Political Connections, Discriminatory Credit Constraint and Business Cycle

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Abstract

This paper builds a banking DSGE model based on endogenous loan to value ratios, taking the different relationship between different types of enterprises and banks into account. Due to the political connections between the bank and enterprises, loan to value ratio for favored enterprises (e.g. state-owned enterprises) is endogenously higher than that for non-favored enterprises (e.g. private enterprises), which is called discriminatory credit constraint in this paper. Compared to non-discriminatory credit constraint, we find that discriminatory credit constraint can further amplify the impact of negative technology shocks on output, and reduce the effectiveness of expansionary monetary policy. Empirical evidence from China industrial firms' data supports our conclusion.

Key Words: Discriminatory Credit Constraint, Political Connections, Financial Accelerator

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1 Introdcution

In the fourth quarter of 2008, affected by the US subprime mortgage crisis, China suffered a drop in total imports and exports, and a fall in GDP growth rate (see Figure 1). In order to resist the adverse influence of the financial crisis on China's economy, the Chinese government decisively launched the "four trillion" rescue plan, and simultaneous expansionary monetary policy (see Figure 2). These expansionary policies allowed China's economy to maintain an annual GDP growth rate of 10% in the period 2009-2011; however, subsequently, China's economic growth has declined. Some Chinese scholars (e.g. Lin, 2013) , explain this situation by pointing out that China's economic slowdown is cyclical, as the global economy has still not recovered; while others (e.g. Y. Li, 2013) believe that China's economy is facing a structural slowdown due to the economic structural imbalance caused by the extensive economic growth of the past. Meanwhile, Le et al. (2014) argue that although the rescue policy may have offset the impact of the financial crisis to some extent, it has only been deferred, and will probably erupt again. In response to this controversial issue, this paper attempts to put forward some new answers. It argues that credit structure imbalance caused by differential treatment of Chinese state-owned enterprises (henceforth, SOEs) and private enterprises (henceforth, PEs) in the credit markets plays an essential role in amplifying the impact of negative technology shock on the economy, and weakens the effectiveness of monetary policy, therefore leading to continuous economic slowdown.

FIGURE 1 ABOUT HERE

FIGURE 2 ABOUT HERE

China's economic growth has long relied on government-led investment. State-ownership has always been one of the most important engines to promote economic growth. Despite the reforms that began in 1978, and which have had a major impact on all aspects of the Chinese economy, SOEs and PEs are still subject to different treatment. Compared with PEs, SOEs attract much greater government support and protection, and enjoy access to more resources, tax reductions, and looser financing conditions (Dollar & Wei, 2007; Song et al., 2011). In China, the financing of PEs has become a major problem in recent years, thus confirming the existence of unfair treatment in the credit market. In this paper, we refer to this situation as discriminatory credit constraint. According to the existing literature (Kiyotaki & Moore, 2012; Iacoviello, 2005), one measure of the extent of credit constraint is loan to value ratio (henceforth, LTV ratio).[1] In Figure 3 we compare average LTV ratios of Chinese state-owned industrial enterprises and private industrial enterprises in China from 2004 to 2011. In general, the LTV ratio of state-owned firms is notably higher than that of private firms. We see a particular increase in the ratio of state-owned firms from 2008, when the financial crisis occurred. Figure 4 describes the relationship between LTV ratios and economic growth. We find that the LTV ratio of PEs is pro-cyclical while that of SOEs is counter-cyclical. The figures reveal that discriminatory credit constraint does indeed exist, and has been particularly serious since 2008.

FIGURE 3 ABOUT HERE

FIGURE 4 ABOUT HERE

How does discriminatory credit constraint affect the running of the macroeconomy? How does it influence the business cycle? Whether or not it is the driver behind the continuous decline of China's economy, in the absence of existing research on the issue, this paper attempts to find answers to these questions. We extend the model of Gerali et al. (2010) (henceforth, GNSS) by introducing a monitor cost to work out the formation endogenously, and evolve the mechanism of the loan to value ratio, incorporating two types of enterprise (SOE and PE) to describe the discriminatory credit constraint they confront. Based on the impulse response results, we find that the discriminatory credit constraint may amplify the impact of technology shocks and reduce the effectiveness of monetary policy. Furthermore, we construct regression models to examine the moderate effect of discriminatory credit constraint. Using China industry-level data from 1999 to 2008 in the estimation, the results support our conclusion from the model analysis.

[1]LTV ratio is equal to the amount of a loan divided by the value of collateral or of an asset purchased. The ratio is decided through negotiation between the bank and the enterprise, and reflects the banks' behaviour of resisting risks. Because loan of an enterprise is almost equal to long-term debt in the balance sheet, we use long-term debt divided by fixed assets as the proxy variable of LTV ratio. Sometimes, for simplification, we can also use the ratio of long-term debt divided by total assets to check the trend of LTV ratio.

The marginal contribution of this paper is as follows. First, we find a new "financial accelerator" discriminatory credit constraint between different types of enterprises, which can accelerate economic fluctuation. Secondly, we find that this "financial accelerator" may also hinder the effectiveness of monetary policy. Thirdly, with regard to modelling, this paper proposes a pioneering model that leaves LTV ratios endogenous, which may be used by further research on credit constraint problems.

The remainder of this paper is organized as follows: Section 2 presents a review of related literature. Section 3 introduces the full DSGE model, while Section 4 describes the calibration of the model. Sections 5 and 6 present the impulse response analysis and empirical analysis respectively. Section 7 comprises concluding remarks.

2 Related Literature

2.1 Financial Misallocation

An increasing number of scholars are focusing on the issue of resources misallocation, an important problem in many countries. Some researchers believe that micro-level resource misallocation can obstruct the growth of total-factor productivity (TFP), thus hindering economic growth, especially in developing countries (Gancia & Zilibotti, 2009; Hsieh & Klenow, 2009; Bartelsman et al., 2013). Finance raised through loans and equity markets, an essential type of resource, is also frequently misallocated, thus motivating further research in this area. Some scholars propose that financial friction may induce misallocation and TFP losses (Gilchrist et al., 2013; Midrigan & Xu, 2010); moreover, the impact is determined by the persistence of technology shock (Moll, 2014).

Financial resources misallocation is relatively severe in China, in particular between SOEs and PEs. Strong intervention by the Chinese government makes the allocation of loan resources biased towards SOEs, rather than PEs (Brandt & Li, 2003; H. Li et al., 2008; Cull et al., 2009; Gordon & Li, 2011). Song et al. (2011) argue that a reallocation of resources could address China's serious inefficiency and lead to fast growth over a prolonged transition. However, others maintain that financial distortion cannot be an impediment to China's economic growth (Guariglia & Poncet, 2008). Some researchers explain the credit misallocation in China as due to political connections between government and firms. Because of incentives for promotion, local government officials may force the banks to provide more loans to SOEs, which may bring fiscal revenue (Gordon & Li, 2011). This situation is also found in other emerging countries, such as Brazil, where the government can control banks to increase loans, influencing firms' strategy for the purpose of improving employment in certain politically important regions (Carvalho, 2014). Cull et al. (2013) contribute to this topic by empirically testing the relationships among investment behaviour of SOEs, political connections and financial constraint, proving that credit misallocation in China is indeed the result of political connections.

This paper accepts the existence of credit misallocation, and agrees that it can be explained by political connections. However, contrary to the papers mentioned above, we argue that a more direct cause is the unfair financial friction between SOEs and PEs, which is itself caused by political connections between SOEs and government. As a main type of unfair financial friction, discriminatory credit constraint may lead to financial resources flowing to inefficient places, thus affecting the running of the macro-economy and the business cycle. This paper constructs a banking DSGE model to research how this discriminatory credit constraint influences the transmission of primary shocks, such as technology shock and monetary policy shock.

2.2 Financial Friction and Banking DSGE models

Before the US subprime crisis, the DSGE model under financial friction did not incorporate an obvious and detailed banking sector. Most studies developed models based on the collateral constraint model of Kiyotaki and Moore (1997), or financial accelerator model of Bernanke et al. (1999). They concentrated on the friction of the demand side in the financial sector. The dynamic relationship between financial position of the enterprise, financing demand, and the financial cost, which drives the business cycle, is specifically described. Since the financial crisis, an increasing number of scholars have paid attention to the banking sector, as it is the supply side of financial activity. This sector was the first and most seriously damaged by the financial shocks suffered as a result of the crisis, and many economists have proposed that it is an important factor in amplifying the influence of shocks on the real economic fluctuation.

Three main types of approach to introduce the banking sector into the DSGE model have been proposed. These models, by Gerali et al. (2010), Dib (2010) and Gertler and Karadi (2011), all reflect the influence of the banking sector by modelling the forming mechanism of loan interest. The first two concentrate on banks' balance sheet and consider banks' monopoly competition leading to interest rate mark-up and rigidity. The third, by Gertler and Karadi (2011), models the banking sector by solving a canonical agency problem between household and banker. For the purpose of preventing the banker's corruption, an incentive compatibility constraint is set for bankers, from which the authors derive an endogenous leverage ratio and loan interest. These three models have also been widely extended. Some scholars extend GNSS to a small open economy and consider international capital flow (Ajevskis & Vitola, 2011; Kamber & Thoenissen, 2011). Others add liquidity requirement to the banking sector (Roger & Vlček, 2011; Dellas et al., 2013).

Scholars have also begun to analyse the role of the banking sector in the Chinese business cycle using DSGE models. Le et al. (2014) build a DSGE model based on Smets and Wouters (2003, 2007), combined with the financial accelerator mechanism of Bernanke et al. (1999). They argue that as a result of government intervention, China was relatively unscathed during the world crisis. They point in particular to the fact that the government requested the state-owned banks to support state-owned firms. However, their model does not distinguish between state-owned banks and private banks, or between state-owned firms and private firms. Xu and Chen (2009) introduce a bank sector to the canonical DSGE model. Through the comparison of simulated data and real data, they find that credit shocks have good ability in explaining the Chinese business cycle. Yan (2012) develops a DSGE model including a bank sector to prove that the effect of macroeconomic shocks on output is negatively related to the interest spread of that banking sector. Kang et al. (2013) extend Gertler and Karadi (2011) to a two-industry DSGE model, and find that the banking sector is the bridge across which exogenous shocks are transmitted between two industries. Wang and Tian (2014) use China's data to test Jermann and Quadrini (2009)'s model to fit Chinese data. Their result shows that financial shock is the most important factor driving the Chinese business cycle, and can explain more than 80% of the Chinese economy volatility.

