Borrowing like China? A Theory of Guarantee Multipliers

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Abstract

Government guarantees on collateral yield a multiplier effect, whereby levying one unit of tax to provide guarantees can amplify loan volumes by more than one unit. The policy works through facilitating efficient utilization of the collateral value in excess of the optimal investment scale when firms are using information-sensitive debt contracts, and through alleviating the limitations imposed by the no-information-production constraint when firms are using information-insensitive contracts. Appropriate levels of tax and guarantee help the economy achieve the socially optimal allocation. When the government has incentive to renege on its commitment, a negative shock to collateral quality can catalyze a crisis due to equilibrium collapse prompted by a breakdown of trust. Transition to a market-based insurance system and a debt swap program represent two avenues to address the financial crises.

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Keywords: Loan Guarantee, Multiplier, Information Production, Financial Crises, Debt Swap

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1 Introduction

The prevalence of implicit and explicit government guarantees is a salient characteristic within China's financial landscape, notably observed in the realm of debt financing for government-affiliated entities, such as local government financing vehicles (LGFVs) and state-owned enterprises (SOEs) (see He and Wei, 2022 and Song and Xiong, 2018 for reviews). Nonetheless, the intricacies of how government guarantees facilitate debt financing pose a puzzle. Firms need guarantee due to their incapacity of pledging their cashflow to borrow money, owing to the presence of moral hazard problems. To honor these guarantees, governments must rely on fiscal revenue derived ultimately from taxation. Given the non-pledgeable nature of firms' cash flows, collecting tax from firms' output becomes implausible, and the government has to instead tax the firms' investment. If each additional dollar of tax revenue solely yield a commensurate increase in borrowing, the guarantee policy should be ineffective, as the concurrent escalation in loans through guarantees and reduction in investment due to taxation would offset each other. Consequently, the efficacy of the guarantee policy hinges upon the existence of a multiplier, whereby one unit of tax revenue, when employed for guarantee purposes, amplifies loans by a magnitude exceeding one unit.

In this paper, we develop a model featuring collateralized lending and private information production to rationalize such a guarantee multiplier. In the model, firms borrow from households, while project outputs are not pledgeable. Hence, firms must provide collateral. Collateral is risky. Households can privately produce costly information to learn the ex-post value of the collateral, and they will withhold lending if they find the collateral worthless. Households trade off the cost of information production and the benefit of avoiding losses, and thus increased borrowing lead to stronger incentives for information production. Inadequate collateral quality might necessitate firms to curtail loan amounts to suppress private information production.

The government derives fiscal income from from lump-sum taxation, and uses the fiscal income to provide guarantee on collateral, thereby committing to indemnifying lenders against losses stemming from bad collateral. Due to the non-pledgeable nature of project outputs, the government must tax the firms' investment. The government optimally determines the level of taxation and the corresponding scale of guarantee to maximize social welfare.

We show that government guarantees yield a multiplier effect, whereby levying one unit of tax to provide guarantees can amplify loan volumes by more than one unit. This

multiplier effect persists until the socially optimal investment is achieved, leading to an improvement in equilibrium investment and social welfare.

The role of government guarantees is contingent upon the information sensitivity of debt contracts. When firms are using information-sensitive debt contracts, tax and guarantee policies facilitate efficient utilization of the collateral value in excess of the optimal investment scale for firms holding good collateral. When tax increases by one unit, firms holding good collateral does not need to reduce investment, since the value of good collateral surpasses the optimal investment. Consequently, taxes collected from firms holding good collateral can be used to subsidize those holding bad collateral, leading to a net increase in investment.

When firms are using information-insensitive debt contracts but the borrowing is constrained by the threat of private information production, the tax and guarantee policies serve to alleviate the limitations imposed by the no-information-production constraint. Employing tax revenue for guarantees reduces households' losses incurred from bad collateral, thus reducing their incentive to produce information. One unit of subsidy provided to bad collateral increases investment by one unit, but the cost of one unit of subsidy in bad states is less than one unit of tax revenue, since the likelihood of bad states occurring is less than certain.

The advantage derived from employing one unit of tax to provide guarantees is more pronounced within information-insensitive contracts than that within information-sensitive contracts. This discrepancy arises because within information-sensitive contracts, information is produced and guarantee policy only alleviates financial constraints for firms found to hold bad collateral. Conversely, within information-insensitive contracts, all firms are constrained by the no-information-production constraint, thereby providing guarantee relieve financial constraints for all firms.

Appropriate levels of tax and guarantee help the economy achieve the socially optimal allocation. Guarantees with scales surpassing a certain level fully relieve the no-information-production constraint and help to attain the socially optimal allocation. Higher initial collateral quality reduces households' incentive to produce information, consequently reducing the requisite guarantee and tax scales.

Evaluating the efficiency of tax revenue utilization through the average social welfare improvement per tax unit expended on guarantees, we demonstrate that maximum efficiency is achieved when guarantee policies just enable firms to adopt unconstrained information-insensitive contracts; that is, the guarantee policies make households indifferent between privately producing information and not under the optimal scale of

investment. Furthermore, the maximum efficiency increases with collateral quality. This is because higher collateral quality reduces the likelihood of bad states occurring and reduces households' incentive to produce private information. Consequently, the government can employ fewer subsidies to eliminate the constraints of private information production.

Our theory not only elucidates China's implicit guarantees but also unveils the underlying mechanism of publicly implemented loan guarantee programs across developed economies. Such programs, aimed at enhancing lending to small and medium enterprises, have proven effective in expanding loan supply. Examples include the Small Business Administration (SBA) 7a Loan Program in the U.S. (see Bachas, Kim, and Yannelis, 2021) and the SOFARIS program in France (see Lelarge, Sraer, and Thesmar, 2010).[1] Given these programs' fiscal dependence and the limited pledgeability of SMEs' cash flows, a multiplier mechanism akin to our model is indispensable for their efficacy.

Despite the positive impact of bolstering loans and investment, guarantee policies may precipitate financial fragility when the government has incentive to renege on its commitment. A negative shock to collateral quality can catalyze a crisis due to equilibrium collapse prompted by a breakdown of trust. We elucidate this mechanism within a repeated game framework. Upon committing to collateral guarantees at the beginning of each period, the government retains the discretion to honor or disregard its commitment at the end of the period. Households are unable to revoke their loans, irrespective of the government's decision to honor or disregard its commitment, as the funds have already been used for investment. Honoring guarantees requires the government to use tax revenue to indemnify lenders. Conversely, reneging allows the government to retain and redirect funds towards government expenditures with positive externalities. However, if the government reneges, households will withhold trust in its commitment for a certain period of time, which undermines the government's the opportunity to enhance investment through government guarantees.

We highlight that the equilibrium with positive government guarantees exists only when collateral quality surpasses a specific threshold. The government weighs the benefits of reneging against the costs of forfeiting future guarantee benefits. Thus, a sufficiently significant benefit from guarantee is needed to establish households' trust. Since the average social welfare improvement per tax unit expended on guarantees increases with

[1]Other loan guarantee programs include the Central Guarantee Fund in Italy (see Lagazio, Persico, and Querci, 2021), the Special Credit Guarantee Program and Emergency Guarantee Program in Japan (see Wilcox and Yasuda, 2019), Small Firms Loan Guarantee program in the U.K., and Small Business Financing program in Canada.

collateral quality, collateral quality must surpass a certain threshold to achieve sufficient benefit from guarantee. High collateral quality thus becomes a commitment mechanism.

However, collateral quality falling below the threshold would lead to consistent government reneging and a breakdown in trust. The economy would be trapped in an unfavorable equilibrium with no guarantees. This mechanism reveals that a negative shock to collateral quality can trigger a financial crisis by eroding trust in government guarantees. If the post-shock collateral quality falls below the threshold, the government's guarantee committment becomes non-credible, and only equilibrium without government guarantees exist. This triggers a reduction in loan amounts and investments, accompanied by a decline in output and social welfare.

Therefore, without negative shocks, the policy of government guarantees can bolster aggregate loans and investment. However, the absence of commitment precipitates financial fragility, particularly in scenarios characterized by low collateral quality. This highlights a paradox prevalent in emerging markets, such as China, where substantial financial constraints hinder economic growth and there is a pressing need for relaxing financial constraints. Paradoxically, these economies' low collateral quality heightens susceptibility to financial crises stemming from negative collateral shocks.

Finally, we examine two potential strategies to address this type of financial crises. Transitioning to a market-based insurance system represents one avenue. The insurance system lacks access to government expenditures, thus precluding the incentive to renege. Furthermore, stringent regulations imposed on insurance companies, such as the implementation of separate account management and frequent data reporting, serve to hinder any potential fund diversion. Consequently, even in scenarios where collateral quality falls below the cutoff value, households will maintain confidence that the insurance company will honor its insurance contract, and the socially optimal allocation can still be achieved.

However, such a transition necessitates time, while the government-backed guarantee system continues to dominate during the transition. Furthermore, a competitive market is the essential prerequisite for attaining the socially optimal allocation in a market-based insurance system. A monopolistic insurance market result in excessively costly insurance contracts and the under-investment problem persists. Therefore, while transitioning to a market-based system holds promise as a definitive solution to financial crises stemming from trust issues, complementary policies are indispensable for addressing imminent financial crises.

The second policy under scrutiny is China's debt swap policy, which was a strategy

to address imminent financial crises due to decline in collateral quality. The program swapped implicit guarantees with explicit local government bonds, which heightened the repercussions of governments' defaults and effectively isolated funds from diversion. Drawing from this background, we characterize this policy as a commitment mechanism. We assume that the government can issue new debt for financing guarantee obligations, but the government cannot redirect the funds acquired from issuing new debt towards government expenditures. Thus, debt issuance can only be utilized to honor guarantee commitments and refinance existing government debt.

We show that while this debt swap policy forestalls immediate crises, it amplifies future financial fragility. In the current period, the government's inability to divert funds rebuild households' trust in guarantee commitments. This enables the firms to use unconstrained information-insensitive debt contracts, thereby restoring efficiency. Nonetheless, the presence of a debt capacity limit and debt-related interest expenses prevents the government from perpetually refinancing all debt. As the government is obliged to repay creditors by tax revenue in the future, the most efficient guarantee scale might become unattainable, which amplifies the government's incentive to renege on guarantee committment. Consequently, a financial crisis is more likely to emerge, even during periods of relatively high collateral quality.

Literature Review

Our paper is related to several strands of literature. First, our paper is closely related to the literature on private information production in banking. The most related paper is Gorton and Ordoñez (2014), who formalize the idea of information sensitivity and argue that private information production constrains the borrowing capacity of borrowers. Borrowers must reduce their borrowing to suppress private information production. In our paper, we show that the presence of this no-information-production constraint will make the government guarantee policy effective and generate a guarantee multiplier, because government guarantee can help to relax this constraint.

