low price for industrial land to attract investment from manufacturing firms (Lichtenberg and Ding, 2009). In fact, it can be considered as a special kind of subsidy for industrial firms. The second channel is to use land conveyance revenue to finance public investment projects, most of which are infrastructure and real estate projects (Peterson, 2006; Fang, Gu, Xiong and Zhou, 2015). To my knowledge, there is no systematic test for the short-run and long-run effect of land-financing channel on economic growth, regardless of the heated debate on its financial risk. Promoting economic growth by land financing requires two conditions. On the demand side, a prosperously growing market of real estate is necessary for land financing. On the supply side, local government should have monopoly power in land supply and have incentive as well as land resources to supply. China in this respect satisfies both requirements, especially after the global financial crisis and the "Four Trillion Yuan" policy in late 2008. First, the ongoing urbanization process in China during the past decade was one of the largest human migrations in history (World Bank and Development Research Center of the State Council of China, 2014). The real estate sector and the urban land market surely benefited from the trend of urbanization. Second, the institution of economic decentralization and political centralization, or the so-called "Regionally Decentralized Authoritarian" (RDA) in China provides strong incentive for local governments to perform regional competition and regional experiments (Xu, 2011). Moreover, the land institution in China confirms that local governments are the only legal entities to supply land in urban areas, providing them with a monopolistic position in the land market.[7] Local governments are acting as

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[7]See Rithmire (2017) and Ding (2003) for a thorough review on the origins and evolution of China's land

4

agents of the central government to pursue land development for macroeconomic management (Rithmire, 2017). Finally, the shocks of financial crisis and the "Four Trillion Yuan" policy greatly released the stringent regulation on land supply and meanwhile encouraged dramatic bank credit expansion in the whole economy. All of these conditions contributed to China's macro-environment of soaring housing prices and land prices, and of rapidly increasing infrastructure investment and real estate investment after 2009.

The second strand of literature studies the fast-growing local government debt and shadow banking activities in China. Bai, Hsieh and Song (2016) provide a detailed analysis of the "Four Trillion Yuan" fiscal stimulus in China, which was mainly financed through bank loans by the off-balance-sheet LGFVs on behalf of local governments. In their paper, the deregulation of local government debt was regarded as partial liberalization of China's financial market, and the aggregate welfare may be worsened due to the inefficient allocation of financial resources in favor of local-government related companies. Chen, He and Liu (2017) further link the emerging shadow banking activities to the fiscal stimulus by showing that, in the rollover pressure of bank loans, local governments were shifting the financing sources from commercial banks to the so-called shadow banking items, most of which were wealth management products and Trust. On the other hand, Ambrose et al. (2015) link the solvency of local government debt to the property market growth in China and find that local governments had advantage in issuing bond with lower risk premium when the expected housing price growth was higher. In light of the aforementioned literature, this paper takes advantage of the deregulation of local government debt and studies the effect of land financing on economic growth. Consistent with Ambrose et al. (2015)'s findings, this paper argues that local governments with higher share of land revenue, or better cash flow condition, tend to obtain lower cost of debt. However, the author admits that the model in this paper doesn't take into account the crowd-out effect of government investment which is found in Huang et al. (2017) who show that local government debt crowded out the investment by private firms, but it had no effects on state-owned and foreign firms.

Third, this paper is related to many studies on China's land market and its relation with urbanization and housing price. With the fast economic growth in the past two decades, China witnessed a fast increasing housing price and quick expansion of urban area. The persistently rising housing price can be partly explained by the local government's control over the supply of residential land (Zhang, Fan and Mo, 2017). As land price and housing price move together, the heavy reliance of local governments on land conveyance revenue helps to form the common belief that housing price and land price are too important to

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institutions and land policy reforms. Also see Deininger (2003) for a comparison of land use policy among different countries.

crash, which further strengthens the confidence in housing price (Fang et al., 2015). On the other hand, the urban expansion could be the result of the shift of local government's effort from promoting industrial growth to "urbanizing" the city when the fiscal revenue from the industrial sector was decreasing, and revenue from urban construction and land conveyance was increasing (Han and Kung, 2015). While more and more people are worried about the housing bubble and the sustainability of local government debt in China, this paper attempts to study the short-run and long-run effect of land financing on China's economic growth which may help us better understand the mechanism of land financing and the financial risk behind it.

Finally, this paper follows the literature on the cost of debt and collateral pricing. In the field of corporate finance, the primary benefit of debt is tax savings. The cost of debt depends on company's characteristics and the quality of collateral. The net benefit of debt can be 3.5% of the asset value after considering all the benefits as well as the cost of debt (Binsbergen, Jules, Graham and Yang, 2010). Collateral plays an important part in taking loans or issuing bonds. On the positive side, collateral can reduce financial frictions such as moral hazard and adverse selection. Companies that can pledge collateral, especially redeployable collateral, often receive lower cost of debt (Benmelech and Bergman, 2009). The negative effect of collateral, however, appears on those who have a past record of default. To secure the loans, companies with bad credit records are more likely to be required to pledge collateral which serves as a negative signal of credit quality. For those young borrowers without previous records, on the other hand, collateral serves as a signal of better credit quality which can solve the problem of asymmetric information (Jimenez et al., 2006). In this paper, there is no tax benefit of debt by local governments. The main issue of local government debt is that the land conveyance revenue serves as a signal of good credit quality.

The rest of the paper is organized as follows. Section two introduces the background of the deregulation of local government debt in China. Section three provides a simple framework to illustrate the mechanism of land financing. Section four describes data source and summary statistics, as well as the construction of main variables. Section five presents empirical results and robustness checks. The sixth section offers supplementary evidence on the mechanisms. The last section draws the conclusion.

2. Deregulation of Local Government Debt

On 9 November 2008, Chinese central government announced the "Four Trillion Yuan" stimulus in response to the negative shock of global financial crisis triggered by the sub-prime

crisis in the United States.[8] As part of the "Four Trillion Yuan" policy, the deregulation of local government debt and the increase of land supply received relatively less attention which will be discussed in this section.

According to the 1994 Budget Law of the People's Republic of China, local governments in China is not allowed to borrow and may not issue local government bonds.[9] Things changed when the U.S financial crisis hit the Chinese economy. On 23 March 2009, The People's Bank of China (PBC) announced a decision on structural adjustment of bank loans to support economic growth.[10] In the announcement, local governments were encouraged explicitly to set up financing vehicles to issue corporate bonds, medium-term notes and other financing sources for the government investment projects. Bank lending was also guided towards the housing market to prevent a big drop in housing prices and to maintain the growth of real estate investment. In fact, housing price recovered shortly after the financial crisis and continued to increase to a historical high level which was in sharp contrast to the persistent fall of the stock market price (Fang et al., 2015). Half year later, the Ministry of Finance (MF) in China also announced a regulation allowing local governments to finance the stimulus projects by all sources of funds, including budgetary revenue, land revenue and fund borrowed by LGFVs.[11]

The announcements by PBC and MF in 2009 were regarded as the deregulation of local government debt (Chen et al., 2017). Figure 1 presents the change of the (publicly traded) local government debt and land conveyance revenue in China. The municipal corporate bonds issued by LGFVs was growing fast since 2009 with a historical high in 2014 and 2015. Although data on listed debt only includes outstanding debt, the trend of fast increasing since 2011 was reliable given that the minimum duration of debt was around five years. It was also likely that LGFVs issued more short-term bonds and notes in recent years to cover the previous debt since 2009 (Chen et al., 2017). The credit to the non-financial sector and revenue of land conveyance also climbed up dramatically after 2008.

[Insert Figure 1 around here]

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[8]The "Four Trillion Yuan" policy is more than a four-trillion-yuan stimulus package. It was also a package of fiscal, monetary, land supply and lending policies. See Bai et al. (2016) and Chen et al. (2017) for a description of the stimulus plan.

[9]The Budget Law was revised in 2014, allowing the provincial-level government to issue bonds subject to the quota set by the State Council. See Ambrose et al. (2015) for more detailed description of the Budget Law in China.

[10]The People's Bank of China, 18/3/2009, "The People's Bank of China on further strengthening the credit structure adjustment to promote the steady and fast development of national economy"(in Chinese), *www.pbc.gov.cn/jinrongshichangsi/147160/147289/147301/2847478/index.html*, accessed on 25/4/2016.

[11]The Ministry of Finance of China, 12/10/2009, "Notice on accelerating the implementation of the local supporting funds for the central investment projects on expanding domestic demand"(in Chinese), *www.gov.cn/zwgk/2009 − 10/13/content_1437713.htm*, accessed on 25/4/2016.

The second important policy change in 2009 was the land supply policy by central government. While expanding money supply was a common practice in response to the global financial crisis in most countries, increasing land supply was a special macroeconomic management tool in China (Rithmire, 2017). According to the Land Management Law in China, each level of governments should make an overall plan for land utilization during a certain period, and the total amount of construction land in the urban areas should not exceed the limit set by the upper level government.[12] Moreover, the transfer of rural land to construction land requires the permission from upper level government.[13] Therefore, the central government in China holds the ultimate power in land transfer and land supply permission. In recent decades, there were two waves of increasing land supply in terms of land transfer permission (Figure 2). The first wave in 2003 was a reflection of central government's formal statement that the real estate sector had become the pillar industry of the national economy when the new leader first came into power.[14] It was also a policy in response to the shock of the SARS virus during 2002 to 2003. Another big change of land policy in that period was the announcement of the provision of land conveyance through bidding, auction and listing implemented on July 1, 2002.[15] This provision was set by the central government to prevent state-owned land being sold at an extremely low price through negotiation. In the anticipation of much higher land prices through auction, the demand for construction land soared immediately after the announcement of the provision. Interestingly, local governments supplied more land through negotiation before the "Deadline of August 31".[16] This was the first big change of land supply policy by central government whose original purpose was to restrict land supply by negotiation. However, this change had the immediate effect of stimulating land supply.

The second change of land policy in 2009, however, reflected the willingness of central government to encourage land supply for investment projects in the four-trillion-yuan stimulus. The permitted amount of construction land transfer in 2009 increased by a factor of 1.5 as large as that in 2008, and the land supply by allocation (transferred with zero fees)

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[12]Construction land refers to the land for residential development, public facilities, industrial use, storage use, transportation use, roads and squares, utilities facilities, green land and for special purpose.

[13]For more details about the Land Management Law, please refer to the official website (in Chinese): *www.mlr.gov.cn/zwgk/flfg/tdglflfg/200506/t20050607_68174.htm*.

[14]The State Council, 12/8/2003, "The state council on promoting a sustainable and healthy development of the real estate market"(in Chinese), *www.gov.cn/gongbao/content/2003/content_62364.htm*, accessed on 25/4/2016.

[15]For details, see *www.mlr.gov.cn/zwgk/flfg/dfflfg/200504/t20050406_636761.htm(in Chinese)*.

[16]On March 31, 2004, the Ministry of Land and Resources announced a notification about the deadline of the requirement that all land should not be supplied through negotiation except for certain special purposes after August 31, 2004. For more details, see *www.landchina.com/DesktopModule/BulletinMdl/BulContentView.aspx?BulID=59854 (in Chinese)*.

and leasing increased dramatically (Figure 2). The increase of land by allocation was mainly driven by the gigantic project of social protection housing which aimed to provide houses for 7.47 million poor families from 2009 to 2011 and to build an additional 36 million houses for poor households from 2011 to 2015.[17] The fast growth of land supply was the outcome of rising demand for land as well as increasing supply of land permitted by the central officials.

[Insert Figure 2 around here]

The combination of expansionary policies in local government debt and land supply since 2009 reduced the cost for local governments to borrow. These policies also provided strong incentives for local governments to increase investment in infrastructure and new towns. For example, there was no establishment of national districts for 15 years since the first one in Shanghai in 1992 and the second one in Tianjin in 1994.[18] However, central government approved 15 national districts from 2010 to 2015 and there are still many applications from local governments under review (appendix Table 8). These new national districts covered provinces in eastern, central and western regions with different development targets. Most of them required large areas of new land and huge investment in infrastructure and real estate development. There were also many provincial-level and prefectural-level new districts or experimental areas established by local governments before 2009, such as high-tech zones, industry parks, new central business districts (CBDs) and old city reconstructions ("*Jiu Cheng Gai Zao*"). The key point here is that these projects or experiments could be easily copied and applied to other regions as long as the local governments were able to take loans. The "Four Trillion Yuan" policy enabled or even encouraged local governments to try similar projects, resulting in a phenomenon that regions with different endowments adopted similar projects to stimulate economic growth.[19] Moreover, there were increasing cases of counties being adjusted to municipal districts ("*Che Xian She Qu*", Appendix Figure 6). Beginning from 2010, there were growing numbers of counties being approved to be adjusted

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[17]General Office of the State Council, 20/12/2008, "Several opinions about promoting the healthy development of the real estate market"(in Chinese), *www.gov.cn/zwgk/2008 − 12/21/content_1184227.htm*. The State Council, 16/3/2011, "The 12th five-year plan for national economic and social development program"(in Chinese), *www.gov.cn/2011lh/content_1825838_2.htm*, accessed on 25/4/2016.

