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Shadow banking activity and entrusted loans in a DSGE model of China

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Abstract

This paper examines how the risky lending activities of the state-owned enterprises (SOEs) affect the effectiveness of monetary and fiscal policy in China with a shadow banking sector. We develop a dynamic stochastic general equilibrium (DSGE) macroeconomic model with two production sectors, where the SOEs have access to low cost funds from the commercial banks (also mainly state-owned) and on-lend to the private sector in the form of entrusted loans. The Bayesian estimation results show that higher restrictions on bank credit push SOEs to engage in more shadow banking in this form which dampens the effectiveness of contractionary monetary policy. Expansionary fiscal policy increases output, but crowds out private investment, which can further drain the financial market and exert a detrimental effect on the Chinese economy.

KEYWORDS

Bayesian estimation, DSGE, entrusted loans, monetary policy, shadow banking, state-owned enterprises

JEL CLASSIFICATION

E32; E44; E52; G21

1 | INTRODUCTION

China's shadow banking has grown dramatically since the 2007–2009 financial crisis. Moody's estimation in 2017 shows that by the first half of 2016, the size of the shadow banking assets reached approximately 82% of Chinese GDP. The Chinese shadow banking system takes the form of credit intermediation involving entities and activities outside the regular banking system that serves to provide liquidity and credit transformation (People's Bank of China, hereinafter PBoC, 2013). It is "shadow" because it lacks a strong safety net and operates at a lower level of regulatory oversight, therefore, it could be a potential source of regulatory arbitrage and systemic risk. One of the core shadow banking activities in China is entrusted loans supplied by cash-rich companies to cash-strapped companies through a third party (usually a commercial bank). The total stock of entrusted loans in the first half of 2016 was estimated to be 2.1 trillion RMB, which accounted for the largest component of the Chinese shadow banking system and became the second after the rapid growth of wealth management products (WMPs)[1] later (Allen, Qian, Tu, & Yu, 2019).

The existence of a shadow banking system in China results from a segmented credit market due to an unbalanced economic structure and heavy bank regulations (Lu, Guo, Kao, & Fung, 2015). The state-owned enterprises (SOEs) are large companies of which at least half of the shares are owned by the Chinese government. Traditional banks favor SOEs for bank loans because the central government would bail out creditors in case of default (Allen, Qian, Zhang, & Zhao, 2012; Dang, Wang, & Yao, 2014; Song, Storesletten, & Zilibotti, 2011). In addition, as large commercial banks are state-owned themselves, managers at these banks are less likely to face strong censure for making nonperforming loans to SOEs. As a result, the SOEs have a preferential position in accessing bank credit (Hale & Long, 2011). In contrast, private-owned enterprises (POEs), especially small-and-medium-sized enterprises (SMEs), face severely restricted access to bank credit. One of the reasons is that these firms usually lack sophisticated accounting reporting system or proper risk assessment mechanism, making it difficult for banks to monitor and evaluate the performance and the underlying risks of their businesses (Lu et al., 2015).

Nevertheless, the funds obtained by the SOEs have not been used efficiently. For instance, the SOEs receive over 85% of loans but only contribute less than 40% of GDP (Tsai, 2015). Compared to POEs, SOEs suffer from low productivity and constitute most China's Zombie firms[2] (Han, You, & Nan, 2019). In order to offset their inefficiency and low productivity, SOEs have the incentive to participate in entrusted lending activities by using their privileged access to cheap funds to on-lend to POEs for higher returns, instead of investing in their own businesses. Allen et al. (2019) reveal that entrusted loans allow large SOEs to provide liquidity to credit-constrained POEs, especially the SMEs. They show that during the period 2004–2013, 73.8% of lenders who engaged in entrusted loans were SOEs.

Research in shadow banking of China has grown rapidly in recent years. Elliott, Kroeber, and Qiao (2015) and Ehlers, Kong, and Zhu (2018) provide a detailed review on the development, structure, size and potential risks of China's shadow banking sector. Lu et al. (2015) and Tsai (2017) document the heavy reliance of the SMEs on informal financing due to their limited access to formal credit. Wang, Wang, Wang, and Zhou (2018) develop a general equilibrium model of China's shadow banking from the perspective of dual-track interest rate liberalization. They argue that if credit misallocation persists

[1] Allen et al. (2019).

[2] Zombie firms refer to companies with low profitability that should declare bankruptcy but remain in the market because of the support from government or banks (Kane, 1987).

and low productivity of SOEs cannot be improved, full interest rate liberalization does not guarantee a Pareto improvement. Allen et al. (2019) use transaction-level analysis and find that the interest rates of nonaffiliated loans[3] indicate a market rate, while the rate of affiliated loans is closer to that of the bank loans.

How has the existence of a large shadow banking system affected fiscal and monetary policy? Recent literature suggests that the effectiveness of monetary policy is hampered because of the growing size of the largely unregulated shadow banking sector. Chen, Ren, and Zha (2018) claim that shadow bank lending increases in response to monetary policy tightening. Similarly, Gabrieli, Pilbeam, and Shi (2018) find that the shadow banking in China weakens the effects of restrictive interest rate-based monetary policy decisions. Bai, Hsieh, and Song (2016) document that the fiscal stimulus implemented by the Chinese government while relieving the impact of the Global Financial Crisis on the Chinese economy sowed the seeds for the expansion of the shadow banking sector. This paper expands along this vein. However, previous literature fails to pay enough attention to the role of SOEs in the Chinese shadow banking system. Our goal is to answer the following research questions: (a) Does the existence of the shadow banking system reduce the effectiveness of monetary policy in tightening credit constraints faced by SOEs? (b) Does an increase in government spending add to the conventional crowding out mechanism by worsening the credit conditions of POEs?

To this end, we construct a dynamic stochastic general equilibrium (DSGE) model allowing for the entrusted lending behavior of SOEs. The rest of our model is in the spirit of the "financial accelerator" literature, in which risky firms (POEs) borrow by using their net worth as collateral. However, different from the standard framework *á la* Bernanke, Gertler, and Gilchrist (1999), our model includes two production sectors (SOEs and POEs), where SOEs can borrow at the risk-free rate, but POEs need to pay a risk premium. Funke, Mihaylovski, and Zhu (2015) study the Chinese shadow banking and develop a DSGE framework with two separate banking systems, including traditional banks and shadow banks. We diverge from their approach in that the SOEs are the center and the dominant shadow banker in the entrusted lending business. Wang et al. (2018) include a competitive banking system with both WMPs and trust loans (shadow banking instruments) and focus on interest rate liberalization. By contrast, we treat SOEs-entrusted lenders as the "financial intermediaries" to POEs and study the effectiveness of the policies under this structure.

The model is then estimated using a Bayesian approach for the period 1995Q1–2015Q4. The impulse response functions show that a contractionary monetary policy exerts a greater negative impact on the output of POEs' than that of the SOEs. This is because the POEs are credit-constrained and are required to pay a risk premium to access funds. Instead, SOEs only pay the risk-free rate. When the credit market becomes tighter, external financial sources become more costly, which results in a higher risk premium and lower output. Furthermore, the effectiveness of the monetary policy is reduced since SOEs have an incentive to adjust the allocation between affiliated and nonaffiliated loans for a greater return. In other words, SOEs act as a buffer between the monetary policy and POEs.

Moreover, our paper also incorporates the transmission mechanism of fiscal policy to address the second research question, given the vital role of government spending in the Chinese economy (Chen, Minford, Tian, & Peng, 2017). Our results show that although government spending immediately stimulates the economy, it can also crowd out private capital investment in the POE sector, which further restricts the financial market and results in a higher risk premium. Due to limited capital

[3]The main difference between affiliated and nonaffiliated loans is the interest rate. Specifically, the interest rate on affiliated loans is lower since lending from the parent company to a subsidiary is less risky. Thus, the lending rate charged by the parent SOEs is set equal to the risk-free rate of bank loans.

investment and capital inputs, the only way for POEs to maintain business is incurring additional costs to hire more labor.[4]

This study contributes to the literature in two ways. First, we provide an empirically estimated model of the Chinese economy with entrusted loans. This feature digs into the operational details of how shadow banking works in China, so our model is featured with greater realism compared to the pure theoretical models in the literature. Second, we provide a novel interpretation of the economic slowdown in the recent decade in China from the policymakers' perspective. During the period 2009–2015, the PBoC implemented contractionary monetary policies to prevent a credit-based overheating of the economy. However, our model shows that tighter credit restriction drives the SOEs to engage in more nonaffiliated loans (entrusted lending to POEs) business, which dampens the effectiveness of the tightened monetary policy. At the meantime, after the 2008 financial crisis, the Chinese government injected a "four-trillion RMB" package to stimulate the economy in the form of fiscal policy and infrastructure investment. Our model implies that the temporary increase in government spending can further restrict the credit resources available to the POEs, which, in turn, exerts a postcrisis detrimental effect on the overall economy in the long run.