Gorton and Ordoñez (Gorton and Ordoñez) study the interaction between the production of publicly supplied safe assets (government bonds) and privately supplied safe assets (asset-backed securities). They show that the supply of government bonds will disincentivize lenders from producing information, because government bonds are safer than privately produced safe assets. In our paper, we study a different policy, government guarantees. We show that government guarantees can suppress information production

by reducing the lenders' losses, which essentially provides an insurance across different lenders. Moreover, in our paper, government bonds play the role of supplementing funds, which allow the government to fulfill its commitment.

Dang et al. (2017) highlight the role of commercial banks as secret keepers who keep their loan return secret by suppressing private information production. In our paper, the government can use the government guarantee policies to keep the secret of municipal corporate debts and the loans of state-owned enterprises, which promote their financing and increase investment. Liu and Sinclair (2022) explore the possibility where borrowers can endogenously improve collateral quality to suppress private information production, such as through securitization, which characterizes the market approach of improving collateral quality. By contrast, this paper studies the possibility where the government can provide guarantee to improve collateral quality, which characterizes the policy approach of improving collateral quality.

Second, our paper contributes to the literature on China's financial system and the financing of the LGFVs and state-owned enterprises. Bai, Hsieh, and Song (2016) argue that four-trillion massive fiscal stimulus leads to a significant expansion of the LGFV debts and a severe capital misallocation. Chen, He, and Liu (2020) focus on municipal corporate bonds (hereafter "MCB", also know as "chengtou" bonds), bonds issued by LGFVs to support infrastructure investment. They show that MCBs rose quickly around 2014 as a way to refinance stimulus-era loans and provide aggregate evidence that WMPs have been investing heavily in MCBs to support local government infrastructure investment. Xiong (2018) attributes the rapid growth of LGFV debt to the tournament competition between local government official. Ambrose, Deng, and Wu (2015), Bai, Hsieh, and Song (2016), and Song and Xiong (2018) show that LGFV debts are back by collateral, especially land, which justifies our model environment of collateralized lending.

In terms of the existence of implicit guarantees. Ang, Bai, and Zhou (2018) and Liu, Lyu, and Yu (2021) show that MCB's credit spreads depend not only on the financial conditions of the issuing LGFVs but also on the fiscal conditions of their backing local governments, which implies the existence of implicit guarantee. Walker et al. (2021) show that the yield spreads of MCBs are significantly lower than those of corporate bonds issued by privately-owned enterprises, which also provides evidence for implicit guarantee. Our paper provides a rationale for the implicit guarantee and our theoretical predictions are consistent with the empirical evidence.

Finally, our paper is related to the literature on government guarantees on loans. The literature primarily discusses the impact of government guarantees on small and medium

enterprises (SMEs). Literature has shown that government guarantees help to improve credit availability and mitigate SMEs' financial constraints. Wilcox and Yasuda (2019) use Japanese data and show that loan guarantees increase loan supply of both guaranteed loans and non-guaranteed loans. Bachas, Kim, and Yannelis (2021) use U.S. data and also find that lenders do increase loan supply in response to loan guarantees. They argue guarantees from government play the role through credit enhancement. Lelarge, Sraer, and Thesmar (2010) use French data and find that loan guarantees are mostly effective on the intensive margin, that is, the program helps newly created firms to be larger, while does not trigger an increase in the overall number of firms created. Besides the positive effects, literature has empirically identified negative effects of loan guarantee programs due to the heightened moral hazard problem, such as increasing default rate (Lelarge, Sraer, and Thesmar, 2010), increasing delinquency rate (Cowan, Drexler, and Yañez, 2015), worsening financial conditions (De Blasio et al., 2018), and reducing profitability (Lagazio, Persico, and Querci, 2021). Our paper provides a novel theoretical framework based on information asymmetry to understand the impact of loan guarantee programs.

The remainder of the paper is organized as follows. Section 2 reviews the institutional background. 3 introduces the general setup of the model. Section 4 characterizes the equilibrium debt contract. Section 5 studies the guarantee multiplier and optimal guarantee policy. Section 6 studies the financial crises due to a breakdown of trust between government and lenders. Section 7 studies two potential strategies to address financial crises. Section 8 concludes.

2 Institutional Background

2.1 The Development of the LGFVs

The emergence of LGFVs in China can be largely attributed to the "tax sharing reform" in 1994, which removed control of local governments over the allocation of local tax revenues. This reform led to a significantly heavier financial burden of local governments. The tax share of local governments fell from about 80 percent to 40 to 50 percent in 1994. Local governments had to assume the same responsibility but possessed much less resources. Consequently, the local government then sought for other sources of funds. A majority of local governments chose to seize land from farmers and urban residents and resell the land. Land sales have become an important source of local revenue. However, since land supply is limited, some local governments found it insufficient to raise funds solely from

selling land. They then find another way of raising funds. They chose to implicitly run deficits by establishing locally controlled state-owned companies, that is, the LGFVs, and then use these companies as channels to borrow from banks or issue bonds (Lu et al., 2013; Bai, Hsieh, and Song, 2016).

The four-trillion RMB stimulus in 2009 plan further promoted the development of LGFVs. Most of the 2009 stimulus package was implemented through China's local governments. To raise sufficient funds for the stimulus investment, local government highly rely on bank loans and bonds through LGFVs (Bai, Hsieh, and Song, 2016; Zilibotti, 2017). The central government also implemented regulatory change (Document No. 92, CBRC, March 18, 2009) to relax the constraints and encourage local governments to set up LGFVs. Consequently, the number of LGFVs that had issued bonds significantly increased: about 1,800 LGFVs had issued bonds by 2015, while less than 100 did so before 2008 (Song and Xiong, 2018). Even according to the official statistics, the outstanding local government debt, which included only a fraction of all LGFV debts, increased from less than 5 trillion yuan in 2008 to 16 trillion yuan in 2015.[2]

Starting from 2010, the central government found that too many loans flowed into overcapacity industries, which led to a low allocation efficiency. Beijing then shifted its focus from stimulating economic growth to containing the risks of low-quality credit and the corresponding risks of the entire commercial banking system. The scale of banks loans made to LGFVs significantly contracted. Then, LGFVs shifted to using municipal corporate bonds (hereafter "MCB", also know as "chengtou" bonds) and trust financing to borrow money. MCBs are bonds issued by LGFVs to support infrastructure investment. Chen et al. (2020) connect the dramatic 2012-2015 growth of MCBs to the 2009 stimulus plan, and provide further evidence that WMPs invest heavily in MCBs. They use cross-sectional variation to show that MCBs rose quickly around 2014 as a way to refinance stimulus-era loans and provide aggregate evidence that WMPs have been investing heavily in MCBs to support local government infrastructure investment.

2.2 Implicit Guarantee

As Zhu (2016) observe, implicit guarantee is pervasive in China's financial system. He notes "many investors believe that, as long as the (issuers and) financial institutions are concerned with their reputations, as long as the regulators are concerned with career advancement, and as long as the Chinese government is concerned with social stability,

[2]http://www.xinhuanet.com/politics/2015-08/29/c_1116414320.htm?from=message&isappinstalled=0

they will take care of the risks that investors themselves should bear when investing in such products."

The implicit guarantee is especially strong for LGFV loans and MCBs, because the funds raised by LGFVs are essentially used for infrastructure investment and other public expenditure. Banks generally take implicit guarantee into account when evaluating the risk of LGFV loans, and thus have strong willing to make loans to LGFVs. MCBs, although being issued by LGFV entities just like other regular corporations, are also implicitly backed by local government, and hence are called "municipal" (He and Wei, 2022).

Investors' expectations of government guarantees can be observed by examining a bond's credit spread. Ang, Bai, and Zhou (2018) and Liu, Lyu, and Yu (2021) show that MCB's credit spreads depend not only on the financial conditions of the issuing LGFVs but also on the fiscal conditions of their backing local governments, which implies the existence of implicit guarantee. Walker et al. (2021) show that the yield spreads of MCBs are significantly lower than those of corporate bonds issued by privately-owned enterprises, which also provides evidence for implicit guarantee.

Although almost all MCBs carry implicit guarantee, the degree of implicit guarantee varies across different local governments. Ang, Bai, and Zhou (2018) show that the degree of implicit guarantee can be determined by two factors. The first one is the capability of offering the guarantee, which is determined by the available fiscal resources of local governments. Therefore, to provide credible guarantee, the local governments need to collect sufficient fiscal revenue, either by collecting tax or selling land. Otherwise, the investors will not trust the local governments. The second factor is the uncertainty of fulfilling the guarantee when defaults indeed occur, because even with the full capability, a local government may be unable or unwilling to offer the guarantee. Therefore, local governments have the rights to determine whether to fulfill the guarantee obligations. In reality, local governments have to prioritize allocating fiscal revenue to social responsibilities that are urgent and are related to social stability, such as paying salaries to doctors, teachers, and police, and providing subsidy to very poor people. When the fiscal revenue is insufficient to simultaneously fulfill these important responsibilities and fulfill guarantee obligations, local governments may determine not to fulfill guarantee obligations.

However, local governments will be punished if they do not fulfill guarantee obligations, or even signal to renege. The investors will be very cautious about the MCB market, and the interest rate of future MCBs will be significantly increased. For example, the 2011 Yunnan Highway default event focused investors' attention on the creditworthi-

ness of local governments in MCB market. Specifically, in April 2011, Yunnan Provincial Highway Development and Investment Co., Ltd. ("Yunnan Highway") issued a default notice to its creditor bank, triggering strong reactions from LGFV bond investors. Although the bond issuer was eventually bailed out by the Yunnan Provincial Government, market investors expressed strong concern over LGFV credit risk and began to question the ability or willingness of local governments to offer implicit guarantee for the LGFVs. Eventually, this event led to a panic in the market and market liquidity of China's MCB market significantly shrank. The recession lasted for almost one year, and it took even more time for the interest rates of MCBs issued by Yunnan LGFVs to go back to the pre-recession level (Liu, Lyu, and Yu, 2021).

2.3 Debt Swap Policy

In 2013, the central government realized the potential high risk behind local governments' rapid debt accumulation through LGFVs. The ratio of local government GDP to debt was excessively high, and local governments did not have sufficient fiscal income to repay these debts. The central government first instructed local governments to screen the LGFV debts under the guidance of National Audit Office (NAO). Based on the NAO report in 2013, as of the end of June 2013, the outstanding LGFV debt was near 7 trillion RMB. Outstanding LGFV debts were classified into three categories, (1) debts that are fully guaranteed by local governments, (2) debts that local governments have contingent obligation, and (3) debts that local governments only have contingent bailout obligation when defaults occur. The first category, for which local governments were responsible for the repayment, accounted for nearly 60% of all LGFV debts, and were directly considered to be local governments' debts.[3] The second and the third categories were considered to be local governments' contingent debts. The central government attached great importance to the risk of implicit debts of local governments, and listed controlling and resolving the risk of local government debt as one major task of 2014.