[18]The governance structure of Chinese economy has five basic levels, namely, central government, provinces, municipalities, counties and towns (Xu, 2011). There are also national districts, provincial-level districts and municipal districts. They are on the same level as provinces, municipalities and counties, respectively.

[19]A typical development model is to build a new city center outside the old one. The first step is to set a piece of land as collateral to borrow money from the bank and set up a company with this initial fund. The second step is to join with some large companies (companies in construction of railways, roads, bridges and other utilities) to invest in infrastructure in the new city center. The infrastructures raise the value of land nearby. The third step is to lease some of the land to the private firms. With this first land conveyance revenue the government is able to repay the bank loan. Land values will increase in addition when private firms start their business using the land. Then local government accumulate land in good locations and lease it to qualified real estate developers at a much higher price. Local government may also move the official buildings and most of the public services to the new center.

as municipal districts. The number reached an historical high in year 2014 and 2015. Municipal district is under direct control of the municipal government. Once a county becomes a municipal district, a large area of rural land can then be allocated by the city officials who therefore obtained much more land resources and authority to plan infrastructure investment and land supply.

In summary, the deregulation of local government debt, together with increased quota for land supply, provided strong incentives for local officials to take loans for the public investment projects financed by future land conveyance revenue.

3. A Simple Model of Land Financing

This section provides a simple framework to illustrate local government's decision on public investment and lender's decision on the interest rate for local governments based on the share of land revenue. The model builds on Cai and Treisman (2005) with the extension of inter-temporal decision on external financing.

3.1. Decision on the public investment

We start with a small and close economy that consists of one government and many lenders. The economy is endowed with productivity A and private capital K which are exogenously given (the assumption of fixed private capital will be relaxed later). The government decides the level of public investment in infrastructure, I_t, at each period t. The public investment can be interpreted as any governmental investment that can increase the productivity of private capital. For example, investment in transportation, telecommunications, education, public health and legal systems. I assume that the accumulation of the public investment follows the process $G_{t+1} = (1 - \delta)G_t + I_t$, where G_t is the stock of public capital at period t with depreciation rate δ.

The total output of the economy, Y, is assumed to be a function of productivity, private capital and public capital in the form of Cobb-Douglas technology

$$Y_t = AK^\alpha G_t^\beta, \tag{1}$$

where $\alpha > 0$, $\beta > 0$ and $\alpha + \beta < 1$. All variables are nonnegative. The assumption that $\alpha + \beta < 1$ reflects the effects of other fixed factors such as land and labor. The Cobb-Douglas form is assuming that the productivity, private capital and public capital are complementary.

Following Cai and Treisman (2005), I assume that the objective of government is a linear combination of private consumption (which equals after-tax income) and government

10

consumption with a given weight on the latter. The price for both consumption is normalized as one. The utility function of government is given as

$$U_t = (1 - \tau)Y_t + \eta V(C_t), \tag{2}$$

where $(1 - \tau)Y_t$ represents private consumption and τ is tax rate. The sub-utility of government consumption (C_t) is denoted by $V(C_t)$ with the assumption that $V'(C_t) > 0$ and $V''(C_t) < 0$. The government consumption can be interpreted as either government officials' consumption or government's spending on public goods and services. The weight for government consumption is η $(\eta > 0)$ which captures the benevolence of the government when η is close to zero and predation when η approaches infinity.

When considering the government's choices on debt, it is necessary to introduce the intertemporal framework and the interest rate. Consistent with the regulation by the Ministry of Finance in China, the budget constraint for the government is constructed as

$$I_t + C_t + (1 + r)D_{t-1} = D_t + \tau Y_t + R_t. \tag{3}$$

The expenditure consists of public investment (I_t), government consumption (C_t) and the repayment of the debt in the last period (D_{t-1}) with the interest rate of r. The equilibrium interest rate at each period is determined by many lenders which I will discuss in the next section. The cash inflow for the government includes new debts in current period (D_t), tax revenue (τY_t) and land conveyance revenue (R_t). It is important to note that land conveyance revenue does not directly affect the decision on government investment but affects the lender's decision on interest rate. To simplify the discussion, I assume that the sequence of $\{R_t\}$ is exogenous given and fully anticipated by both the government and lenders.[20]

The government chooses the level of public investment, government consumption and the debt at the beginning of each period t to maximize her life-time discounted utility, which is given by $\sum_{t=0}^{\infty} \rho^t U_t$, where ρ $(0 < \rho < 1)$ is the subjective discount rate for the government. The utility maximization subjects to the budget constraint (equation 3) and the accumulation process of public capital. We assume no uncertainty in the government's decision and the government is perfect foresight. To prevent the model from engaging into Ponzi-type scheme, I impose constraints that $\lim_{t \to \infty} \left(\frac{G_{t+1}}{(1+r)^t} \right) \geq 0$ and $\lim_{t \to \infty} D_t \geq 0$. Then

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[20]We can solve for the equilibrium of $\{R_t\}$ by introducing resident's demand for housing, real estate developer's demand for land, labor supply decision and local government's decision on land supply. One example of these extensions is Zhang et al. (2017) who model the local government's decision on land supply with production sector, housing sector and public sector in the framework of spatial equilibrium model. However, introducing labor market and land market will not change the intuition in the current model but makes it complicated in the analysis.

we can solve for the first order decision of public investment

$$\frac{\partial Y_{t+1}}{\partial G_{t+1}} = \frac{r + \delta}{\tau + \frac{1-\tau}{\eta V'(C_{t+1})}}, \tag{4}$$

where the right-hand side of the equation can be interpreted as the opportunity cost of government investment. When the interest rate r is smaller, the opportunity cost of public investment becomes smaller, inducing a higher level of G_{t+1}. The intuition is that the time value of today relative to tomorrow is smaller so that the marginal return of future production becomes higher and the government is willing to have a higher investment level in equilibrium. Note that the equilibrium level of public capital G stays as a constant if we assume the subjective discount rate equals the financial discount rate, i.e., $\rho(1 + r) = 1$. Under this assumption, we can derive the optimal level of investment in each period

$$I_t = I(=\delta G) \equiv \delta \left[\beta A K^\alpha \left(\frac{\tau + \frac{1-\tau}{\eta V'(C_0)}}{r + \delta} \right) \right]^{\frac{1}{1-\beta}} \tag{5}$$

from which we obtain the first proposition from the model.

Proposition 1. *The optimal level of government investment is decreasing in the interest rate of public debts under the assumption that $\rho(1 + r) = 1$, all else being equal.*

3.2. Decision on the cost of debt

Modeling the relation between the interest rate of debt and the share of land revenue requires additional assumptions about the different liquidation value of different fiscal revenue. In the context of China, tax revenue is strictly regulated and highly shared by the central government since the reform of tax sharing system in 1994 (Man and Hong, 2010). The land conveyance revenue, on the other hand, is more flexible and less shared by the central government (Han and Kung, 2015). In the eyes of the lenders, therefore, land conveyance revenue is regarded as the collateral of better quality because it is more likely to be used for debt repayment compared to tax revenue. Besides, infrastructure investment can increase the value of land in the future which also strengthens the confidence in repaying the debt by future land conveyance revenue. The ability to pledge collateral, especially for borrowers who have no precious records, therefore serves as a signal of borrowers' credit quality and reduces the cost of external financing (Benmelech and Bergman, 2009; Jimenez et al., 2006). The expected payoff for the lender is constructed as follow:

$$E\pi = (1 - q)(1 + r)D + q(\theta_1 \kappa \tau Y + \theta_2 \kappa R) - (1 + r_f)D,$$

where the demand of loans by the government is a certain percentage of the total fiscal revenue, $D = \kappa(\tau Y + R)$, and κ is the loan-to-value ratio. The expected return from lending comprises of two parts. When the government repays all the debt, the lender receives $(1+r)D$ with interest rate r in the contract. In case of a default happening, the lender can claim for a liquidation value from both the tax revenue and the land conveyance revenue. The liquidation probabilities for the tax revenue and the land conveyance revenue are denoted by θ_1 and θ_2 $(0 \leq \theta_1, \theta_2 \leq 1)$, respectively. The probability of default is q $(0 \leq q \leq 1)$. The outside option for the lender is $(1 + r_f)D$ where r_f is the risk-free rate being the same for all lenders.

In a competitive market with many lenders and one government, the equilibrium condition for the interest rate is zero profit for all lenders, i.e., $E\pi = 0$. The share of land conveyance revenue in total fiscal revenue is denoted by $s \equiv \frac{R}{\tau Y + R}$. Then we can derive the equilibrium interest rate for the government debt

$$1 + r = \frac{1 + r_f}{1 - q} - \frac{q}{1 - q}(\theta_1 + (\theta_2 - \theta_1)s).$$

It is intuitive to check that both a higher default rate and a higher risk-free rate contribute to a higher cost of debt for the government. What's less intuitive, however, is that the interest rate is decreasing (increasing) in the share of land conveyance revenue s when $\theta_2 - \theta_1 > 0$ $(\theta_2 - \theta_1 < 0)$. The liquidation probability of the land conveyance revenue is larger than that of the tax revenue when θ_2 is greater than θ_1. Then lenders are willing to offer a lower interest rate for the government with a higher share of land conveyance revenue which I summarize in proposition 2.

Proposition 2. *The interest rate of the government debt is decreasing in the share of land conveyance revenue in total fiscal revenue when the liquidation probability of the land conveyance revenue is higher than that of tax revenue, i.e., $r = r(s)$ and $r'(s) < 0$, all else being equal.*

3.3. Policy effects on land financing and economic growth

To model the policy effects of central government on regional economic growth, we further consider an economy of multiple regions. Each region i has one local government and many lenders with sufficient credit resources. Region i is endowed with productivity A_i and private capital K_i. I assume the local governments in each region are making decisions simultaneously and independently. Therefore, the decisions on public investment in each region follow the same logic as discussed in Proposition 1 and 2.

What's different is that now we consider the government investment in two periods, t_0 and t_1. In the first period t_0, the issuance of local government debt is strictly regulated by the central government and the interest rate of local government debt is set to be the same level, $\bar{r}$, for local governments in all regions. The $\bar{r}$ is sufficiently high relative to the risk-free rate so that all local governments can hardly raise money by themselves for the public investment projects.[21] In the second period t_1, however, the central government deregulates the interest rate for the local government debt and allows local governments to bargain with the lenders. The interest rate of region i in second period, therefore, is a monotone decreasing function of the share of land conveyance revenue in the total fiscal revenue denoted by $r(s_i)$ $(r'(s_i) < 0)$, as suggested in Proposition 2. The interest rate in different period can be summarized as

$$
r_t = \begin{cases} \bar{r} \ , & t = t_0 \\ r(s_i), & t = t_1. \end{cases}
$$

Facing the deregulation of public debt, local government in region i with a higher initial share of land conveyance revenue (s_i) can obtain a lower cost of debt (Proposition 2) and then achieves a higher level of public capital (Proposition 1). The economic growth rate in region i from period t_0 to t_1 is therefore derived as follow:

$$
g_{i,t1}^Y = \beta g_{i,t1}^G = \beta \left[\left(\frac{\bar{r} + \delta}{r(s_i) + \delta} \right)^{\frac{1}{1-\beta}} - 1 \right]. \tag{6}
$$

Under the assumption of fixed private capital and unlimited credit supply for local governments, the policy effects of public-debt deregulation varies across regions. The regions with a higher share of land conveyance revenue benefits more from the policy due to a larger reduction in the cost of debt. Note that the subjective discount rate always equals the financial discount rate by assumption, i.e., $\rho_t(1+r_t) = 1$. I summarize the model implications by the following proposition which I will test empirically using China's county-level data.

