Monopolized Land Supply and Excessive Leverage of Local Governments in China

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In China, a distinctive feature is that all land is publicly owned, encompassing two forms: state-owned and collectively owned. However, only state-owned land is permitted to sell in the land market, establishing a monopoly on its supply by local governments. Alongside selling land to enterprises, local governments also utilize it to establish financing vehicles, using them as paid-in capital for borrowing in the financial market. This study emphasizes the relationship between land supply and the leverage of local government financing vehicles in contemporary China. The study finds that an increase in land not only raises the amount of debt but also leads to an increase in the leverage ratio, results a much larger amount of debt than under given leverage ratio, which is referred to as excessive leverage. This occurs through both revenue and risk channels, increasing the probability of project termination, and causing greater economic losses in the state of termination.

Key Words: Land; Local government debt; Excessive leverage.
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1. INTRODUCTION

China is one of the few countries in the world that implements a system of public ownership of land. This public ownership can be divided into two types: state-owned land, which generally includes urban and industrial areas, and collectively owned land, which is jointly owned by villagers in the name of a collective in rural areas, mainly for agricultural use. In essence, the ownership of these lands belongs to the state, and what can be utilized and traded is only the land use rights. Among these two types of land, only the use rights of state-owned land can enter the market through auctions or direct transfer (sell, essentially), while collective land in rural areas must be expropriated by the state and converted into state-owned land before it can be sold in the market. As a result, the government effectively monopolizes

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all land supply in the market, and local governments are responsible for exercising this monopoly power.

Since the beginning of the new millennium, local governments in China have supplied a substantial amount of land to the market, which is essentially a result of institutional arrangements. On one hand, China's political-economic system operates as a regional decentralized authoritarian mode (RDA) (Xu, 2011). While the central government retains control over personnel, it delegates economic and social management affairs to the local authorities, hence makes local governments deeply engage in economic activities and compete with each other (Maskin et al., 2000). On the other hand, the fiscal reform in 1994, known as the tax-sharing reform, centralized a large portion of fiscal revenues to the central government, leaving local governments significant revenue gaps (Jin and Zou, 2005; Shen et al., 2012, etc.). In the classic framework of economic analysis, land is a scarce factor with inelastic supply. The value of land should be equal to the discounted sum of all economic benefits it will generate in the future. With rapid economic growth and urbanization in recent decades, the value of land in China has continuously risen. Facing financial constraints, local governments choose to sell the land to industrial and real-estate enterprises or use them as collateral for financing in financial markets. Two sets of figures provide some intuitive insights. First, the revenue from the land sales amounted a significant portion of local government revenue. According to the data released by the Ministry of Finance, in 2021, general revenue of local government was 11.1 trillion yuan, and local government fund revenue was 9.4 trillion yuan, totaling 20.5 trillion yuan. Among them, land sales income [1] amounted to 8.5 trillion yuan, accounting for 41.5%. Second, the municipal corporate bonds (MCBs) issued by local government financing vehicles (LGFV) constitute a huge amount of implicit debt of local governments. According to data collected by Wind Info, the total new issuance of MCBs in the first half of 2023 was 3.38 trillion yuan, with outstanding MCBs reaching approximately 15 trillion yuan. As LGFVs are locally state-owned and primarily use the fund for providing public goods and services, MCBs are essentially backed by government credit.

The problem of local government debt began to attract the attention of the central government since 2010. After a comprehensive audit by the National Audit Office, the severity of the problem was recognized. In 2014, the legislator revised the Budget Law to allow provincial governments to issue local government bonds to replace high-risk and costly outstanding debt. After a short-term reduction in risk, the issue seemed to be forgotten. However, the financing constraints of local governments have not been

[1] Although the corresponding Chinese term can be literally translated as "land transfer income", we use "land sales income" for clarity. It includes the revenue obtained through auctions and direct transfers of land.

eased. Although the Ministry of Finance stipulated in 2013 that it would guide LGFVs to gradually relinquish their role in financing for local governments, in reality, MCBs issued by LGFVs quickly gained a significant share in the bond market afterward. Thus, the issue of local government debt had never truly disappeared. In recent years, against the backdrop of China's economic slowdown and the shock of the COVID-19 pandemic, both central and local governments are facing fiscal pressures. Local government debt has once again become a hot topic.

The above analysis shows that land plays a crucial role in the issue of MCBs and further has profound implications for the macro economy, giving rise to the term "land economy" (Jin, 2007). In such an economy, land is not only a factor of production, but also a policy tool for macroeconomic regulation (Nitikin et al., 2012). Clearly, policy makers are also aware of this, as they have tightened the supply of land while tightening monetary policy (Liu and Huang, 2016). However, to understand the micro-mechanism of land economy and use land as a tool for macroeconomic regulation prudently, we need to understand the leverage and risk characteristics of land, and how it influences the behavior of local governments and other relevant participants. This paper is aimed to provide a micro-foundation for the land economy in a contract theory framework.