Then, to solve the high risk problem, in September 2014, the State Council issued the Document No. 43 that put strict restrictions on LGFVs raising funds for new investments,[4] including forbidding local governments from providing guarantees to MCBs, but the regulation still allowed LGFVs to use MCB proceeds to repay existing bank loans or other borrowings. Moreover, Document No. 43 encouraged local governments to replace

[3]http://www.gov.cn/gzdt/2013-12/30/content_2557187.htm
[4]http://www.gov.cn/zhengce/content/2014-10/02/content_9111.htm

maturing LGFV debts with local government bonds, which guided the local government bond swap program since 2015 (Chen, He, and Liu, 2020).

In 2015, the Ministry of Finance formally launched three rounds of debt swap program and issued a total of 3.2 trillion RMB quotas to the program.[5] The program allowed local governments to refinance certain LGFV debts by local government bonds that are ultimately backed by the central government. The first two rounds, with a quota of 2 trillion RMB, were only allocated to outstanding debts that would mature in 2015 and were classified as local governments' debts (the first category). The third round, with a quota of RMB 1.2 trillion , can be used for both local government debts and local governments' contingent debts. At the end of December 2015, the Ministry of Finance proposed to swap all LGFV debts and other forms of liabilities for local governments bonds within three years.[6] After that, the debt swap program was accelerated. The swap quota were 5 trillion RMB in 2016, 3 trillion RMB in 2017, and around 1.3 trillion RMB in 2018. By the end of 2018, the outstanding government debt in the form of non-government bonds was only 315.1 billion RMB according to the Ministry of Finance (Qiu, Wang, and Wang, 2022).

3 The Model Setup

3.1 Agents and Preferences

We apply a repeated game framework with private information production and government guarantee on collateral. Consider a discrete-time infinite-horizon economy with three types of agents: a government, a continuum of firms with measure 1, and a continuum of households with measure 1. There are two types of goods, numeraire goods and collateral. Each household is endowed with e units of numeraire at each period. Each firm is endowed with one unit of collateral at each period. Numeraire is perishable, and thus agents must consume all numeraire at the end of each period.

Numeraire goods can be invested and consumed. Collateral cannot be consumed and is not eligible for investment. However, collateral potentially has an intrinsic value. In period t, a fraction p_t of collateral endowment is "good", and one unit of good collateral delivers M units of numeraire at the end of period; a fraction $1 - p_t$ of collateral is "bad", and one unit of bad collateral delivers nothing at the end of period. We assume that

[5] http://www.gov.cn/xinwen/2016-05/26/content_5077112.htm
[6] http://www.gov.cn/gongbao/content/2016/content_5059103.htm

M is a constant over time, while p_t can be changed by exogenous shocks. Henceforth, we will always use subscript to denote time. We will call p_t the "quality of collateral". Collateral disappears after delivering numeraire. This type of collateral corresponds to debt-based financial instruments, which no longer exist after repayment. Then, the only state-variable over time will be the credit of the government.

Firms and households are risk-neutral. They derive utility from consuming numeraire. We use c to denote numeraire consumption, superscript "H" to represent households, and superscript "F" to represent firms. Therefore, in period t, a household's utility function is $u^H = c_t^H$, and a firm's utility function is $u^F = c_t^F$.

The government has no endowment. Different from firms and households, the government aims to maximize social welfare, which equals the sum of consumption of households and firms. Since both firms and households are risk-neutral, social welfare equals the discounted sum of their utility. The discount factor is β, and social welfare in period t then equals

$$V_t = \sum_{h=t}^{\infty} \beta^{h-t}[c_h^C + c_h^F]. \tag{1}$$

3.2 Production Technology and Collateral

Only firms have access to an inelastic fixed supply of nontransferrable managerial skills, which we denote by L^*. These skills can be combined with numeraire in a stochastic Leontief technology to produce more numeraire, K'.

$$K' = \begin{cases} A\min\{K, L^*\} & \text{with prob. } q \\ 0 & \text{with prob. } 1-q \end{cases}$$

We assume that $qA > 1$, which means that the investment technology is efficient. The optimal investment is $K^* = L^*$.

Resources are in the wrong hands. Firms have managerial skills but do not have goods eligible for investment. households have goods eligible for investment but do not know how to manage projects. Therefore, the need for borrowing and lending between firms and households emerges.

Firms must borrow from households, but the output of the project is not pledgeable, and thus firms cannot borrow against the output and must have collateral to back the debt. This assumption can be justified by either agency friction or informational friction: first, since only firms have skills to manage the loans (such as monitoring), they can always

threaten the households to repudiate the contract by ceasing to operate the projects (see, for example, Hart and Moore 1994, Diamond and Rajan (2006), Farhi and Tirole 2011, and Moreira and Savov 2017); second, one can consider the case that the output of the projects is not verifiable, and then the firms can cheat the households by claiming the projects have no output and never repay (see, for example, Gorton and Ordoñez 2014).

3.3 Market Structure and Information Production

At the beginning of each period, each firm is randomly matched with a household. The firm has all the bargaining power in the matching, and it makes a take-or-leave-it offer to the household. Thus, the firm will always make the household indifferent between lending and not lending. The uncertainty of the collateral will only be resolved at the end of each period, which means that the firm does not know whether the collateral is good or bad when it repays the debts. At the end of each period, the matches between firms and households break, and new matches are formed in next period.

Households can *privately* produce information about the true value of the collateral. By incurring a cost of γ units of numeraire to hire an outside analyst, a household can learn the end-of-period value of the collateral. γ is constant over time. The prior of the collateral being good is the quality of collateral, p_t. With probability p_t, the household will find that the collateral is good and has a high value. With probability $1 - p_t$, the household will find that the collateral is bad and has a low value. The privately produced information will not become public until the end of the period. However, the household can choose to disclose it earlier.

3.4 Taxation and Government Guarantee

Although the government has no endowment, it can tax the agents. Since the project output is not pledgeable, the government does not have the ability to collect tax from the output, either. Thus, the government can only tax the firms' investment. In this paper, we will consider a lump-sum tax: the government taxes the firms from their investment at the beginning of each period. The tax in period t is T_t, meaning that for any amount of investment, the firm must pay T_t units of numeraire to the government.

The government can provide guarantee on collateral at the beginning of each period, which means that the government guaranteed to indemnify the lender for losses caused by bad collateral. At the end of each period, the government will use the tax revenue to indemnify the lenders. Denote the scale of government guarantee as s_t, which means that

in period t, the government announces that it will pay s_t units of numeraire to the lender for one unit of collateral if the collateral is bad. Since the collateral value is M when the collateral is good, we have $s_t \leq M$. Since firms rely on collateral to borrow, providing guarantee on collateral can enable firms to borrow more money from households, which increases the scale of efficient investment, leading to more numeraire consumption at the end of period.

If the government provides guarantee, bad collateral will provide the lender with s_t units of numeraire from the government indemnity. Thus, even when a household finds the collateral bad, she is still willing to lend some numeraire to the matched firm. We assume that the firm and the household will have a renegotiation after the household produces information and finds the collateral bad. The household will show the information to the firm, and the firm will offer another debt contract to the household. To be consistent, the firm still has all bargaining power in the renegotiation.

3.5 Timeline

The timing of the economy in period t is as follows.

Beginning of period t

(i) Period t starts. Each firm is first randomly matched with a household.

(ii) The government announces the scale of government guarantee.

(iii) Firms determine the borrowing amount and offer debt contracts to their matched households.

(iv) Households decide whether to produce information. If a household produces information and find collateral bad, she renegotiates with the matched firm. Finally, households determine whether to accept the loan offers.

(v) If a household decides to lend, the matched firm obtain loans. The government taxes firms for their investments. Then, firms invest the remaining numeraire.

End of Period t

(i) The project payoffs are realized, and the fundamental value of the collateral is realized.

(ii) Firms repay their loans based on the fundamental value of the collateral.

(iii) The government fulfills its promise of guarantee.

(iv) Firms and households consume, and next period starts.

Note that the firm repays the loan *after* the fundamental value of collateral is realized.

Thus, even when the project succeeds, if the firm knows that the collateral is bad, it will claim that the project has failed and will transfer the worthless collateral to the household. Then, the amount of goods received by the household at the end of the period is determined only by the value of collateral and committed interest rates, and is independent to the output of the projects. Specifically, if the collateral value is larger than the committed repayment, the household will always receive the full repayment, either in the form of the firm's repayment or in the form of the numeraire delivered by the collateral. If the collateral value is smaller than the committed repayment, the household will only receive the collateral value.[7]

4 Equilibrium Debt Contract

In this section, we will characterize the equilibrium decisions of firms and households under any government guarantee s_t. Now, when the collateral is good, one unit of collateral will deliver M units of numeraire. When the collateral is bad, the government will indemnify the household by paying s_t units of numeraire.

In the presence of the lump sum tax, a firm needs to borrow $K^* + T_t$ units of numeraire to achieve the optimal investment. However, the firm may not be able to invest its optimal level of investment due to the collateral constraint.

Similar to Gorton and Ordoñez (2014), the debt contract may be information-sensitive, which means the household will produce information about the final value of collateral, or information-insensitive, which means that the household does not produce information. Since the discussion is in spirit similar to Gorton and Ordoñez (2014), we will discuss the contract choice in a succinct way.

4.1 Information-sensitive Debt Contract

If the firm chooses to trigger the household's information production, the debt conditions are conditional on the resulting information. The firm offers to borrow L_t^{IS} from the household and commits to repay R_t^{IS} units of numeraire at the end of the period. Then, the household produces information about the collateral.

If the household finds collateral good, the household knows that the collateral is worth M units of numeraire at the end of the period, and she will accept the offer and lend to

[7] If we adopt the alternative assumption that the firm repays the loan *before* the fundamental value of collateral is realized, all of the results will remain unchanged.

the firm. If the household finds collateral bad, the household will only obtain s_t units of numeraire from the government. Then, the household will renegotiate with the firm. Since the household has produced information and the information production cost is a sunk cost, and the firm has all the bargaining power, the firm will borrow s_t units of numeraire from the household.[8]

Although the firm does not need to compensate the household for her cost of producing information in renegotiation, the firm must compensate the household when the collateral is good. Otherwise, the household will directly exit the market and will not bothering with producing information. By assumption, the household is risk neutral and breaks even in the lending. To simplify the analysis, we assume that the value of good collateral is always sufficient to sustain both the optimal investment and the information production cost.

Assumption 1. *The value of good collateral is sufficient to sustain the optimal investment and the information production cost, that is,* $M > K^* + \gamma/p_t$.