The remainder of the paper is organized as follows. Section 2 presents the DSGE framework. In Section 3, we estimate the model by Bayesian methods and illustrate the dynamic properties of the model. Section 4 elaborates on the historical shock decompositions of output and total investment. Section 5 concludes.

2 | THE MODEL

The spirit of our framework is the financial accelerator model proposed by Bernanke et al. (1999). Entrusted loans enter in our model through the SOE sector. There are two intermediate goods producers, which includes SOE producing branches and POEs, which require external finance to invest in capital. SOEs obtain bank loans from commercial banks at the safe rate of interest and determine the allocation of affiliated and nonaffiliated loans in each period. The model features nominal price rigidity and capital adjustment costs. There are seven structural shocks: a reserve ratio shock, a monetary policy shock, a government spending shock, two TFP shocks and two investment-specific technology shocks in both SOE and POE sectors.

2.1 | Households

There is a continuum of households indexed by l, who maximize lifetime utility which is separable in the current level of real consumption, $C_{l,t}$, and leisure, $\left(1-N_{l,t}\right)$:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln\left(C_{l,t}\right)+\ln\left(1-N_{l,t}\right)\right] \tag{1}$$

[4]Government spending crowds out private investment, which results in a lower level of capital inputs in the POEs production phase. However, positive fiscal policy temporarily increases the output (both in SOEs and POEs sectors), with less capital inputs, the only way to increase the output in POEs is to increase the other inputs in the Cobb–Douglas production function—i.e. labor inputs.

where E_0 is the rational expectations operator, $\beta \in (0, 1)$ is the discount factor and $N_{l,t}$ is the hours worked. The l-th household faces an inter-temporal budget constraint in each period,

$$C_{l,t} + D_{l,t} \leq w_{l,t} N_{l,t} + R^D_{t-1} \frac{D_{l,t-1}}{\pi_t} - T_t + \Pi^{\text{Retail}}_t \tag{2}$$

where $D_{l,t}$ is the level of real financial wealth in the form of real bank deposits with a riskless gross rate of return R^D_t. π_t is the inflation rate and $w_{l,t}$ is the real wage. Households receive the interest payment of their deposits from the previous period and the real profit from the final goods producers Π^{Retail}_t. Furthermore, households pay the real lump-sum transfer tax T_t every period. To save on notation, we drop the index l on Π^{Retail}_t and T_t as the optimal conditions are the same across different households.

2.2 | Commercial banks

We assume commercial banks collect deposits from households at the real deposit rate R^D_t and make loans to SOE-entrusted lenders at the real risk-free lending rate R^L_t, and satisfies the following profit function,

$$\pi^{CB}_t = B_t R^L_t - D_t R^D_t \tag{3}$$

where B_t is the total loan amount. To motivate a nontrivial but simple banking sector, we impose the reserve requirement of a constant ratio,[5] τ, imposed by the regulators; therefore, only a proportion of the total deposits,

$$B_t = \left(1 - \tau e^{\varepsilon^\tau_t}\right) D_t \tag{4}$$

where $e^{\varepsilon^\tau_t}$ is an exogenous reserve ratio shock and ε^τ_t follows an AR (1) process.

2.3 | SOEs entrusted lenders

Although SOE-based entrusted lenders can be in the production sector, the main purpose of this paper is to understand their entrusted lending behavior; therefore, for model convenience, we focus on the resource allocation of SOEs-entrusted lenders in this section and leave the producing behavior to their subsidiaries, denoted as SOEs.

In each period, the representative SOE-based entrusted lender borrows from commercial banks and choose the number of affiliated loans to an SOE, indexed by j, and the nonaffiliated loans to a POE, indexed by i. Recalling that the differences between the two types of loans are the underlying risks and the interest rates, the SOEs charge the risk-free rate to their subsidiaries, but require a higher rate on the nonaffiliated loans to the POEs. POEs are fraught with risk because their return to capital investment is subject to the idiosyncratic shock ω^i, which is a random variable assumed to be log-normally distributed and i.i.d. across time and firms, with $E\left(\omega^i\right) = 1$,

$$\log(\omega) \sim N\left(-\frac{1}{2}\sigma^2_\omega, \sigma^2_\omega\right) \tag{5}$$

[5]A higher reserve ratio implies a tighter bank credit regulation.

At the end of period t, the amount of nonaffiliated loans to POE i, $B_{i,t+1}^{\mathrm{POE}}$, is determined by the difference between the expenditure on physical capital and the POEs' net worth,

$$B_{i,t+1}^{\mathrm{POE}} = Q_t^{\mathrm{POE}} K_{i,t+1}^{\mathrm{POE}} - Net_{i,t+1} \tag{6}$$

where Q_t^{POE} is the price paid per unit of capital in period t, $K_{i,t+1}^{\mathrm{POE}}$ is the quantity of capital purchased and Net_{t+1} is the net worth accumulated by the survivor POEs. The amount of the affiliated loans to SOEs follows a similar condition,

$$B_{j,t+1}^{\mathrm{SOE}} = Q_t^{\mathrm{SOE}} K_{j,t+1}^{\mathrm{SOE}} \tag{7}$$

where $B_{j,t+1}^{\mathrm{SOE}}$ is the amount of the affiliated loans and is determined by the expenditure on capital $Q_t^{\mathrm{SOE}} K_{j,t+1}^{\mathrm{SOE}}$. SOEs are different from POEs because they can obtain funds easily from their parent company without friction which do not require using net worth as collateral.

SOE-based entrusted lenders that act as a financial intermediary to SOEs and POEs face an opportunity cost of funds between t and $t + 1$, which equals to the risk-free rate, R_{t+1}^{L}. The idiosyncratic risk involved in lending is perfectly diversified in equilibrium in our model; thus, the optimal contract arrangement is determined by the following equation,

$$\left[1 - F\left(\overline{\omega}^i\right)\right] R_{t+1}^{NA} B_{i,t+1}^{\mathrm{POE}} + (1-\mu) \int_0^{\overline{\omega}} \omega^i R_{t+1}^{K} Q_t^{\mathrm{POE}} K_{i,t+1}^{\mathrm{POE}} dF(\omega) + R_{t+1}^{L} B_{j,t+1}^{\mathrm{SOE}} = R_{t+1}^{L} \left(B_{i,t+1}^{\mathrm{POE}} + B_{j,t+1}^{\mathrm{SOE}}\right) \tag{8}$$

which implies that the total expected return on both nonaffiliated and affiliated loans equals the opportunity costs of the total funds.[6] The first item on the left-hand side of the equation implies the yield on the non-defaulted loans to POEs. $F\left(\overline{\omega}^i\right)$ is the default probability with a continuous and once-differentiable CDF function. R_{t+1}^{NA} is the contractual rate on the nonaffiliated loans. The POE can repay the loan if the idiosyncratic shock is higher or equal to the threshold, $\overline{\omega}^i$. That is, $\overline{\omega}^i$ is defined by,

$$\overline{\omega}^i R_{t+1}^{K} Q_t^{\mathrm{POE}} K_{i,t+1}^{\mathrm{POE}} = R_{t+1}^{NA} B_{i,t+1}^{\mathrm{POE}} \tag{9}$$

when $\omega^i \geq \overline{\omega}^i$, the POE repays the promised amount $R_{t+1}^{NA} B_{i,t+1}^{\mathrm{POE}}$ and keeps the difference, i.e., $\omega^i R_{t+1}^{K} Q_t^{\mathrm{POE}} K_{i,t+1}^{\mathrm{POE}} - R_{t+1}^{NA} B_{i,t+1}^{\mathrm{POE}} = \left(\omega^i - \overline{\omega}^i\right) R_{t+1}^{K} Q_t^{\mathrm{POE}} K_{i,t+1}^{\mathrm{POE}}$. It declares itself bankrupt and exits the market if $\omega^i < \overline{\omega}^i$. The second item thus implies that the value left in the account of the bankrupt POE subject to a monitoring cost,[7] is μ. The idea here is that the SOE-based entrusted lender needs to pay an extra cost to observe the borrower's realized return on capital, i.e., the monitoring cost equals $\mu \int_0^{\overline{\omega}} \omega^i R_{t+1}^{K} Q_t^{\mathrm{POE}} K_{i,t+1}^{\mathrm{POE}}$, in which R_{t+1}^{k} indicates the capital return. Equation (8) indicates that SOE-entrusted lenders hold a perfectly safe portfolio where the expected rate of return equals the safe rate of return.