Given a constant leverage ratio, as the land of an LGFV increase, the amount of debt that can be raised will also increase proportionally. This is one of the most fundamental conclusions in corporate finance. The premise of this conclusion is that the increase in land will not affect the existing leverage ratio. However, the results of this article show that, given other things the same, the increase in land not only increases the debt of local governments but also leads to an increase in leverage ratio, results a much larger amount of debt than under given leverage ratio. This is defined as the excessive leverage phenomenon. Based on this, we distinguished between two channels of excessive leverage, namely the revenue channel and the risk channel. For the revenue channel, the increase in land makes the relative return of projects higher in the event of failure, which will attract investors to provide larger-scale investments while also increasing the leverage ratio of the LGFV. For the risk channel, the increase in land makes the LGFV more passive in response to shocks, and the investor therefore bears less risk, further increasing the leverage of the LGFV. The above results are closely related to two properties of land, namely, the relatively stability of land prices and the fact that land can remain intact even in the event of project failure, with its value fully recovered. Based on this, we also analyzed the risk consequences of the excessive leverage, including LGFV risks under non-systematic shocks and macroeconomic risks under systematic shocks. The former includes an increased probability of project termination due to a lower response threshold and a greater social loss caused by excessive leverage. The latter includes the large-scale bankruptcy of LGFVs, local government debt crises, and economic downturns caused by various systematic shocks.

The remaining sections of are arranged as follows: Section 2 is a literature review; Section 3 presents the theoretical model and its solution, and provides it a detailed discussion; Section 4 derives the excessive leverage and its channels; Section 5 turns to the political economy of local government debt based on the results of the model; Section 6 concludes the paper.

2. LITERATURE REVIEW

Leverage is a core notion of the corporation finance theory. Since the birth of the MM theorem (Modigliani and Miller, 1958), economists have been searching for robust determinants of leverage, including growth rates, sizes, tangibility of assets, durability, and profitability, among others (Frank and Goyal, 2008; Oztekin, 2015). Of all these factors, this article places particular emphasis on the tangibility and durability of assets, which are the key attribute relied upon in the analysis. Long and Malitz (1985) and Harris and Raviv (1991) found that companies investing in tangible assets had stronger debt financing ability than those investing in intangible assets. The reason is that creditors can more effectively observe the investment behavior, risk, and return of these companies. A related concept is durability, since land is not only tangible, but also durable. Hart and Moore (1994) defined assets with large liquidation value as durable asset. Their conclusion was that durability facilitates project financing. Although they did not explicitly derive the relationship between durability and leverage, their findings are consistent with the the results in this paper. Their results were also coined by Tirole (2006), who found that under the condition of constant expected returns, the larger the liquidation value of a project, the stronger the company's financing ability. Rampini (2019) distinguished between durability and pledgeability, arguing that durability leads to an increase in asset prices, making it harder to finance, while the cash flow capacity after liquidation reflects pledgeability rather than durability. However, in practice, it is difficult to separate pledgeability from durability because, in a complete market, durable assets usually have higher liquidation cash flows. It is worth noting that the conclusions of Rampini (2019) are not as contradictory to the findings of this paper as they may initially appear. While Rampini discusses financing the purchase of durable assets, the context of this paper is about local governments using durable land to facilitate financing. There are also models in dynamic settings that predict the excessive leverage as a result of positive feedback effect, which is similar to the financial amplification mechanism, commonly seen in discussions of the US subprime crisis (Adrian and Shinn, 2009; Acemoglu et al., 2015). Unlike these studies, this article focuses on the excessive leverage phenomenon under a static condition, which does not depend on dynamic self-reinforcement mechanism. It is also important to mention here that an earlier version of this model has been published in Chinese (Luo and Wang, 2017). While the two models share similarities in their settings, this paper simplifies the assumptions and makes a new interpretation of the model.

Now we turn to the literature on local government debt in China. A large amount of research on this issue takes the 4 trillion yuan economic stimulus package in 2009 as the background. Huang and Du (2018) found that the stimulus package led to a significant expansion of local government debt, driving up land prices and increasing the reliance on land-mortgaged financing. Huang et al. (2020) studied the rapid growth of local government debt caused by the stimulus package in 2009, which crowded out private sector investment, reduced future economic growth potential, and accumulated systemic financial risks. Chen et al. (2022) explained that local governments with higher bank loans under the 2009 stimulus package issued more municipal corporate bonds between 2012 and 2015. These findings indicate a close connection between the stimulus package, local government debt, land-mortgaged financing, and municipal corporate bonds.The difference between these literatures and our study is evident. While they emphasized the effects of the stimulus package on local government debt, they omitted the micro-mechanism of how land, as an asset monopolized by local governments, amplifies local government debt. This is precisely what this paper aims to emphasize. Other studies have also identified factors influencing local government debt. For instance, Liu et al. (2022) verified that political centralization of the prefecture-level city is positive correlated with the implicit debts of local governments. There was also a large amount of Chinese literature attempting to identify socio-economic consequences of local government debt, which we will not list here.

Another strand of literature deals with the risk facet of the local government debt. Yan (2007) suggested that a large amount of land supply and rapid growth in land prices increased credit risks while expanding credit scale. Zong (2011) analyzed a variety of risks faced by LGFVs and concluded that the stimulus package and the contraction policies aftermath would increase the credit risk of land mortgages. He and Man's (2012) research found that the model of land-mortgaged financing may expose explicit risks due to changes in domestic and international economic conditions. Ye (2016) suggested that the Ministry of Finance's February 2016 document that removed the financing function of the land reserve institution was precisely due to concerns about the risk of land mortgage loans. Luo (2019) discussed the risks that local governments may face during the process of LGFVs' transitions. Unlike these studies that emphasize macro-credit risks, this article studies the impact of excessive leverage on the risks of LGFVs at the micro level. Although aggregating LGFVs in the economy may reveal macro risk characteristics, it is not the main concern of this article.