Proposition 3. *After the deregulation of local government debt, the economic growth rate is higher in the region with a higher share of land conveyance revenue in total fiscal revenue, all else being equal.*

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[21]In China, the issuance of local government debt before the "Four Trillion Yuan" policy is strictly regulated and most of local governments can only borrow money through a certain central departments, for example, the Ministry of Finance.

3.4. Extension on Private-capital Mobility

In the benchmark model, private capital in each region is assumed to be fixed over time. However, it can be relaxed by introducing free mobility of private capital across regions. Under this assumption, private capital will inflow into the regions with higher productivity and better public infrastructure. In equilibrium, the after-tax marginal return for private capital in each region i achieves the same level which we denote as $\widetilde{r}$, that is,

$$(1 - \tau)\frac{\partial Y_i}{\partial K_i} = \widetilde{r}.$$

Each region is small relative to the whole economy so that the capital inflow into a single region has no impact on the economy-wide net return $\widetilde{r}$. Together with the technology (equation 1) we have

$$K_i = \left(\frac{1 - \tau}{\widetilde{r}}\alpha A_i G_i^{\beta}\right)^{\frac{1}{1-\alpha}}.$$

Clearly the government's decision on public investment now also changes the private capital inflow. Anticipating the inflow of private capital, the first order condition of government investment in equation 4 now is derived as

$$\frac{\partial Y_{t+1}}{\partial G_{t+1}} + \frac{\partial Y_{t+1}}{\partial K_{t+1}}\frac{\partial K_{t+1}}{\partial G_{t+1}} = \frac{r + \delta}{\tau + \frac{1-\tau}{\eta V'(C_{t+1})}}.$$

Solving this F.O.C we have the equilibrium public capital

$$G_{i,t+1} = \left(\frac{1}{1-\alpha}\right)^{\frac{1}{1-\beta}}\left[\beta A_i K_{i,t+1}^{\alpha}\left(\frac{\tau + \frac{1-\tau}{\eta V'(C_{i,t+1})}}{r_i + \delta}\right)\right]^{\frac{1}{1-\beta}},$$

where $K_{i,t+1}$ is a function of A_i and $G_{i,t+1}$. Similar to Cai and Treisman (2005), there will be a competition effect on government investment, that is, $\left(\frac{1}{1-\alpha}\right)^{\frac{1}{1-\beta}} > 1$. The effect of interest rate r on the government investment now becomes larger because of the competition effect. Then the economic growth rate in region i from period t_0 to t_1 is modified as:

$$g_{i,t1}^{Y} = \beta g_{i,t1}^{G} = \beta\left[\left(\frac{\overline{r} + \delta}{r(s_i) + \delta}\right)^{\frac{1-\alpha}{1-\alpha-\beta}} - 1\right].$$

Since $\frac{1-\alpha}{1-\alpha-\beta} > \frac{1}{1-\beta}$, the effect of public-debt deregulation on economic growth becomes larger compared to equation 6. When the private capital is perfectly mobile across regions, a lower cost of debt not only directly increase government investment, but also indirectly attracts private investment in the participation of better public infrastructures. I summarize

15

the implications of extension on the perfect mobility of private capital as the following proposition.

Proposition 4. *A larger share of land revenue increases both government investment and private investment under the assumption of perfect mobility of private capital. The effect of local-government-debt deregulation on economic growth is larger when private capital is perfectly mobile across regions, compared to the case of fixed private capital.*

Note that there is no crowd-out effect of government financing on private financing in this simple model. In reality, it is possible that local government debt crowds out private capital which hinders economic growth (Huang et al., 2017). However, the logic of this simple model still holds if the empirical evidence suggests a positive and significant correlation between the share of land revenue and economic growth, though the estimation could be possibly downward biased when there is crowd-out effect.

4. Data

To test the land-financing mechanism (Proposition 3), county-level data are used as the basic unit of analysis.[22] The reasons are as follows. First, the primary decisions of land supply are made in county-level governments subject to the restriction of an annual supply plan set by the upper level governments. Second, the sample size of counties is much larger than the size of prefectures. There are more variation of local government's behavior in counties compared to that in provinces or prefectures. What's more, the size of counties is smaller and it is more comparable across regions using county-level data, compared to prefecture-level data. By focusing on counties we can rule out the influences of some super big cities. The drawbacks, however, is that the reliable economic data of counties in China are unavailable until 2004.

The macro-economic data of counties are from the National Bureau of Statistics of China via CEIC China Premium Database which covers counties' gross economic output, fiscal revenue, population, fixed asset investment and other economic variables from 2004 to 2014.[23] Note that there are a total of 2,815 county-level administrative regions at the end of 2015, including districts, counties, county-level cities and autonomous counties.[24] However, the

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[22]Results are robust using prefectural-level city data. See appendix Table 11.

[23]Note that the data of GDP per capita of counties is not used in this paper because they are only available from 2005 to 2010 with many missing data.

[24]In 2015, there are 34 provincial-level regions (23 provinces, 4 municipalities, 5 autonomous regions and 2 special administrative regions), 334 prefecture-level regions (294 prefecture-level cities, 30 autonomous prefectures, 7 prefecture-level districts, 3 leagues), and 2,815 county-level regions. For more details, see official website (in Chinese): *www.mca.gov.cn/article/sj/tjbz/a/2015/*.

number of county-level regions kept changing during recent decades and many economic data of autonomous counties were missing or unreported. To fix the idea, I simply adopt the consistent sample of 2,071 county-level administrative regions (hereafter termed counties) in the CEIC database.[25] For the fiscal data, special attention should be paid to the reform of the classification of governmental incomes and expenses in 2007.[26] The fiscal data in CEIC is directly obtained from the Chinese National Bureau of Statistics who had calibrated the data to make it comparable before and after 2007.

There are three key variables in this paper that are not reported by county-level governments, namely, land conveyance revenue, geographic elevation and night light intensity. For the county-level land supply data, I manually collect the information from every land transaction reported daily by the Ministry of Land and Resources.[27] I aggregate the data to the county level. The collected land data are from China Land Market website (www.landchina.com). The data cover land transactions as early as in 1992 in Shenzhen city. However, the land transactions are incomplete and not well-organized until the announcement of land registration regulation in early 2008.[28] To check the completeness of transaction-level land data, I compare the aggregate data with the reported national data (see appendix Table 9). It is not difficult to find that only after 2007 the transaction-level data is closed to the national data. Therefore, I only use the land data since 2007. To obtain the county-level land conveyance revenue, I sum up all the transaction value in each county in each year.[29] The geographic elevation data which measures the amount of developable land resources are based on the GTOPO-30 Digital Elevation Model raster data from CHGIS datasets from Harvard University.[30] The map of the Chinese counties is from the Global Administrative Areas Database developed by Robert Hijmans.[31] I calculate the average ele-

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[25]There are 2076 counties in CEIC database, but five of them do not have data after 2008.

[26]Ministry of Finance, 10/2/2006, "Scheme of classified reform on the governmental incomes and expenses (in Chinese)" (initiated from Jan.1, 2007), `www.mof.gov.cn/zhengwuxinxi/ caizhengwengao/caizhengbuwengao2006/caizhengbuwengao20062/200805/t20080519_23693.html`, accessed on 25/4/2016.

[27]Land transaction refers to the initial transfer of land use right by the local government in the primary land market.

[28]Ministry of Land and Resources, 30/12/2007, "Land registration regulation (in Chinese)" (effected on Feb.1, 2008), $www.gov.cn/flfg/2008-01/03/content\_849402.htm$, accessed on 25/4/2016.

[29]I drop 405 observations in land transactions which have transaction values of more than 5 billion yuan per piece of land, or an area of more than 1000 hectares, or per hectare land price of more than 500 thousand yuan per square meter (which means less than the highest record in 2015). I also drop 119,016 duplicated observations (most of which are before 2008).

[30]Data are available on the website $www.fas.harvard.edu/chgis$.

[31]Data are available on the website $www.gadm.org/country$. We use the old version of the map in 1999 instead of the new version in 2005 because the county samples in CEIC are based on all counties (excluding districts) before 2000 and most of the current districts appearing in CEIC are those changed from county to district. Therefore, the map in 1999 is more consistent with the data in CEIC.

vation per unit area of each county in the software ArcGIS 10.0. Lastly, the luminosity data in this paper are from the National Oceanic and Atmospheric Administration (NOAA) who publicly provide global maps of stable night lights from 1992 to 2013. Although satellite data of stable light at night is a useful supplement for economic growth data in regions with poor quality data (Chen and Nordhaus, 2011; Henderson, Storeygard and Weil, 2012), there are some problems need to be addressed in the calculation of the growth of night light intensity which I discuss in the appendix.[32]

In the empirical analysis, three are three constructed variables. The share of land conveyance revenue in total fiscal revenue is calculated as

$$LandRev\_share_i = (LandRevenue_i)/(FiscalRevenue_i + LandRevenue_i).$$

Since the tax revenue is a function of the gross output in the theoretical model, I also calculate the ratio of land conveyance revenue to gross domestic output

$$LandRev\_Y_i = LandRevenue_i/GDP_i,$$

in order to separate the effects of land conveyance revenue from tax revenue. The last one is the measure of developable amount of plain-land defined as the reverse of average elevation

$$Plain_i = -ln(AverageElevation_i)/(MaxElevation),$$

which is normalized by the maximum value of elevation in all counties. Larger value of $Plain$ means more developable land resources. $Plain$ is used as the instrument for the share of land revenue.[33]

[Insert Table 1 around here]

Table 1 summarizes the main variables used in the analysis. Note that the author prefers to use the values in current price rather than in constant price. The main concern is that the price index could be manipulated to smooth the GDP fluctuation. For example, there was a crash down of GDP growth rate in 2009 in terms of current price. But the fast decrease in 2009 disappeared if we revise the GDP using the prefectural deflator (the county-level price index is unavailable). However, I do check the results using the constant price and they are robust. I also use the night light intensity, to some extent, to response to the concern of

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[32]For comparison, I also calculate the average firm-level TFP of counties using the firm-level data from 1998 to 2007. This database is collected by the National Bureau of Statistics of China and it covers all state-owned industrial firms and non-state firms with sales over five million yuan. See Brandt et al. (2012) for a detailed description of Chinese firm-level industry data. Industry in the data includes manufacturing, mining and public utilities. I focus on manufacturing firms with a two-digit industry code from 13 to 42.

[33]Figure 9 in appendix presents the distribution of elevation in China.

inconsistent price and unreliable macro-data. Table 1 suggests that there was an obvious re-jump of the nominal GDP growth rate during 2010 to 2011 reflecting the effect of the "Four Trillion Yuan" policy. The land conveyance revenue was similar before 2009 but climbed up rapidly after 2009. The share of land revenue increased from 23% to 34% during the sample period. The growth of the night light data also reached a historical high in 2010.

5. Results

5.1. Benchmark Results

To test the main prediction in the model (Proposition 3), the empirical strategy borrows the idea of difference in differences (Angrist and Pischke, 2008). As model shown, counties with a higher share of land revenue benefited more from the deregulation of local government debt. The increased public investment contributed to a higher economic growth rate. The empirical model is given as follow.

$$Economic\ Growth_{i,t} = \alpha_0 + \beta \cdot LandRev\_share07_i \cdot Post09_t$$

$$+ \sum_{j=1}^{J} \gamma_j \cdot X_{j,i,t} + \delta_t + \nu_i + \epsilon_{i,t},$$

where $Economic\ Growth_{it}$ is the economic growth rate of county i in year t calculated as $gy_t = (y_t - y_{t-1})/y_{t-1}$ based on the nominal GDP data. The difference between GDP in current price and constant price is discussed in the data section. $LandRev\_share07_i$ is the share of land revenue in 2007. I use the earliest available data of land supply in 2007 to alleviate the endogeneity problem. $Post09_t$ equals 1 for every year after 2009 (including 2009). The control variables X_{ijt} control for the population and other confounding effects. The variable δ and ν control for the year fixed effects and county fixed effects, respectively. The error term, ϵ_{it} is assumed to be i.i.d. The coefficient β on the interaction term between $LandRev\_share07_i$ and $Post09_t$ is the main focus in testing the land-financing mechanism.