[6]The total funds of SOE-entrusted lenders, B_t, are obtained from the commercial banks, which equals $B_{t+1}^{\mathrm{POE}} + B_{t+1}^{\mathrm{SPB}}$ aggregately.

[7]This is the so-called 'costly state verification' (CSV), and there are several important contributions in business cycle literatures that incorporate with CSV, such as Townsend (1979), Williamson (1987), Carlstrom and Fuerst (1997), Fisher (1999), Christiano, Motto, and Rostagno (2004), Arellano, Bai, and Kehoe (2012) and Jermann and Quadrini (2012).

By substituting (10) into (9), we obtain the risk premium, denoted as s_t, of the nonaffiliated loan contract, which is a critical link between capital expenditure and financial conditions,

$$s_t = E_t\left(\frac{R^K_{t+1}}{R^L_{t+1}}\right) = \frac{1 - Net_t / Q^{\mathrm{POE}}_t K^{\mathrm{POE}}_{t+1}}{\Gamma\left(\overline{\omega}\right) - \mu G\left(\overline{\omega}\right)} \tag{10}$$

where $G\left(\overline{\omega}\right) = \int_0^{\overline{\omega}} \omega dF(\omega)$, $\Gamma\left(\overline{\omega}\right) = \left[\int_{\overline{\omega}}^{\infty} \overline{\omega} dF(\omega)\right] + G(\omega)$ and $\Gamma\left(\overline{\omega}\right) - \mu G\left(\overline{\omega}\right)$ implies the net share of capital return goes to the SOE-entrusted lenders and $1 - Net_t / Q^{\mathrm{POE}}_t K^{\mathrm{POE}}_{t+1}$ indicates the firm's leverage ratio. The risk premium is a number larger than unity, which is negatively related to the net worth. Intuitively, this implies that the higher the net worth, the lower the risk premium.

2.4 | Private-owned enterprises

We first determine the net worth accumulation of the POEs. In each period, POEs face a survival rate,[8] γ, therefore, $(1-\gamma)$ POEs exit the market. Let V_t be equity in period t, then, the aggregate net worth in period $t+1$, Net_{t+1} is given by,

$$Net_{t+1} = \gamma V_t \tag{11}$$

with

$$V_t = R^K_t Q^{\mathrm{POE}}_{t-1} K^{\mathrm{POE}}_t - \left[R^L_t + \frac{\mu \int_0^{\overline{\omega}} \omega R^K_t Q^{\mathrm{POE}}_{t-1} K^{\mathrm{POE}}_t dF(\omega)}{B^{\mathrm{POE}}_t}\right] B^{\mathrm{POE}}_t \tag{12}$$

where γV_t is the equity held by entrepreneurs at t–1 who are still in business at t. Entrepreneurial equity V_t equals gross earnings of capital investment, $R^K_t Q^{\mathrm{POE}}_{t-1} K^{\mathrm{POE}}_t$, on holdings of equity from t–1 to t, less repayment of borrowings (repayment of the loans, $R^L_t B^{\mathrm{POE}}_t$ plus the risk premium). The ratio of defaults costs to quantity borrowed reflects the premium for external finance,

$$\frac{\mu \int_0^{\overline{\omega}} \omega R^K_t Q^{\mathrm{POE}}_{t-1} K^{\mathrm{POE}}_t dF(\omega)}{Q^{\mathrm{POE}}_{t-1} K^{\mathrm{POE}}_t - Net_t} \tag{13}$$

Turning to the production phase, POEs borrow money from SOE-based entrusted lenders and purchase capital in period t for use in the following period $t+1$. Capital and hired labor are used to produce intermediate goods, $Y^{\mathrm{POE}}_{i,t+1}$, from a Cobb–Douglas production function,

$$Y^{\mathrm{POE}}_{i,t+1} = A^{\mathrm{POE}}_{t+1} \left(K^{\mathrm{POE}}_{i,t+1}\right)^{\alpha_1} \left(N^{\mathrm{POE}}_{i,t+1}\right)^{(1-\alpha_1)} \tag{14}$$

[8]This assumption is to rule out the case that one SME may accumulate net worth sufficiently in the future and never require borrowing from the financial intermediary. Empirically, it is well accepted that substantial number of start-ups firms end in failure and this is a common situation globally, e.g., Hall and Woodward (2010) investigate the extreme cross-sectional dispersion in entrepreneurs' payoffs.

where A_{t+1}^{POE} is an exogenous TFP shock in the POE sector.

$K_{i,t+1}^{\mathrm{POE}}$ is the amount of capital purchased by the POE in period t, $N_{i,t+1}^{\mathrm{POE}}$ is the labor demand and α_1 is the income share of capital. POEs maximize profit by selling intermediate goods to the final goods producers, paying the wage and interests on the loans. At the end of each period, they sell back the non-depreciated capital to the capital goods producers.[9] We will discuss the final goods producer sector and capital goods producers in the following sections. The expected gross return to holding one unit of capital is derived as,

$$E_t\left(R_{t+1}^K\right) = \frac{\mathrm{MPK}_{i,t+1}^{\mathrm{POE}} + Q_{t+1}^{\mathrm{POE}}\left(1-\delta^{\mathrm{POE}}\right)}{Q_t^{\mathrm{POE}}} \tag{15}$$

where $\mathrm{MPK}_{t+1}^{\mathrm{POE}}$ represents the marginal product of capital[10] in the POE's sector and δ^{POE} is the depreciation rate.

2.5 | State-owned enterprises

In each period t, the SOE j purchases physical capital by borrowing money from their parent company at the risk-free rate R_{t+1}^L. Combining capital, $K_{j,t+1}^{\mathrm{SOE}}$ with the hired labor, $N_{j,t+1}^{\mathrm{SOE}}$, in period $t+1$, SOE produces intermediate output and resell the non-depreciated capital back to the capital good producers. The Cobb–Douglas production function is specified as,

$$Y_{j,t+1}^{\mathrm{SOE}} = A_{t+1}^{\mathrm{SOE}}\left(K_{j,t+1}^{\mathrm{SOE}}\right)^{\alpha_2}\left(N_{j,t+1}^{\mathrm{SOE}}\right)^{(1-\alpha_2)} \tag{16}$$

where A_{t+1}^{SOE} is the exogenous technology shock, which is the same across all SOEs, and it follows an AR (1) process.

α_2 is the income share of capital in SOES' sector. The gross return of capital can be written as,

$$R_{t+1}^L = \frac{MPK_{j,t+1}^{\mathrm{SOE}} + Q_{t+1}^{\mathrm{SOE}}\left(1-\delta^{\mathrm{SOE}}\right)}{Q_t^{\mathrm{SOE}}} \tag{17}$$

where $MPK_{j,t+1}^{\mathrm{SOE}}$ is the marginal product of capital in the SOE's sector and δ^{SOE} is the depreciation rate. We can see from the gross capital return in the POEs sector, Equation (15), when capital inputs are homogeneous across sectors, the marginal product of capital of private firms is clearly higher than that of state firms as $R_{t+1}^K > R_{t+1}^L$. Intuitively, this implies a higher efficiency in the credit-constrained firms.

[9]There is a representative capital goods producer who purchases raw output as materials inputs, I_t, and produce new capital goods for both SOEs and POEs by using the following capital accumulation technologies,
$K_t = \left[I_t - \frac{\phi_K}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}\right] + (1-\delta)K_{t-1}$. Where ϕ_K is the parameter for adjustment cost. The new capital goods are sold at price Q, where the Tobin's Q is described by, $\frac{1}{Q} = \left[1 - \phi_K\left(\frac{I_t}{K_{t-1}} - \delta\right)\right]$. Total investment and capital imputs are $I_t = I_t^{\mathrm{SOE}} + I_t^{\mathrm{POE}}$ and $K_t = K_t^{\mathrm{SOE}} + K_t^{\mathrm{POE}}$.