3. THE MODEL

We model a typical LGFV with limited cash but can obtain financing through land. Based on Holmstrom and Tirole's (1998, 2011) liquidity supply model, we examine a liquidity-constrained LGFV facing liquidity shocks while investing in a project over two periods in the presence of imperfect information disclosure. Consider a representative LGFV with cash A at time 0. A can be the retained earnings from the previous period of the LGFV or a subsidy given by the local government before time 0. In addition, the local government can increase its financing capability by providing L units of land for each unit of investment. The main reason for differentiating land from cash is that land is not only tangible but also durable, hence can be easily claimed by creditors when necessary, while cash is consumed during the project implementation. Generally, the asset structure of the LGFV in reality are far more complex, but land is undoubtedly the most distinguished asset among LGFV. It is worth noting here that we implicitly assumed that land supply can always meet the LGFV's demand and no price is paid for it. This assumption is particularly relevant to the institutional structure of land management in China that mentioned in the previous section, namely, the monopolized land supply by local governments.

At time 0, the LGFV considers starting an investment project with its own assets, and the investment I will be endogenously determined in the model, where $I - A - IL$ is the funds provided by the investor. If started, the project will experience an exogenous shock ρ at time 1, and an additional fund ρI is needed for the recover of the project . The range of ρ is $[0, 1]$, and we assume that its probability density function is symmetric, denoted by $f(\rho)$, and the corresponding distribution function is denoted by $F(\rho)$. This shock can be understood as the occurrence of any form of disaster or accident. We assume that there exists moral hazard in the model: The LGFV's bureaucrat (i.e., the manager who runs the LGFV, always a bureaucrat of the local government) chooses whether or not to work hard. Let p_H and p_L be the probabilities of project success when the bureaucrat works hard and not, respectively. If the bureaucrat chooses not to work hard, he will receive a private benefit of B on unit investment. We assume that $0 < p_L < p_H < 1$ and denote $\Delta p = p_H - p_L$. If the project succeeds, the total return of the LGFV at time 2 is $R^S I$, and if the project fails, the corresponding return is $R^F I$. We let $R^S - R^F = R$. R^F can be interpreted as the residual value of unit investment, and R is the net cash flow from project success. Here, we assume that:

ASSUMPTION 1. $R^F = L$.

That is to say, land is the only residual value when the project fails. In contrast, the cash invested in the project is consumed and cannot be recovered. This assumption is rather straightforward in our simplified framework, considering the tangibility and durability of land compared to the cash. It is worth noting that by setting $R^F = L = 0$, we return the model to the basic case of Holmstrom and Tirole (1998).

In addition to the moral hazard mentioned above, there is another type of information asymmetry in this article, namely adverse selection. It is well known of the low quality of information disclosure of LGFVs in China, mainly as a result of the unwillingness of LGFVs to disclose its debt situation (Brixi, 1998). Due to the information disadvantage of the investor, the presence of adverse selection makes them passive in their interpretation of the information disclosed by LGFVs. We can draw an analogy with Akerlof's (1970) discussion of the market for lemons. Therefore, we write the assumption explicitly as:

ASSUMPTION 2. *Let p^l_H be the objective probability of project success of the external investor based on his observed information of the LGFV, and $p^l_H < p_H$.*

Let a financing contract at time 0 be $(I, \lambda(\rho), R^S_b(\rho), R^F_b(\rho))$, in which $\lambda(\rho) \in \{0,1\}$ indicates whether the LGFV would respond to the shock ρ, where $\lambda(\rho) = 1$ and $\lambda(\rho) = 0$ mean whether or not additional funds are provided to recover the project respectively. $R^S_b(\rho)$ and $R^F_b(\rho)$ respectively represent the unit investment return retained by the LGFV after the project succeeds and fails. In this contract, the external investor provides $I - A - IL$, and they will receive a return of $(R^S - R^S_b(\rho))I$ if the project succeeds, and a return of $(R^F - R^F_b(\rho))I$ if it fails. Since the LGFV is liquidity constrained, if $\lambda(\rho) = 1$, we assume that the investor has sufficient liquidity and that all additional ρI is provided by them. In order to make the model meaningful we assume:

ASSUMPTION 3.

$$\int_0^1 \max\{p^l_H R^S + \left(1 - p^l_H\right) R^F - \rho, 0\} f(\rho) d\rho - 1 > 0.$$

Assumption 3 ensures that the project has a positive net present value (NPV) when the bureaucrat works hard, meaning that the project is worth implementing. This is a rather loose assumption that does not affect the generality of the results. Here we dropped the other part of a similar assumption made in Holmstrom and Tirole (1998), since that part of the condition can be guaranteed by the incentive compatibility condition in the following text.

Assuming that both the LGFV and the investor are risk-neutral, i.e., the utility function is linear in the project's return without time preference, we define the following second-order optimal problem for the LGFV:

$$\max_{\left\{\lambda(\rho), R_b^S(\rho), R_b^F(\rho)\right\}} I \int_0^1 \left[p_H R_b^S(\rho) + (1 - p_H) R_b^F(\rho)\right] \lambda(\rho) f(\rho) d\rho - A - IL, \tag{1}$$

subject to:

$$I \int_0^1 \left[p_H^l \left(R^S - R_b^S(\rho)\right) + \left(1 - p_H^l\right) \left(R^F - R_b^F(\rho)\right) - \rho\right] \lambda(\rho) f(\rho) d\rho \geq I - A - IL, \tag{2}$$

$$\Delta p \left(R_b^S(\rho) - R_b^F(\rho)\right) \geq B, \forall \rho, \tag{3}$$

$$0 \leq R_b^S \leq R^S, \forall \rho, \tag{4}$$

and

$$0 \leq R_b^F \leq R^F, \forall \rho. \tag{5}$$

In the objective function, the LGFV chooses a contract to maximize its expected net return. Equation (1) is the participation constraint (referred to as IR), where the left side is the expected return obtained by the external investor, and the right side is his initial investment paid in. Equation (3) is the incentive compatibility constraint (referred to as IC) that guarantees the bureaucrat of the LGFV not to shirk. Intuitively, the left hand side of (3) is the net return of being working hard, and the right side is the forgoing private benefit that could be realized in case of shirk. Equations (4) and (5) are boundary constraints on the choice variables.