The benchmark results in Table 2 suggest a statistically and economically significant correlation between land financing and economic growth. On average, counties with a 23% share of land revenue in 2007 had 1.6 percentage points higher of the GDP growth rate after 2009 compared to those with zero land revenue (column 1 in Table 2; $0.071 * 0.23 = 0.016$). For counties with more than half of the land revenue in 2007, there would be an increase of over 3.5 percentage points of GDP growth rate after 2009. One concern for the result is the convergence effect that counties with a smaller size of gross output may have a higher

$LandRev\_share07_i$ and then enjoyed a higher economic growth rate after 2009 due to the convergence of GDP. To check the convergence effect of size, I include the interaction term between the (log of) GDP level in 2007 ($lnY07$) and $Post09_t$ (column 2). The convergence effect does exists that counties with a larger GDP in 2007 were growing slower than others after 2009. The core coefficient β, however, stays highly significant and positive.

[Insert Table 2 around here]

Another challenge to the result is that the financial crisis was going together with the deregulation of local government debt.[34] Counties that were less vulnerable to the shock of global demand should had higher economic growth rate relative to those more exposed to the global market. To check the impact of financial crisis, I calculate the share of exporting firms in the total number of manufacturing firms in 2007 using firm-level manufacturing database, i.e., $Export\_share07_i$. The higher the exporting share is, the more vulnerable the county is during the financial crisis. After controlling the exporting share, results are robust (column 3). Interestingly, counties exposed more to the global market were actually growing faster than those less vulnerable to the financial crisis. One possible explanation is that these counties with higher share of exporting firms were the regions attracting more migrant workers. The agglomeration of labor contributed to a higher price of urban land and then higher land revenue for the local government. Column 4 in Table 2 also controls the time-varying (log of) population to account for the effects of population growth and labor inputs on economic growth. There is positive and significant relation between population and economic growth. The land-financing effect remains positive and significant after controlling the population.

To show that the share of land revenue, $LandRev\_share07_i$, is mainly driving by the land conveyance revenue, I also construct another variable, $LandRev\_Y07_i$, which is the ratio of land conveyance revenue to GDP in 2007. Results are similar to the basic results as shown in the last two columns. Results on real GDP growth rate with constant price are similar but the coefficients are slightly smaller (appendix Table 10).

5.2. Comparing Pre-policy Trends

The major challenge to the difference-in-differences strategy is that the change of economic growth rate after 2009 may be driven by the preexisting differences before the policy shock. To deal with this issue, I compare the pretreatment trends for the treated and untreated

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[34]There were other policies during the sample period that might affect economic growth. For example, a decrease of benchmark interest rate occurred during 2008 to 2009, followed with an appreciation of CNY during 2010 to 2011. However, the effects of interest rate and exchange rate policies are captured by year fixed effects. The home purchase restriction policies during 2011 to 2014 might also affect real estate investment and land demand by developers. These policy effects can also be captured by year and county fixed effects.

groups. Since we do not have a natural experiment to separate the counties, I manually divide the counties into two groups according to their share of land revenue in 2007 and check whether their pre-policy trends are similar. I choose the top 30% of $LandRev\_share07_i$ as the cut-off point and the group with higher share of land revenue is denoted as high-share group and the rest as low-share group. The time trends of two groups were similar and the gap between two groups was stable before 2009 (Figure 3). The economic growth rate of the low-share group was higher than that of the high-share group. But the gap between two groups declined quickly after 2009. The high-share group even captured up with the low-share one during 2013 to 2014. Looking at the difference of economic growth rate between two groups, it is indeed after 2009 that the high-share group was growing faster than the other group. The gap between two groups was persistent and becoming larger over time. This simple test suggests that there is no systematic differences between two groups before the policy shock.

[Insert Figure 3 around here]

The empirical test of land-financing mechanism may be invalid if the ranking of the share of land revenue was changing frequently over time. I compare the trend of $LandRev\_share_{i,t}$ between two groups (top 50% v.s bottom 50% in 2007). Counties with a high share of land revenue in 2007 were still having a higher share from 2008 to 2014, though the gap between two groups was slightly decreasing (appendix Figure 7). The coefficient of auto-correlation is about 0.52. Therefore, the distribution of the share of land revenue is quite stable over the sample period.

5.3. Measuring Annual Effects Over Time

In order to examine the timing of the changes and the persistence of land-financing effects on economic growth, I estimate the annual effects with the following empirical model:

$$
\begin{aligned}
Economic\ Growth_{i,t} =& \alpha_0 + \sum_{t=2006}^{2014} \beta_t \cdot LandRev\_share07_i \cdot YEAR_t \\
&+ \sum_{j=1}^{J} \gamma_j \cdot X_{j,i,t} + \delta_t + \nu_i + \epsilon_{i,t},
\end{aligned}
$$

where I allow the coefficient β_t to change in different years and $YEAR_t$ is the dummy for each year t.[35] The control variables include $lnY07 \cdot Post09$, $lnExport\_share07 \cdot Post09$ and $lnPop$. Figure 4 presents the mean and confidence interval of the coefficient β_t in different years. The coefficients of the interaction terms are in a relatively low level from 2006 to

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[35]The regression is weighted by the fiscal revenue in 2007. The base-level in 2005 is omitted.

2008 but increase fast since 2009. The estimation of the annual coefficients indicate that the "Four Trillion Yuan" policy effect occurred in 2009 and was increasing over time. Counties with a higher share of land revenue were persistently growing faster than those with a lower share of land revenue.

<div align="center">[Insert Figure 4 around here]</div>

While many people are worried about the risk of local government debt in China, the estimation of the annual effects of land financing suggests a persistent and growing advantage over the sample period for the counties with a higher initial share of land revenue. The examination of long-term effects may require sample of more than 10 years which is unavailable currently. To this stage, we can only say that land financing could be a way to promote economic growth in the sample period and it need more evidence to check the sustainability of land financing.

5.4. Instrumental Variable Approach

The estimation of land-financing effect in the basic regression may be under-estimated because counties with more land conveyance revenue tend to have more fiscal revenue, resulting in a lower share of land revenue. On the other hand, the counties with more fiscal revenue tend to have a lower cost of debt due to the size effect. Thus the share of land revenue may under-estimate the impact of land revenue on the cost of debt. To address this concern, I construct another variable measuring the amount of developable land resources, i.e., $Plain_i = -ln(AverageElevation_i)/(MaxElevation)$, which is normalized by the maximum value of the elevation in all counties. The reason is that regions with more developable land resources (e.g.,less mountains and more plains) have more collateral of good quality. Local governments have less land to sell if there are a lot of mountains, that is, a smaller value of $Plain_i$.

The land plainness, $Plain_i$, is a valid instrument variable (IV) for the share of land revenue in the following ways. First, it is closely related with the share of land revenue. The adoption of average elevation as instrument variable for land supply basically follows the idea of Saiz (2010) who first uses satellite data on elevation and water bodies to precisely estimate the amount of developable land in US. Similarly, there are many counties in China that are severely constrained by geography. Counties with more mountains tend to have less developable land reserves for leasing, and hence have a smaller share of land revenue. The land plainness can precisely capture the amount of developable land in different counties.

Second, land plainness is unrelated with economic growth rate (gy) after controlling for the initial size of GDP. One concern is that the plainness is highly correlated with GDP and

<div align="center">22</div>

GDP growth rate.[36] It is true that counties with more plain land tend to have a larger size of GDP and hence a smaller economic growth rate due to growth convergence. However, $Plain_i$ is related to gy_{it} only because it is related to the size of GDP. After controlling the size of initial GDP, $Plain_i$ affects the change of gy_{it} only through the land-financing channel.[37] It can be proved that the conditional independence and exclusion restrictions underlying the IV estimation may be more likely to be valid after conditioning on covariates, that is, the "lnY07" in this case (Angrist and Pischke, 2008). In the IV regressions, I control for the county fixed effects and the interaction term with initial GDP size ($lnY07 \cdot Post09$). Besides, the identification strategy (difference in differences) focuses on the change of economic growth rate among different groups before and after 2009. The instrumental variable $Plain_i$ is static over time. It is unnecessarily correlated with the change of gy_{it} without the channel of land financing.

The IV regression is constructed as follows:

$$First\ stage: \ LandRev\_share07_i \cdot Post09_t = \ \eta_0 + \phi \cdot Plain_i \cdot Post09_t$$
$$+ \sum_{j=1}^{J} \lambda_j \cdot X_{j,i,t} + \mu_t + \theta_i + \omega_{i,t};$$

$$Second\ stage: \ Economic\ Growth_{i,t} \ = \ \alpha_0 + \beta \cdot LandRev\_share07_i \cdot Post09_t$$
$$+ \sum_{j=1}^{J} \gamma_j \cdot X_{j,i,t} + \delta_t + \nu_i + \epsilon_{i,t}.$$

The results of IV regressions are shown in Table 3. The fist-stage regression suggests a high correlation between the IV and the share of land revenue. In the second-stage regressions, the estimated coefficients are much higher than the basic results. The counties with 23% share of land revenue in 2007 now had 4.2 percentage-points advantage of the nominal GDP growth after 2009, compared to those with zero land revenue ($0.184*0.23 = 0.042$). For counties with more than half of the land revenue in 2007, there would be an increase of over 9 percentage points of GDP growth rate after 2009. The land-financing effect is more than two times as large as that in the basic regressions. With an average of 17% of GDP growth rate in our sample, the 4.2 percentage advantage is actually very large. After controlling

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[36]Thanks the anonymous referees for pointing out this.

[37]The OLS estimation is as follow:

$$Economic\ Growth_{i,t} \ = 0.192^{***} + 0.00009 \cdot Plain_i - 0.015^{***} \cdot lnY07_i,$$
$$(0.005) \qquad (0.0008) \qquad \qquad (0.001)$$

where standard errors are in parentheses. Year fixed effect is controlled. Total observations are 10,577 for all samples after 2009. Significance levels: *** 1%, ** 5% and * 10%.

for the initial GDP, export share and population, the estimated land-financing effect is even larger (column 4). The IV regression indicates that OLS estimations in the basic results are downward biased.

[Insert Table 3 around here]

5.5. *Robustness Checks*

Night Light Intensity. One important threat to the author's argument is that the GDP growth data does not reflect the "real" economic growth and has no implication for the social welfare. To address this concern, I investigate the change of night light intensity during the sample period. The satellite data of stable light at night is a useful supplement for economic growth data in regions with poor quality data (Chen and Nordhaus, 2011; Henderson et al., 2012). A higher growth rate of night light intensity means faster growth of infrastructures (e.g., roads), quicker urban expansion or more population concentration. Compared to the number of GDP, the change of night light intensity reflects the real change of the city where people live in. The calculation of growth rate of night light and the adjustment of the night light data are discussed in the appendix. I check the IV regressions on the growth of night light and use the plainness as instrumental variable. Results are reported in Table 4. The first-stage regressions are almost the same as that in Table 3. The first two columns are the results on original night light data while the last two columns are results on adjusted night light data. It is unsurprising to find that the results are close to the IV regressions in Table 3. Counties with a 23% share of land conveyance revenue in 2007, in this time, had 7.5 percentage-points advantage in the growth rate of night light intensity after 2009 ($0.326 * 0.23 = 0.075$). The results on night light intensity confirms the estimations on GDP growth.

[Insert Table 4 around here]

Manufacturing Productivity Hypothesis. The fast economic growth in China from 1978 to 2007 was driven by productivity growth rather than capital investment (Zhu, 2012). The share of land revenue may capture the productivity of different counties. More land conveyance revenue may be the outcome of higher productivity and thus higher economic growth rate. To rule out this possibility, I construct the average firm-level TFP in each county in 2007 using the firm-level manufacturing database.[38] The regression model is similar to the benchmark regression but we use the level of (log of) TFP to substitute for *LandRev_share*. Results are reported in the first two columns in Table 5. In contrast to the basic results, I find that counties with higher manufacturing productivity were growing slower after

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[38]We follows Olley and Pakes (1996)'s method to calculate TFP using intermediate input as control function. The detailed calculation process follows Brandt et al. (2012).

2009. Therefore, the share of land revenue does not capture the effect of manufacturing productivity.

<center>[Insert Table 5 around here]</center>

Year Selection. Another concern of the benchmark results is that the share of land revenue needs not to be chosen in 2007. The last two columns in Table 5 report the benchmark regression using the share of land conveyance revenue in 2008 and 2009. The estimated effects of land financing is similar to the basic results. For example, the counties with a 23% share of land conveyance revenue in 2008 was growing faster by 1.8 percentage points after 2009, compared to those with zero land revenue ($0.078 * 0.23 = 0.018$).