To maximally utilize the government guarantee, the firm will always post all its one unit of collateral to the household, as the government only indemnifies the lender for the loss. The netting mechanism in collateralized lending ensures that if the collateral value exceeds the committed repayment, the firm will get back the residual value. Then, the household's participation constraint is

$$p_t(R_t^{IS} - L_t^{IS}) + (1 - p_t)(s_t - s_t) - \gamma = 0, \tag{2}$$

If the household finds the collateral good, the firm can borrow $K^* + T_t$ to achieve the optimal investment, and thus $L_t^{IS} = K^* + T_t$ and the firm can invest K^*. When the collateral is bad, the collateral is worth s_t, and the firm can borrow s_t and invest $s_t - T$ units of numeraire. Denoting the expected investment under information sensitive contracts as K_t^{IS}, we have

$$K_t^{IS} = p_t K^* + (1 - p_t)(s_t - T_t). \tag{3}$$

The firm's expected net profit is

$$\pi_t^{IS} = p_t(qA - 1)K^* + (1 - p_t)(qA - 1)(s_t - T_t) - \gamma.$$

[8]The assumption of bargaining power is for simplicity. As long as the household has some bargaining power, she can obtain a strictly positive interest from the renegotiation, which is strictly better than refusing to lend.

4.2 Information-insensitive Debt Contract

The firm can also choose to borrow without triggering information acquisition. Still, the household is risk neutral and breaks even. The firm offers to borrow L_t^{II} from the household and commits to repay R_t^{II} units of numeraire at the end of the period. Without producing information, the household always lends L_t^{II}. The household can obtain a full repayment R_t^{II} if the collateral is good, and can only obtain s_t units of numeraire when the collateral is bad. Thus, the household's participation constraint is

$$p_t R_t^{II} + (1 - p_t)s_t - L_t^{II} = 0. \tag{4}$$

When the firm offers an information-insensitive contract, if the household deviates by producing information and finds the collateral bad, she can still renegotiate with the firm. Renegotiation reduces the losses caused by receiving bad collateral. The household does not want to deviate if the expected gains from acquiring information is smaller than the cost γ, that is,

$$p_t(R_t^{II} - L_t^{II}) + (1 - p_t)(s_t - s_t) \leq \gamma. \tag{5}$$

Injecting R_t^{II} solved from (4), we know (5) can be equivalently converted to

$$(1 - p_t)(L_t^{II} - s_t) \leq \gamma. \tag{6}$$

Intuitively, the household suffers a loss of $L_t^{II} - s_t$ units of numeraire the collateral is bad, which occurs with a probability of $1 - p_t$. Private information acquisition can help to avoid the loss. (6) determines how the firm's borrowing is constrained by the private information acquisition; thus, we will call (6) the no-information-production constraint in borrowing activities. With this no-information-production in borrowing activities, the firm can maximally borrow

$$L_t^{CII} = \frac{\gamma}{1 - p_t} + s_t$$

units of numeraire. Since this borrowing amount is constrained by the no-information-production, we call this contract *constrained* information-insensitive debt contract. Denoting the expected investment under information sensitive contracts as K_t^{CII}, we have

$$K_t^{CII} = L_t^{CII} - T_t = \frac{\gamma}{1 - p_t} + s_t - T_t. \tag{7}$$

The firm's expected net profit under constrained information-insensitive debt contract

is

$$\pi_t^{CII} = (qA-1)K_t^{CII}.$$

The comparison between K_t^{CII} and the firm's optimal borrowing amount determines whether the no-information-production is binding. If $K^* > K_t^{CII}$, the firm can maximally borrow L_t^{CII} and invest K_t^{CII} units of numeraire. The firm will use a constrained information-insensitive debt contract.

If $K^* \leq K_t^{CII}$, the firm can borrow its desirable amount of numeraire, $L_t^{UII} = K^* + T_t$, and invest K^* units of numeraire. If the firm can invest its desirable amount K^*, we call this contract *unconstrained* information-insensitive debt contract. The firm's expected net profit is

$$\pi_t^{UII} = (qA-1)K^*.$$

The cutoff of the collateral quality which makes the investor indifferent between producing information and not under L_t^{UII}, that is, $L_t^{CII} = L_t^{UII}$, is $\bar{p}_1 = 1 - \frac{\gamma}{K^*+T_t-s_t}$.

4.3 Choice of Information Sensitivity of Debt Contracts

The firm compares the net profits from the information-insensitive debt contracts and the profits from the information-sensitive debt contracts. The unconstrained information-insensitive debt contracts are always strictly better than the information-sensitive contracts, because the firms can borrow the same amount of numeraire for certain and do not need to compensate the households for their cost of information production. Therefore, when $p_t > \bar{p}_1$, the information-insensitive debt contracts always prevail.

When $p < \bar{p}_1$, there exists two cutoff points, $\bar{p}_2$ and $\bar{p}_3$, satisfying $\bar{p}_2 < \bar{p}_3$, such that the firm indifferent between using information-insensitive and information-sensitive debt contracts, that is, $\pi_t^{CII} = \pi_t^{IS}$. $\bar{p}_2$ and $\bar{p}_3$ are two roots of the following equation:

$$p_t(qA-1)K^* + (1-p_t)(qA-1)(s_t - T_t) - \gamma = (qA-1)K_t^{CII}. \tag{8}$$

Obviously, $\bar{p}_1$, $\bar{p}_2$,and $\bar{p}_3$ are all functions of s_t. Then, we have the following proposition, which addresses the choice of contract information sensitivity.

Proposition 1. *Given the government guarantee s_t,*

(i) if $\bar{p}_3(s_t) \leq p_t < \bar{p}_2(s_t)$, the firm will use information-sensitive debt contract, $K_t = K_t^{IS}$;

(ii) if $\bar{p}_2(s_t) \leq p_t \leq \bar{p}_1(s_t)$, the firm will use constrained information-insensitive debt contract, $K_t = K_t^{CII}$;

(iii) if $p_t > \bar{p}_1(s_t)$, the firm will use unconstrained information-insensitive debt contract, $K_t = K^*$.

Based on Proposition 1, we make the following assumptions.

Assumption 2. *(i) The original collateral quality without government guarantee locates at $p_t \in (\bar{p}_3(0), \bar{p}_2(0))$. (ii) $\bar{p}_3(0)M > K^*$.*

In reality, only relatively high-quality financial assets can be used as collateral. Moreover, since we are focusing on emerging markets like China, we assume that the original collateral quality without government guarantee is not very high. Then, without government guarantee, the firm will choose information sensitive contract. Finally, we assume that $\bar{p}_3(0)M > K^*$, which means that the expected value of collateral can support the optimal investment. This assumption allows us to solely focus on the borrowing constraints due to information friction. This is because if this condition is not satisfied, even if unconstrained information-insensitive contracts are used, the firms still cannot borrow the optimal scale of investment. The problem of insufficient collateral value cannot be solved by the tax and guarantee policy, since the tax is levied from the investment.

5 Guarantee Multiplier

In this section, we will discuss the role of government guarantee in promoting investment and improving social welfare.

5.1 The Effect of Government Guarantee

Since only $1 - p_t$ proportion of collateral is bad, the government only needs to indemnify $1 - p_t$ proportion of households. Thus, T_t units of tax revenue can support $\frac{T_t}{1-p_t}$ units of government guarantee; that is, $T_t = (1 - p_t)s_t$. We will first present a proposition to show the marginal effect of government guarantee, which shows the key intuition behind the guarantee multiplier.

Proposition 2. *(i)When firm are using information-sensitive contract, increasing the lump-sum tax by one unit will increase the expected borrowing amount by $p_t + 1$ units, and the investment will increase by p_t units.*

(ii) When firms are using constrained information-insensitive contract, increasing the lump-sum tax by one unit will increase the borrowing amount by $\frac{1}{1-p_t}$ units, and the investment will increase by $\frac{p_t}{1-p_t}$ units.

(iii) When firms are using unconstrained information-insensitive contract, increasing the lump-sum tax by one unit will increase the borrowing amount by one unit, and the investment does not change.

Proof. See Appendix A.1. □

Proposition 2 suggests that the effect of government guarantee depends on the information sensitivity of debt contracts. When firms are using information-sensitive debt contract, increasing tax by one unit will increase the expected borrowing amount by more than one units, and the investment will increase. In other words, government guarantee is effective. This is because the optimal scale of investment K^* is smaller than the collateral value when the collateral is good ($K^* < M$). When the government raises tax by one unit, for those firms holding good collateral, their investment will not change. However, for those firms holding bad collateral, their subsidy increases by more than one unit, and their tax only increases by one unit. In other words, government guarantee allows the government to use the good collateral value (M) in excess of the optimal investment scale (K^*) to subsidize firms holding bad collateral. Thus, levying one unit of tax will reduce the expected investment by less than one unit, while providing guarantee will increase the investment by one unit. This means that the government guarantee can improve equilibrium investment and social welfare.

When firms are using constrained information-insensitive debt contract, the investment is determined by the no-information-production constraint. Besides increasing the expected value of collateral, using tax revenue on guarantee relaxes the information production constraint, and thus levying one unit of tax can increase the scale of loans by more than one unit. The equilibrium investment is thus increased. More specifically, information production helps the investors to avoid the losses in bad states. Thus, when determining whether to privately produce information under an information-insensitive debt contract, households only care about bad states. One unit of subsidy in bad states leads to one unit of increase in investment. However, one unit of subsidy in bad states costs the government less than one unit of tax revenue, as bad states only occur with a probability of $1 - p_t$. Thus, one unit of tax revenue can increase the investment by more than one unit.

The marginal benefit of using one unit of tax to provide guarantee under constrained

information-insensitive contracts is larger than that under information-sensitive contracts. This is because when firms are using information-sensitive contract, providing guarantee only relaxes the financial constraints of those firms holding bad collateral, which accounts for $1 - p_t$ proportion of all firms. The investment of those firms holding good collateral does not change, since they have already achieve the optimal scale of investment. By contrast, when firms are using constrained information-insensitive contract, *all* firms are constrained by the no-information-production constraint. Providing guarantee relaxes the financial constraints of *all* firms. Thus, the marginal effect of providing guarantee is larger under constrained information-insensitive contracts.

Finally, when firm are using unconstrained information-insensitive contract, the firm has already reached the optimal investment, and the guarantee policy will not further increase the investment.

In summary, the government guarantee on collateral has a multiplier effect, that is, levying one unit of tax to provide guarantee can increase the scale of loans by more than one unit. The equilibrium investment and social welfare are thus improved. This effect exists as long as the socially optimal investment has not been achieved. When firms are using information-sensitive debt contracts, the policy of tax and guarantee has positive effects since it helps to utilize the excessive collateral value when firms holding good collateral. When firms are using constrained information-insensitive debt contracts, the policy of tax and guarantee has positive effects since it helps to relax the no-information-production constraint.