Recent literature on financial shocks, bank sector and Chinese business cycle contributes to identifying the role of the banking sector in economic volatility, but there remain two aspects that deserve further discussion. Existing literature cannot clearly explain the mechanism whereby the banking sector amplifies the shocks, and to date no study has incorporated the two different kinds of firms into the model. As mentioned in Le et al. (2014), intervention by government forced the state-owned banks to financially support state-owned firms during the period of global financial crisis, leading to a Chinese credit boom in the following period and causing surplus productivity in manufacturing, stimulating the deferred bank crisis to explode.

3 Full Model

In this section, we extend the GNSS model by distinguishing two types of enterprise: state-owned enterprises and private enterprises. We attempt to describe the discriminatory credit constraint confronted by state-owned firms and private firms, and calibrate its impacts on the economy when exogenous shocks occur. As Figure 5 shows, the whole economy incorporates patient and impatient households, wholesale banks, bank lending and bank deposit branches, SOEs and PEs, retailers, capital goods producers and a central bank. The blue line describes the cash flow of bank money including the deposits from patient households, wholesale loans issued by wholesale banks, and loans to impatient households, SOEs and PEs with different LTV ratios. All the LTV ratios should be decided by wholesale banks, who also undertake the default cost (CSV cost). We assume the LTV ratio for impatient households is constant, while that for enterprises is time-varied. Considering that the banks in China will provide less strict loan conditions to SOEs because of their strong government background, we assume that the government will pay subsidies to wholesale banks, which are directly connected to the loan amount supporting SOEs (as the blue dashed line shows in Figure 5).

FIGURE 5 ABOUT HERE

3.1 Households

3.1.1 Patient Households

Following GNSS, the representative of patient households maximizes its whole-life expected utilities:

$$E_0 \sum_{t=0}^{\infty} \beta_P^t \left[\left(1 - a^P\right) \log\left(c_t^P - a^P \tilde{c}_{t-1}^P\right) + \log h_t^P - \frac{\left(n_t^{P,A}\right)^{1+\phi^A}}{1+\phi^A} - \frac{\left(n_t^{P,B}\right)^{1+\phi^B}}{1+\phi^B} \right] \tag{1}$$

where, c_t^P is the consumption, a^P is the parameter to measure the consumption habit, h_t^P is housing, $n_t^{P,A}$ and $n_t^{P,B}$ are the hours worked in the state-owned firms (Firm A) and private firms (Firm B) respectively, which have inverse Fischer elasticity ϕ^A and ϕ^B. The representative patient household earns a wage with a real wage rate $w_t^{P,A}$ of state-owned firms and $w_t^{P,B}$ of private firms to support their consumption and accumulation of housing Δh_t^P with housing price q_t^h. The budget constraint is:

$$c_t^P + d_t^P + q_t^h \Delta h_t^P \leq w_t^{P,A} n_t^{P,A} + w_t^{P,B} n_t^{P,B} + \frac{d_{t-1}^P \left(1 + r_{t-1}^d\right)}{\pi_t} + t_t^P \tag{2}$$

where d_t^P is the deposit, r_{t-1}^d is the net deposit interest rate of $t-1$ period, and t_t^P is lump-sum taxes and dividends.

3.1.2 Impatient Households

Similarly, the impatient households also choose the labour supply, consumption and housing investment to maximize their expected utilities as:

$$E_0 \sum_{t=0}^{\infty} \beta_I^t \left[\left(1 - a^I\right) \log\left(c_t^I - a^I \tilde{c}_{t-1}^I\right) + \log h_t^I - \frac{\left(n_t^{I,A}\right)^{1+\phi^A}}{1+\phi^A} - \frac{\left(n_t^{I,B}\right)^{1+\phi^B}}{1+\phi^B} \right] \tag{3}$$

and subject to:

$$c_t^I + \frac{b_{t-1}^I \left(1 + r_{t-1}^{bH}\right)}{\pi_t} + q_t^h \Delta h_t^I \leq w_t^{I,A} n_t^{I,A} + w_t^{I,B} n_t^{I,B} + b_t^I \tag{4}$$

where b_t^I is the money borrowed from banks with a net loan interest r^{bH}. The households should provide their housing as collateral, so they confront a borrowing constraint set by banks

$$b_t^I \left(1 + r_t^{bH}\right) \leq m^H E_t \left[q_{t+1}^h h_t^I \pi_{t+1}\right] \tag{5}$$

That means the total amount of loan and interest should be less than the expected value of housing multiplied by loan to value ratio m^H.

3.2 Enterprises

In this model, we incorporate two types of enterprise, state-owned enterprises and private enterprises, indexed as $s = A, B$ respectively. We intend to describe the different efficiency of state-owned and private enterprises, and to analyse the different financial friction they confront. In common with most standard set-ups, the representative enterprise selects the labour, capital, consumption and loans to maximize its whole-life utility of consumption c_t^s.

$$E_0 \sum_{t=0}^{\infty} \beta_s^t \left(1 - a^s\right) \log \left(c_t^s - a^I \tilde{c}_{t-1}^s\right) \tag{6}$$

where, $beta_s$ is the subjective discount factor of enterprise s, and a^s is the consumption habit parameter.

3.2.1 State-owned Enterprises

The production function of state-owned enterprises is like Cobb-Douglas technology

$$y_t^A = z_t \left(u_t^A k_{t-1}^A\right)^{\alpha_A} \left(n_t^A\right)^{1-\alpha_A} \tag{7}$$

where, k_{t-1}^A is the capital, n_t^A is hours worked, z_t is technology shocks , and u_t is time-varying utilization rate of capital (See Schmitt-Grohé & Uribe, 2006), which leads to a cost:

$$\psi\left(u_t^A\right) k_{t-1}^A = k_{t-1}^A \left(\frac{\kappa_1^u}{2}\left(u_t^A - \bar{u}_t^A\right)^2 - \kappa_2^u \left(u_t^A - \bar{u}_t^A\right)\right)$$

where κ_1^u and κ_2^u are positive parameters, which measure the cost of improvement of capital utilization. Utilization rate of capital reflects the capacity. If the utilization rate decreases, the firm can be regarded as having excess capacity. The labour n_t^A is aggregated from patient labour and impatient labour by C-D technology with parameter μ^n :

$$n_t^A = \left(n_t^{I,A}\right)^{\mu^n} \left(n_t^{P,A}\right)^{1-\mu^n} \tag{8}$$

The state-owned enterprises earn revenue by selling their products. Their main expenditure consists of purchasing capital goods to invest, paying wages and their own consumption. They can borrow money from banks to help them start the business and smooth the consumption. Then we can write the budget constraint as follows:

$$\begin{aligned}\frac{y_t^A}{x_t^A} + b_t^A + q_t^k\left(1-\delta\right)k_{t-1}^A = q_t^k k_t^A + \psi\left(u_t^A\right)k_{t-1}^A + w_t^{P,A}n_t^{P,A} + w_t^{I,A}n_t^{I,A} \\ + c_t^A + \frac{b_{t-1}^A\left(1+r_{t-1}^{bE}\right)}{\pi_t}\end{aligned} \tag{9}$$

where, δ is the depreciation rate of capital, q_t^k and $1/x_t^A$ are the relative price of state-owned enterprise-made products and capital goods compared to consumption goods price, b_t^A is the amount of borrowed money, r_t^{bE} is the net loan interest for enterprises, $w_t^{P,A}$ and $w_t^{I,A}$ are real wage rates for patient households and impatient households respectively.

In order to introduce the endogenous law of evolution for loan to value ratio, we construct a scenario to show the loan default and information asymmetry. We assume the project has probability to succeed of $1-\eta$, and then the enterprise will return the total loan payable to banks including the interest. However, there is η probability that the project may fail. If the project fails, both the enterprise and the banks will incur a cost. The enterprises are not willing to return the total debt, so loan default occurs. The bank will pay a cost for "Costly State Verification" (CSV, mentioned in BGG, 1999), which is assumed to be positively related to loan to value ratio and the total loan and interest payable ($m_{t-1}^A/2\kappa_f$ multiplied by total debt). For enterprises, the loan payable is diminished, so they only return $1-m_{t-1}^A/2\kappa_f$ to the bank. This is a threshold value: if the return rate is less than the threshold, the bank will pay CSV cost to hire a person to recoup the loan payable. However, the enterprise should also incur the total cost of project failure. We assume the project failure cost is $\kappa_f m_{t-1}^A q_t^k k_{t-1}^A$, which is positively related to the loan to value ratio and capital. This is because when the LTV ratio is relatively higher, the enterprise will have higher leverage and will be motivated to invest in more risky projects, which will lead to more loss when the project fails.

Then we can aggregate the budget constraint of enterprises under two different conditions by weight of their probabilities, $1-\eta$ and η respectively:

$$\frac{y_t^A}{x_t^A} + b_t^A + q_t^k (1-\delta) k_{t-1}^A = q_t^k k_t^A + \psi \left(u_t^A\right) k_{t-1}^A + w_t^{P,A} n_t^{P,A} + w_t^{I,A} n_t^{I,A} + c_t^A$$
$$+ \frac{b_{t-1}^A \left(1 + r_{t-1}^{bE}\right)}{\pi_t} \left(1 - \eta \frac{m_{t-1}^A}{2\kappa_f}\right) + \kappa_f m_{t-1}^A q_t^k k_{t-1}^A \tag{10}$$

The firm also confronts borrowing constraint set by banks

$$b_t^A \left(1 + r_t^{bE}\right) \leq m_t^A E_t \left[q_{t+1}^k k_t^A \pi_{t+1} (1-\delta)\right] \tag{11}$$

In our model, we assume the loan to value ratio is endogenous, which means the loan to value ratio depends on the negotiation of banks and enterprises. However, state-owned enterprises have more power in the loan market, so we assume that only state-owned enterprises and banks can make a decision about loan to value ratio.