[10]$MPK = \frac{1}{X}\frac{\alpha Y}{K}$ here X is the relative price of the intermediate wholesale goods.

2.6 | Government sector and monetary policy

We specify the government budget constraint by assuming that government spending is financed by households' tax payment,

$$G_t = T_t \tag{18}$$

which follows an AR (1) process.

The central bank implements monetary policy according to a Taylor rule as in Dai, Minford, and Zhou (2015) for the Chinese economy,

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_m} \left[\left(\frac{\Pi_t}{\Pi}\right)^{a_\pi} \left(\frac{Y_t}{Y}\right)^{a_y}\right]^{1-\rho_m} \varepsilon_t^m \tag{19}$$

where R_t, Π_t are the nominal interest rate and inflation rate, respectively. The parameter ρ_m captures the degree of interest rate smoothing, a_π and a_y are the elasticities of the policy target with respect to inflation and output gap. ε_t^m is a random shock to the nominal interest rate.

2.7 | Final good producers: Retailers

To incorporate sticky prices in the model, we introduce a unit mass of monopolistic competitive retailers. They purchase intermediate wholesale goods from POEs and SOEs at a price P_t^W, and bundle them into the homogeneous final products. Let $Y_{z,t}$ be the quantity of output sold by a retailer z, measured in units of wholesale goods, then, the total final usable goods, Y_t, are the following composite of individual retail goods,

$$Y_t = \left[\int_0^1 \left(Y_{z,t}\right)^{\frac{\varepsilon-1}{\varepsilon}} dz\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{20}$$

where $\varepsilon > 1$ is the elasticity of substitution among different types of intermediate goods that captures the markup to the intermediate goods' prices. The wholesale output, $Y_{z,t}$, is composed of sectoral output according to,

$$Y_{z,t} = \left[a\left(Y_{i,t}^{\text{POE}}\right)^{\rho} + (1-a)\left(Y_{j,t}^{\text{SOE}}\right)^{\rho}\right]^{\frac{1}{\rho}} \tag{21}$$

where a implies the weight of using POEs goods in bundling the final goods and ρ is the substitutability between two types of intermediate goods. Final output can be transformed into consumption goods purchased by households, capital goods purchased by producers and government at the price P_t. Variation in resources devoted to reserve requirements and monitoring cost also matter in principle. In particular, the aggregate resource constraint is given by,

$$Y_t = C_t + I_t + G_t + \tau D_t + \mu \int_0^{\varpi} \omega R_t^K Q_{t-1}^{\text{POE}} K_t^{\text{POE}} dF(\omega) \tag{22}$$

where τD_t and $\mu \int_0^{\overline{\omega}} \omega R_t^K Q_{t-1}^{\text{POE}} K_t^{\text{POE}} dF(\omega)$ reflect the reserves deducted from commercial banks and aggregate monitoring costs, respectively.

Following the Calvo (1983) price setting behavior, we introduce a sticky price in the retail sector. With probability $(1-\theta)$, a given retailer is assumed to be able to reset its price (P_t^*) at period t. Incorporating price rigidity, we have the log-linearized[11] New Keynesian Phillips Curve,

$$\tilde{x}_t = \beta E_t \tilde{x}_{t+1} + \frac{(1-\theta)(1-\theta\beta)}{\theta}\left(-\tilde{x}_t\right) \tag{23}$$

3 | EMPIRICAL ANALYSIS

In the empirical analysis, we estimate our model with China's quarterly data by Bayesian methods. Based on the estimation results, we investigate the implications of impulse responses.

3.1 | Data

The sample period for the estimation is 1992Q1–2015Q4. We use eight observable macroeconomic variables as there are eight structural shocks in the model. We use five common macroeconomic variables; GDP, consumption, investment, labor and inflation and three variables of our interest[12]; risk premium, capital investment return in POEs' sector and SOEs output in real term. The sources of GDP, consumption, inflation and labor are from Datastream.[13] All the data are seasonally adjusted, and nominal variables are converted to real terms by using the consumer price index. We then take natural logarithm of real GDP, real consumption, real investment, real SOEs' output and labor and multiply by 100.[14]

3.2 | Calibrated parameters

We first calibrate some parameters that are difficult to identify from the data (Table 1). The values we choose are consistent with the extant literature of the Chinese economy. The discount factor β is set to be 0.99, which can be used to pin down the steady-state quarterly real deposit rate of 0.01 or 4% expressed at an annual frequency. The steady-state reserve ratio is set as 0.15, which is the average value of the reserve ratio in China between 1995 and 2015. We choose the quarterly depreciation rate as 0.035 to be consistent with the literature, which implies an annual rate of 14% (Li & Liu, 2017). We take the steady-state government spending to total output, G/Y, to be 0.14, which is the historical average of nominal spending over nominal GDP ratios between 1995 and 2015. There is no literature for the parameters regarding the CES aggregator in the retailers' sector, therefore, we choose the weight parameter $a = 0.5$, which implies the final goods producers have no preference between POEs and SOEs intermediate goods, and the substitutability of the goods ρ is set to be 0.95. The value of the survival ratio is calibrated as 0.97 (Zhuang, Shu, & Fu, 2018). The risk spread, $R^K - R^L$, is set equal to four hundred basis points, which is the average value of the risk premium in our data. We

[11]Detailed log-linearised model equations are listed in Appendix A.

[12]We consider these observed variables because the SOEs' lending activities to POEs are central to this paper.

[13]The codes of the variables are provided in the appendix.

[14]This converts levels to percentage deviations from trends.

TABLE 1 Calibrated parameters

Parameters	Values	Definitions
β	0.99	Discount factor
τ	0.15	Reserve ratio in steady state
δ^{POE}	0.035	Quarterly depreciation rate in POEs' sector
δ^{SOE}	0.035	Quarterly depreciation rate in SOEs' sector
G/Y	0.14	Government spending to GDP ratio
a	0.5	Weight parameter in retailers' CES aggregator
ρ	0.95	Substitutability parameter in retailers' CES aggregator
γ	0.97	Quarterly survival ratio in steady state
R^K–R^L	0.04	Quarterly risk premium in steady state
μ	0.20	Monitoring cost in steady state

set a higher value of realized payoffs lost in bankruptcy, μ equals 0.2 (Carlstrom & Fuerst, 1997), as previous literature provides no relevant information about the magnitude of the parameter value in the Chinese market.

3.3 | Estimated parameters and priors

We estimate the rest of the parameters by using Bayesian methods in *Dynare*. The prior densities, means and standard deviations are shown in Table 2. We follow most of the literature to set the priors in order to capture the main features of the Chinese economy. The serial correlation parameters of the shock processes (ρ^{τ}, ρ_a^{POE}, ρ_a^{SPB}, ρ_k^{POE}, ρ_k^{SPB}, ρ^s and ρ^G) all follow Beta distributions with mean 0.5, and standard deviations 0.2. All the standard errors of the innovations are assumed to have Inverse-gamma distribution with a mean of 0.1 and degree of freedom 2, which implies an infinite standard deviation (Li & Liu, 2017).

The prior of the parameter that determines nominal price rigidity, θ, follows a Beta density with mean 0.5 and standard deviation 0.2, which is different from Li and Liu (2017)[15] and implies the expected duration between price changes is about two quarters.[16] Chinese research, such as Liu (2008) and Li and Liu (2017) calibrate the capital share in the Cobb–Douglas function since they only have one intermediate goods producer. As different levels of capital intensity may be observed between two producing sectors, we differ from their approach and choose to estimate these parameters. The priors of α_1 and α_2 are Beta (0.4, 0.10) and Beta (0.5, 0.10), the capital share in SOEs is set to be 0.50 to reflect a higher level of capital intensity in the state sector. Our model uses the same investment adjustment cost function as with Bernanke et al. (1999), therefore, we follow their assumption to set the prior means for ϕ_K^{POE} and ϕ_K^{SPB} as 0.25 and allow wide variation in estimating these values by setting the standard deviation as 1.5. As for the monetary policy rule, the parameters ρ_m, a_π, a_y are all conventional with one exception that the prior mean of a_y is set to be 0.5, indicating a higher reaction on output stabilization in China (Funke et al., 2015).

[15]In their paper, Li and Liu (2017), the prior they use for this parameter suffers unbounded density in Dynare (Beta density with mean 0.5 and standard deviation 0.1).

[16]Bils and Klenow (2004) find the duration is between 6 months and 1 year. We choose two quarters, which suggests that $\theta =$ 0.5.