6. Mechanism Discussion

In this section, two important channels of the theoretical model are tested. First, local governments with a higher share of land revenue receive a lower cost of debt (Proposition 2). Second, local governments with higher share of land revenue invest more in infrastructures (Proposition 1). Since public data of infrastructure investment is unavailable, fixed asset investment is used as proxy for infrastructure investment. Though infrastructure investment is only part of the fixed asset investment, Proposition 4 suggests that private investment will be affected by infrastructure investment. Therefore, the variation of fixed asset investment, to some extent, reflects the change of infrastructure investment.

6.1. Land Financing and Cost of Debt

According to the theoretical model, regions with a higher share of land revenue should receive a lower cost of debt after the deregulation of local government debt in 2009. Though comprehensive information of the interest rate of local government debt is unavailable, this paper follows Bai et al. (2016) and Chen et al. (2017)'s methodology to collect the municipal corporate bond (MCB) data from WIND database.[39] The MCBs are issued by the local government financing vehicles (LGFVs) in the forms of corporate bond, enterprise bond, medium-term note, short-term financing bill, and private placement note (PPN). I calculate the simple-average interest rate of the bond issued by LGFVs in different prefecture-level city at each year (county-level information is unavailable).

Figure 5 presents the relation between the cost of debt and the plainness in each prefectural-level city. The cost of debt for each city is calculated by simple average of the interest rate of all the outstanding MCBs, most of which were issued between 2013 to 2016. It is clear that

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[39]The data of MCBs was collected on 19 June 2017 with all outstanding bonds.

<center>25</center>

cities with more developable land resources tend to have lower cost of debt (Figure 5(a)). One may argue that the plainness is highly correlated with the economic development. To address this concern, the author plots the change of the cost of debt between 2013 to 2016 (Figure 5(b)). The pattern still holds when the relative economic development of each city was stable over the sample period.

[Insert Figure 5 around here]

Table 6 reports results on the cost of debt in the simple cross-section regressions. The first two columns are results on the cost of debt and the last two columns are on the change of the cost of debt. After controlling for per capita GDP in each city in 2007, results are consistent with the patterns in Figure 5. When the share of land revenue increases by 10 percentage points, the interest rate of MCBs decreases by 0.1 percentage points. Results are similar for plainness. [40]

[Insert Table 6 around here]

As an example, Figure 5 highlights three representative cities in Jiangsu province, namely, Yancheng, Nantong and Taizhou, together with four first-tier cities for reference. Most of the cities in Jiangsu province are rich in developable land resources, especially Yancheng city with the highest plainness. While Yancheng city ranked only 114 among 257 cities in terms of per capita GDP in 2007, the decrease of the cost of debt in Yancheng was even larger than Beijing and Shenzhen (Figure 5(b)). Similarly, the decline of the cost of debt in Shanghai was larger than other three first-tier cities, which is consistent with the land financing mechanism. Moreover, Yancheng city responded more strongly to the deregulation of local government debt (appendix Figure 8). The share of land revenue in Yancheng was only 10% in 2008, but jumped sharply to 60% in 2010. Regions with more developable land resources tended to have a higher share of land revenue after the deregulation of local government debt, which in turn brought them with a lower cost of debt.

6.2. Land Financing and Fixed Asset Investment

The author also checks results on fixed asset investment. Although fixed asset investment consists of many kinds of investment, public investment projects should also be reflected in this variable. Following the land-financing mechanism, it is expected that the fixed asset investment in the counties with a higher share of land revenue should be greater after 2009

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[40]I also test the relation between land conveyance revenue and the amount (or growth) of MCBs. Results support the model's prediction that regions with a larger share of land revenue have a larger amount (and a higher growth rate) of MCBs.

compared to others. The empirical model is given as follow.

$$Fixed\ Asset\ Investment_{i,t} = \alpha_0 + \beta \cdot LandRev\_share07_i \cdot Post09_t$$

$$+ \sum_{j=1}^{J} \gamma_j \cdot X_{j,i,t} + \delta_t + \nu_i + \epsilon_{i,t},$$

where most of the notations are the same as benchmark model but the dependent variable is changed as fixed asset investment.

[Insert Table 7 around here]

The results in Table 7 confirm that fixed asset investment was indeed higher after 2009 in the counties with a higher initial share of land revenue. On average, counties with a 23% share of land revenue in 2007 grew faster by 3.7 percentage on fixed asset investment after 2009 compared to those with zero land revenue (column 1 in Table 7; $0.16 * 0.23 = 0.037$). Results are robust after controlling for initial size of GDP, export share and population.

7. Conclusions

The importance of government investment was recognized long ago by Keynes who, in his famous book "*The General Theory of Employment, Interest and Money*", argued that increasing government investment in public projects, rather than raising deficit consumption, can strengthen the confidence of private firms to invest in regions with better infrastructure, and therefore effectively induce domestic demand for investment in a recession (Backhouse and Bateman, 2013). One of the main problems, however, is how to finance government investment projects. China, in this sense, is performing a huge experiment using the state-owned land to finance the public projects.

This paper attempts to test an important question whether local governments are able to promote economic growth by increasing public investment financed with land conveyance revenue. Employing the exogenous event of the "Four Trillion Yuan" policy in China which allowed local governments to take loans through special vehicles, this paper finds strong evidence that regions with a higher initial share of land conveyance revenue were growing faster after 2009 based on the county-level data in China from 2005 to 2014. The land-financing effect was persistent and even increasing over the sample period. On average, counties with a 23% share of land revenue had a GDP growth rate of 2 to 4 percentage points higher than those with zero land revenue after the policy shock. There is similar evidence on the growth of night light intensity. Results are robust using the amount of developable land resources as instrumental variable.

While more and more people are worrying about the financial risk of local government debt in China, this paper focuses on the asset quality of local governments. In most countries, tax revenues are the main sources to repay local government debt. It would be surprising to find that a country with fast growth of local government debt and infrastructure investment can maintain her economic growth for ten years without a fast growth of tax revenues. In China, however, land conveyance revenue plays a major role in maintaining the growth of infrastructure investment. This special feature pushes us to pay more attention to China's land institutions. In an institution that (urban) land is owned by the state, local governments, as the agents of central government, tend to borrow more money and invest more in infrastructure compared to those without land revenues. In contrast to the view that commercial banks are forced to lend more money to local government financing vehicles and state-owned firms, this paper suggests that it is economically rational for commercial banks to do this because urban land is valuable asset of good quality. Therefore, perhaps a more important question on China's financial risk is the change of asset quality of local governments when urbanization is slowing down and housing price is decreasing. The policy makers may want to concern about the influence of land institutions and the incentive problem of local governments when dealing with the risks of local government debt. It is also helpful to make the cost of debt correctly reflect the solvency risk of local governments' financing vehicles. On the other hand, China's experience of boosting economic growth by infrastructure investment is not necessarily applicable in other countries without considering income sources of governments and related institutions. Overall, this paper addresses the special role of land in stimulating economic growth under the institution that urban land is owned and supplied by the state.

References

Ambrose, B.W., Deng, Y., Wu, J., 2015. Understanding the risk of China's local government debts and its linkage with property markets. Working Paper .

Angrist, J.D., Pischke, J.S., 2008. Mostly harmless econometrics: An empiricist's companion. Princeton university press.

Aragn, F.M., 2015. Do better property rights improve local income?: Evidence from first nations' treaties. Journal of Development Economics 116, 43 – 56.

Backhouse, R.E., Bateman, B.W., 2013. The dog called investment, in: Hirai, T., Marcuzzo, M.C., Mehrling, P. (Eds.), Keynesian Reflections: Effective Demand, Money, Finance, and Policies in the Crisis. Oxford University Press, Oxford, pp. 24–39.

Bai, C.E., Hsieh, C.T., Song, Z.M., 2016. The long shadow of a fiscal expansion. Brookings Papers on Economic Activity 60, 309–327.

Benmelech, E., Bergman, N.K., 2009. Collateral pricing. Journal of Financial Economics 91, 339–360.

Besley, T., Burgess, R., 2000. Land reform, poverty reduction, and growth: Evidence from India. The Quarterly Journal of Economics 115, 389–430.

Binsbergen, V., Jules, H., Graham, J.R., Yang, J., 2010. The cost of debt. The Journal of Finance 65, 2089–2136.

Brandt, L., Biesebroeck, J.V., Zhang, Y., 2012. Creative accounting or creative destruction? firm-level productivity growth in Chinese manufacturing. Journal of Development Economics 97, 339–351.

Brandt, L., Van Biesebroeck, J., Wang, L., Zhang, Y., 2017. WTO accession and performance of Chinese manufacturing firms. American Economic Review 107, 2784–2820.

Cai, H., Treisman, D., 2005. Does competition for capital discipline governments? decentralization, globalization, and public policy. The American Economic Review 95, 817–830.

Cao, K.H., Birchenall, J.A., 2013. Agricultural productivity, structural change, and economic growth in post-reform China. Journal of Development Economics 104, 165–180.

Chen, X., Nordhaus, W.D., 2011. The value of luminosity data as a proxy for economic statistics. Proceedings of the National Academy of Sciences 119, 8589–8594.

Chen, Z., He, Z., Liu, C., 2017. The financing of local government in China: Stimulus loan wanes and shadow banking waxes. Working Paper .

De Janvry, A., Emerick, K., Gonzalez-Navarro, M., Sadoulet, E., 2015. Delinking land rights from land use: Certification and migration in mexico. The American Economic Review 105, 3125–3149.

Deininger, K.W., 2003. Land policies for growth and poverty reduction. World Bank Publications.

Ding, C., 2003. Land policy reform in China: assessment and prospects. Land use policy 20, 109–120.

Elvidge, C.D., Hsu, F.C., Baugh, K.E., Ghosh, T., 2014. National trends in satellite-observed lighting, in: Global urban monitoring and assessment through Earth observation. CRC Press Boca Raton, FL, USA, p. 97.

Fang, H., Gu, Q., Xiong, W., Zhou, L.A., 2015. Demystifying the Chinese housing boom, in: NBER Macroeconomics Annual 2015, Volume 30. University of Chicago Press.

Gao, H., Ru, H., Tang, D.Y., 2016. Subnational debt of China: The politics-finance nexus. Working paper .

Han, L., Kung, J.K.S., 2015. Fiscal incentives and policy choices of local governments: Evidence from China. Journal of Development Economics 116, 89–104.

Henderson, J.V., Storeygard, A., Weil, D.N., 2012. Measuring economic growth from outer space. American Economic Review 102, 994–1028.

Hsieh, C.T., Klenow, P.J., 2009. Misallocation and manufacturing TFP in China and India. The Quarterly Journal of Economics 124, 1403–1448.

Huang, Y., Pagano, M., Panizza, U., 2017. Local Crowding Out in China. Technical Report. Einaudi Institute for Economics and Finance (EIEF).

Jimenez, G., Salas, V., Saurina, J., 2006. Determinants of collateral. Journal of Financial Economics 81, 255–281.

Kemper, N., Ha, L.V., Klump, R., 2015. Property rights and consumption volatility: Evidence from a land reform in Vietnam. World Development 71, 107 – 130.

Li, H., Yang, Z., Yao, X., Zhang, H., Zhang, J., 2012. Entrepreneurship, private economy and growth: Evidence from China. China Economic Review 23, 948–961.

Lichtenberg, E., Ding, C., 2009. Local officials as land developers: Urban spatial expansion in China. Journal of Urban Economics 66, 57–64.

Man, J.Y., Hong, Y.H. (Eds.), 2010. China's local public finance in transition. Cambridge, MA: Lincoln Institute of Land Policy.

Nizalov, D., Thornsbury, S., Loveridge, S., Woods, M., Zadorozhna, O., 2016. Security of property rights and transition in land use. Journal of Comparative Economics 44, 76 – 91.

Olley, S., Pakes, A., 1996. The dynamics of productivity in the telecomunications equipment industry. Econometrica 64, 1263–97.

Peterson, G.E., 2006. Land leasing and land sale as an infrastructure-financing option. World Bank Policy Research Working Paper .

Rithmire, M.E., 2017. Land institutions and Chinese political economy: Institutional complementarities and macroeconomic management. Politics & Society 45, 123–153.

Saiz, A., 2010. The geographic determinants of housing supply. The Quarterly Journal of Economics 125, 1253–1296.