3.2.2 Private Enterprises

Following Song et al. (2011) we assume the private enterprises can hire managers with remuneration w_t^m to improve their labor efficiency by χ. Then the production function of private firm is:

$$y_t^B = z_t (1-\psi) \left(u_t^B k_{t-1}^B\right)^{\alpha_B} \left(\chi n_t^B\right)^{1-\alpha_B} \tag{12}$$

Meanwhile, to prevent the manager diverting funds from the company to their own benefit, the remuneration satisfies an incentive constraint $w_t^m > \psi y_t^B$, where ψ is the parameter satisfying an assumption $\chi > (1-\psi)^{-\frac{1}{1-\alpha^B}}$ proved by Song et al. (2011) to keep the firm willing to hire a manager. Similarly to state-owned enterprises, we can write the budget constraint of private enterprises as

$$\frac{y_t^B}{x_t^B} + b_t^A + q_t^k (1-\delta) k_{t-1}^B = q_t^k k_t^B + \psi \left(u_t^A\right) k_{t-1}^B + w_t^{P,B} n_t^{P,B} + w_t^{I,B} n_t^{I,B} + c_t^B$$
$$+ \frac{b_{t-1}^B \left(1 + r_{t-1}^{bE}\right)}{\pi_t} \left(1 - \eta \frac{m_{t-1}^B}{2\kappa_f}\right) + \kappa_f m_{t-1}^B q_t^k k_{t-1}^B$$

3.3 Banking Sector

Following Gerali et al. (2010), the bank sector in our model is also split into three parts: a wholesale bank and two retailer branches. Unlike Gerali et al. (2010), however, we assume the banks know the collateral provided by enterprises, and will choose LTV ratio to ensure that the borrowing constraint of enterprises is always binding.

3.3.1 Wholesale Branch

Following GNSS, each wholesale branch operates under perfect competition. On the liabilities side they will combine their own bank capital k_t^w with deposit d_t transferred from deposit retail branches on the liabilities side. On the assets side, they will issue loans b_t^I to impatient households, and loans b_t^A and b_t^B to state-own and private enterprises respectively. The law of evolution for bank capital is $\pi_t k_t^w = \left(1-\delta^b\right) k_{t-1}^w + j_{t-1}^{bank}$, where δ^b measures resources used to manage the bank capital, j_{t-1}^{bank} is profit of total banks.

According to the analysis on the scenario of loan default and information asymmetry, banks will incur a CSV cost. We assume that all of this cost is undertaken by wholesale branches, and then they will choose deposit and loans to maximize their expected profit as follows:

$$\max_{m_t^s, b_t^s, b_t^I} r_t^{wE}\left(b_t^A + b_t^B\right) + r_t^{wH} b_t^I - r_t d_t - \frac{\kappa_{kb}}{2}\left(\frac{k_t^w}{b_t} - \nu^b\right)^2$$
$$-\frac{\eta}{2\kappa_w}\left(m_t^A + m_t^B\right)\left(1 + r_t^{bE}\right) + T\left(b_t^A\right)$$

where, r_t^{wE}, r_t^{wH} are wholesale loan rate for enterprises and impatient households respectively, k_t^w and b_t are bank capital and total loan, ν^b is the capital acquirement ratio set by the regulator, κ_{kb} and $kappa_w$ are parameters, $T\left(b_t^A\right)$ is the subsidy from government [2] for loans to state-owned firms, $T\left(b_t^A\right) = \frac{\kappa_1^T}{2}\left(b_t^A - \bar{b}^A\right)^2/\bar{b}^A + \kappa_2^T b_t^A$, where κ_1^T and $\kappa_2^T$are positive parameters. This subsidy is to reflect the tight relations between banks and state-owned enterprises. As we know, the majority of banks in China are really controlled by government, which includes both central government and local government. Then the leaders and shareholders of state-owned firms may influence the banks to reduce the loan conditions and requirements. Moreover, motivated by the pursuit of promotion, officials of local government continuously improve their political performance by exerting pressure on banks and state-owned firms for GDP growth. Furthermore, when the loans of state-owned firms became non-performing, the

[2] When closing the model, the cost of this subsidy is finally borne by patient households.

government helps the banks to strip away bad assets. These phenomena reflect the strong relations between banks and state-owned enterprises, so we use the subsidy to reveal this relationship, which is also the main driver of discriminatory credit constraint between state-owned and private firms.

Following GNSS, we assume the deposit rate faced by the wholesale banks is equal to Taylor Rule rate r_t, which is paid to the deposit retailer. The balance sheet constraint of wholesale branches is $b_t^A + b_t^B + b_t^I = b_t = k_t^w + d_t$. In addition, they choose the loan to value ratio under the condition $m_t^s q_{t+1}^k k_t^s \pi_{t+1} (1+\delta) = (1 + r_t^{bE})$. After some algebra with regard to the first order conditions, we can derive the interest spread between wholesale loan rates and Taylor Rule rate:

$$r_t^{wH} = r_t - \kappa_{kb} \left(\frac{k_t^w}{b_t} - \nu^b \right) \left(\frac{k_t^w}{b_t} \right)^2 \tag{13}$$

Similar to GNSS, the interest spread comes from the cost of capital acquirement. Furthermore, we can get the interest spread between wholesale loan rates for impatient households and private enterprises:

$$r_t^{wE} = r_t^{wH} + \eta m_t^B \frac{1 + r_t^{bE}}{\kappa_w} \tag{14}$$

This spread reflects the cost of probability of loan default or CSV cost. Meanwhile, we also can derive a similar equation from the first order condition for loan of state-owned enterprises. Combining them, we can derive the relationship of loan to value ratios for two types of firms:

$$m_t^A - m_t^B = \frac{T' \left(b_t^A \right) \kappa_w}{\eta \left(1 + r_t^{bE} \right)} \tag{15}$$

It is obvious that the extent of discriminatory credit constraint is positively related to the marginal subsidy rate to banks for SOE loans, and negatively related to the loan interest rate of enterprises.

3.3.2 Deposit Retailer Branch

The deposit retailer branches operate under monopoly competition. They collect deposits from patient households with deposit rates $r_t^d(i)$ and transfer the deposits to the wholesale branch with interest rate r_t, equal to the Taylor Rule rate. According to Beneš and Lees (2007), the total deposit market each retailer confronts is $d_t = \left[\int_0^1 d_t(i)^{1/\varepsilon_d} \right]^{\varepsilon_d}$, where ε_d is the elasticity of substitution of deposit. After cost minimization, we can derive the deposit demand of each retailer as $d_t(i) = \left[r_t^d(i)/r_t^d\right]^{-\varepsilon_d} d_t$. We assume the deposit retailers have a quadric adjustment cost when adjusting the deposit rate; then we can write the profit function of deposit retailer branch as:

$$\max_{r_t^d(i)} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[r_t d_t(i) - r_t^d(i) d_t(i) - \frac{\kappa_d}{2} \left(\frac{r_t^d(i)}{r_{t-1}^d(i)} - 1 \right)^2 r_t^d d_t \right] \tag{16}$$

where, $\Lambda_{0,t}^P$ is random discount factor of patient households, and κ_d is parameter of sticky extent. The first order condition for $r_t^d(i)$ yield, after imposing symmetric equilibrium, is:

$$-1 + \varepsilon_d - \varepsilon_d \frac{r_t}{r_d} - \kappa_d \left(\frac{r_t^d}{r_{t-1}^d} - 1 \right) \frac{r_t^d}{r_{t-1}^d} + \beta_P E_t \left[\frac{\lambda_{t+1}^P}{\lambda_t^P} \kappa_d \left(\frac{r_{t+1}^d}{r_t^d} - 1 \right) \frac{r_{t+1}^d}{r_t^d} \frac{d_{t+1}}{d_t} \right] = 0 \tag{17}$$

In the steady state the deposit interest is $r_t^d = \frac{\varepsilon_d}{\varepsilon_d - 1} r_t$. Because $\varepsilon_d < 0$, the deposit rate is marked down to Taylor rule rate.

3.3.3 Loan Retailer Branch

Similar to deposit retailer branches, we assume the loan retailer branches operate under monopoly competition. The loan demands of each loan retailer branch for enterprises and impatient households (indexed by $j = E, H$) are $b_t^j(i) = \left[r_t^{bj}(i)/r_t^{bj}\right]^{-\varepsilon_{bj}} b_t^j$, where ε_{bj} is the elasticity of substitution of loan demand. Loan retailer branches select loan interest rate to maximize their profit as follows:

$$\begin{aligned} \max_{r_t^{bj}(i)} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \Bigg[& r_t^{bE}(i) b_t^E(i) - r_t^{wE} b_t^E(i) - \frac{\kappa_{bE}}{2} \left(\frac{r_t^{bE}(i)}{r_{t-1}^{bE}(i)} - 1 \right)^2 r_t^{bE} b_t^E \\ & + r_t^{bH}(i) b_t^H(i) - r_t^{wH} b_t^E(i) - \frac{\kappa_{bH}}{2} \left(\frac{r_t^{bH}(i)}{r_{t-1}^{bH}(i)} - 1 \right)^2 r_t^{bH} b_t^H \Bigg] \end{aligned} \tag{18}$$

where, $\Lambda_{0,t}^P$ is random discount factor of patient households, κ_{bE} and κ_{bH} are parameter of sticky extent. The first order conditions for $r_t^{bE}(i)$ and $r_t^{bH}(i)$ yield, after imposing symmetric equilibrium,

$$1 - \varepsilon_{bj} + \varepsilon_{bj} \frac{r_{wj}}{r_{bj}} - \kappa_d \left(\frac{r_t^{bj}}{r_{t-1}^{bj}} - 1 \right) \frac{r_t^{bj}}{r_{t-1}^{bj}} + \beta_P E_t \left[\frac{\lambda_{t+1}^P}{\lambda_t^P} \kappa_{bj} \left(\frac{r_{t+1}^{bj}}{r_t^{bj}} - 1 \right) \frac{r_{t+1}^{bj}}{r_t^{bj}} \frac{b_{t+1}^j}{b_t^j} \right] = 0 \tag{19}$$