TABLE 2 Prior distributions

Parameters	Prior density	Prior mean	Prior standard deviation
α_1	Beta	0.4	0.10
α_2	Beta	0.5	0.10
θ	Beta	0.5	0.20
ϕ_K^{POE}	Normal	0.25	1.5
ϕ_K^{SOE}	Normal	0.25	1.5
a_π	Normal	1.5	0.15
a_y	Normal	0.5	0.05
ρ_m	Beta	0.5	0.20
ρ^τ	Beta	0.5	0.20
ρ_a^{POE}	Beta	0.5	0.20
ρ_a^{SOE}	Beta	0.5	0.20
ρ_k^{POE}	Beta	0.5	0.20
ρ_k^{SOE}	Beta	0.5	0.20
ρ^s	Beta	0.5	0.20
ρ^G	Beta	0.5	0.20
σ^m	Inverse-Gamma	0.1	2
σ^τ	Inverse-Gamma	0.1	2
σ_a^{POE}	Inverse-Gamma	0.1	2
σ_a^{SOE}	Inverse-Gamma	0.1	2
σ_k^{POE}	Inverse-Gamma	0.1	2
σ_k^{SOE}	Inverse-Gamma	0.1	2
σ^s	Inverse-Gamma	0.1	2
σ^G	Inverse-Gamma	0.1	2

3.4 | Posterior estimates

Posterior distributions are listed in Table 3. The capital shares in the POE and SOE sectors are estimated to be 0.4236 and 0.4519, indicating a higher level of capital intensity in the state sector. Our estimates favor a strong rigidity in nominal price setting ($\theta = 0.8256$), which is close to 0.84 in Zhang (2009). In terms of the monetary policy function, the mean of the coefficient on the lagged interest rate is estimated to be less persistent, 0.5283, and the mean of the long-run reaction to inflation is 1.2248, which is lower than the prior, 1.5. While the reaction to the output gap is slightly higher with a mean value of 0.5256. This is consistent with the accepted belief that the PBoC assigns a higher weight to stabilizing output. The parameters of the adjustment costs are estimated to be lower than the prior mean with the values of 0.1700 (ϕ_K^{POE}) and 0.2030 (ϕ_K^{SPB}).

Regarding the parameters of the exogenous shock processes, we find that the investment shock in the POE sector, productivity shocks in the state sector and risk premium shock are estimated to be the most persistent with mean values of coefficients of 0.9837, 0.7032 and 0.7604, respectively. The productivity shock in the private sector has a relative lower persistence with an AR (1) coefficient of

TABLE 3 Posterior distributions

Parameters	Posterior mean	Posterior standard deviation
α_1	0.4236	0.0031
α_2	0.4519	0.0029
θ	0.8256	0.0125
ϕ_K^{POE}	0.1700	0.0073
ϕ_K^{SOE}	0.2030	0.0018
a_π	1.2248	0.0079
a_y	0.5256	0.0027
ρ_m	0.5283	0.0024
ρ^τ	0.5526	0.0064
ρ_a^{POE}	0.5457	0.0088
ρ_a^{SOE}	0.7032	0.0097
ρ_k^{POE}	0.9837	0.0030
ρ_k^{SOE}	0.6010	0.0025
ρ^s	0.7604	0.0144
ρ^G	0.4835	0.0051
σ^m	0.8619	0.0457
σ^τ	4.6991	0.1339
σ_a^{POE}	3.6357	0.1827
σ_a^{SOE}	2.3407	0.1154
σ_k^{POE}	5.7795	0.1135
σ_k^{SOE}	2.6479	0.0625
σ^s	2.7604	0.0758
σ^G	4.2909	0.0820

0.5457. The posterior means of the government spending shock is 0.4835, the investment shock in SOEs is 0.6010 and the reserve ratio shock is 0.5526, which also has low persistence.

3.5 | Nowcasting output, consumption, investment and inflation

Before any macroeconomic model can be used in business cycle analysis, it can be argued that it must satisfy the most basic of validation conditions of being able to track the past. While forecasting is not the objective, in this section, we examine the empirical validity of the model by conducting an in-sample tracking exercise. [17] We implement nowcasting on the chosen macroeconomic variables, GDP, consumption, investment and inflation rate. The dashed lines depict the mean estimate of the filtered endogenous variables, which implies the model fit for the variables at the estimated periods between 1992Q1 and 2015Q4 (96 quarterly periods) given information up to period t–1. The black lines are the filtered raw data. While the model nowcast misses the amplitude of the variables and in

[17]For a full discussion of forecasting with a DSGE model see Del Negro and Schorfheide (2013).

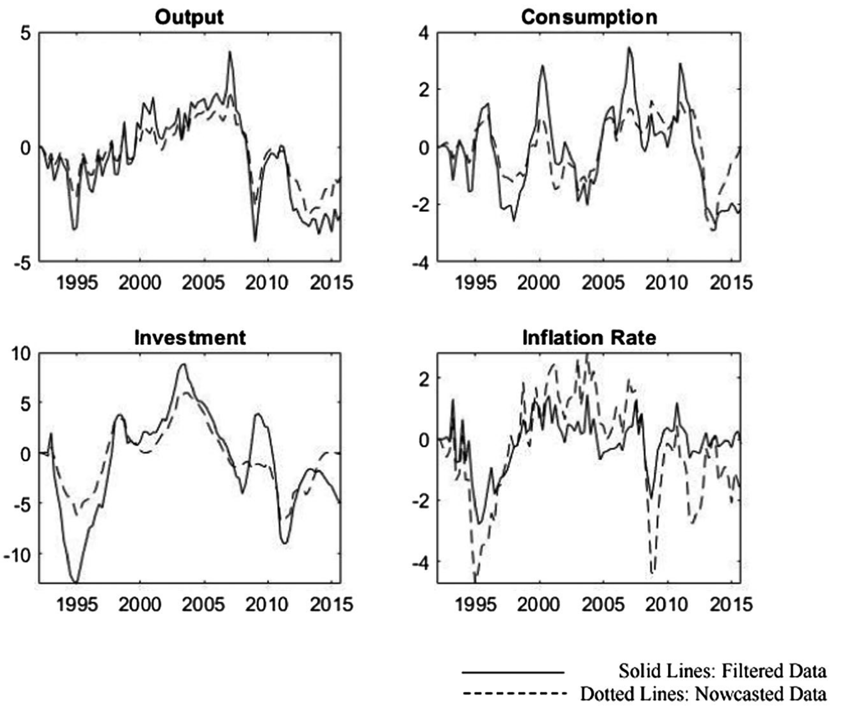

FIGURE 1 Nowcasting versus data 1992Q1–2015Q4. ——— Solid Lines: Filtered data. ------- Dotted Lines: Nowcasted data

TABLE 4 Nowcasting versus random walk 1992Q1–2015Q4

	Mean of residuals %		Absolute mean of residuals %		Root mean square error %	
	Nowcasting	Random walk	Nowcasting	Random walk	Nowcasting	Random walk
Y	−0.1637	−0.0394	0.6278	0.6528	0.7591	0.8543
C	−0.0948	−0.0136	0.6771	0.5661	0.8498	0.7164
π	−0.2324	−0.0108	0.9627	0.5412	1.1692	0.7666
I	−0.4410	−0.0307	2.0973	1.0541	2.7210	1.2970

some cases, spectacularly, the phase and turning points are captured reasonably for the estimated periods (Figure 1).

Table 4 displays the one-step ahead prediction using our model as a benchmark against the “ignorance” model of a random walk.

Table 4 records a mixed picture of the model performance in the historic tracking exercise. The model is superior to the random walk prediction for GDP but performs poorly in inflation and investment. The nowcast errors are picking up the few instances of spectacular underpredictions shown in Figure 1.