The following Proposition characterizes the effect of government guarantee on the information sensitivity of debt contracts.

Proposition 3. *When* $s_t < \frac{K^*(1-p_t)p_t(qA-1)-qA\gamma+p_t\gamma}{(1-p_t)p_t^2(qA-1)}$, *the firm will use information sensitive contracts. When* $\frac{K^*(1-p_t)p_t(qA-1)-qA\gamma+p_t\gamma}{(1-p_t)p_t^2(qA-1)} \leq s_t < \frac{(1-p_t)K^*-\gamma}{p_t(1-p_t)}$, *the firm will use constrained information insensitive contracts. When* $s_t \geq \frac{(1-p_t)K^*-\gamma}{p_t(1-p_t)}$, *the firm will use unconstrained information insensitive contracts.*

Proof. See Appendix A.2. □

Proposition 3 shows that government guarantee can avoid information production and relax information constraints. When the scale of government guarantee is sufficiently high, the firm can use unconstrained information insensitive contracts and achieve the optimal scale of investment. This is because government guarantee increases the collateral value in the bad state and thus reduces households' incentive to produce information. Thus,

the firms can borrow more money under an information-insensitive contract and have stronger incentive to use it. When the scale of government guarantee is sufficiently large, the firm can borrow to invest the optimal scale of investment under information insensitive contracts.

5.2 Optimal Government Guarantee

Now we are ready to study the optimal government guarantee policy. Since the collateral is one-period and all numeraire is consumed within each period, it is equivalent for the government to maximize the sum of the net project output and positive externality of fiscal expenditure, minus the possible cost of producing information.

Then, the government solves the following optimization problem:

$$\begin{aligned} &\max_{T_t}(qA-1)K_t - \gamma \cdot \mathrm{I}\{Con = IS\} \qquad (9)\\ &s.t. \quad T_t = (1-p_t)s_t \\ &\qquad \mathrm{I}\{Con = IS\} = \begin{cases} 1 & \text{if IS contract is used} \\ 0 & \text{if II contract is used} \end{cases} \end{aligned}$$

K_t denotes the firms' equilibrium investment, which is a function of collateral quality and is given in Section 4. $\mathrm{I}\{Con = IS\}$ is a two-value function. It equals one when the firm uses information-sensitive contract, and equals zero when the firm uses information-insensitive contract. The following proposition characterizes the optimal government guarantee policy.

Proposition 4. *Denote* $s_t^* = \frac{(1-p_t)K^* - \gamma}{p_t(1-p_t)}$ *and* $T_t^* = \frac{(1-p_t)K^* - \gamma}{p_t}$. *(i) Any* s_t *in the range of* $[s_t^*, M]$ *can help the firms to achieve the optimal investment scale, and corresponding range of optimal scale of lump-sum tax is* $[T_t^*, (1-p_t)M]$. *(ii) The lower bounds of the scale of guarantee* (s_t^*) *and optimal taxation* (T_t^*) *both decrease with* p_t.

Proof. See Appendix A.3. □

Proposition 4 shows that a proper guarantee policy can help the economy to achieve the socially optimal allocation. The socially optimal allocation is achieved when the firms can invest optimal scale of goods, K^* under information-insensitive debt contracts. The government guarantee can change the information sensitivity of debt contracts. A sufficient scale of guarantee will make the collateral sufficiently safe and make the households

no longer have incentive to produce information. Thus, there exists a lower bound of the scale of guarantee, when the scale of guarantee is higher than the lower bound, the no-information-production constraint is no longer binding and the socially optimal allocation can be achieved. Finally, when the initial collateral quality is higher, the households have lower incentive to produce information, and thus the necessary scales of guarantee and taxation to achieve unconstrained information-insensitive debt contracts are also lower.

5.3 Efficiency of Utilizing Tax Revenue

In this subsection, we will study the efficiency of utilizing tax revenue on government guarantee. We use the *average benefit* of per unit of tax to measure the efficiency of utilizing tax revenue; that is, the increase in social welfare divided by the total amount of tax revenue T_t. More specifically, denote the social welfare in period t when the lump-sum tax is T_t as $v(T_t)$, that is, $v(T_t) = (qA-1)K_t - \gamma \cdot \mathrm{I}\{Con = IS\}$. The increase in social welfare equals $v(T_t) - v(0)$, and the *average benefit* of per unit of tax, denoted as $\lambda(T_t)$, equals

$$\lambda(T_t) = \frac{v(T_t) - v(0)}{T_t}.$$

This variable measures the efficiency of utilizing tax revenue. We will characterize how the scale of lump-sum tax T_t and collateral quality p_t affect the average benefit of per unit of tax.

Corollary 1. *(i) When $T_t \leq T_t^*$, the average benefit of per unit of tax increases with T_t; when $T_t > T_t^*$, the average benefit of per unit of tax increases with T_t. Therefore, the average benefit of per unit of tax achieves its largest value when $T_t = T_t^*$.*

(ii) When $T_t = T_t^*$, the average benefit of per unit of tax increases with p_t.

Proof. See Appendix A.4. □

Corollary 1 shows that when the lump-sum tax is lower than the lower bound of the optimal range, the average benefit of per unit of tax increases with tax. Further raising tax will reduce the average benefit of per unit of tax. Thus, the average benefit of per unit of tax achieves its largest value at the lower bound of the optimal tax (T_t^*).

Intuitively, If the government chooses not to guarantee, that is, $T_t = (1-p_t)s_t = 0$, the firm will choose to use information-sensitive contract, and $K_t = K_t^{IS}$. If the government chooses to guarantee, the equilibrium debt contract and investment depend on the scale of guarantee. When the tax is lower than the lower bound of optimal range,

the first part of subsidy will be used to make the firm use an information-insensitive contract. The rest of subsidy will improve the investment in the range of constrained information-insensitive contract. When T_t becomes higher, the tax revenue spent in the range of constrained information-insensitive contract will account for a larger proportion. According to Proposition 2, the benefit of using one unit of tax revenue is larger in the range of constrained information-insensitive contract, and thus the average the average benefit of per unit of tax increases with T_t when $T_t \leq T_t^*$. When the firm is using unconstrained information-insensitive contract, increasing the lump-sum tax will not increase the investment, and thus the benefit is zero. Thus, any increase in T_t when $T_t > T_t^*$ will reduce the average benefit. Therefore, the average benefit of per unit of tax achieves its largest value when $T_t = T_t^*$.

Corollary 1 also suggests that the largest average benefit of using per unit of tax increases with the collateral quality (p_t). In other words, when the existing collateral in the economy has higher quality, it is more efficient to utilize tax revenue to provide guarantee.

Intuitively, when the original collateral quality is higher, the bad state is less likely to occur, and the households have less incentive to produce private information to avoid losses. Thus, the government can use less units of subsidy to make the firms choose to use information insensitive contracts. More units of subsidy is used under information insensitive contracts, and thus the average benefit is larger. Moreover, one unit of subsidy in bad states costs $1-p_t$ units of tax revenue. Thus, it is also cheaper to provide guarantee. This effect also leads to a higher efficiency of utilizing tax revenue to provide guarantee.[9]

6 Government Incentive to Renege and Financial Crises

6.1 Extended Settings of Positive Externality and Reneging

In the previous section, the only role of taxation is to provide guarantee. Thus, the government will always fulfill its promise. In this section, we will study the government's incentive to renege on its promise of guarantee. We consider the following case. After making promise to provide guarantee on collateral (s_t) at the beginning of each period, the government can determine whether to fulfill its promise at the end of each period. If

[9]Note that this result is based on the assumption that without government guarantee, the collateral quality is relatively low and makes the firm choose information-sensitive contract, and thus Corollary 1 characterizes the reality in emerging market economies.

the government chooses to fulfill its promise, it will use the tax revenue to indemnify the lenders. If the government reneges on its promise, it keeps the money and can use it for alternative government expenditures.

The alternative government expenditures have a positive externality. By diverting 1 unit of goods to government expenditure, the government can obtain social welfare of φ units, and $\varphi > 1$. Thus, the marginal utility obtained from government expenditure is always larger than 1. This function captures the positive externality of government expenditures.

The positive externality is necessary for the government to have incentive to renege. This is because if there is no positive externality, fulfilling guarantee promise and giving the goods to households will also bring one unit of welfare. Thus, fulfilling guarantee promise is equivalent to reneging on promise and spending the goods on government expenditure, and the government will always fulfill its promise. When there is a positive externality, the government can create additional social welfare by diverting the funds to government expenditures, which incentivizes the government to renege.

This case captures the moral hazard problem of government guarantee in reality. The government can renege on its promise and do not indemnify households who suffered losses due to receiving bad collateral. This time is too late for households to withdraw their loans. The government can then divert the funds to other fiscal expenditures. Then, the government can both promote the investment and utilize the positive externality of alternative government expenditures.

However, households will inflict a punishment on a dishonest government. After observing the government default, all households in the economy will not believe the government for one period, which means that the government loses the chance to increase investment by government guarantee.[10]

We focus on rational expectation equilibrium. When the government commits to providing a guarantee of s_t units, households may or may not believe that the government will keep its promise of guarantee. If the government makes promise and households trust the government, bad collateral will provide the lender with s_t units of numeraire from the government indemnity. If the households do not trust the government, they will still produce private information, and the guarantee policy will have no effect.

The timeline of the economy is updated accordingly. At the end of period t, the government's behavior changes from "fulfilling its promise of guarantee" to "determining

[10]We use this one-period punishment to capture the fact that in reality the government usually regains the trust of people after a certain period of time.

whether to fulfill its promise of guarantee".

6.2 Government Incentive to Renege

When households trust the government, the equilibrium result is the same as what we have characterized in Section 3 and Section 4. Now, we discuss the government's incentive to default. As we have pointed out in the extended settings, if the government reneges on its promise and divert the funds to alternative government expenditures, the government will lose the chance to promote investment by government guarantee for one period.

In this repeated game between the government and households, the government trades off the benefit of utilizing the positive externality of government expenditures and the cost of losing the chancing to promote investment in next period. This determines whether the equilibrium with government guarantee exists.

This repeated game involves multiple equilibria. A continuum of the households' belief can all be equilibria. This is because for any belief of s_t, if the benefit of guarantee is sufficiently large to make the government keep promise, the government will not deviate to increase the guarantee, because the households will not lend more numeraire based on the current belief. The government will not deviate to decrease the guarantee, either, because of the punishment. The households will not deviate to decrease the belief, because the firm always make the households indifferent between lending and not.