In the steady state the loan interest is $r_t^{bj} = \frac{\varepsilon_{bj}}{\varepsilon_{bj} - 1} r_t^{wj}$. Because $\varepsilon_{bj} > 0$, the loan interest rate is marked up to wholesale loan interest rate. Then, we can write the total profit of banking sector as

$$j_t^{bank} = r_t^{bE}\left(b_A + b_B\right) + r_t^{bH} b_t^I - r_t^d d_t - \frac{\kappa_{kb}}{2}\left(\frac{k_t^w}{b_t} - \nu^b\right)^2 \\ -\frac{\eta}{2\kappa_w}\left(m_t^A + m_t^B\right)\left(1 + r_t^{bE}\right) + T\left(b_t^A\right) \tag{20}$$

3.4 The Rest of the Economy

3.4.1 Capital Goods Producer

Following Iacoviello (2005) and GNSS, we assume the capital goods producer produces capital goods with a quadric adjustment cost, and then maximizes profit as follows:

$$\max_{i_t(i)} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[q_t^k \left[1 - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right] i_t - i_t\right] \tag{21}$$

where, $i_t$is investment, $\Lambda_{0,t}^P$ is random discount factor of patient households, κ_I is the adjustment cost parameter. In our model, both state-owned and private enterprises use homogenous capital, so the capital can be freely traded, which means all capital goods have a unique capital goods price q_t^k. The first order condition is:

$$\frac{1}{q_k^t} = 1 - \kappa_I\left(\frac{i_t}{i_{t-1}} - 1\right)\frac{i_t}{i_{t-1}} - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 + \beta_P \kappa_I E_t\left[\frac{\lambda_{t+1}^P}{\lambda_t^P}\left(\frac{i_{t+1}}{i_t} - 1\right)\frac{i_{t+1}}{i_t}\frac{q_{t+1}^k}{q_t^k}\right]$$

And the aggregated capital is $k_t^A + k_t^B - (1-\delta)\left(k_{t-1}^A + k_{t-1}^B\right) = \left[1 - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right] i_t$.

3.4.2 Retailer

In our model, the retailers combine the different products of two types of enterprises, by C-D technology $y_t = \left(y_t^A\right)^{\mu^y}\left(y_t^B\right)^{1-\mu^y}$ where, μ^y is the weight of state-owned enterprises made products in total final goods. By maximization of profit under cost constraint, we can derive

$$\frac{\mu^y}{1-\mu^y} = \frac{y_t^A}{y_t^B}\frac{x_t^B}{x_t^A} \tag{22}$$

We introduce the sticky price as (Calvo, 1983). Only γ of retailer may change the price in each period, and then we can derive the New Keynes Philips Curve,

$$\log\frac{\pi_t}{\bar{\pi}} = \beta_P \log\frac{\pi_{t+1}}{\bar{\pi}} - \frac{(1-\gamma)(1-\beta\gamma)}{\gamma}\left[\mu^y \log\frac{x_t^A}{\bar{x}^A} + (1-\mu^y)\log\frac{x_t^B}{\bar{x}^B}\right] \tag{23}$$

where, $\bar{x}$ is steady state of the relative price of the final goods to intermediate goods that is equal to the mark-up rate.

3.4.3 Market clear condition and Central bank

To close the model, we give the market clear condition for final goods as

$$y_t = q_t^k \left[1 - \frac{\kappa_I}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right] i_t + \left[c_t^A + c_t^B + c_t^H + c_t^P\right] + \frac{\delta^b k_{t-1}^w}{\pi} + Adj_t \quad (24)$$

As to housing market, we assume the housing held by all households is equal to an exogenous constant $\bar{h}$, that is, $h_t^I + h_t^P = \bar{h}$. The central bank follows the standard Taylor rule,

$$\log \frac{1+r_t}{\bar{r}} = \rho \log \frac{1+r_{t-1}}{\bar{r}} + (1-\rho)\left[\phi_y \log \frac{y_t}{\bar{y_{t_1}}} + \phi_\pi \log \frac{\pi_t}{\bar{\pi}}\right] + \varepsilon_t^{MP} \quad (25)$$

where, ρ measures the continuity of monetary policy, ϕ_y and ϕ_y are the weights assigned to inflation and output stabilization respectively, and $\bar{r}$ is steady state value of interest rate.

3.5 Calibration

In the previous subsection, we built the full DSGE model with discriminatory credit constraint. In this subsection, we calibrate the structural parameters according to related literature and China's data, in order to analyse the impulse-response figures of the main economic variables under technical shock and monetary policy shock.

Table 1 shows the calibrated parameters which influence the steady state of the model. We select Chinese average deposit benchmark interest rate as steady state value of deposit interest rate. According to the steady state deposit interest rate, we calibrate the objective discount factor of patient households as 0.9926. For the discount factors of impatient households and of state-owned enterprises, we follow GNSS to calibrate them as 0.975. Considering that private enterprises are more motivated to enlarge production and borrow money, we calibrate their discount factor as 0.0970, which means they are more impatient than state-owned enterprises.

TABLE 1 ABOUT HERE

We calibrate the steady state of LTV according to Chinese industrial firm data. We use the total debt minus amount payable to calculate the long-term debt, and then use the long-term debt divided by total fixed assets to calibrate LTV ratio. According to the data, we calibrate the LTV ratio of state-owned enterprises as 0.50, while the LTV ratio of private enterprises is only 0.46. As the data of household loan is not available, we calibrate the LTV ratio of impatient households as 0.7, the same as GNSS. According to the Commercial Bank Report of the People's Bank of China, the non-performing loan rate is around 1%, so we calibrate the steady state loan default rate as equal to 0.01. Then we can calculate the parameter of default cost for firm κ_f as 1.4279. We use Chinese average loan benchmark interest rate as steady state value of loan interest rate to firms, and choose 7-day Shanghai inter-bank offered rate (SHIBOR) as the proxy of steady state value of Taylor Rule rate. There is an important assumption that the steady state value of banks' leverage ratio is equal to the requirement of 0.08 set by the central bank (similar to GNSS). According to these interest rates, we can calibrate the parameter of CSV cost κ_w as 1, and we calibrate the substitution elasticity of deposit market and loan market for enterprises in order to match the steady state LTV ratio. With regard to the substitution elasticity of the loan market for households, we follow GNSS to calibrate it as 2.79.

The depreciation rate of capital is calibrated as normal, 0.025, which means 10% per year. Values for the capital share in production function vary in the literature, with Chinese scholars estimating it in a range between 0.3 and 0.6. To describe the characteristic of investment-led growth of SOEs, we calibrate the capital share of SOEs and PEs as 0.5 and 0.33 respectively. Following Gertler and Karadi (2011) and GNSS , we calibrate the steady state of utilization of capital as 1, and calibrate the parameter of adjustment cost for capital utilization as $\kappa_1^u = 0.00478$ and $\kappa_2^u = 0.0478$. Following the majority of studies, we calibrate the steady state mark-up rate in the goods market as 1.2, which matches the substitution elasticity of 6. Considering that the private economy is growing rapidly and already occupies more than 60% of the GDP, we calibrate the weight of SOE-produced goods as 0.4. Following GNSS, the share of impatient households is calibrated as 0.2.

We calculate the management cost of bank capital as 0.0865. The subsidy to banks for SOE loans is hard to calibrate. The steady state of marginal subsidy rate κ_2^T can be calculated as 0.0004. As to the second order marginal subsidy rate κ_1^T , we calibrate it as 0.02, and will test its range in the further analysis.

Table 2 reports the calibration values of other parameters, which do not affect steady state. We calibrate the parameter of sticky price γ as 0.75, which means the enterprise has one chance to change their price a year. The parameters of adjustment cost are calibrated according to GNSS posterior mean values. This is for two reasons. First, Chinese financial architecture is bank-oriented, as is the euro area, so their banking systems are similar to some extent. Secondly, our model is based on the GNSS model, so the parameters may be more suitable to show the mechanism of financial frictions. With regard to the coefficient of Taylor rule, we calibrate the coefficient on inflation rate ϕ_π as 1.5, while the coefficient on output is 0.125, following Rannenberg (2013). Following GNSS, we calibrate the continuity parameter of monetary policy ρ as 0.75.

TABLE 2 ABOUT HERE

4 Simulation and Discussion

In this section, we analyse the role of discriminatory credit constraint based on the impulse responses of technology shocks and monetary policy shocks. By comparing results from the model with discriminatory credit constraint with those from a model where the two types of enterprise have the same LTV ratio, we find the impact of discriminatory credit constraint on the economy. We also explain the mechanism whereby it amplifies the technology shocks and hinders the effectiveness of monetary policy. Finally, we focus on the source of discriminatory credit constraint. When enlarging the parameter value of marginal subsidy rate for SOE loans, we find that the impact of discriminatory credit constraint decreases.

4.1 Technology Shock

Figure 6 describes the response fluctuations of the main macro-economic variables after one unit of negative technology shock. As a result of technology decrease, both the production cost and the product price increase, leading to a decline in consumption. While being aware that the technology shock is temporary, representative patient households may increase their current consumption and diminish their deposit, causing the deposit supply to decrease. For impatient households and enterprises, their loan demand increases. Impatient households would like to borrow more money to maintain their consumption, while enterprises would like to borrow money to smooth the influence of negative technology shock. However, limited by equilibrium, the total loan decreases as deposit supply decreases, therefore causing the interest rate to increase. These results are in line with existing literature.

FIGURE 6 ABOUT HERE

In our model, endogenous LTV ratios and different treatment of SOEs and PEs are described clearly. From Figure 6 we can see that under the situation of discriminatory credit constraint, loan to SOE grows slightly, while loan to PE falls significantly. This may be interpreted according to the different LTV ratios. Both the LTV of SOEs and that of PEs is decreasing, which reveals that the LTV of SOEs is counter-cyclical, while that of PEs is pro-cyclical. SOEs have more power to influence the bank because of their strong background, so the credit constraint they confront is less binding. However, PEs can only accept the loan condition proposed by banks. As a consequence, more loan resources flow to SOEs. Due to China's special characteristics the financial market is not perfect, leading to banks' unfair treatment towards different types of enterprise. In China, central and local government force banks to support SOEs with low requirements for collateral, and may even vouch directly for the SOEs so that they receive loans. These factors ensure that the loan direction is biased toward SOEs.