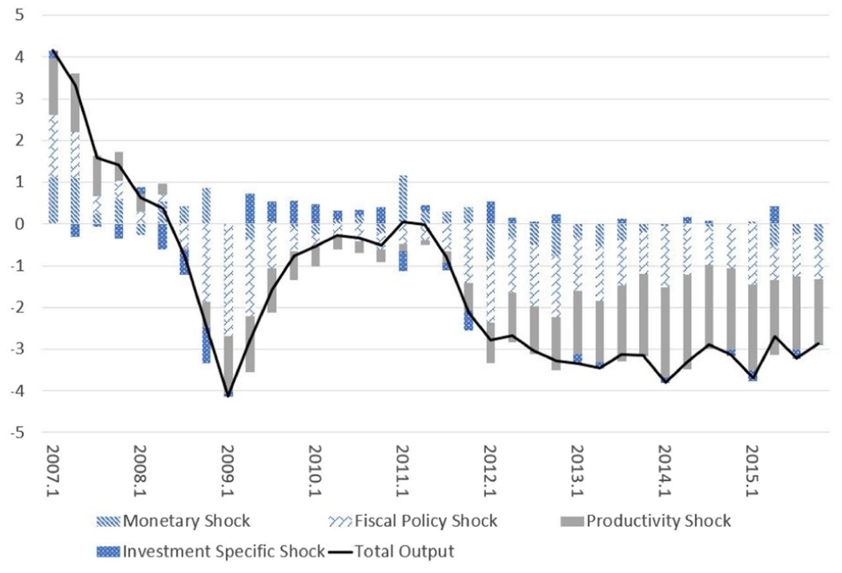

FIGURE 2 Historical shock decomposition of output

3.6 | Historical decomposition

Before moving to an analysis of macroeconomic policy with this model, a valid question is to ask how empirically important are the shocks that drive it? We conduct a shock decomposition for the period immediately prior to the Global Financial Crisis and the period following. Figure 2 shows the historical shock decomposition for GDP from 2007Q1 to 2015Q4. Monetary shocks are the sum of interest rate shocks, reserve ratio shocks and shocks to the risk premium. Productivity shocks are the sum of shocks to the SOE and POE sectors. Investment shocks are the sum of shocks to investment in the SOE and POE sectors, and the fiscal policy shock is the shock to government spending.

Figure 2 shows that monetary policy was counter-cyclical with the peak in 2007, and trough of 2009. However, while monetary policy played a significant role in this period, its impact was small compared with fiscal policy and productivity shock. The risk premium shock which shows the influence of the shadow banking system in this model amounted to about 30% of the monetary shocks. Certainly, monetary policy shocks helped to pull the economy out of the growth slowdown it experienced in 2009, but output fluctuations are largely driven by fiscal policy and productivity shocks[18] post-2011.

3.7 | Credit allocation of with different level of bank credit tightness

To explain the effect of bank credit tightness on the decision of the SOE-entrusted lenders' credit allocation, we run experiments under different levels of reserve ratio but keep everything else the same. The higher value of the reserve ratio implies a tighter level of bank credit regulation.

Table 5 shows the steady-state values of the total quantity of bank loans to GDP ratio (B/Y), the share of the affiliated loans in the total credit, B^{SOE}/B and the ratio of nonaffiliated loans to total, B^{POE}/B. The steady-state value of bank loans to GDP ratio decreases from 171% to 78% when the

[18]The dominance of productivity shocks in DSGE models accords with the mainstream finding for China. See Le, Matthews, Meenagh, Minford, and Xiao (2014).

TABLE 5 Bank credit tightness

	$\tau = 0.05$	$\tau = 0.10$	$\tau = 0.15$
B/Y	171%	109%	78%
B^{SOE}/B	83%	81%	80%
B^{POE}/B	17%	19%	20%

reserve ratio increases from 5% to 15%, permanently. However, the proportion of nonaffiliated loans to POEs increases from 17% to 20%. The finding from our model indicates that tighter bank, while reducing overall credit availability increases SOE engagement in more lending to POEs, partially muting the effect of tighter regulation on POEs.

4 | MONETARY AND FISCAL POLICY

4.1 | The Effectiveness of the monetary policy

Chinese GDP growth rate fell from 14% in 2007 to 9.6% in the fourth quarter of 2008 due to the Global Financial Crisis. To combat the pressure of the economic downturn, the PBoC engineered a loose monetary policy, which included lower interest rates in 2009. In the same period, the central government announced a "four-trillion" stimulation package that injected multitrillion RMBs into the Chinese market. In 2010, the economy bounced back to 10% GDP growth rate.

To prevent the potential overheated market, by the end of 2009, the PBoC reversed its policy and conducted a contractionary monetary policy with the aim of tightening the credit supply. The standard transmission of monetary policy through interest rate mechanisms indicates a tighter monetary policy leading to a rise in real interest rates, which in turn increases the cost of borrowing, thus causing a decline in credit supply and capital investment and resulting in a fall in output. Since our model contains two types of producing sectors and SOEs' entrusted lending behavior, the questions we want to find out are (a) which production sector is affected more by the tightened policy? (b) whether the effectiveness of monetary policy is dampened due to the entrusted lending to POEs?

Figure 3 shows the impulse responses of a temporary monetary policy shock. As can be seen, a tighter monetary policy exerts a more negative impact on POEs' output compared to that of SOEs. A one standard deviation temporary shock in the nominal interest rate decreases POEs output by 0.36% and SOEs output by 0.31% in Panel A. A higher interest rate increases the cost of borrowing in both sectors that causes a decline in credit supply. Fewer bank loans to the state sector decreases output. With the private sector the downturn is augmented by the "financial accelerator" effect (Bernanke et al., 1999). A lower net worth in the credit-constrained companies that POEs have less collateral for their loans and become riskier. This can be shown in Panel D, POEs net worth decreases approximately 7%. Hence, to compensate a higher default probability, SOE-entrusted lenders charge a higher risk premium (Panel B), which further discourages the borrowing and investment spending.

To understand the effectiveness of monetary policy, we impose the same monetary policy shock under two different scenarios; a high and a low default probability. Figure 4 shows that the effectiveness of the policy is dampened when the default probability is higher. The contraction in output by the POEs is greater as the risk premium rises to compensate for the marginal higher risk. From the perspective of the SOE-entrusted lenders who are risk neutral, the higher return increases their incentive to engage in more nonaffiliated loans to POEs. The overall impact on POEs' output is still negative, but the magnitude is smaller when the default risk is higher, indicating that the effectiveness of monetary policy is attenuated.

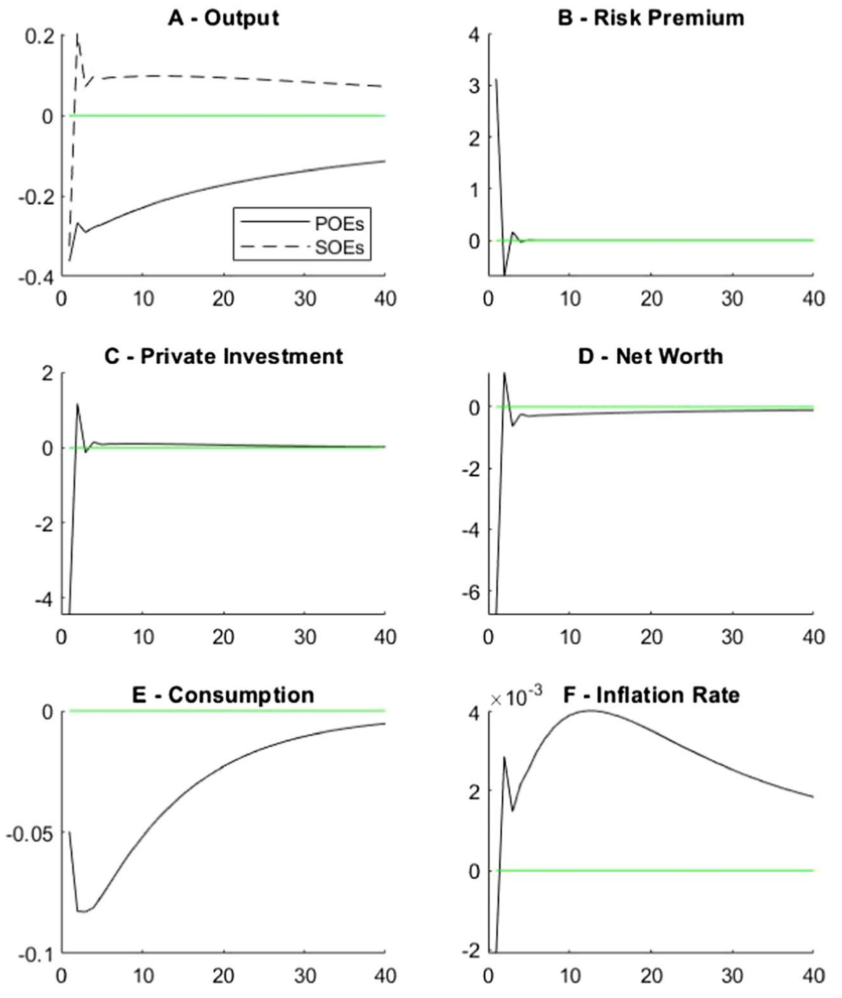

FIGURE 3 Contractionary monetary policy shock. In panel A, POEs output decreases by 0.36%, while SOEs output decrease by 0.31%. Risk Premium goes up by approximately 3% (panel B, which leads a reduction in private investment by more than 4% (panel C) and a fall in net worth by approximately 7% (panel D). Household consumption and the inflation rate decrease by 0.05% and 0.002%, respectively