Since the size of the shock ρ does not affect the final project return, the LGFV has no reason to choose to cover a larger shock rather than a smaller one. Therefore, we can see that the choice of $\lambda(\rho)$ is equivalent to choosing a threshold $\hat{\rho}$ such that $\lambda(\rho) = 0, \forall \rho > \hat{\rho}$ and $\lambda(\rho) = 1, \forall \rho \leq \hat{\rho}$. Hence equations (1) and (1) in the above optimization problem can be equivalently rewritten as:

$$\max_{\left\{\hat{\rho}, R_b^S(\rho), R_b^F(\rho)\right\}} I \int_0^{\hat{\rho}} \left[p_H R_b^S(\rho) + (1 - p_H) R_b^F(\rho)\right] f(\rho) d\rho - A - IL, \tag{6}$$

and

$$I\int_0^{\hat{\rho}} \left[p_H^l \left(R^S - R_b^S(\rho)\right) + \left(1 - p_H^l\right)\left(R^F - R_b^F(\rho)\right) - \rho\right] f(\rho)d\rho \geq I - A - IL. \tag{7}$$

Let $\rho_1 \equiv p_H^l R + R^F$, $\rho_0 \equiv p_H^l R + R^F - p_H^l B/\Delta p$ be the total income and pledgeable income expected by the investor, respectively, where pledgeable income is the maximum expected return that the LGFV can promise to investors, i.e., total income minus the necessary information rent paid to the bureaucrat. We present the technical details of the solution in the appendix and obtain the following proposition:

PROPOSITION 1. *Given $L < p_H B/\Delta p F(\rho^*)$, we have a unique solution to the LGFV's second-order optimization problem that can be expressed as an optimal contract $(I^*, \rho^*, R_b^{F*}, R_b^{S*})$ with $\rho^* \in (\rho_0, \rho_1)$, where,*

$$I^* = A/[1 - L - \rho_0 F(\rho^*) + \int_0^{\rho^*} \rho f(\rho)d\rho];$$

$$\rho^* = \left\{\hat{\rho} \in [0,1] \middle| p_H B/\Delta p(1 - \int_0^{\hat{\rho}} F(\rho)d\rho) - L(\rho_1 - \hat{\rho} + (p_H - p_H^l)B/\Delta p) = 0\right\};$$

$$R_b^{S*}(\rho) = B/\Delta p, \forall\rho;$$

$$R_b^{F*}(\rho) = 0, \forall\rho.$$

The condition $L < p_H B/\Delta p F(\rho^*)$ is actually the second-order sufficient condition for the existence of a solution to the optimization problem, and its economic interpretation is intuitive. The right-hand side of the inequality, $p_H B/\Delta p F(\rho^*)$, is the expected net return to the LGFV at the optimal response threshold ρ^*. Therefore, if $L \geq p_H B/\Delta p F(\rho^*)$, the LGFV has no incentive to start any projects because holding land idle can achieve a higher expected income.

The proposition defines the unique optimal contract provided by the LGFV, and we will discuss the meaning of each ingredient in turn.

It can be observed from the expression of I^* that the optimal investment is positively correlated with cash, land, and pledgeable income ρ_0. Since $\rho^* \in (\rho_0, \rho_1)$, the investment is negatively correlated with ρ^*. The reason is that if the investor is obliged to provide additional liquidity for a larger range of shocks, his gross net expected return will decrease, reducing the initial investment he would like to paid in. From the expression of I^*, we can also calculate the leverage ratio of the LGFV, $I/(A + IL)$:

$$\frac{I}{A + IL} = \frac{1}{1 - \rho_0 F(\rho^*) + \int_0^{\rho^*} \rho f(\rho)d\rho}. \tag{8}$$

It can be observed that the land L does not directly affect the leverage ratio of the LGFV, which can be only indirectly affected by L through its impact on the pledgeable income ρ_0 and the equilibrium response threshold ρ^*. We will discuss this point in detail in the following text.
The expression that defines the unique ρ^* in the parentheses is derived from the necessary first-order condition for the optimality of ρ^*. We can use this condition to derive the excessive leverage later. It is worth noting at the moment that when we set $L = 0$, the first order condition for the optimality of ρ^* becomes:

$$\int_0^{\rho^*} F(\rho)d\rho = 1,$$

which is exactly the same as the condition in Holmstrom and Tirole's basic model. Since $\rho^* \in (\rho_0, \rho_1)$ and $p_H > p_H^l$, then $L(\rho_1 - \hat{\rho} + (p_H - p_H^l)B/\Delta p$ is positive, and by the fact that $F(\rho) > 0, \forall\rho$, the existence of land L and adverse selection $(p_H > p_H^l)$ both contribute to a decrease in ρ^*. It is straightforward that adverse selection discourages the investor's willingness of bearing risk, however, the reason that how the land is negatively correlated to the best response threshold is not clear. We will turn to this problem later in the following text.