Under the conditions of negative technology shock, discriminatory credit constraint can enlarge the fluctuation of output. By changing the parameters to make the credit constraint of both types of enterprise the same, eliminating the subsidy to banks for SOE loans, we can get another series of impulse responses with no discrimination. From Figure 6, we can see that the growth of output with no discriminatory credit constraint is slightly higher. This means that the financial accelerator effect (KM type) is enlarged when the credit constraint is discriminatory. When the economy deteriorates, banks tend to lower LTV ratio to control the CSV cost. Due to the subsidy for SOE loans, banks only lower the LTV ratio of PEs, but maintain or increase the LTV ratio of SOEs. The relatively lower LTV ratio will induce a sharp decrease in capital demand. Because SOEs and PEs use the same capital for investment, the capital prices are influenced by capital demand of both types of enterprise.

As the figure shows, compared to the model with no discrimination, the decrease of LTV for PEs has a greater influence on the capital price, making it decrease further. This is due to resource misallocation. At the first time, despite of the different LTV ratios, PEs and SOEs have almost the same profit rate, and there is no misallocation. However, the borrowing constraints with different binding extent lead to different operation situation of two types of firms. With more binding borrowing constraint, PEs may only decrease loan and investment, or even fire sale the capital, which induce to supply's further decline. Correspondingly, the supply of SOEs is less decreasing. Due to substitution elasticity of demand between two types of firms, the demand structure cannot change intermediately. Thus, SOEs' profitability and capital return become lower than PE's. Contiguous enlargement of the loan gap between SOE and PE leads to more severe misallocation, therefore causing aggregate capital price's further decline. Further decline of capital price makes both the borrowing constraints of PEs and SOEs more binding, and causing aggregate output's decline amplified. As a consequence, discriminatory credit constraint set by banks sharpens the decrease of capital price, and then the total collateral is less valuable, while the total loan of enterprises declines further, thus leading to more decline of total output.

Furthermore, discriminatory credit constraint may worsen the economic structure and sharpen the excess capacity of SOEs. From Figure 6, we can see that the capital of SOEs increases, while that of PEs decreases, and the capital utilization of SOEs decreases faster than that of PEs. This reflects the change of economic structure and greater excess capacity of SOEs. As we know, SOEs in China are less efficient, so their output growth relies on investment. Continuous investment improves SOEs' capacity of production, but the demand cannot satisfy the supply. At the beginning of the 21st century, benefitting from the trend of globalization, China's exports increased rapidly, which supported the excess capacity of manufacturing. However, after the global crisis of 2008, external demand decreased sharply, and the problem of excess capacity became more important. Although our model cannot describe the results of economic structure imbalance and excess capacity, we know that they are disincentives to economic development.

4.2 Monetary Policy Shock

Figure 7 reports the impulse responses of the main macro-economic variables under a standard deviation of expansionary monetary policy shock. As a result of expansionary monetary policy, the deposit interest rate decreases, and then households decrease deposits to increase current consumption. The growth of aggregate demand stimulated by expansionary monetary policy causes output to grow. For banks, decreasing policy interest rate makes them lower loan interest rates, which leads to growth of total loan. These results are similar to those in the related literature.

FIGURE 7 ABOUT HERE

We pay further attention to the loans to different types of enterprise. Compared with the model without discrimination, LTV ratio of SOEs decreases slightly, but that of PE decreases more significantly. More loans flow to SOEs rather than PEs. Due to the subsidy for SOEs, banks set relatively higher LTV for SOEs, but lower LTV ratio for PEs, in order to lend more money to SOEs and improve their profit. With a similar mechanism to the situation under negative technology shocks, decreasing PEs' LTV has a dramatic influence on the capital price, as the figure shows. Total loan to enterprises decreases more sharply, therefore leading to lower effectiveness of expansionary monetary policy when stimulating output growth. Since expansionary monetary policy cannot promote economic growth effectively, growing liquidity cannot flow to the real economy, and then it flows to the housing market. Compared to the LTV ratios for enterprises, LTV ratio for impatient households is higher and more fixed, as household loan is less risky. When the real economy cannot absorb the liquidity released by central banks, it is reasonable that the liquidity flows to households. As a consequence, housing and real estate become more valuable due to their collateral value, leading to growing housing demand and a prosperous housing market. This is in line with China's housing market boom since 2009.

Furthermore, in the model with discriminatory credit constraint SOEs confront the more serious problem of excess production capacity. This has the same mechanism as that under negative technology shocks. Banks' unfair treatment to different types of enterprise leads to different capital investment decisions of SOEs and PEs. Having obtained financial support, SOEs implement more capital assets investment. However, unsustainable growth of aggregate demand cannot support fast growing supply, thus causing excess production capacity in SOEs. This is also in line with the actual situation since 2009.

4.3 Further Analysis on Amplification Effect of Discriminatory Credit Constraint

According to the above analysis on impulse response figures, we find that discriminatory credit constraint has an amplification effect on the transmission of negative technology shocks. In order to make clear the source of amplification effect and how it changes according to the extent of discrimination, we further examine the impulse response figures under different parameters of subsidy.

As the first order marginal subsidy rate κ_2^T is depends on the steady state of LTV ratios of SOEs and PEs, we can adjust only the second order marginal subsidy rate κ_1^T to change the extent of discrimination. As we can see from Figure 8, higher subsidy rate leads to relatively smaller amplification effect. This is due to the double effect of subsidy. In fact, the subsidy for SOE loan has both income effect and substitution effect on credit constraint and total loans to enterprises. On one hand, when the government improves the marginal subsidy rate, the banks may earn more income, and then they will properly lower the interest rate (under negative technology shocks) and increase loan supply to maximize their profit. This is income effect. On the other hand, when the government improves the marginal subsidy rate, the banks are willing to lend more to SOEs rather than PEs, and then they will set higher LTV for SOEs and lower LTV for PEs. Resource misallocation makes the capital price decrease more sharply, leading to decline of total loan to enterprises. This is substitution effect. With regard to the total loan to enterprises, these two effects play opposite roles. Generally, the substitution effect is more significant than the income effect, so we find the amplification effect of discriminatory credit constraint. However, when we further improve the marginal subsidy rate, the substitution effect changes less, but income effect increases to some extent; therefore, the amplification effect is slightly weakened.

We can also find this mechanism through the equation of the gap between LTV ratios. Under the assumption of the same loan default rate for all types of enterprises, from Eq.(15) we can have the expression of gap of LTV ratios:

$$m_t^A = m_t^B + \frac{\kappa_w \left(\kappa_1^T \left(b_t^A/\bar{b}^A - 1\right) + \kappa_2^T\right)}{\eta\left(1 + r_t^{bE}\right)} \tag{26}$$

Where b_t^A is SOE loan, κ_1^T and κ_2^T are parameters of subsidy for SOE loan, r_t^{bE} is the loan rate to enterprises. It is obvious that the gap of LTV ratio is positively related with the two parameters of subsidy for SOE loan, and negatively related with loan interest. When we increase the κ_1^T , under the condition of increasing b_t^A , the numerator of the fraction at the right hand side of Eq.(26) also increases. However, the income effect of increasing subsidy lowers the loan interest $r_b E$, decreasing denominator of the fraction, so we cannot judge the value of fraction increases or decreases. Through the figure, we know generally the gap of LTV ratios is positive related to the subsidy parameter κ_1^T, but the marginal effect is negative related to the parameter.

FIGURE 8 ABOUT HERE

5 Empirical Evidence from China

Finally, we analyse in detail the impact of discriminatory credit constraint on transmission of technology shocks and monetary shocks. In this section, we empirically test the robustness of the model result using data of Chinese industrial firms. We focus our testing on two conclusions from the model analysis: first, that the gap between LTV ratios of SOEs and PEs will be enlarged by expansionary monetary policy; secondly, that loans flow more to SOEs than to PEs under expansionary monetary policy shocks, due to discriminatory credit constraint.

5.1 Regression model

First, we build a benchmark regression model to analyse the factors influencing the economic growth:

$$IAV_{i,t} = \beta_0 + \beta_1 TFP_{i,t} + \beta_2 Int_t + \beta_3 DCC_{i,t} + \beta_4 N_{i,t} + \mu_i + \varepsilon_{i,t} \tag{27}$$

where, $IAV_{i,t}$ is logarithm of industrial added value of industry i in the year t, as the proxy of economic growth, $TFP_{i,t}$ is logarithms of TFP of industry i in the year t, measuring the technology level improvement, Int_t is real interest rate of year t , measuring the monetary policy, is the ratios of average SOE LTV ratio to average PE LTV ratio in industry i in the year t, measuring the discrimination extent of credit constraint, $N_{i,t}$ is logarithm of employee numbers of industry i in the year t, measure the labor[3], μ_i and $\varepsilon_{i,t}$ are fix effect and residual error respectively.

We estimate TFP using Solow Residual Method (Barro, 1999; Felipe, 1999). We first estimate the capital share of production function, under the assumption of constant returns to scales by (28), and then calculate TFP by equation (29). The two equations are as follows:

$$IAVtoN_{i,t} = \beta_0 + \alpha KtoN_{i,t} + \varepsilon_{i,t} \tag{28}$$

$$TFP_{i,t} = IAV_{i,t} - \hat{\alpha} K_{i,t} - (1 - \hat{\alpha})\, N_{i,t} \tag{29}$$

where $IAVtoN_{i,t}$ is the ratio of logarithm of industrial added value to logarithm of employee numbers, $KtoN_{i,t}$ is the ratio of logarithm of capital assets to logarithm of employee numbers, α is the capital share coefficient, $\hat{\alpha}$ is its estimated value.

According to the conclusion above on discriminatory credit constraint drawn by impulse response figures, following Fisman and Love (2003) we can build the regression model as follows to examine the moderate effect of discriminatory credit constraint:

$$\begin{aligned} IAV_{i,t} = \beta_0 + \beta_1 TFP_{i,t} + \beta_2 Int_t + \beta_3 DCC_{i,t} \\ +\beta_4 \left(DCC_{i,t} \times TFP_{i,t}\right) \beta_5 N_{i,t} + \mu_i + \varepsilon_{i,t} \end{aligned} \tag{30}$$

where, $(DCC_{i,t} \times TFP_{i,t})$ represents product items of TFP and the discrimination extent of credit constraint. Because the improvement of TFP may promote economic growth, so β_3 should be significantly positive. If coefficient β_4 is also significantly positive, it means the higher discrimination extent may amplify the influence of TFP on industrial added value growth.