4.2 | The effect of the fiscal policy

To support the economic recovery in 2009 and 2010, the Chinese central government undertook a fiscal stimulus program worth four trillion RMB. It approximately equals 11% of the annual GDP in that year (Bai et al., 2016). In a typical forward-looking, rational expectations closed economy, general equilibrium model, an expansionary fiscal policy will induce a Ricardian Equivalence effect. An increase in government spending, will induce a "crowding out effect". Our model follows the same rule that private investment decreases after the expansionary policy (Figure 5 panel C). A one standard deviation temporary government spending shock increases output in both sectors, which explains the economic recovery after the stimulus program. The impact effect on both sectors are sectors are similar but decreases after the expansionary policy (Figure 5 panel A). The POEs output increases by 0.009%, while SOEs output increases by 0.008% (Panel A).

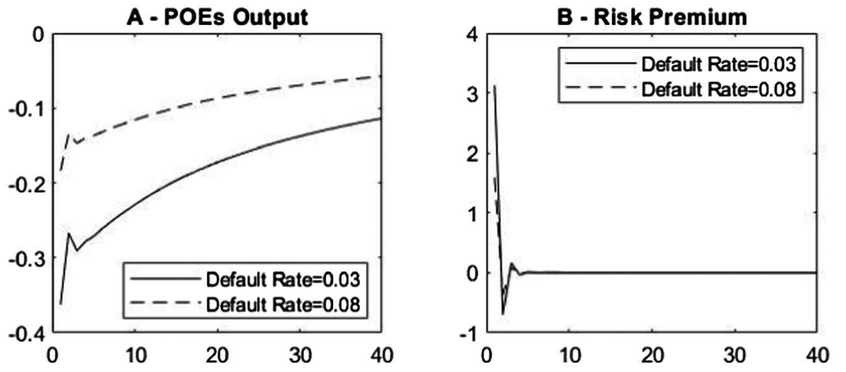

FIGURE 4 The effectiveness of the monetary policy. Panel A plots the output responses in the private sector under different default risks. The blue line indicates default risk equals 8%, while the red line implies 3%. The POEs output responses with less magnitude and persistence when the default risk is higher. Risk premium increases only by 1.5% when default risk is higher, compared to a 3% increase when default risk is lower (panel B)

However, POEs output drops dramatically compare with the SOE sector in a very short period. This is because positive government spending crowds out private investment by more than 0.06% (panel C). The lower private investment in the economy decreases the net worth in the POE sector by 0.1% (panel D), which in turn triggers the "financial accelerator" effect. The lower the net worth, the higher the risk premium POEs need to pay (0.04% in panel E). Thus, the positive fiscal policy raises the cost of borrowing in the private sector, which may explain the economic slowdown after 2010.[19] The private sector contributes more than 60% of China's GDP growth and provides over 70% of employment (Elliott et al., 2015). Hence, POEs are the backbone and play an essential role in the Chinese economy. If the "stimulus" package leads to a lower level of private investment, it is not surprising to observe an eventual fall in the GDP growth rate.

4.3 | The effect of the tighter bank credit policy

Figure 6 shows the transmission mechanism of a one standard deviation shock on bank credit tightness, specifically, the reserve ratio. As can be seen from the figure, a tighter bank credit policy decreases total amount of credit to both sectors, which reduces the private investment (Panel C) and both SOEs output and POEs output by 0.018% and 0.02%, respectively (Panel A). Less capital investment in the private sector reduces their net worth by 0.45%, which triggers the "financial accelerator" effect since POEs have less collateral to borrow. Entrusted lenders then raise the risk premium by 0.2%.

5 | CONCLUSION

We build a DSGE model of the Chinese economy incorporating the entrusted lending market, which constitutes one of the main segments of China's shadow banking system. Credit misallocation has been an ongoing issue in China. Commercial banks strongly favor SOEs for loans because of the implicit government guarantee. By taking advantage of the privileged access to the formal banking

[19]According to the World Bank, China's GDP growth rate has decreased from 10.6% in 2010 to 6.9% in 2015.

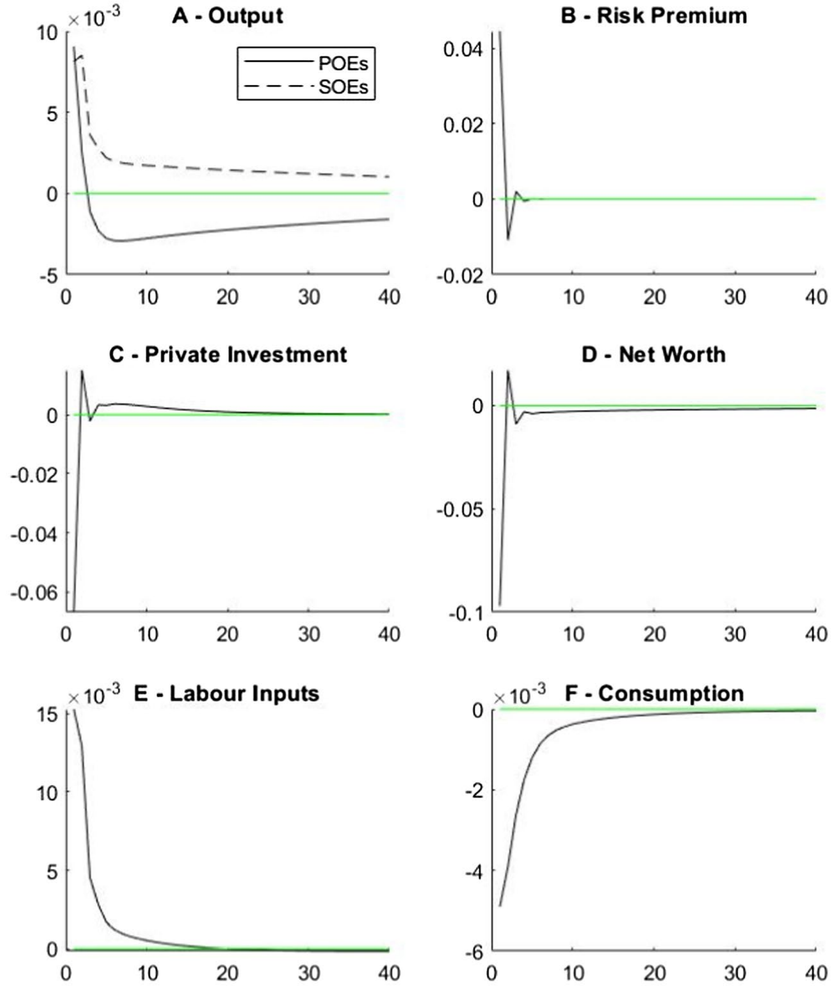

FIGURE 5 Positive government spending shock. A positive government spending shock increases output in both sectors, 0.009 in POEs and 0.008 in SOEs, respectively (panel A). However, it crowds out private investment by more than 0.06% (panel C), which in turn decreases the net worth in the POEs sector by 0.1% (panel D). Lower net worth increases risk premium by more than 0.04% because POEs have less collateral when they borrow money (panel E). POEs invest less in the capital inputs. Therefore, they need to hire more labor to produce output (panel E). Households consumption is crowded out by 0.005%

system, state sectors obtain over 75% of the bank loans. In contrast, POEs face severe financial constraints in gaining access to formal bank credit, compelling them to rely on shadow banks for funding, mainly through entrusted loans. SOEs have a long history of low productivity and inefficiency, which creates the incentive to engage in entrusted lending.

The research findings of this study provide several policy implications. First, we find that tighter bank credit regulation, through a higher reserve ratio, incentivizes SOEs to raise the proportion of risky loans to POEs. As a result of tighter credit, SOEs increase lending to POEs, which provide a higher return on loans. However, high return is accompanied with high risk. Without controlling SOEs' risk lending activities, the default probability of entrusted loans may induce a systemic risk to the whole economy. Loosening bank credit regulation, therefore, may be a potential way to attenuate the expansion of SOEs' entrusted lending activities in the first place.