The solution of $R_b^{S*}(\rho)$ provides the distribution scheme for project returns: the LGFV only receives the minimum return that can maintain the bureaucrat's effort, and the remaining part belongs to the investor. Combining with the solution $R_b^{F*}(\rho) = 0, \forall\rho$, we find that the platform's return does not depend on the size of the shock, meaning that all risks are borne by the investor. The reason lies in the assumption that the LGFV is liquidity constrained, while the investor have sufficient liquidity, allowing him to bear more risk. As a result, the LGFV's goal is to maximize the investment to earn a fixed expected return of $p_H^l B/\Delta p$ per unit investment, while the investor achieve break-even according to the IR condition. The solution of the LGFV's payoff when the project fails $R_b^{F*}(\rho)$ implies that when the project fails, all the residual value, or the value of land L is claimed by the investor, and the platform's return is 0. Intuitively, this is one of the conditions that maximizes the investment while still keeping the bureaucrat motivated.
Moreover, the solution also characterizes some aspect of the capital structure of the LGFV. We know that $R_b^F(\rho) = 0, \forall\rho$ in the optimal contract. This seems to suggest that the investor has priority of repayment in the event of project failure, hence the contract seems indicating debt financing. However, we have learned earlier that the LGFV does not bear liquidity risk, and all liquidity shocks are covered by the investor, hence making him

more like a shareholder. We will address this issue in the discussion of the political economy of local government debt later.

Note that the range of the second order optimal response threshold ρ^* is also given by the proposition. For comparison, what is the first-order efficient response threshold in this model? The answer is ρ_1, which is just the upper bound of the range. This is because in the absence of moral hazard issues, there is no need to spend extra resources to motivate the bureaucrat. Therefore, the LGFV's pledgeable income is always ρ_1, which means that it is worth to cope with any liquidity shock $\rho \leq \rho_1$. One can also understand this first-order efficiency from the perspective of maximizing social surplus, since for any $\rho \leq \rho_1$, the total social surplus is $\rho_1 - \rho$, which is always non-negative.

4. EXCESSIVE LEVERAGE AND ITS CHANNELS

In the third part, we have solved the optimal financing contract for the LGFV. In this section, we will derive the central proposition of this paper from the solution to address important questions, such as how excessive leverage is caused by land, what are its channels, and to what extent this excessive leverage increases the platform's risk. In addition, we will also consider the macro risk implications of the excessive leverage under systematic shocks. We start from the equilibrium leverage ratio $I/(A + IL)$ derived in the last part to see how it is affected by land. We can infer from the equation (8) that the term $\rho_0 F(\rho^*) - \int_0^{\rho^*} \rho f(\rho) d\rho \equiv P_0$ in the denominator is positively related to the leverage ratio. Taking the derivative of P_0 with respect to L, we get:

$$\frac{dP_0}{dL} = \frac{d\rho_0}{dL} F(\rho^*) - (\rho^* - \rho_0) f(\rho^*) \frac{d\rho^*}{dL}. \tag{9}$$

The sign of the equation (9) is determined by the signs of $d\rho_0/dL$ and $d\rho^*/dL$. Remember that $\rho_0 \equiv p_H^l R + R^F - p_H^l B/\Delta p$ and $R^F = L$, it is straightforward that $d\rho_0/dL > 0$. To obtain the sign of $d\rho^*/dL$, we employ the equation that determined the optimal response threshold ρ^* in proposition 1, that is,

$$p_H B/\Delta p(1 - \int_0^{\rho^*} F(\rho) d\rho) - L(\rho_1 - \rho^* + (p_H - p_H^l)B/\Delta p) = 0.$$

Differentiate the equation with respect to L, and get:

$$[L - \frac{p_H B}{\Delta p} F(\rho^*)] \frac{d\rho^*}{dL} = \rho_1 - \rho^* + \frac{(p_H - p_H^l)B}{\Delta p} + L \frac{d\rho_1}{dL}.$$

It is easy to see that the right-hand side of the equation is greater than zero since $\rho^* < \rho_1$ and that $d\rho_0/dL > 0$ implies $d\rho_1/dL > 0$. Remember the second-order condition $L < p_H/B\Delta pF(\rho^*)$ mentioned in proposition 1, we know that $d\rho^*/dL < 0$. Hence we have established that $dP_0/dL > 0$. Combined with equation (8), we know that the increase in land does indeed lead to an increase in the leverage of the LGFV. We summarize the result as the following proposition:

Proposition 2. *When the land of an LGFV's project increases, its leverage ratio will also increase, leading to a further increase in investment beyond what would be caused solely by the increase in land at the given leverage ratio.*

It is a common practice in economic analysis to hold other conditions constant when discussing the impact of a variable's change. However, from the proposition given above, we know this is not always the case. In the context of this paper, it is inappropriate to assume that the leverage is fixed as land supply increases. This is precisely the excessive leverage we emphasized in this paper. From the previous analysis, it can be also concluded that the excessive leverage phenomenon is formed through two channels, which can be summarized as the revenue channel and the risk channel. The revenue channel refers to the increase in the return in the event of project failure as a result of the increase in land. Since all the project's return belong to the investor when the project fails, his expected return on unit investment (ρ_0) will also increase, making a larger-scale investments more attractive, and hence leading to a higher leverage ratio.