To determine whether the equilibrium in which households trust the government exists, we need to compare the benefit of utilizing the positive externality of government expenditures and the cost of losing the chancing to promote investment in next period. From providing guarantee, social welfare can be improved by $v(T_t) - v(0)$. The discount factor is β, and thus the total loss of losing the chancing to promote investment in next period is $\beta[v(T_t) - v(0)]$. The net benefit of diverting T_t unit of goods to government expenditure is $(\varphi - 1)T_t$ units of social welfare. This is because fulfilling guarantee promise and giving the goods to households will also bring T_t units of welfare. To compare the benefit and cost, we can divide both sides by T_t, and consider the average benefit and average cost per unit of tax. Therefore, we are essentially comparing the average benefit of providing guarantee $\frac{\beta[v(T_t)-v(0)]}{T_t} = \beta\lambda(T_t)$ and the average benefit of diverting funds to alternative government expenditures $\frac{(\varphi-1)T_t}{T_t} = \varphi - 1$, which is a constant. Then, we have the following lemma.

Lemma 1. *(i) The government has the largest incentive to keep promise when $T_t = T_t^*$. (ii) If the equilibrium in which households trust the government does not exist when*

$T_t = T_t^*$, *any equilibrium with households' trust does not exist.*

Proof. See Appendix A.5. □

Since the average benefit of diverting funds to alternative government expenditures is a constant, the government incentive to keep promise depends on the average benefit of providing guarantee.[11] Corollary 1 shows that the average benefit of providing guarantee achieves the largest value when $T_t = T_t^*$. Thus, for any $T_t \neq T_t^*$, the government has larger incentive to renege. Increasing or decreasing T_t will both make the government have stronger incentive to renege.

Thus, if the equilibrium in which households trust the government does not exist when $T_t = T_t^*$, any equilibrium with households' trust does not exist. This is because when $T_t = T_t^*$, the government obtains the maximum amount of benefit compared to the case without guarantee. Losing this amount of benefit is the strongest punishment that the households can inflict. Thus, if the government still has incentive to renege, the government will have incentive to renege under any level of tax. There is no level of tax that can make households trust the government. Then, we have the following proposition.

Proposition 5. *There exists a cutoff collateral quality $\hat{p}$, such that*

(i) When $p_t \geq \hat{p}$, there exists two types of equilibria. One with government guarantee, in which the government provides guarantee at the beginning of the period, and keeps promise at the end of period, and the households trust the government. One without government guarantee, in which the household never trust the government, and the government never provides guarantee.

(ii) When $p_t < \hat{p}$, only the equilibrium without government guarantee exists.

Proof. See Appendix A.6. □

Proposition 5 suggests that only when the collateral quality is high, can the equilibrium with government guarantee exist. If the collateral quality is low, no equilibrium with government guarantee exists.

Intuitively, to convince the households that it will keep promise, the government must have sufficiently large benefit from guarantee. Corollary 1 shows that the benefit under the optimal scale of guarantee, which is the largest possible benefit, is increasing in the collateral quality. Thus, high collateral quality becomes the government's commitment

[11] Note that the results do not rely on the assumption of constant benefit of government expenditures. In Appendix B.1, we show that if we alternatively adopt a decreasing-return-to-scale function of government expenditures, the results remain unchanged.

mechanism, which enables the government to credibly promises to provide guarantee. When the collateral quality is lower than the cutoff value, even under the optimal scale of guarantee, the benefit is insufficient to prevent the government from defaulting, and thus only the equilibrium without government guarantee exists. The economy will be stuck in bad equilibrium.

Proposition 5 implies that in emerging market economies, even if the government is perfectly benevolent, which means that the only target of the government is to maximize social welfare, it must has a credible commitment mechanism to achieve the socially optimal allocation. Collateral quality can play the role of commitment mechanism. If the collateral quality is low, there is no trust between the government and households, and the government cannot effectively promote investment. This explains why emerging market economies only provide explicit or implicit guarantee when they have high growth rates, because high growth rates generally mean the assets used as collateral are more likely to be valuable in the future. In the following subsection, we will discuss how a negative shock to collateral quality can lead to financial crises caused by the collapse of the trust between government and households.

6.3 Negative Shock and Financial Crises

Finally, we study how a negative shock to collateral quality can lead to financial crises due to the collapse of multiple equilibria. We assume that at the beginning of period t, a negative shock to collateral quality occurs. Then, such a shock can lead to a financial crisis, even the shock to collateral quality is very small.

Proposition 6. *If the collateral quality before the shock is higher than $\hat{p}$, and in the current equilibrium government guarantee exists, a negative shock which reduces the collateral quality to a level smaller than $\hat{p}$ will lead to drops in investment, output, and social welfare.*

Proposition 6 suggests that a negative shock to collateral quality can lead to a collapse of the multiple equilibrium. Before the shock, the benefit of guarantee is sufficient to make the government keep promise, and the households are willing to lend more numeraire. The investment, output, and social welfare are at high levels. However, after the shock, the benefit of guarantee is insufficient, and only the equilibrium without government guarantee exists. The households no longer trust the government, and the government's best response is to withdraw its guarantee. The loan amount and investment will significantly shrink, and the output and social welfare will drop. A financial crisis occurs.

This result captures the emerging markets' reactions to economic slowdown. For example, Chinese government provided much explicit or implicit guarantee to debts issued by financial platforms owned by local governments and state-owned enterprises, which is a reason for the high-speed growth and prosperity in the past twenty years. However, starting from 2016, with the decrease of the economic growth rate, the central government withdrew its guarantee provided to state-owned enterprises, and also stipulated that local governments should not provide guarantee to financial platforms. Debt defaults occurred more frequently. This corresponds to the result in Proposition 6.

A natural corollary of Proposition 6 is that the negative shock to collateral quality can have an amplification effect. When the current collateral quality in the neighborhood of the cutoff value, a very small shock to collateral quality can lead to substantial drops in investment, output, and social welfare. This result is summarized in the following corollary.

Corollary 2. *(Amplification) If the collateral quality before the shock is higher than $\hat{p}$ and is in the δ-neighborhood of $\hat{p}$, and $\delta \to 0$, then an infinitesimal negative shock to collateral quality can lead to substantial drops in investment, output, and social welfare.*

Corollary 2 illustrates the financial fragility induced by government guarantee. When there are no shocks, the government can stimulate economic growth by providing guarantee to borrowers. However, the problem of the lack of commitment leads to financial fragility, especially when the current collateral quality is low. This generates a paradox. Emerging market economies face tight financing constraints and have urgent need to relax financing constraints by providing guarantee. However, emerging market economies are also the economies with low collateral quality, which means that they have large risks of suffering financial crises caused by negative collateral shocks.

7 Policies to Prevent Financial Crises

In the previous section, we have shown that when the government has incentive to renege on its promise of guarantee, a negative shock to collateral quality can lead to financial crises due to the collapse of multiple equilibria. In this section, we will discuss two possible policies that can help the economy to deal with financial crises.

7.1 Transition to Market Insurance

Financial crises may occur because the government can divert the funds to alternative government expenditures. Thus, one way to prevent financial crises is to use a market mechanism that does not have access to the government expenditures with positive externality. We will show that a market insurance can be an alternative solution to the underinvestment problem due to the constraint of private information production.

Now, we assume that there is no government, but the firms can spontaneously establish an insurance company to deal with the collateral risk. At the beginning of each period, the insurance company will offer an insurance contract to the firms. The contract includes an insurance premium and a compensation. Again, the output has no pledgeability and thus the firms have to use the money raised for investment to pay the premium. When the collateral becomes bad, the insurance company will compensate the collateral holders for the losses. Denote the insurance premium as ι and the compensation for each unit of collateral as κ. We have the following proposition.

Proposition 7. *In a competitive market, the insurance company will set the insurance premium (ι) as any value in $[T_t^*, (1-p_t)M]$, and the compensation for each unit of collateral $\kappa = \frac{\iota}{1-p_t} \in [s_t^*, M]$.*

The market insurance and government guarantee policy are equivalent and can both help the economy to achieve the socially optimal allocation. Intuitively, market insurance also increases the value of collateral when it becomes bad, and reduces the losses of households. The households thus have less incentive to produce information, because the benefit is smaller. In other words, the government guarantee policy is a mandatory insurance. The government collects tax and uses the tax to provide guarantee for the bad collateral. Thus, the holders of good collateral only pay taxes and do not receive any compensation. The holders of bad collateral both pay taxes and receive compensation. Thus, the government guarantee policy and market insurance can play the same role in mitigating the constraints of private information production.

In contrast to the government, the market insurance company does not have access to the government expenditures with positive externality. Moreover, the regulators typically have strict regulations on the insurance company, such as requiring the funds to be managed in separated account and requiring the insurance company to report data on a frequent basis. Thus, unlike the government, it will be much harder for the market insurance company to divert funds. Consequently, there is no trust problem between the households and the insurance company. Even if the collateral quality falls lower than

the cutoff value $\hat{p}$, the households still believe that the insurance company will execute the insurance contract and the guarantee policy will still be effective. Therefore, the government can conduct a transition from the government guarantee system to a market-based insurance system. Then the reduction in collateral quality will not cause a financial crisis. The socially optimal allocation can be realized.

However, the transition to a market-based insurance system has several constraints. First, it takes a long time to complete the transition, and it may also take time for the investors to build trust of the market-based system. Currently, government guarantee is still the dominant system in securing collateral in China. The negative shock may occur any time before the transition completes. Thus, it is still meaningful to study the policy that can prevent crises under the current government guarantee system. Second, achieving the socially optimal allocation requires a fully competitive market and the insurance company should make zero profits. This is because unlike the government, the insurance companies maximize their profits rather than social welfare. A monopolistic insurance market may provide excessively expensive insurance contracts and there will still be an under-investment problem. However, establishing such a competitive market may take even longer time. Finally, providing insurance contracts to local government financing vehicles (LGFVs) requires the scale of the insurance company to be very large, because the LGFVs generally have very large scale of assets. However, this requires the insurance companies to hold a lot of equity to comply with the regulations on financial institutions. This also delays the process of transition.

Therefore, although the transition to a market-based system may be the ultimate solution to the financial crises due to the trust problem, discussing alternative measures that can deal with the imminent financial crises is also meaningful. In the next subsection, we will discuss a debt swap policy.

7.2 Debt Swaps

In this subsection, we will discuss the debt swap policy, which is another policy to prevent financial crises due to the trust problem. In China, the government decided to swap implicit debt for explicit government debt in 2015. Started in March 2015, the central government allowed the local governments to swap various types of debts for which the local governments are liable, including bank loans, trust financing and LGFV bonds, with local government bonds. The Ministry of Finance (MOF) was in charge of identifying the debts for which local governments have repayment responsibility. The local government

then has explicit responsibility to repay these debts. They were allowed to issue new local government bonds and use the issuance proceeds to repay the these debts.