Smith, A., 1976. An Inquiry into the Nature and Causes of the Wealth of Nations (1st edn 1776, vol. II of The Glasgow Edition of the Works and Correspondence of Adam Smith, edited by RH Campbell, AS Skinner and WB Todd). Oxford: Oxford University Press.

World Bank, Development Research Center of the State Council of China, 2014. Urban China : Toward Efficient, Inclusive, and Sustainable Urbanization. World Bank, Washington, DC.

Xu, C., 2011. The fundamental institutions of China's reforms and development. Journal of Economic Literature 49, 1076–1151.

Zhang, J., Fan, J., Mo, J., 2017. Government intervention, land market, and urban development: Evidence from Chinese cities. Economic Inquiry 55, 115–136.

Zhang, Y., Barnett, S.A., 2014. Fiscal vulnerabilities and risks from local government finance in China. Working paper .

Zhu, X., 2012. Understanding China's growth: Past, present, and future. The Journal of Economic Perspectives 26, 103–124.

Table 1: Summary statistics: sample without missing values

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
GDP growth rate	0.20	0.17	0.21	0.22	0.14	0.21	0.23	0.15	0.11	0.08
(current price)	(0.28)	(0.11)	(0.12)	(0.13)	(0.15)	(0.09)	(0.10)	(0.10)	(0.08)	(0.12)
GDP growth rate	0.17	0.14	0.16	0.14	0.14	0.15	0.14	0.14	0.11	0.09
(constant price)	(0.23)	(0.10)	(0.10)	(0.11)	(0.15)	(0.08)	(0.08)	(0.07)	(0.08)	(0.10)
GDP (current price)	46.3	54.2	68.4	81.5	90.0	108.3	129.7	145.6	157.2	172.1
(100 million yuan)	(61.5)	(73.1)	(90.4)	(108.5)	(120.0)	(141.9)	(171.8)	(188.5)	(199.3)	(209.4)
Fiscal revenue (no land)	1.72	2.16	2.91	3.56	4.19	5.44	7.09	8.41	10.43	11.59
(100 million yuan)	(3.2)	(4.0)	(5.5)	(6.7)	(7.5)	(9.3)	(12.1)	(13.2)	(15.3)	(16.7)
Land conveyance revenue			1.19	1.17	2.31	4.63	5.30	5.10	7.25	5.47
(100 million yuan)			(3.62)	(2.89)	(6.25)	(11.43)	(12.09)	(9.80)	(13.38)	(9.56)
Land conveyance area			72.7	75.0	107.5	143.5	181.0	212.1	234.6	178.2
(hectare)			(123.7)	(136.1)	(205.5)	(232.7)	(240.8)	(266.3)	(305.9)	(212.0)
Share of land revenue			0.23	0.21	0.25	0.34	0.34	0.31	0.34	0.28
in total revenue			(0.19)	(0.17)	(0.19)	(0.21)	(0.20)	(0.18)	(0.19)	(0.17)
Night light intensity	4.54	4.98	5.68	6.09	6.69	7.79	8.30	9.08		
	(5.42)	(5.88)	(6.21)	(6.64)	(7.03)	(7.89)	(8.38)	(8.94)		
Growth rate of night light	0.20	0.14	0.19	0.12	0.12	0.23	0.12	0.13		
	(0.21)	(0.13)	(0.15)	(0.11)	(0.10)	(0.16)	(0.07)	(0.08)		
Plain	2.78									
	(1.66)									
N	1735	1787	1668	1698	1749	1744	1605	1601	1698	1779

Note: Standard deviations are in parentheses. The constant price of GDP growth rate is based on the deflator of prefecture-level city (2004 = 100). All other values are in current price. Source and construction of the variables are described in section 4. Growth rate of GDP and night light intensity excludes samples with extreme value greater than 2. Around 67 and 13 observations are excluded respectively due to this criterion. Data on fiscal revenue do not include land conveyance revenue. Data of land conveyance are only reliable after 2007. All the night light data are adjusted according to Elvidge, Hsu, Baugh and Ghosh (2014) in which the estimated coefficients are only available before 2012 (see appendix).

Table 2: OLS regression, dependent variable is economic growth rate (2005-2014)

	(1)	(2)	(3)	(4)	(5)	(6)
LandRev_share07 · Post09	0.071***	0.088***	0.081***	0.084***		
	(0.014)	(0.014)	(0.014)	(0.014)		
LandRev_Y07 · Post09					0.249***	0.222***
					(0.077)	(0.085)
lnY07 · Post09		-0.023***	-0.029***	-0.029***		-0.027***
		(0.002)	(0.003)	(0.003)		(0.003)
lnExport_share07 · Post09			0.125***	0.127***		0.129***
			(0.021)	(0.021)		(0.021)
lnPop				0.069**		0.064**
				(0.030)		(0.030)
Constant	0.194***	0.194***	0.193***	-0.059	0.194***	-0.043
	(0.006)	(0.006)	(0.006)	(0.109)	(0.006)	(0.109)
County fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Observations	17,336	17,230	16,742	16,669	17,230	16,669
R-square	0.120	0.127	0.131	0.132	0.119	0.130
Num. of Counties	1,815	1,772	1,723	1,723	1,772	1,723

Note: Samples of GDP growth rate with extreme value greater than 2 are excluded (67 out of 17,336). Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.

Table 3: IV regression, dependent variable is economic growth rate (2005-2014)

	First Stage		Second Stage	
	(1)	(2)	(3)	(4)
Plain · Post09	0.020***	0.017***		
	(0.0009)	(0.001)		
LandRev_share07 · Post09			0.184***	1.048***
			(0.067)	(0.118)
County fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Control variables		✓		✓
Observations	16,466	16,373	16,466	16,373
Num. of Counties	1,697	1,692	1,697	1,692

Note: The $Plain_i$ is used as the instrumental variable for $LandRev\_share07_i$. Control variables include $lnY07 \cdot Post09$, $lnExport\_share07 \cdot Post09$ and $lnPop$. Samples of GDP growth rate with extreme value greater than 2 are excluded (around 67). Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.

Table 4: IV regression, dependent variable is growth rate of night light intensity

	gLight		gLight_adj	
	(1)	(2)	(3)	(4)
LandRev_share07 · Post09	0.326***	0.276***	0.220***	0.146
	(0.065)	(0.095)	(0.066)	(0.096)
County fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Control variables		✓		✓
Observations	15,114	14,997	13,437	13,335
Num. of Counties	1,681	1,676	1,681	1,676

Note: The calculation of night-light growth rate ($gLight_{i,t}$) and the adjusted night-light growth rate ($gLight\_adj_{i,t}$) is discussed in appendix. Instrumental variable is $Plain_i$. Control variables include $lnY07 \cdot Post09$, $lnExport\_share07 \cdot Post09$ and $lnPop$. Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.

Table 5: Robustness checks, dependent variable is economic growth rate (2005-2014)

	(1)	(2)	(3)	(4)
lnTFP07 · Post09	-0.065***	-0.050***		
	(0.007)	(0.008)		
LandRev_share08 · Post09			0.078***	
			(0.015)	
LandRev_share09 · Post09				0.082***
				(0.014)
County fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Control variables		✓	✓	✓
Observations	17,986	17,757	16,956	17,469
R-square	0.132	0.136	0.135	0.134
Num. of Counties	1,901	1,839	1,752	1,804

Note: Samples of GDP growth rate with extreme value greater than 2 are excluded (67 out of 17,336). The control variables include $lnY07 \cdot Post09$, $lnExport\_share07 \cdot Post09$ and $lnPop$. Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.

Table 6: Results on the cost of debt

	Cost of debt		Change of cost of debt	
	(1)	(2)	(3)	(4)
LandRev_share07	-1.010***		-0.357	
	(0.307)		(0.500)	
Plain		-0.097***		-0.071*
		(0.032)		(0.038)
GDP per capita07	-0.397***	-0.344***	-0.061	-0.005
	(0.062)	(0.068)	(0.075)	(0.078)
Constant	5.894***	5.999***	-2.093***	-1.87***
	(0.153)	(0.195)	(0.209)	(0.228)
Observations	256	252	142	140
R-square	0.160	0.168	0.008	0.023

Note: The first two columns are results on the interest rate of MCBs and the last two columns are results on the change of interest rate between 2013 to 2016. The interest rate of MCBs in each prefecture-level city is the simple average of all the outstanding MCBs collected on 19 June 2017. Robust standard errors in parentheses. Significance levels: *** 1%, ** 5% and * 10%.

Table 7: Results on fixed asset investment

dependent variable: lnI	(1)	(2)	(3)	(4)
LandRev_share07 · Post09	0.160***	0.235***	0.240***	0.248***
	(0.055)	(0.053)	(0.053)	(0.053)
lnY07 · Post09		-0.100***	-0.075***	-0.073***
		(0.010)	(0.011)	(0.011)
lnExport_share07 · Post09			-0.731***	-0.735***
			(0.087)	(0.087)
lnPop				0.197***
				(0.064)
Constant	1.984***	1.979***	2.020***	1.304***
	(0.015)	(0.015)	(0.015)	(0.234)
County fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Observations	18,947	18,739	18,216	18,141
R-square	0.836	0.840	0.842	0.843
Num. of Counties	1,815	1,772	1,723	1,723

Note: Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.
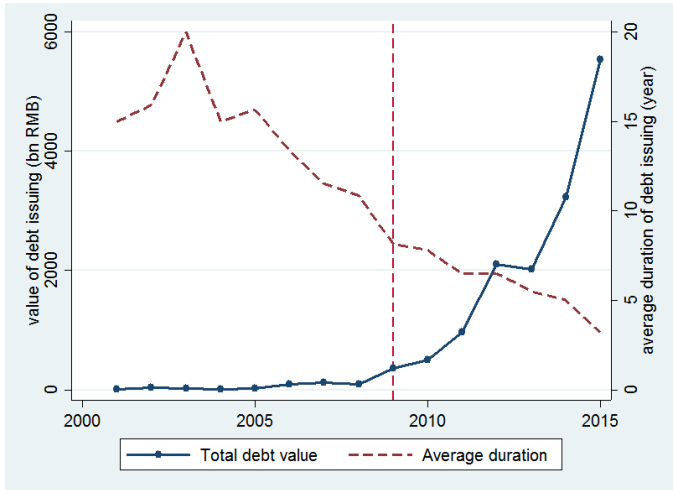
(a) Publicly Traded Debt of LGFVs
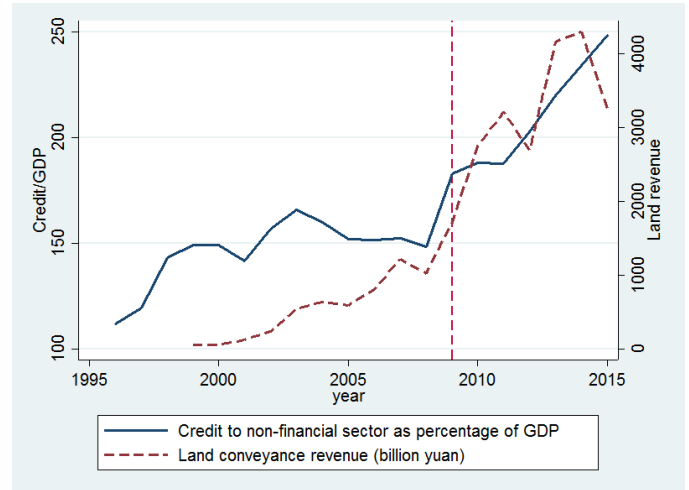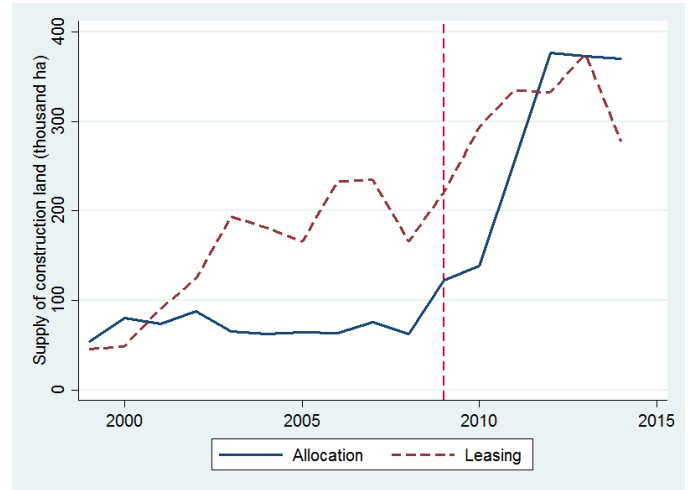