The risk channel is less straightforward. To clarify this, note that the optimization problem for ρ^* solved in the appendix is:

$$\max_{\hat{\rho}} \frac{A[(\rho_1 + \frac{(p_H - P_H^l)B}{\Delta p} F(\hat{\rho}) - (1 + \int_0^{\hat{\rho}} \rho f(\rho) d\rho)]}{1 + \int_0^{\hat{\rho}} \rho f(\rho) d\rho - \rho_0 F(\hat{\rho}) - L}. \tag{10}$$

When $\hat{\rho} \in (\rho_0, \rho_1)$, an increase in $\hat{\rho}$ not only survives the project from shocks with a higher probability, preserving the LGFV's return to a greater extent (as long as the project survives the shock, a return of $p_H^l B/\Delta p$ is guaranteed, as shown in the numerator of the equation above). On the other hand, for shocks that are between ρ_0 and $\hat{\rho}$, the investor suffers losses, because even if the project survives the shock by providing his additional liquidity $\hat{\rho}$, he can only obtain an expected return of ρ_0. Therefore, as $\hat{\rho}$ increases, the investor bears more risk, which reduces their willingness to participate and limits the LGFV's ability to raise larger investments, as shown in the denominator of (10). The LGFV needs to balance these two effects to select the optimal ρ^*. So, what impact does an increase in land have on this balance? The answer is that when the second-order condition $L < p_H B/\Delta p F(\rho^*)$ is satisfied, an increase in land makes the second effect dominating the first effect. To understand this, note that the investment $A/[1 - \int_0^{\hat{\rho}} (\rho_0 - \rho) f(\rho) d\rho - L]$ in equation (10) is an increasing and convex function of L, and $\int_0^{\hat{\rho}} (\rho_0 - \rho) f(\rho) d\rho$ is a decreasing function of $\hat{\rho}$. Therefore, the increase in L leads to a higher marginal contribution of a decrease in ρ^* to the increasing of investment. Hence overall, the increase in L leads to a reduction in ρ^*, which allows the LGFV to shift more risk to the investor and further increase its leverage. This is why we refer to it as the risk channel. We summarize the analysis as follows:

PROPOSITION 3. *The excessive leverage phenomenon is formed through two channels: the revenue channel and the risk channel. The revenue channel refers to that an increase in land raises the investor's expected return, making a larger-scale investments more attractive, and hence leading to a higher leverage ratio. The risk channel refers to that an increase in land decreases the investor's risk taking and further increases the leverage ratio.*

The excessive leverage also has some implication on the risk of project termination. In the context of this paper, project termination means that there is not enough liquidity to cover the shock ρ, and there are generally two reasons for this. One is that the contract's terms have stipulated that this shock is beyond the investor's obligation, meaning that $\rho > \rho^*$. Since there is a lower response threshold ρ^* of liquidity shocks as more land is supplied, the probability of project termination rises. The other is that even if the investor is responsible to provide liquidity when $\rho \leq \rho^*$, he may not be able to undertake the contract due to external shocks or other factors, which are not formally modeled here but nevertheless common in reality. Another problem is inconceivable commitment. It should be noted that when the shock is greater than ρ_0, the investor do not have an incentive to provide additional liquidity, because regardless of the realized value of the shock ρ, the expected return on investment per unit of investment for the investor is always ρ_0, hence the *ex post* dominant strategy of the investor is default: give up the claim for ρ_0 and no longer provide liquidity $\rho > \rho_0$. Hence when micro shocks to the investor is non-verifiable, investors will always have excuse to default, leading to project termination. When this happens, the probability of project termination further increases to $1 - F(\rho_0)$, meaning that a greater social welfare loss. Hence the implementation of the optimal contract is rather important, however, we will not address the problem in this paper.

We now turn to the macro risks briefly. Consider an economy that consists a large number of LGFVs and investors. If the shocks faced by them are independently and identically distributed, the investors will have enough liquidity to satisfy the needs of all LGFVs as a whole, because the shock faced by an individual platform is the same as the shock faced by all platforms as a whole. Specifically, some LGFVs may face shocks greater than ρ^*, while others smaller than ρ^*, and the shortfall in the former can be precisely compensated by the excess of the latter. However, if the economy is hit by a systematic shock, such as a large number of LGFVs facing a common shock simultaneously, or investors experiencing a sudden liquidity drain, or a significant drop in land prices, then the excessive leverage will lead to an increased susceptibility to macroeconomic risks. The first two kinds of shocks will directly result in the termination of a large number of ongoing projects, incurring massive sunk costs. In this case, regulatory authorities are expected to direct investors to continue lending, or provide additional liquidity to the market, so as to ensure project completion. A closely related issue is local government debt problem. When a project is terminated, then the LGFV goes bankrupt, leaving its outstanding debt as the local government's liability. Since the shock is systematic, local governments as a whole will then face a debt crisis nationwide. Relatively speaking, the consequences of a land price shock are more severe, since the excessive leverage relies on the stability of land value. The declining of price national wide will lead to a devaluation of collateral, requiring the corresponding bad-debt provision to be made, and ultimately lead to balance sheet recession of the banking system. On the other hand, local governments also lose its revenue from land finance, and the emergence of fiscal cliff will significantly increase the difficulty of solving the local government debt problem.

5. THE POLITICAL ECONOMY OF LOCAL GOVERNMENT FINANCING

In the previous discussion, readers might find it challenging to distinguish between local governments, LGFVs, and bureaucrats, which could lead to confusion. Firstly, in reality, the latter two are essentially the same party, and the differentiation made earlier was for convenience in presentation. As the optimal contract resolved the moral hazard issue, making the bureaucrat's interest aligned with that of the LGFV. Moreover, the model actually adopted a public choice perspective (Buchanan and Tullock, 1965), hence we do not assume that local governments pursue social welfare maximization or other similar objectives; instead, they represent the interests of the bureaucrats comprising them. In reality, the managers of LGFVs are often local government bureaucrats. As LGFVs are wholly state-owned enterprises of local governments, the debts of the LGFVs are, in essence, the debts of local governments. Thus, we can consider local governments, LGFVs, and bureaucrats as one party. They are the debtor in the debt contract, while investors represent the other party. Therefore, the driving force behind local government debt is the self-interested behavior of bureaucrats. Understanding this point is necessary for a better interpretation of the results of this model.