[3]We use capital and labour to estimated TFP by Solow Residual Method. Due to the co-linearity problem, we select only two of the three variables included in the regression model.

Similarly, in order to test moderate effect of discrimination extent on the effectiveness of monetary policy, we build another regression model with a product term as follows:

$$\begin{aligned} IAV_{i,t} = \beta_0 + \beta_1 TFP_{i,t} + \beta_2 Int_t + \beta_3 DCC_{i,t} \\ +\beta_4 \left(DCC_{i,t} \times Int_t\right) \beta_5 N_{i,t} + \mu_i + \varepsilon_{i,t} \end{aligned} \tag{31}$$

where, $(DCC_{i,t} \times Int_t)$ represents product items of Int_t and the discrimination extent of credit constraint. Because the industrial added value is negatively related to interest rate, if coefficient β_4 is significantly positive, it means the higher discrimination extent may hinder the influence of monetary policy on industrial added value growth.

5.2 Data Source and Description

The data set we use come from the *China Annual Survey of Industrial Firms* from 1999 to 2008. First, we sort the firms according to whether they belong to SOE or PE, and eliminate those firms with fewer than 8 employees in order to ensure the firms' existence and scale. Secondly, to maintain the effectiveness of LTV ratio, we eliminate the firms with long-term debt and negative capital assets, because we use the ratio of long-term debt to capital assets as the proxy of LTV ratio. Moreover, we exclude the firms whose LTV ratio is bigger than 3, to ensure a reasonable and suitable scale of firms. Following this procedure, we have a sample with 397,069 observations. Thirdly, for the purpose of calculating the discrimination extent of credit constraint, we aggregate the firms' data to industrial-level data. In the *China Annual Survey of Industrial Firms*, all firms are classified into 39 industries, such as Coal Mining, Oil and Gas, and Textiles. Taking all the factors into account, we obtain an industrial-level sample of 335 observations of 39 industries from 1999 to 2008.[4]. Finally, we estimate the TFP of each industry in each year. As shown in the first column in Table 5, the capital share is significant at 5% level, with a value of 0.790. It is marginally bigger than other scholars' estimated results, because for our model we select industrial firms, which have a relatively higher capital share than the agriculture

[4]Due to the data availability, we cannot obtain the data covering the years from 2008 to 2014. However, since discriminatory credit constraint is long-standing in China, the data from 1999 to 2008 can be used to examine its impact.

and public services industries. Then we calculate the TFP through Eq.(29). The measurement and descriptive statistic of variables are reported in Table 3 and Table 4 respectively. The correlation analysis is not reported, and all the correlation coefficients are smaller than the co-linearity threshold of 0.7 (Mason et al., 1990).

TABLE 3 ABOUT HERE

TABLE 4 ABOUT HERE

5.3 Results and Analysis

5.3.1 Discriminatory Credit Constraint, TFP and Economic Growth

Table 5 reports the regression results. As shown in Table 5, Reg.(5) estimates the model(30) using the Fix Effects method[5]. The coefficient of product item $DCC_{i,t} \times TFP_{i,t}$ is 0.257 and significant at 5% level. This reveals that, in industries where the extent of discrimination of credit constraint between SOE and PE is higher, when TFP decreases, the growth rate of industrial added value will decrease more dramatically. This is in line with our conclusion from the model analysis. Discriminatory credit constraint can amplify the impact of technology shock on total output.

The coefficient of TFP is significantly positive, and the coefficient of interest rate is significantly negative, also in line with existing theory. Reg.(3) is the benchmark estimation, which is the reference to regression models with product items. All estimated coefficients are significant, and in line with existing literature. The coefficient of $DCC_{i,t}$ is significantly negative, which shows that discriminatory credit constraint is damaging to economic growth.

TABLE 5 ABOUT HERE

5.3.2 Monetary Policy and Loan Flow Direction

Table 5 also reports the regression results of Eq.(31). As shown in Reg.(5), the coefficient of product item $DCC_{i,t} \times Int_t$ is 5.238 and significant at 5% level; the coefficient of real interest rate is -27.70, significant at 1% level. According

[5]The Hausman test has been made for all panel regressions. All the results support the fixed effect model.

to our calculation of coefficients, we find that if the extent of discrimination of credit constraint increases by 1 unit, when real interest rate decreases by 0.1 percentage points, the increase of industrial added value growth rate will decrease by 0.5238 percentage points. That is, in industries where discriminatory credit constraint between SOEs and PEs is greater, expansionary monetary policy will be less effective in promoting economic growth. Therefore, discriminatory credit constraint may hinder the effectiveness of expansionary monetary policy.

In Reg.(5), the estimated values of other coefficients are also significant, in line with the benchmark model. For robustness, we also add the two product items in regression at the same time. All the results are significant and consistent with Reg.(4) and Reg.(5).

6 Conclusion Remarks

An increasing number of scholars have started to do research on the Chinese banking sector and China's business cycle. However, they pay little attention to China's economic slowdown, which has been continuous since 2012 and is actually the sequel to the 2008 US crisis and China's subsequent expansionary monetary and fiscal policy. Some scholars believe the slowdown may be explained by the global business cycle, while others argue that it could be the result of Chinese economic structural imbalance. We find that discriminatory credit constraint between SOEs and PEs is the essential factor accelerating China's continuing economic slowdown.

We extend the GNSS model with a bank sector limited by capital acquirement, incorporating banks' CSV cost and two types of enterprise. We find that the endogenous LTV ratio of PEs is pro-cyclical, while that of SOEs is counter-cyclical. From both theoretical and empirical analysis, we draw the following conclusions. First, the benefit connections between government, SOEs and banks constitute the main source of discriminatory credit constraint. Secondly, discriminatory credit constraint can amplify the impact of technology shock on total output. Thirdly, discriminatory credit constraint can hinder the effectiveness of expansionary monetary policy. Finally, the discriminatory credit constraint may also worsen the economic structure of SOEs and PEs, and may sharpen the excess production capacity of SOEs.

Our model can be used by further research on the impact of banks' unfair treatment towards firms of different scale or stock price, as well as in comparison of the different business cycles in countries with different types of financial architecture, such as the euro area and the US.

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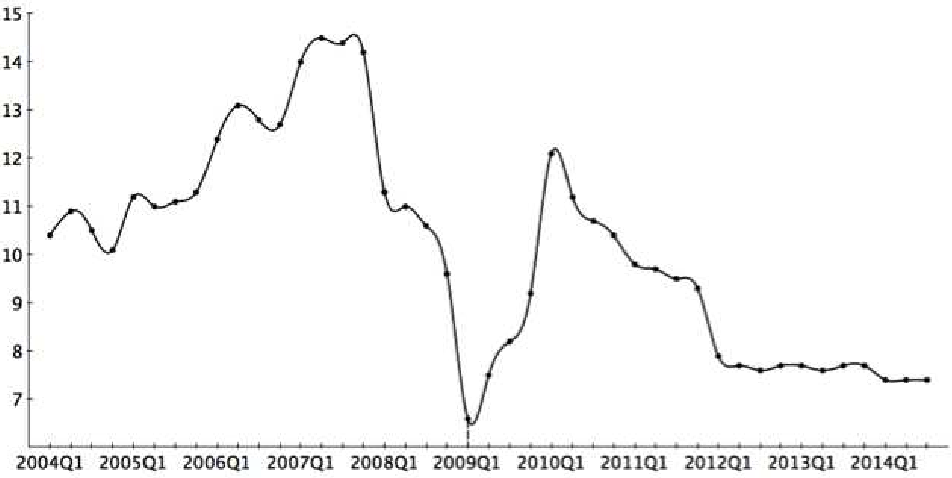

Figure 1: 2004Q1-2014Q3 China's Year-on-Year GDP Growth Rate (%)

Data Source: National Bureau of Statistics of China

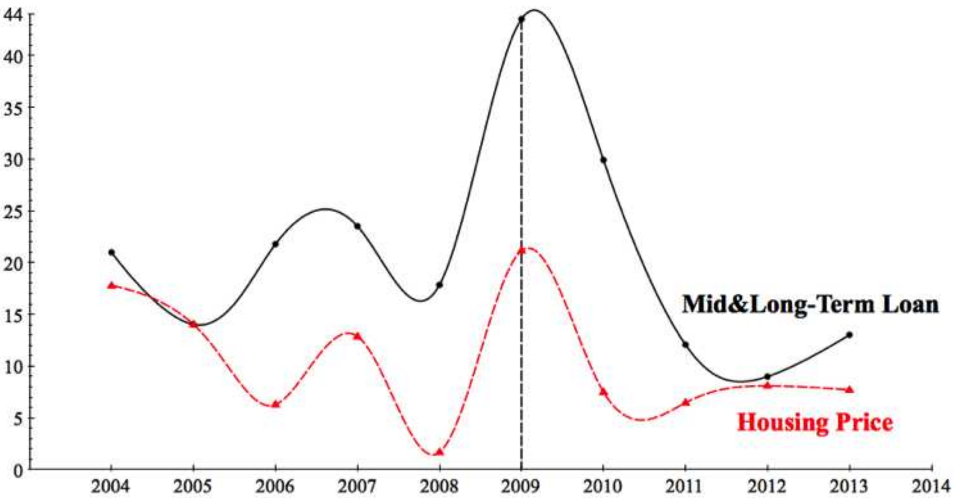

Figure 2: 2004-2013 Annual Growth Rate of China's Middle & Long-Term Loan (%)