Since local governments swap the implicit guarantee with explicit local government bonds, they will be more seriously punished if they cannot repay the debts. Implicit guarantee does not involve clear contracts while the local government bonds have very clear contracts and the defaults will have more profound and persistent influence. Following this idea, we characterize the debt swap policy as a commitment mechanism in the model. The households will more severely punish the government if the government issues new government bonds and does not use the newly raised money to fulfill guarantee promise. Moreover, in reality, since the funds raised by newly issued debts are managed in special accounts, diverting these funds to general government expenditure is very difficult. Thus, we will directly assume that the government cannot divert the funds raised by issuing new debts to government expenditures.

An alternative way to understand the assumption is that for government bonds, households will punish the government for longer times. If the government issues new debt but again does not fulfill the guarantee promise, the households will punish the government for N periods, and $N > 1$. Our assumption that the government cannot divert funds is equivalent to assuming $N \to \infty$, which is an extreme case and is for simplicity. If we adopt a finite N, as long as $N > 1$, the debt swap policy will have effect, and larger N corresponds to a stronger effect of the debt swap policy.

Specifically, after the project payoffs and the fundamental value of the collateral are realized, the government can decide to issue a new debt to finance the guarantee responsibility. The government issues a debt to external investors, and need to repay the debt in the next period.[12] The external investors are risk neutral. Since the government debt is safe, the required interest rate r is $\frac{1}{\beta}$. The government can not only use government debt to replace guarantee responsibility, it can also use newly issued debt to roll over old debts. Thus, the debt issuance in period t can be used to fulfill guarantee promise in period t and repay government debt issued in period $t-1$. To characterize the fact that the issuance of government debt is constrained by taxation capacity and government credit, we assume that the sum of the principal and interest cannot surpass an upper bound ζ. That is, denoting the scale of the debt in period t as B_t, we require that for any t, $B_t(1+r) \leq \zeta$ should be satisfied.

We consider this policy as a bailout policy in case of financial crisis. When there is a

[12]Here, for simplicity, we assume that the government needs to repay the debt in the next period. Allowing the government to issue debt with longer maturity will not change the results.

negative shock to the collateral quality and makes it lower than the threshold $\hat{p}$ in period t, the government can issue a new debt at the end of the period. Thus, the debt issuance revenue in each period can either be used to fulfill guarantee promise or roll over existing debts. That is, for any t, $B_t \leq (1-p_t)s_t + B_{t-1}(1+r)$. Finally, in every period, if the largest possible average benefit from guarantee is lower than than the average benefit from government expenditures, that is, $\beta\lambda(T_t^*) < \varphi - 1$, the government will not use any tax revenue to provide guarantee, and the only possible funds spent on guarantee is the debt issuance revenue, and thus we have $B_n \geq (1-p_n)s_n$ in this case.

Denote the collateral quality after the negative shock as $\tilde{p}_t$ and $\tilde{p}_t < \hat{p}$. Without debt swap, market investors will rationally expect that the government will renege and thus do not trust the government guarantee promise. A financial crisis will occur. By contrast, with the debt swap policy, the government can use the debt issuance revenue to fulfill guarantee promise, and the households will always believe the government.

For $n \geq t$, the government needs to solve the following optimization problem.

$$
\begin{aligned}
\max_{T_n, B_n, s_n} \ & (qA-1)K_n - \gamma \cdot \mathrm{I}\{Con = IS\} + (\varphi - 1)G_n \\
s.t. \quad & G_n + (1-p_n)s_n + B_{n-1}(1+r) = T_n + B_n \\
& B_n(1+r) \leq \zeta \\
& B_n \leq (1-p_n)s_n + B_{n-1}(1+r) \\
& B_n \geq (1-p_n)s_n \qquad \text{if} \quad \beta\lambda(T_n^*) < \varphi - 1 \\
& B_{t-1} = 0 \\
& \mathrm{I}\{Con = IS\} = \begin{cases} 1 & \text{if IS contract is used} \\ 0 & \text{if II contract is used} \end{cases}
\end{aligned}
$$

Then, we have the following proposition.

Proposition 8. *(i) When the debt capacity ζ is sufficient, the debt swap policy can prevent the financial crisis from occurring in the current period.*

(ii) The debt swap policy will make the financial crisis more easily occur in the future. That is, the cutoff collateral quality $\hat{p}$ will increase.

Proof. See Appendix A.7. □

Proposition 8 suggests that as long as the debt capacity is sufficient, the debt swap policy can prevent the financial crisis from occurring. This is because the debt swap

policy plays the role of a commitment mechanism. The government cannot divert the money raised by new debts and the households thus believe the government will fulfill guarantee promise. Information-insensitive debt contracts can be used and efficiency can be restored. The debt capacity needs to be sufficiently large to offset the effect of the negative shock. Otherwise, if the debt capacity is very small, the government can only issue very little amount of debt, and the government will still have incentive to default.

However, the debt capacity is not infinite, which means that the accumulation of debt will make the existing debt approach the debt capacity. If the government repay a part of the debt, it must use a part of the tax revenue, this further reduces the efficiency of utilizing funds and increases the government's incentive to renege. On the other hand, if the government does not repay any debt and always roll over all debt, when the debt capacity is arrived, the government cannot add any new debt and cannot rely on debt rollover to cover interest payment. It must repay the interest of the debt by tax revenue, which again reduces the amount of total resources and increases the government's incentive to default. The cutoff collateral quality also becomes higher, and a financial crisis will occur under a higher collateral quality.

In summary, the debt swap policy prevent the financial crisis from immediately occurring while further increases the financial fragility in the future. The existence of the debt capacity and the interest of the debt prevent the government from permanently rolling over all debt. The government must pay the creditors in the future.

8 Conclusion

We propose a guarantee multiplier to understand the prevalence of implicit government guarantee in China and the loan guarantee programs in developed economies. The government guarantee on collateral has a multiplier effect, that is, levying one unit of tax to provide guarantee can increase the scale of loans by more than one unit. This effect exists as long as the socially optimal investment has not been achieved. When firms are using information-sensitive debt contracts, the policy of tax and guarantee has positive effects since it helps to utilize the excessive collateral value when firms holding good collateral. When firms are using constrained information-insensitive debt contracts, the policy of tax and guarantee has positive effects since it helps to relax the no-information-production constraint, which allows the firms to borrow more money without triggering information production. The marginal benefit of using one unit of tax to provide guarantee under constrained information-insensitive contracts is larger than that under information-sensitive

contracts. A proper guarantee policy can help the economy to achieve the socially optimal allocation.

When there is a trust problem between the government and lenders, a negative shock to the collateral quality may lead to a collapse of the equilibrium, because the lower collateral quality decreases the benefit of guarantee, which disincentives the government to keep promise. Multiple equilibria collapse to a single bad equilibrium, and a financial crisis then occurs. Transition to a market-based insurance system can solve the problem of financial crisis but has some constraints. A debt swap policy can also prevent the financial crisis from occurring in the current period, while it will make the financial crisis more easily occur in the future.

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Appendix A Proofs

A.1 Proof of Proposition 2

When the firm is using information-sensitive debt contract, the investment is

$$K_t^{IS} = p_t K^* + (1 - p_t)(s_t - T_t).$$

One unit increase in tax (T_t) can increase the scale of guarantee (s_t) by $\frac{1}{1-p_t}$, and thus the net increase in investment is

$$(1 - p_t)(\frac{1}{1 - p_t} - 1) = p_t,$$

and the scale of loans will increase by $p_t + 1$, since $L_t^{IS} - T_t = K_t^{IS}$.

When the firm is using constrained information-insensitive debt contract, the investment is

$$K_t^{CII} = \frac{\gamma}{1 - p_t} + s_t - T_t.$$

Again, one unit increase in tax (T_t) can increase the scale of guarantee (s_t) by $\frac{1}{1-p_t}$, and thus K_t^{II} can increase by $\frac{1}{1-p_t} - 1 = \frac{p_t}{1-p_t}$, and the scale of loans will increase by $\frac{1}{1-p_t}$, since $L_t^{CII} - T_t = K_t^{CII}$.

When the firm is using unconstrained information-insensitive debt contract, the scale of loans is always $K^* + T_t$, and the investment is constant and equals K^*.

A.2 Proof of Proposition 3

Solving s_t from $L_t^{CII} > L_t^{UII}$, that is,

$$\frac{\gamma}{1 - p_t} + s_t \geq K^* + T_t,$$

and notice that $T_t = (1 - p_t)s_t$, we have

$$s_t \geq \frac{(1 - p_t)K^* - \gamma}{p_t(1 - p_t)}. \tag{A.1}$$

Thus, when $s_t \geq \frac{(1-p_t)K^* - \gamma}{p_t(1-p_t)}$, K^* is not constrained by the no-information-production constraint, and the firm can use unconstrained information insensitive contracts.

Then, when $\pi_t^{CII} \geq \pi_t^{IS}$, the firm will choose to use constrained information-insensitive contracts, that is,

$$(qA-1)K_t^{CII} \geq p_t(qA-1)K^* + (1-p_t)(qA-1)(s_t - T) - \gamma.$$

Solving s_t from this inequality, we have

$$s_t \geq \frac{K^*(1-p_t)p_t(qA-1) - qA\gamma + p_t\gamma}{(1-p_t)p_t^2(qA-1)}. \tag{A.2}$$

Finally, we need to compare the two cutoffs (A.1) and (A.2). Since

$$-\gamma - \frac{-qA\gamma + p_t\gamma}{p_t(qA-1)} = \frac{qA\gamma(1-p_t)}{p_t(qA-1)} > 0,$$

we have $(A.1) > (A.2)$. Therefore, when $s_t < \frac{K^*(1-p_t)p_t(qA-1)-qA\gamma+p_t\gamma}{(1-p_t)p_t^2(qA-1)}$, the firm will use information sensitive contracts. When $\frac{K^*(1-p_t)p_t(qA-1)-qA\gamma+p_t\gamma}{(1-p_t)p_t^2(qA-1)} \leq s_t < \frac{(1-p_t)K^*-\gamma}{p_t(1-p_t)}$, the firm will use information-insensitive contracts.

A.3 Proof of Proposition 4

(i) Socially optimal investment K^* can be achieved if the guarantee policy helps to the firms to use unconstrained information-insensitive contracts. Proposition 3 has shown that $s_t \geq \frac{(1-p_t)K^*-\gamma}{p_t(1-p_t)}$, K^* is not constrained by the no-information-production constraint, and the firm can use unconstrained information insensitive contracts. Since $T_t = (1-p_t)s_t$, we have when $T_t \geq \frac{(1-p_t)K^*-\gamma}{p_t}$, the firm can use unconstrained information insensitive contracts. Finally, since we have assumed that $p_tM > K^*$, the upper bound of s_t is M. To see this, $p_tM > K^*$ implies $(1-p_t)M < M - K^*$. Then, when $s_t = M$, the collateral becomes completely safe. The lump-sum tax is $T_t = (1-p_t)M$, which is smaller than $M - K^*$. This means that the firm can still invest K^* when the collateral is good, and socially optimal allocation can be achieved.