As indicated by the results of the model, the value function of the LGFV equals to the information rent gained by the bureaucrat. If we separate the LGFV and the bureaucrats, the latter receive all expected returns from unit investments in the form of information rent, while the LGFV's revenue remains zero. Consequently, the model's conclusion is consistent with the assumption of self-interested politicians in public choice theory, where bureaucrats utilize financing platforms and local governments to pursue personal gains.

Another important result of the model is that bureaucrats obtain a fixed return on unit investment, determined by the model's information cost. This leads bureaucrats to strive for implementing projects with the maximum possible investment. This conclusion is consistent with the hypothesis of budget-maximizing governments (Niskanen, 1971). In fact, in all economies where government bureaucrats are in charge of investments, the symptom of investment hunger (Kornai, 1980) exists, which was common not only in China but also in the former Soviet Union and Eastern Europe. The fundamental reason is that bureaucrats can obtain personal gains from investment projects, regardless of their efficiency. Therefore, from the results of the model, we can observe that bureaucrats are willing to accept a lower response threshold and tolerate a higher probability of project failure to achieve larger projects. It is precisely this excessive investment behavior of government bureaucrats that leads to the excessive leverage.

6. CONCLUSION

In existing literature, land has been recognized as an important asset that provides local governments with substantial revenue, however, the microeconomic mechanism of its role played in local government financing is not fully recognized. This paper shows that while land is being used as collateral for loans, it also amplifies the leverage of local government, resulting excessive leverage. We distinguished two channels that lead to excessive leverage, namely the revenue channel and the risk channel. The revenue channel refers to that an increase in land raises the investor's expected return, making a larger-scale investments more attractive, and hence leading to a higher leverage ratio. The risk channel refers to that an increase in land decreases the investor's risk taking and further increases the leverage ratio. These results heavily rely on the monopolized supply of land and its two distinguishing properties. One is that its price is relatively stable over the long term, and the other is that its tangibility and durability make it possible for investors to claim it when the project fails. We also analyzed the risk implication of the excessive leverage, including the increased probability of project termination due to a lower response threshold, and the social losses caused by excessive leverage.

In terms of policy, the most important goal at present is the stability of land prices. In this paper, the rise in land prices will further increase the excessive leverage, and a rapid fall in land prices will trigger macroeconomic risks.In fact, there is a certain relationship between excessive leverage and the incentives of local governments in existing theory, as it is in their interest to increase leverage and investment in the absence of macro shocks. However, the significant loss incurred by excessive leverage is borne by society as a whole. Therefore, to curb the rapid rise and decline in land prices, systematic economic and political system reforms are necessary, such as institutional reforms of the monopolized state-owned land system, as well as reforms to the existing bureaucratic system. In the last, we gave political economy analysis of the of local government debt in China, which rationaled the model adopted in this paper.

APPENDIX A

The Lagrangian function for the second-order optimal problem is:

$$
\begin{aligned}
L =& I \int_0^{\hat{\rho}} \left[p_H R_b^S(\rho) \ + (1-p_H)\, R_b^F(\rho)\right] f(\rho) d\rho - A - IL \\
&+ \mu \left\{ I \int_0^{\hat{\rho}} \left[p_H^l \left(R^S - R_b^S(\rho)\right) + \left(1-p_H^l\right)\left(R^F - R_b^F(\rho)\right) - \rho\right] f(\rho) d\rho - I + A + IL \right\} \\
&+ \int_0^{\hat{\rho}} \phi(\rho) \left[\Delta p \left(R_b^S(\rho) - R_b^F(\rho)\right) - B\right] f(\rho) d\rho + \int_0^{\hat{\rho}} \eta_1(\rho) R_b^S(\rho) f(\rho) d\rho \\
&+ \int_0^{\hat{\rho}} \eta_2(\rho) \left[R^S - R_b^S(\rho)\right] f(\rho) d\rho + \int_0^{\hat{\rho}} \xi_1(\rho) R_b^F(\rho) f(\rho) d\rho \\
&+ \int_0^{\hat{\rho}} \xi_2(\rho) \left[R^F - R_b^F(\rho)\right] f(\rho) d\rho.
\end{aligned}
\tag{A.1}
$$

Here, μ, $\phi(\rho)$, $\eta_1(\rho)$, $\eta_2(\rho)$, $\xi_1(\rho)$, and $\xi_2(\rho)$ are non-negative Lagrange multipliers for each constraints. By taking the first-order conditions of $R_b^S(\rho)$ and $R_b^F(\rho)$, we have:

$$\left[I p_H - I \mu p_H^l + \Delta p \phi(\rho) + \eta_1(\rho) - \eta_2(\rho)\right] f(\rho) = 0, \forall \rho, \tag{A.2}$$

$$\left[I\left(1-p_H\right) - I\mu\left(1-p_H^l\right) - \Delta p \phi(\rho) + \xi_1(\rho) - \xi_2(\rho)\right] f(\rho) = 0, \forall \rho. \tag{A.3}$$