Data Source: National Bureau of Statistics of China

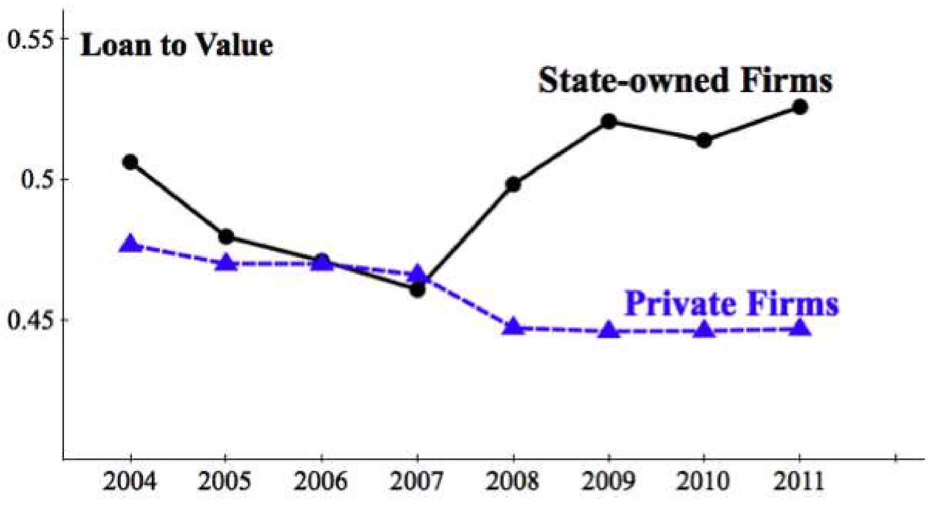

Figure 3: Loan to Value Ratio of State-own and Private Industry firms in China

Data Source: National Bureau of Statistics of China

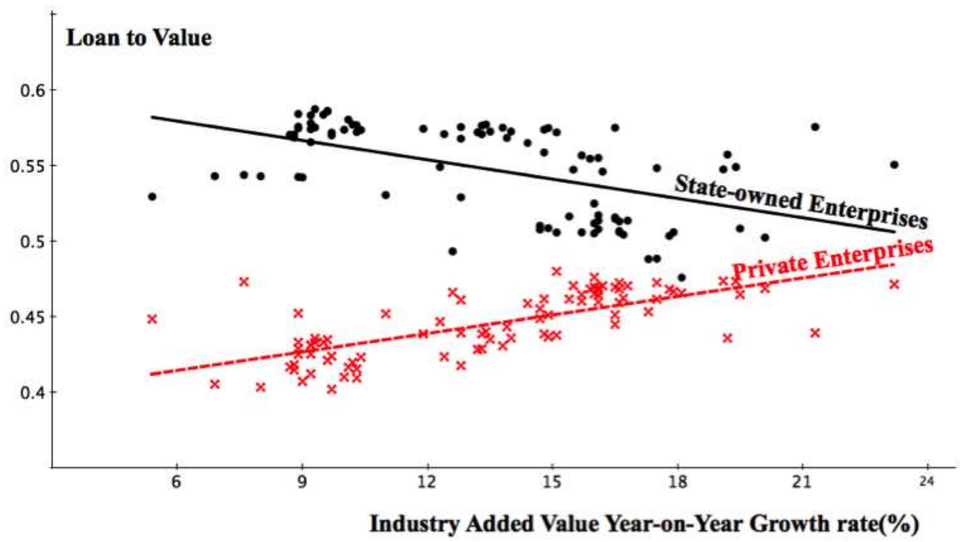

Figure 4: 2001.11-2013.09 Loan to Value Ratio of Industrial Enterprises and Industry Growth

Data Source: Calculated based on data from National Bureau of Statistics of China. Note: Due to lack of payables' data, we use receivables as its proxy, so the loan to value ratio is calculated as the differences of total debs and receivables, divided by total assets. The black solid line is trend line of SOEs, while the red dash line is trend line of PEs.

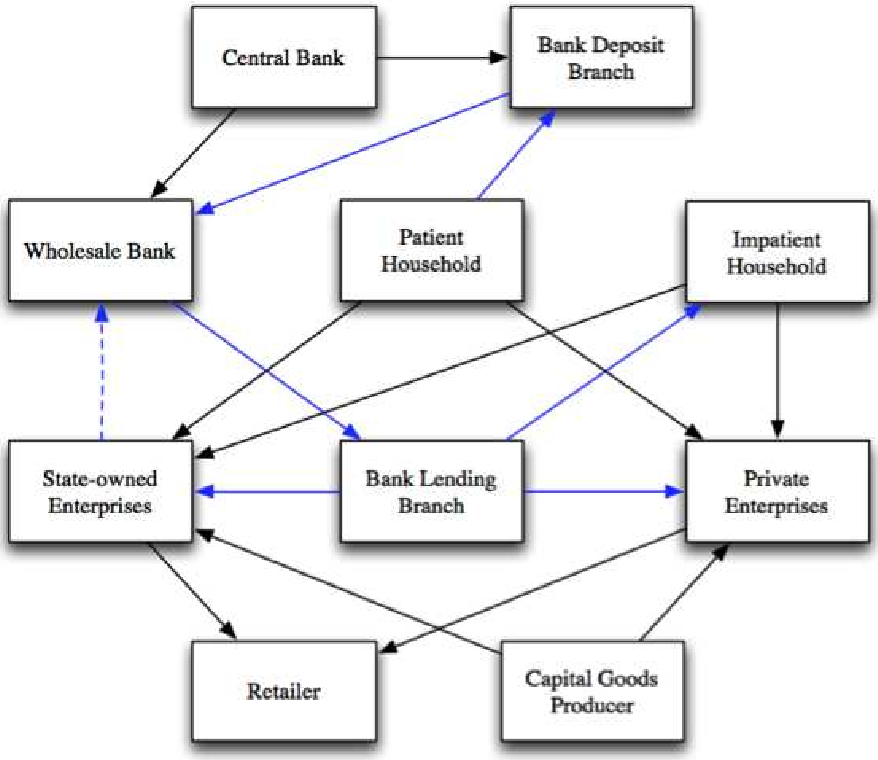

Figure 5: Framework of the completed DSGE model

Data Source: National Bureau of Statistics of China

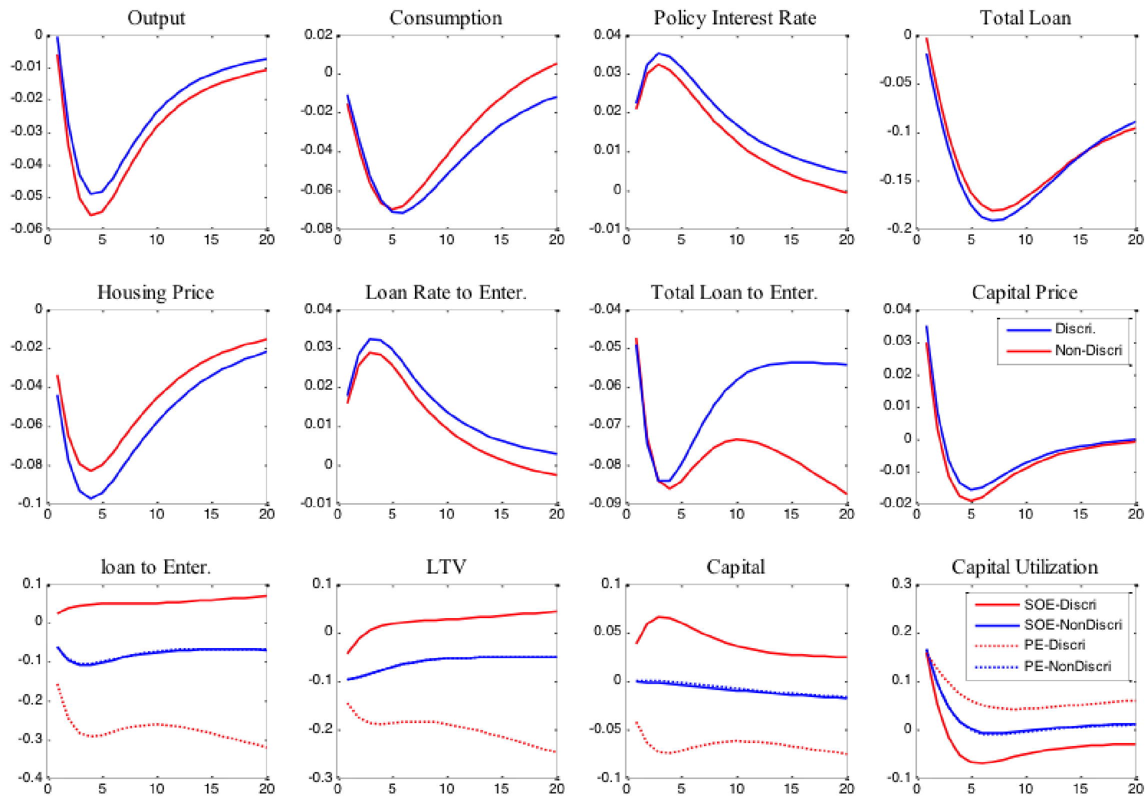

Figure 6: The Amplification Effect of Discriminatory Credit Constraint on the Transmission of a Negative Technology Shock

Note: All variables are shown as percentage deviation from steady state. The red line is from model with discriminatory credit constraint, while the blue line is from model without non-discriminatory credit constraint (No subsidy for SOE loan and the same LTV steady state). The first eight figures are about macro variables. In the last four figures, solid line and dotted line are expressed as SOE and PE respectively.