(b) Growth of debt and land finance

Fig. 1. Debt and land conveyance revenue in China
Source: China's National Bureau of Statistics, Bank for International Settlements (BIS), Wind.
Note: Debts of LGFVs included listed and non-listed corporate bonds, medium-term notes, short-term bills, privately raised company bonds, SMEs' collection notes and bonds with special purposes.
Data did not include bonds issued directly by local governments.
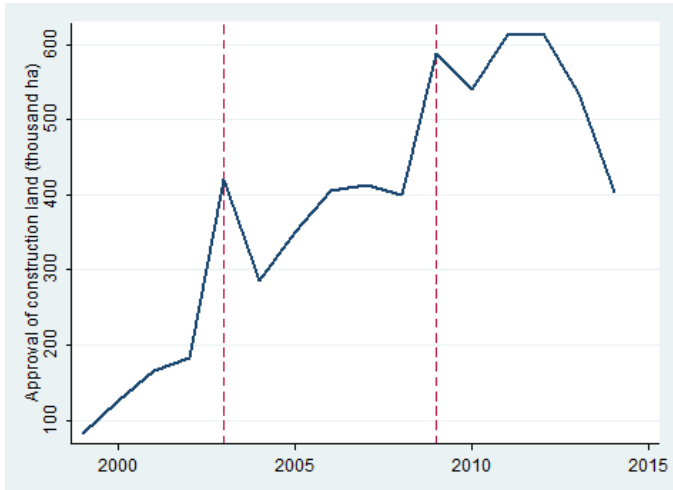
(a) Approval of construction land   (b) Supply of construction land

Fig. 2. Land Supply in China: 1999-2014

Note: Construction land refers to land for residential development, public facilities, industrial use, storage use, transportation use, roads and squares, utilities facilities, green land and for special purpose. Source: Ministry of Land and Resources of the People's Republic of China via WIND database.
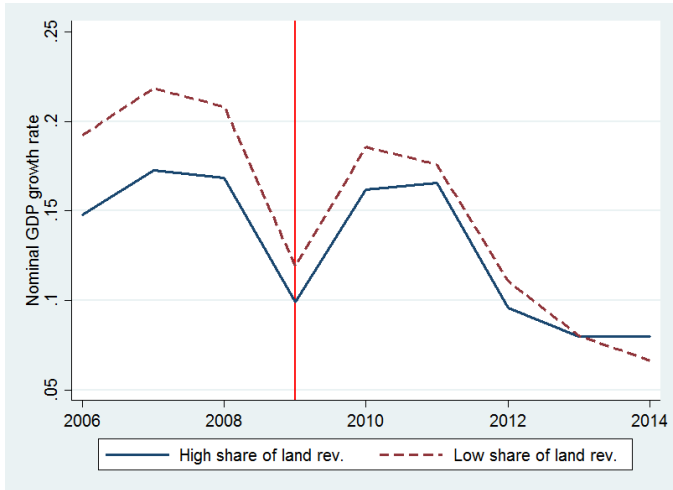
(a) Trend of growth rate
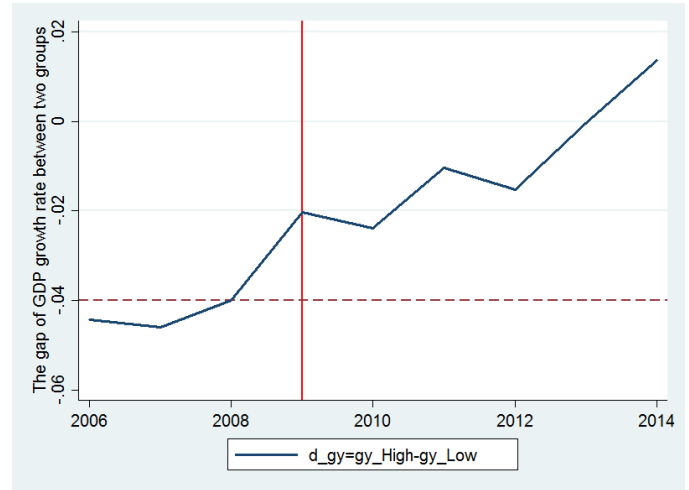
(b) Difference between two groups

Fig. 3. Pre-policy Trends of Two Groups

Note: The cut-off point is top 30%. The mean of each group is weighted average using fiscal revenue in 2007 as the weight.
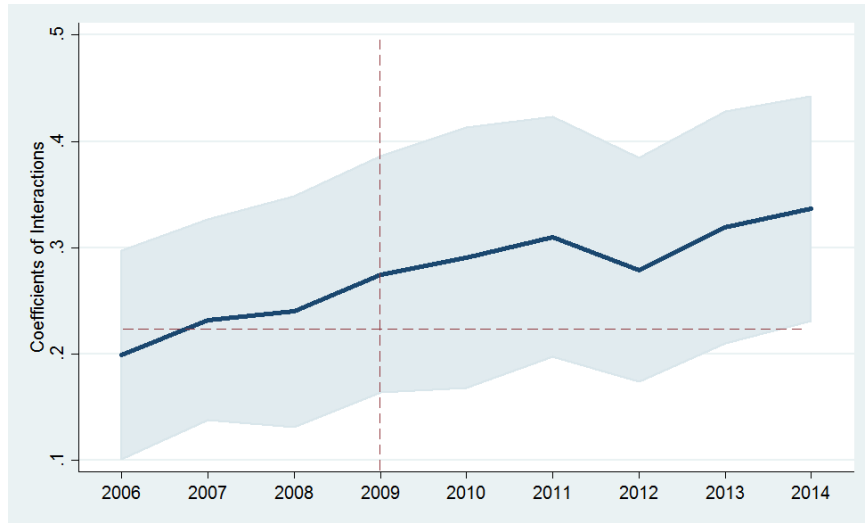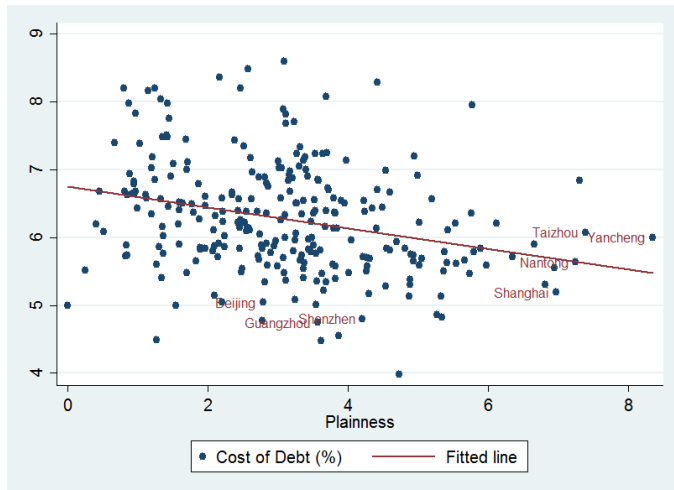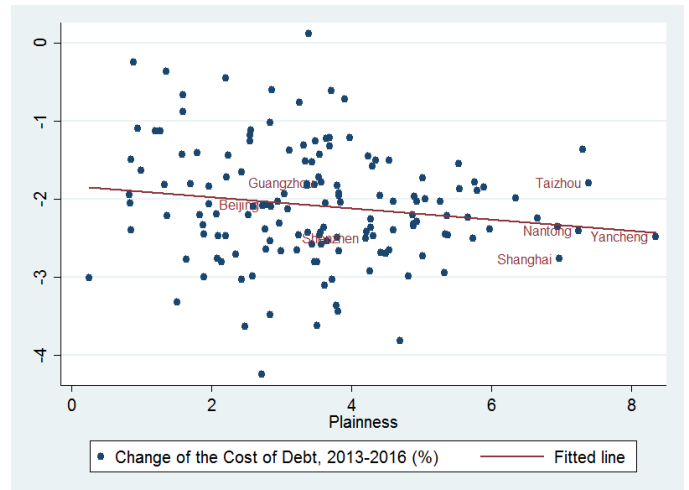
41

Fig. 4. Annual Effects Over Time

Note: The regression is weighted by the fiscal revenue in 2007. The base-level in 2005 is omitted. The confidence interval is 95%.

(a) Simple average of the cost of debt

(b) Change of the cost of debt: 2013-2016

Fig. 5. Interest rate of MCBs and plainness

Note: The interest rate of MCBs in each prefecture-level city is the simple average of all the outstanding MCBs collected on 19 June 2017.

Appendix A. Calculation of night-light growth rate

There are several problems when using the data of night lights . First, the intensity of night lights has been adjusted and averaged to a digital number (DN) in a fixed interval of $[0, 63]$ in every year, resulting in possible underestimation for regions with the highest night light intensity. Second, data of night lights were obtained by six different satellites from 1992 to 2003, and different satellites may have different observations. Even the same satellite may observe differently over time. Therefore, comparing data of night lights in different years may require some adjustment for the raw data. In this paper, I use night light maps of 2004 to 2009 by F16 satellites and maps of 2010 to 2013 by F18 satellites. There is a jump of light data from 2009 to 2010 since the satellite was changed during that time. However, we argue that this jump should not affect our results because the change of night light could be captured by the year fixed effect. To match the idea of economic growth, I assume that light intensity has not decreased over time. Therefore, the change of average night lights per area is calculated as follows.

$$dlight_t = \begin{cases} light_t - light_{t-1}, & light_t - light_{t-1} > 0 \\ 0 & , & light_t - light_{t-1} \leq 0 \end{cases}$$

After obtaining $dlight$ for 2005 to 2013, I calculate the average night light per area based on the original data in 2004 following the equation: $light_t = light_{2004} + \sum_{k=2005}^{t} dlight_k$. Then we can obtain the growth of night light per area from $glight_t = dlight_t / light_{t-1}$. By this adjustment, we have a nondecreasing night light sample.

To solve the incomparable problem of the same satellite in different years, I adopt the method proposed by Elvidge et al. (2014) who employed a quadratic linear estimation to calibrate the data in different years by different satellites. The basic idea is that we choose a region r that both economic output and night lights increase stably and reliably. Then perform the following regression using all the data in region r.

$$DN_{r,t} = c_0^{st,year} + c_1^{st,year} DN_{r,st,year} + c_2^{st,year} DN_{r,st,year}^2 + \varepsilon.$$

The left hand side $DN_{r,t}$ is the night light number of region r in the year with the highest night lights, the right hand side $DN_{r,st,year}$ is night light data of region r in different year by different satellites. By performing this regression for all years and all satellites, we can obtain the three coefficients respectively. Then we can recalculate $DN_{i,t}$ for all other regions in different years by different satellites. For the calculation of adjusted night light data, I directly use the coefficients of $c_0^{st,year}$, $c_1^{st,year}$ and $c_2^{st,year}$ estimated by Elvidge et al. (2014).

Appendix B.   Tables and graphs

Table 8: National new district establishments: 1992-2015

Date	National New District	City	Province	Target
1992 Oct.	Pudong New District	Shanghai	-	-
1994 Mar.	Binhai New District	Tianjin	-	-
2010 Jun.	Liangjiang New District	Chongqing	-	Inland
2011 Jun.	Zhoushan Archipelago New District	Zhoushan	Zhejiang	Ocean Economy
2012 Aug.	Lanzhou New District	Lanzhou	Gansu	Northwest
2012 Sep.	Nansha New District	Guangzhou	Guangdong	Pearl River Delta
2014 Jan.	Xixian New District	Xi'an, Xianyang	Shaanxi	West
2014 Jan.	Guian New District	Guiyang,Anshun	Guizhou	West
2014 Jun.	West Coast New District	Qingdao	Shangdong	Ocean Economy
2014 Jun.	Jinpu New District	Dalian	Liaoning	Northeast
2014 Oct.	Tianfu New District	Chengdu, Meishan, Ziyang	Sichuan	West
2015 Apr.	Xiangjiang New District	Changsha	Hunan	Central
2015 Jun.	Jiangbei New District	Nanjing	Jiangsu	Yangtze River Delta
2015 Sep.	Fuzhou New District	Fuzhou	Fujian	Taiwan
2015 Sep.	Dianzhong New District	Kunming	Yunnan	South Asia
2015 Dec.	Haerbin New District	Haerbin	Heilongjiang	Russia

Source: Summarized by the author.