Assume for now that $R_b^S(\rho) < R^S$ for all ρ, and by the complementary slackness condition, we know that $\eta_2(\rho) = 0$ for all ρ. Furthermore, by the non-negativity of the Lagrange multiplier and $p_H^l < p_H$, equation (A.2) tells us that $\mu > 1$, so its corresponding IR constraint is binding. Combining these results with equation (A.3), we have $\xi_1(\rho) > 0$ for all ρ and $\xi_2(\rho) = 0$ for all ρ. Therefore, we have $R_b^F(\rho) = 0$ for all ρ. Additionally, we know that $\eta_1(\rho) = 0$ for all ρ, otherwise it would violate the IC condition. However, it seems that we cannot deduce from equation (A.2) and (A.3) alone that $\phi_1(\rho) > 0$ for all ρ.
Hence we substitute $R_b^F(\rho) = 0$ into the original problem. Since the IR is binding, we can solve for the investment I:

$$I = \frac{A}{1 - L - \rho_1 F(\hat{\rho}) + \int_0^{\hat{\rho}} \rho f(\rho) d\rho + \int_0^{\hat{\rho}} p_H^l R_b^S(\rho) f(\rho) d\rho}. \tag{A.4}$$

Substituting the IR into the objective function, we can write the objective function as:

$$\begin{aligned}
&\left[\rho_1 F(\hat{\rho}) + \int_0^{\hat{\rho}} \left(p_H - p_H^l\right) R_b^S(\rho) f(\rho) d\rho - \int_0^{\hat{\rho}} \rho f(\rho) d\rho - 1\right] I \\
&= \frac{A\left[\rho_1 F(\hat{\rho}) + \int_0^{\hat{\rho}} \left(p_H - p_H^l\right) R_b^S(\rho) f(\rho) d\rho - \int_0^{\hat{\rho}} \rho f(\rho) d\rho - 1\right]}{1 - L - \rho_1 F(\hat{\rho}) + \int_0^{\hat{\rho}} \rho f(\rho) d\rho + \int_0^{\hat{\rho}} p_H^l R_b^S(\rho) f(\rho) d\rho} \\
&\equiv \frac{A\left[NPV(\hat{\rho}) + \int_0^{\hat{\rho}} \left(p_H - p_H^l\right) R_b^S(\rho) f(\rho) d\rho\right]}{\int_0^{\hat{\rho}} p_H^l R_b^S(\rho) f(\rho) d\rho - NPV(\hat{\rho}) - L},
\end{aligned} \tag{A.5}$$

in which $NPV(\hat{\rho}) \equiv \rho_1 F(\hat{\rho}) - \int_0^{\hat{\rho}} \rho f(\rho) d\rho - 1$ is the net present value per unit of investment when the response threshold is $\hat{\rho}$. Hence the optimization problem becomes:

$$\max_{R_b^S} \frac{A\left[NPV(\widehat{\rho}) + \int_0^{\hat{\rho}} \left(p_H - p_H^l\right) R_b^S(\rho) f(\rho) d\rho\right]}{\int_0^{\hat{\rho}} p_H^l R_b^S(\rho) f(\rho) d\rho - NPV(\hat{\rho}) - L}, \tag{A.6}$$

subject to:

$$\frac{B}{\Delta p} \leq R_b^S(\rho), \forall \rho. \tag{A.7}$$

It is easy to find the first order condition:

$$-p_H f(\rho) NPV(\hat{\rho}) - L\left(p_H - p_H^l\right) f(\rho) + \gamma(\rho) = 0, \forall \rho,$$

in which $\gamma(\rho)$ is the Lagrangian multiplier. Since $\gamma(\rho) > 0, \forall\rho$, hence $R_b^S(\rho) = B/\Delta p, \forall\rho$.
Substituting $R_b^S(\rho) = B/\Delta p, \forall\rho$ into (A.4), we have the equilibrium investment I^*. Finally, we are left with the last variable to be solved: $\hat{\rho}$. Substituting the solution of $R_b^S(\rho)$ back into (A.6), we finally transform the problem into:

$$\max_{\hat{\rho}} \frac{A[(\rho_1 + \frac{(p_H - P_H^l)B}{\Delta p} F(\hat{\rho}) - (1 + \int_0^{\hat{\rho}} \rho f(\rho) d\rho)]}{1 + \int_0^{\hat{\rho}} \rho f(\rho) d\rho - \rho_0 F(\hat{\rho}) - L},$$

which is just the modified objective function (10), where $\rho_0 = \rho_1 - \frac{p_H^l B}{\Delta p}$. By observing the formula, we can see that the numerator achieves its maximum at $\hat{\rho} = \rho_1 + (p_H - p_H^l)B/\Delta p$, and the denominator achieves its minimum at $\hat{\rho} = \rho_0$, therefore,

$$\rho_0 < \rho^* < \rho_1 + \frac{(p_H - p_H^l)B}{\Delta p}. \tag{A.8}$$

The optimal response threshold ρ^* satisfies the condition:

$$\frac{p_H B}{\Delta p}\left(1 - \int_0^{\rho^*} F(\rho) d\rho\right) - L\left(\rho_1 - \rho^* + \frac{(p_H - p_H^l)B}{\Delta p}\right) = 0. \tag{A.9}$$

In addition, we know that $\rho^* < \rho_1$, otherwise the investor is required to provide additional liquidity that is obvious not consistent with social welfare optimality. Combining with (A.8), we obtain $\rho_0 < \rho^* < \rho_1$. At this point, we also check the second-order sufficient condition. Taking derivative of equation (A.9) and setting it less than zero, we have $L < (p_H B/\Delta p)F(\rho^*)$, which is the condition provided in Proposition 1.

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