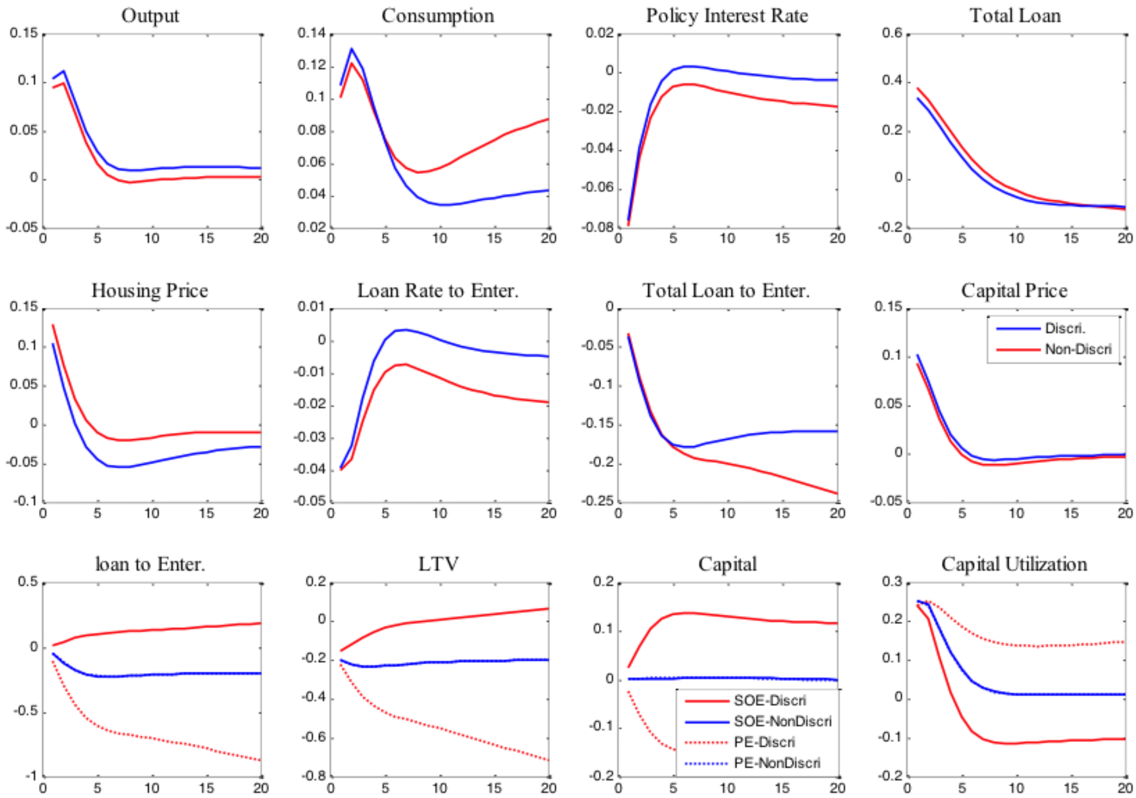

Figure 7: The Weakening Effect of Discriminatory Credit Constraint on the Transmission of an Expansionary Monetary Policy Shock

Note: All variables are shown as percentage deviation from steady state. The red line is from model with discriminatory credit constraint, while the blue line is from model without non-discriminatory credit constraint (No subsidy for SOE loan and the same LTV steady state). The first eight figures are about macro variables. In the last four figures, solid line and dotted line are expressed as SOE and PE respectively.

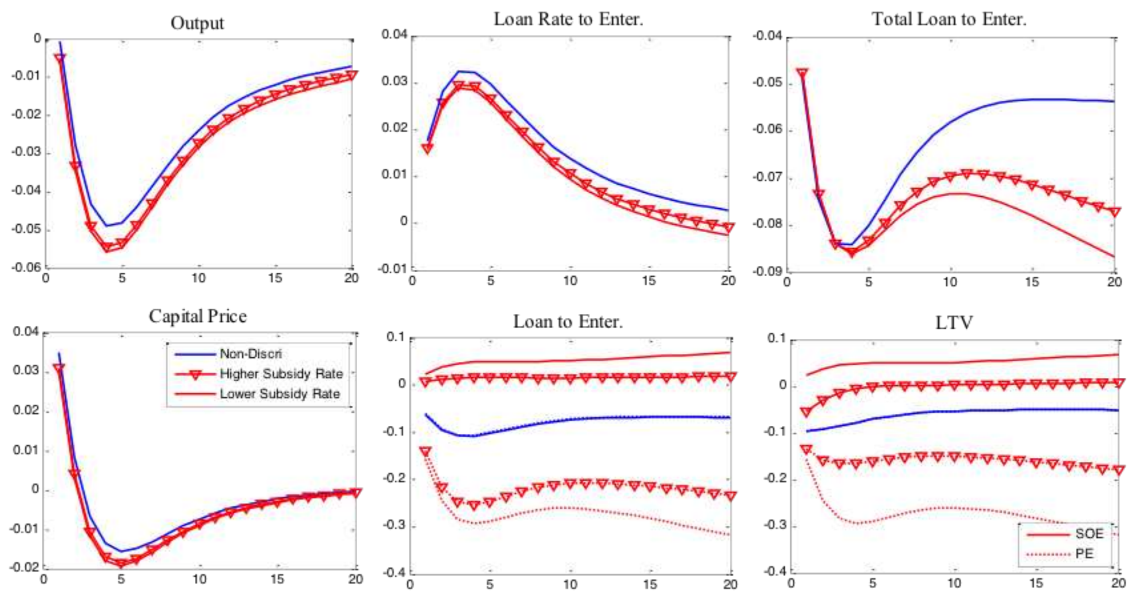

Figure 8: The Amplification Effect and Different Extent of Discrimination

Note: It is similar to Figure 6&7. Diamond red line is model with discriminatory credit constrain and higher marginal subsidy rate (with $\kappa_1^T = 0.05$, while in benchmark model $\kappa_1^T = 0.02$).

Table 1: Calibrated Parameters Influencing Steady State

Parameter	Description	Value
β_P	Discount factor of Patient households	0.9926
β_I	Discount factor of Impatient households	0.975
β_A	Discount factor of SOE	0.975
β_B	Discount factor of PE	0.97
$\bar{m}^A$	Steady state LTV ratio for SOE	0.5
$\bar{m}^B$	Steady state LTV ratio for PE	0.46
m^H	LTV ratio for Impatient households	0.7
η	Steady State Loan Default rate	0.01
κ_w	Parameter of default cost with LTV	1
κ_f	Parameter of CSV cost with LTV ratios	1.4279
ε^d	Substitution elasticity of Deposit market	-3.3
ε^{bH}	Substitution elasticity of Household Loan demand	2.79
ε^{bE}	Substitution elasticity of Enterprises Loan demand	10.7128
δ	Depreciation rate of capital	0.025
$\bar{u}$	Steady state utilization rate of capital	1
α^A	Capital share of SOE	0.5
α^B	Capital share of PE	0.33
κ_2^u	Parameter of adjustment cost for capital utilization	0.0478
κ_1^u	Parameter of adjustment cost for capital utilization	0.00478
$\bar{x}$	Steady state markup rate of goods market	1.2
μ^y	Share of SOE-produced goods	0.4
μ^n	Share of impatient household labor	0.2
δ^b	Management cost of bank capital	0.0865
ν^b	Capital acquirement rate	0.08
κ_2^T	Parameter of Subsidy rate to SOE loan	0.0004
κ_1^T	Parameter of Subsidy rate to SOE loan	0.02

Table 2: Calibrated Parameters Not Influencing Steady State

Parameter	Description	Value
γ	Price Stickiness	0.75
κ_{bE}	Firm rate adjust. cost	10.22
κ_{bH}	HH rate adjust. cost	3.63
κ_d	Deposit rate adjust. cost	9.51
κ_f	Invest. adjust. cost	10.26
κ_{kb}	Leverage dev. cost	11.49
ϕ_π	T. R. coeff on π	1.5
ϕ_y	T. R. coeff on y	0.125
ρ	T. R. Continuity	0.75
a	Consumption habit	0.5

Table 3: Variables & Measurements

Variable	Name	Measurements	Source
$IAV_{i,t}$	Output	Logarithm of aggregated industrial added value	China Annual Survey of Industrial Firms
$N_{i,t}$	Labor	Logarithm of aggregated employees	China Annual Survey of Industrial Firms
$K_{i,t}$	Capital Assets	Logarithm of aggregated capital assets	China Annual Survey of Industrial Firms
$TFP_{i,t}$	TFP	Calculated by Eq.	Estimated by this paper
Int_t	Monetary Policy	Real interest rate	WDI from Word Bank
$DCC_{i,t}$	Discrimination Extent	SOE average LTV / PE average LTV	China Annual Survey of Industrial Firms

Note: LTV is calculated as aggregated long-term loans divided by aggregated capital assets.

Table 4: Description of Variables

Variable	Obs.	Mean	Std. Dev.	Min	Median	Max
$IAV_{i,t}$	187	15.178	2.16	7.476	15.706	18.073
$N_{i,t}$	335	10.769	2.012	2.485	11.186	14.087
$K_{i,t}$	335	15.147	2.076	5.956	15.477	18.713
$TFP_{i,t}$	187	0.874	0.52	-1.433	0.956	2.524
Int_t	335	0.02	0.028	-0.023	0.025	0.072
$DCC_{i,t}$	335	1.258	0.726	0.056	1.12	6.628

Table 5: Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	FE	FE	FE	FE	FE
VARIABLES	$IAVtoN_{i,t}$	$IAV_{i,t}$	$IAV_{i,t}$	$IAV_{i,t}$	$IAV_{i,t}$	$IAV_{i,t}$
$KtoN_{i,t}$	0.790***					
	(0.0321)					
$TFP_{i,t}$		0.352***	0.330***	0.397***	0.166*	0.198**
		(0.0711)	(0.071)	(0.0753)	(0.0961)	(0.0934)
Int_t		-22.81***	-21.91***	-27.70***	-20.51***	-28.10***
		(1.397)	(1.444)	(2.811)	(1.528)	(2.715)
$DCC_{i,t}$			-0.0874**	-0.200***	-0.345***	-0.602***
			(0.041)	(0.0621)	(0.112)	(0.133)
$DCC_{i,t} \times Int_{i,t}$				5.238**		7.348***
				(2.193)		(2.206)
$DCC_{i,t} \times TFP_{i,t}$					0.257**	0.355***
					(0.104)	(0.105)
$N_{i,t}$		0.756***	0.795***	0.785***	0.804***	0.793***
		(0.0363)	(0.0402)	(0.0398)	(0.0397)	(0.0385)
Constant	0.295***	7.270***	6.955***	7.125***	7.004***	7.261***
	(0.0463)	(0.423)	(0.443)	(0.441)	(0.435)	(0.428)
Observations	187	187	187	187	187	187
R-squared	0.766	0.951	0.952	0.954	0.954	0.958
No. of Industry		39	39	39	39	39
Hausman Test (p Value)		0.0000	0.0005	0.0008	0.0023	0.0006

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.