Table 9: Comparison of Collected land supply data

year	obs.	land leasing revenue (bn yuan)			land leasing area ('000 ha)			land allocation area ('000 ha)		
		transaction	official	(%)	transaction	official	(%)	transaction	official	(%)
2000	1146	0.48	59.56	0.80	1.37	48.63	2.82	1.46	80.57	1.81
2001	2353	1.57	129.59	1.21	4.25	90.39	4.70	8.58	73.98	11.59
2002	13389	23.86	241.68	9.87	19.37	124.23	15.59	8.41	88.05	9.56
2003	18173	32.05	542.13	5.91	29.12	193.60	15.04	10.49	65.26	16.08
2004	37578	113.28	641.22	17.67	50.98	181.51	28.09	19.37	62.05	31.22
2005	28857	129.34	588.38	21.98	41.38	165.59	24.99	18.66	64.62	28.88
2006	38373	109.93	807.76	13.61	73.40	233.02	31.50	10.45	63.79	16.38
2007	130276	921.78	1221.67	75.45	219.24	234.96	93.31	88.03	76.09	115.69
2008	108519	853.94	1025.98	83.23	190.84	165.86	115.06	97.34	62.38	156.04
2009	137885	1493.57	1717.95	86.94	223.60	220.81	101.26	158.69	122.29	129.77
2010	175494	2758.77	2746.45	100.45	314.89	293.72	107.21	188.05	138.27	136.01
2011	199543	3059.54	3212.61	95.24	353.97	335.09	105.64	303.98	257.21	118.19
2012	188853	2674.65	2690.00	99.43	330.24	332.43	99.34	352.16	377.13	93.38
2013	220724	4109.70	4164.90	98.67	373.38	374.80	99.62	363.38	373.28	97.35
2014	174321	3086.19	3437.74	89.77	267.66	277.35	96.51	311.46	369.83	84.22

Source: China Land Market website, Ministry of Land and Resources of China.

Note: Observations include land leasing and land allocation. I drop 405 observations which have transaction values of more than 5 billion yuan per piece of land, or an area of more than 1000 hectares, or per hectare land price of more than 500 thousand yuan per square meter (less than the highest record in 2015). I also drop 119,016 duplicated observations (most of which are before 2008).

Table 10: OLS regression, dependent variable is economic growth rate (constant price)

	(1)	(2)	(3)	(4)
LandRev_share07 · Post09	0.049***	0.054**		
	(0.013)	(0.012)		
LandRev_Y07 · Post09			0.276***	0.274**
			(0.105)	(0.108)
County fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Control variables		✓		✓
Observations	14,509	14,273	14,412	14,273
R-square	0.038	0.046	0.038	0.045
Num. of Counties	1,527	1,487	1,487	1,487

Note: The real GDP is calculated with the prefectural level deflator (2004=100). We exclude the samples of GDP growth rate with extreme value greater than 2 (67 out of 17,336). The control variables include $lnY07 \cdot Post09$, $lnExport\_share07 \cdot Post09$ and $lnPop$. Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.

Table 11: Prefectural-level results, dependent variable is economic growth rate (2005-2014)

	(1)	(2)	(3)	(4)
LandRev_share07 · Post09	0.068**	0.073***	0.068**	0.072**
	(0.027)	(0.028)	(0.028)	(0.030)
lnY07 · Post09		-0.007*	-0.011**	-0.012***
		(0.004)	(0.004)	(0.005)
lnExport_share07 · Post09			0.045	0.053
			(0.040)	(0.045)
lnPop				-0.135**
				(0.056)
Constant	0.17***	0.171***	0.171***	1.268***
	(0.008)	(0.008)	(0.008)	(0.455)
City fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Observations	2,856	2,856	2,816	2,728
R-square	0.383	0.384	0.384	0.391
Num. of Cities	286	286	282	281

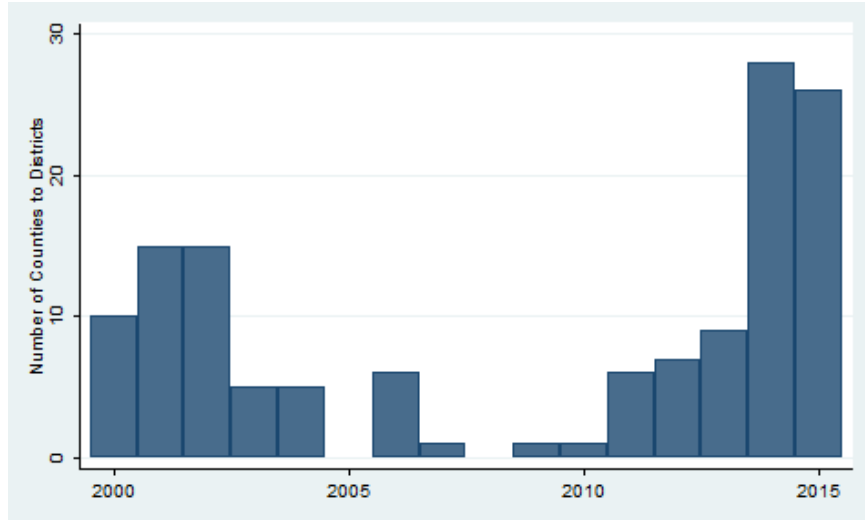Note: Robust standard errors clustered at the county level in parentheses. Significance levels: *** 1%, ** 5% and * 10%.
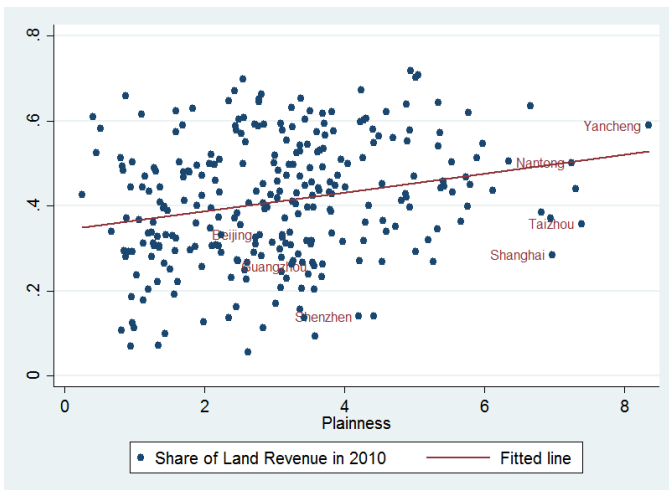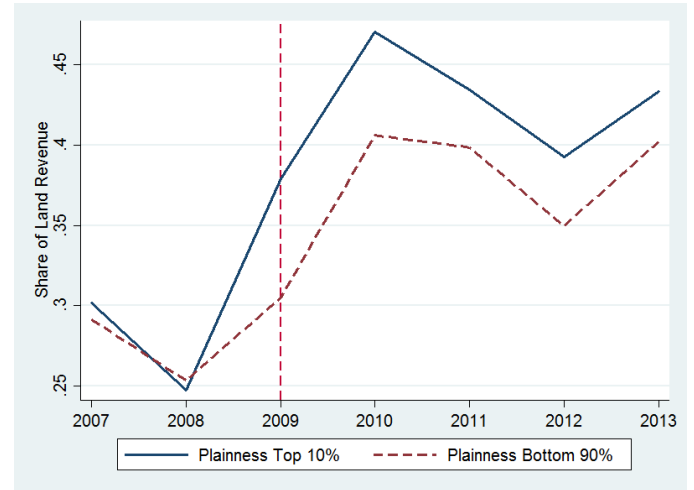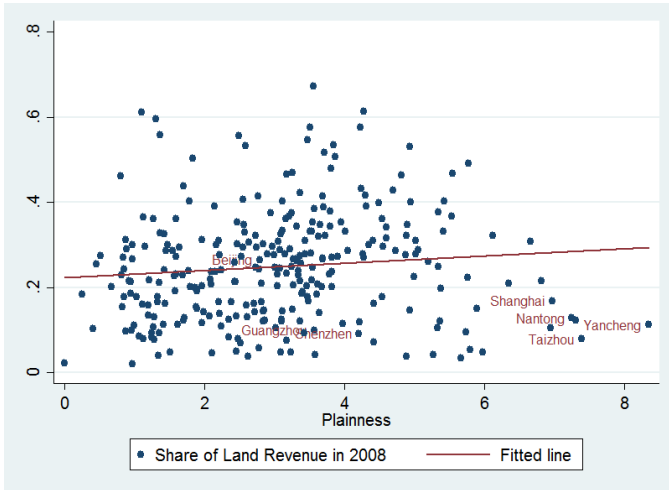
Fig. 6. Number of Counties Adjusted to Districts

Source: Ministry of Civil Affairs of the People's Republic of China. Collected and summarized by the author.

Note: Different counties in the same city are counted separately.

Fig. 7. Share of Land Revenue Over Time: High v.s Low

Note: The cut-off point is top 50%.

(a) Share of land revenue: 2008 v.s 2010

(b) Trend of share of land revenue

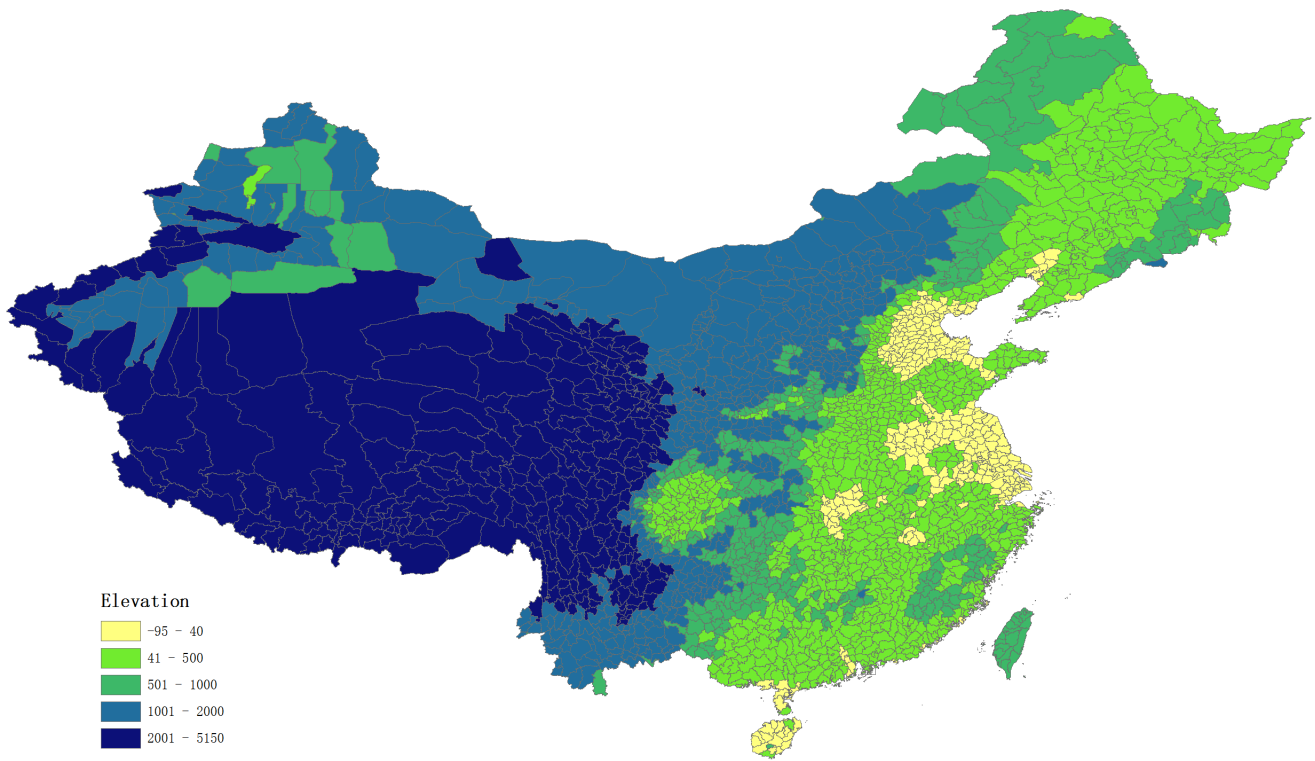Fig. 8. Share of land revenue and plainness

Fig. 9. Elevation Distribution in China

Source: China GIS data, Center for Geographic Analysis, Harvard University. Calculated and graphed by the author.