(ii) $T_t^* = \frac{(1-p_t)K^*-\gamma}{p_t}$, since the denominator increases with p_t and the numerator decreases with p_t, we have T_t^* decreases with p_t.

$s_t^* = \frac{(1-p_t)K^*-\gamma}{p_t(1-p_t)} = \frac{K^* - \frac{\gamma}{1-p_t}}{p_t}$. Still, the denominator increases with p_t and the numerator decreases with p_t, and we have s_t^* also decreases with p_t.

A.4 Proof of Corollary 1

(i) If the government chooses not to guarantee, that is, $T_t = (1 - p_t)s_t = 0$, the firm will choose to use information-sensitive contract, and $K_t = K_t^{IS}$. When the firm is using information sensitive debt contracts, as shown by Proposition 2, one unit of tax revenue spent on guarantee increases the investment by p_t units. When the firm is using constrained information-insensitive contract, spending one additional unit of tax revenue on guarantee increases the investment by $\frac{p_t}{1-p_t}$ units. Since $p_t < 1$, we have $\frac{p_t}{1-p_t} > p_t$. Thus, the benefit of using one unit of tax revenue is higher in the range of constrained information-insensitive contract.

According to Proposition 3, without government guarantee, the firm will choose to use an information sensitive contract. When the government provides guarantee and $T_t \leq T_t^*$, the first part of subsidy ($T_t \in [0, \frac{K^*(1-p_t)p_t(qA-1)-qA\gamma+p_t\gamma}{p_t^2(qA-1)}]$) will be used to make the firm use an information-insensitive contract. The rest of subsidy will improve the investment in the range of constrained information-insensitive contract. When T_t becomes higher, the tax revenue spent in the range of constrained information-insensitive contract will account for a larger proportion. Since the benefit of using one unit of tax revenue is higher in the range of constrained information-insensitive contract, the average the average benefit of per unit of tax increases with T_t when $T_t \leq T_t^*$.

Then, when the firm is using unconstrained information-insensitive contract, increasing the lump-sum tax by one unit will not increase the investment, and thus the benefit is zero. Thus, any increase in T_t when $T_t > T_t^*$ will reduce the average benefit. Therefore, the average benefit of per unit of tax achieves its largest value when $T_t = T_t^*$.

(ii) If the government chooses not to guarantee, that is, $T_t = 0$, the firm will choose to use information-sensitive contract, and social welfare equals $(qA-1)p_tK^*-\gamma$. When $T_t = T_t^*$, the government helps the firms to borrow K^* under an unconstrained information-insensitive contract, and social welfare equals $(qA - 1)K^*$. Thus, the welfare gain is

$$(qA - 1)K^* - [(qA - 1)p_tK^* - \gamma] = (qA - 1)(1 - p_t)K^* + \gamma.$$

The average benefit of per unit of tax equals

$$\frac{(qA - 1)(1 - p_t)K^* + \gamma}{T_t^*} = \frac{(qA - 1)(1 - p_t)K^* + \gamma}{\frac{(1-p_t)K^*-\gamma}{p_t}},$$

which is equivalent to

$$\frac{p_t[(qA-1)K^* + \frac{\gamma}{1-p_t}]}{K^* - \frac{\gamma}{1-p_t}}. \tag{A.3}$$

Since p_t increases with p_t, and $\frac{\gamma}{1-p_t}$ increases with p_t, we have the numerator increases with p_t, and the denominator decreases with p_t. Therefore, the average benefit of per unit of tax (A.3) increases with p_t.

A.5 Proof of Lemma 1

Since the average benefit of diverting funds to alternative government expenditures is a constant, the government incentive to keep promise depends on the average benefit of providing guarantee. Corollary 1 shows that the average benefit of providing guarantee achieves the largest value when $T_t = T_t^*$. Thus, for any $T_t \neq T_t^*$, the government has larger incentive to renege, compared to $T_t = T_t^*$. Increasing or decreasing T_t will both make the government have stronger incentive to renege. Then, if the equilibrium in which households trust the government does not exist when $T_t = T_t^*$, any equilibrium with households' trust does not exist. This is because if the government has incentive to renege when $T_t = T_t^*$, any other T_t will make the government have even stronger incentive to renege.

A.6 Proof of Proposition 5

If the government chooses not to guarantee, that is, $T_t = 0$, the firm will choose to use information-sensitive contract, and social welfare equals $(qA-1)p_tK^* - \gamma$. When $T_t = T_t^*$, the government helps the firms to borrow K^* under an unconstrained information-insensitive contract, and social welfare equals $(qA-1)K^*$. Thus, according to the proof of Corollary 1, the largest average benefit of per unit of tax equals

$$\lambda(T_t^*) = \frac{p_t[(qA-1)K^* + \frac{\gamma}{1-p_t}]}{K^* - \frac{\gamma}{1-p_t}}.$$

The government is indifferent between reneging and not if the discounted value of the benefit equals the average benefit of government expenditures, $\varphi - 1$. Thus, as long as

$$\beta\lambda(T_t^*) \geq \varphi - 1, \tag{A.4}$$

the government will not have incentive to renege. Thus, $\hat{p}$ is the solution of p_t in the

following equation:

$$\beta\lambda(T_t^*) = \beta\frac{p_t[(qA-1)K^* + \frac{\gamma}{1-p_t}]}{K^* - \frac{\gamma}{1-p_t}} = \varphi - 1. \tag{A.5}$$

Solving for p_t from equation (A.5), one root of this equation is larger than 1. Since $p_t < 1$, only the root smaller than 1 can be the solution $\hat{p}$.

Under $\hat{p}$, the government is indifferent between reneging and not. As shown by Corollary 1, the largest average benefit of using per unit of tax to provide guarantee ($\lambda(T_t^*)$) increases with the collateral quality (p_t) for any $0 < p_t < 1$. Thus, any p_t smaller than $\hat{p}$ cannot make (A.4) hold under any T_t, which means that when $p_t < \hat{p}$, only the equilibrium without government guarantee exists.

A.7 Proof of Proposition 8

When the debt capacity ζ is sufficiently large, in period t, the government can issue new debt of $(1-\tilde{p}_t)s_t^*(\tilde{p}_t)$, where $s_t^*(\tilde{p}_t)$ denotes the optimal guarantee scale under $\tilde{p}_t$. Since the government cannot divert the funds from issuing new debts, the households will then trust the government, and information-insensitive contracts can be used. Then, starting from period $t+1$, the government can roll over the debt in the previous period, and can also fully replace the guarantee promise in the current period with newly issued debts. The financial crises will not occur.

However, in a future period $t+N$, when

$$[B_{t+N} + s_t^*(p_{t+N})](1+r) > \zeta$$

and

$$B_{t+N}(1+r) \leq \zeta,$$

the government cannot fully replace the guarantee promise in the current period, but can still roll over the existing debt. We consider the extreme case in which $B_{t+N}(1+r) = \zeta$. In this case, in period $t+N$, the government cannot replace any guarantee promise with debt before repaying a part of the debt. In period $t+N+1$, the total debt obligation at the beginning of the period becomes $B_{t+N}(1+r) = \zeta$. In order to roll over the debt, the government must repay $\zeta - \frac{\zeta}{1+r} = \zeta\frac{r}{1+r}$. Otherwise the sum of the principal and interest will surpass the upper bound ζ. This reduces the tax revenue by $\zeta\frac{r}{1+r}$, and only $T_{t+N} - \zeta\frac{r}{1+r}$ can be used to provide guarantee.

Then, the upper bound of the tax is M, which means that the tax cannot exceed the value of good collateral. Then, since the debt capacity ζ is sufficiently large, $T_{t+N} - \zeta\frac{r}{1+r}$ will still be smaller than T^*_{t+N}. Since T^*_{t+N} provides the largest average benefit of guarantee, the average benefit of guarantee under $T_{t+N}-\zeta\frac{r}{1+r}$ will be even smaller. Thus, even if $p_{t+N} > \hat{p}$, which means that the largest average benefit of guarantee is higher than the average benefit of government expenditures, the average benefit of guarantee under $T_{t+N} - \zeta\frac{r}{1+r}$ can be smaller than the average benefit of government expenditures. That is, if $\beta\lambda(T^*_{t+N}) = \varphi - 1$, we have $\beta\lambda(T_{t+N} - \zeta\frac{r}{1+r}) < \varphi - 1$. There thus exists a $\hat{p}' > \hat{p}$, only when $p_{t+N} \geq \hat{p}'$, can $\beta\lambda(T_{t+N} - \zeta\frac{r}{1+r}) = \varphi - 1$.

Appendix B Supplementary Materials

B.1 Decreasing-return-to-scale Function of Government Expenditures

Here, we alternatively assume that by diverting T_t unit of goods to government expenditure, the government can obtain social welfare of $f(T_t)$ units, and $f(\cdot)$ satisfies $f'(\cdot) > 0$, $f''(\cdot) < 0$, $f'(0) = \infty$, and $f'(\infty) = 1$, which means that $f(\cdot)$ is a strictly increasing and strictly concave function, and the marginal utility obtained from government expenditure is always larger than 1. This function captures the positive externality of government expenditure and also captures the feature that the positive externality is decreasing in the current fiscal expenditure.

Then, for any $T_t < T^*_t$, Corollary 1 still shows that the average benefit of providing guarantee achieves the largest value when $T_t = T^*_t$. Thus, any $T_t < T^*_t$ will have a smaller average benefit of providing guarantee. By contrast, since the government expenditure function is decreasing return to scale, reducing T_t will lead to a larger average benefit of diverting funds. Thus, for any $T_t < T^*_t$, the government has larger incentive to renege, compared to $T_t = T^*_t$.

For any $T_t > T^*_t$, we directly compare the total benefit. In this case, $v(T_t) - v(0)$ does not change for any further increase in T_t, since the firms have already invested the optimal amount. However, $f(T_t) - T_t$ will continue increasing since the marginal utility obtained from government expenditure is always larger than 1. Thus, for any $T_t > T^*_t$, the government also has larger incentive to renege, compared to $T_t = T^*_t$.

Therefore, the government has the largest incentive to keep promise when $T_t = T^*_t$. Increasing or decreasing T_t will both make the government have stronger incentive to

renege. Then, if the equilibrium in which households trust the government does not exist when $T_t = T_t^*$, any equilibrium with households' trust does not exist. This is because if the government has incentive to renege when $T_t = T_t^*$, any other T_t will make the government have even stronger incentive to renege. Therefore, under this collateral quality, the government will always renege and the households will never trust the government. No equilibrium with government guarantee can survive.