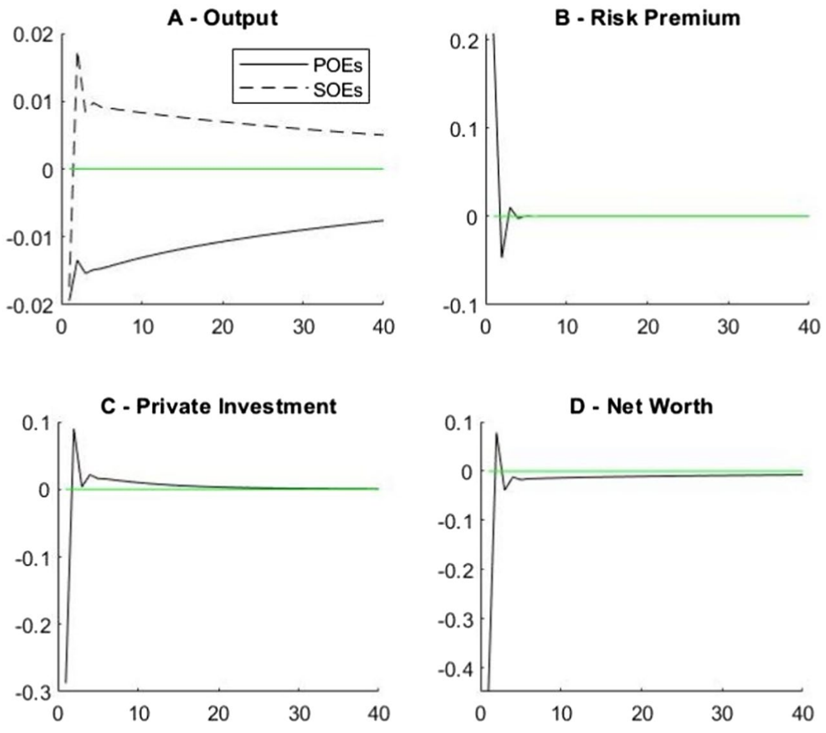

FIGURE 6 Tighter bank credit tightness shock. Tighter bank credit policy decreases total amount of credit to both sectors, which reduces the private investment (Panel C) and both SOEs output and POEs output by 0.018% and 0.02%, respectively (Panel A). Less capital investment in the private sector reduces their net worth by 0.45%, which triggers the "financial accelerator" effect since POEs have less collateral to borrow. Entrusted lenders then raise the risk premium by 0.2%

Second, we find that the effectiveness of monetary policy is dampened since SOE-entrusted lenders are free to adjust the credit allocation to POEs. The credit-constrained (private) sectors must bear a higher cost of borrowing when monetary policy becomes tighter. However, with the opportunities to borrow from the SOEs, POEs can offer higher returns and offset their shortage of funds proportionally, which in turn makes the monetary policy less effective. According to this finding, we suggest that reforming the state sector by restricting the provision of government guarantees might be an effective method to curtail the risky behavior of SOEs and enhance the efficacy of monetary policy.

Third, provisional government spending increases the output in both private and state sectors. However, it crowds out private investment, which reduces its net worth and increases the risk premium. Consequently, POEs must reduce their external finance and slowdown production. Bai et al. (2016) document that, at the end of 2010, approximately 75% of fiscal stimulus funds were spent on public infrastructure projects. Hence, most of the liquidity released by banks flows into government projects rather than into the POEs, which results in a subsequent fall in private investment. Without enough funds flowing to the private sector, it is not surprised to observe an economic downturn after 2010. Therefore, fiscal policy needs to be implemented with caution as it may harm the real economy unless regulators can target the funds at the private sector. Specifically, if the fiscal stimulus can provide more financial opportunities to the private firms rather than infrastructure projects, POEs may not have to turn to the entrusted lending market, and the economy might be improved in the longer term.

The model in this paper is imperfect in many ways and only partially meets the rigors of empirical validity. However, it represents a first step to rigorously model the role of SOEs in the entrusted loan market. WMPs can be embedded in the framework, which will make our model more sophisticated. The assumption of risk neutrality by the SOEs is a modeling convenience, but this assumption is not crucial to the results and our conclusions still hold under alternative assumptions of risk preference. The finding is qualitatively consistent with the moral hazard behavior of SOEs in the past. Recent government policy has focused on restricting SOEs behavior which should feature in future research. A further modeling convenience that we assume is that government spending is financed by a non-distortionary lump-sum tax. Fiscal policy is spending driven. As China moves to a mature stage of development at a lower steady-state rate of growth, future work needs to examine the role of taxes on the supply side of the economy.

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APPENDIX A.THELOG-LINEARIZEDEQUATIONS

Goods demand

$$\tilde{Y}_t = \frac{C}{Y} \times \tilde{C}_t + \frac{I}{Y} \times \tilde{I}_t + \frac{G}{Y} \times \tilde{G}_t + \frac{\tau D}{Y} \times \tilde{D}_t$$

$$\tilde{C}_t = \tilde{C}_{t+1} - \tilde{R}_t + E_t \tilde{\pi}_{t+1}$$

Goods supply

$$\tilde{Y}_t = a \times \left(\frac{Y^{\text{POE}}}{Y} \right)^{\rho} \times \tilde{Y}_t^{\text{POE}} + (1-a) \times \left(\frac{Y^{\text{SOE}}}{Y} \right)^{\rho} \times \tilde{Y}_t^{\text{SOE}}$$

$$\tilde{Y}_t^{\text{POE}} = \tilde{A}_t^{\text{POE}} + \alpha_1 \times \tilde{K}_t^{\text{POE}} + \left(1 - \alpha_1\right) \times \tilde{N}_t^{\text{POE}}$$

$$\tilde{Y}_t^{\text{SOE}} = \tilde{A}_t^{\text{SOE}} + \alpha_2 \times \tilde{K}_t^{\text{SOE}} + \left(1 - \alpha_2\right) \times \tilde{N}_t^{\text{SOE}}$$

Labor demand

$$\tilde{w}_t = \rho \times \tilde{Y}_t^{\text{POE}} - \tilde{x}_t - (\rho - 1) \times \tilde{Y}_t - \tilde{N}_t^{\text{POE}}$$

$$\tilde{w}_t = \rho \times \tilde{Y}_t^{\text{SOE}} - \tilde{x}_t - (\rho - 1) \times \tilde{Y}_t - \tilde{N}_t^{\text{SOE}}$$

$$\tilde{N}_t = \frac{N^{\text{POE}}}{N} \times \tilde{N}_t^{\text{POE}} + \frac{N^{\text{SOE}}}{N} \times \tilde{N}_t^{\text{SOE}}$$

Labor supply

$$\tilde{w}_t = \tilde{C}_t + \imath \times \tilde{N}_t$$

Capital demand

$$\tilde{R}_t^K = \left(1 - \varepsilon_1\right) \times \left[\rho \times \tilde{Y}_t^{\text{POE}} - \tilde{K}_t^{\text{POE}} - \tilde{x}_t - (\rho - 1) \times \tilde{Y}_t\right] + \varepsilon_1 \times \tilde{Q}_t^{\text{POE}} - \tilde{Q}_{t-1}^{\text{POE}}$$

$$\tilde{R}_t^L = \left(1 - \varepsilon_2\right) \times \left[\rho \times \tilde{Y}_t^{\text{SOE}} - \tilde{K}_t^{\text{SOE}} - \tilde{x}_t - (\rho - 1) \times \tilde{Y}_t\right] + \varepsilon_2 \times \tilde{Q}_t^{\text{SOE}} - \tilde{Q}_{t-1}^{\text{SOE}}$$

$$\tilde{Q}_t^{\text{POE}} = \phi_K^{\text{POE}} \times \left(\tilde{I}_t^{\text{POE}} - \tilde{K}_t^{\text{POE}}\right) - \left(1 - \phi_K^{\text{POE}}\right) \times \tilde{e}_t^{\text{POE}}$$

$$\tilde{Q}_t^{\text{SOE}} = \phi_K^{\text{SOE}} \times \left(\tilde{I}_t^{\text{SOE}} - \tilde{K}_t^{\text{SOE}}\right) - \left(1 - \phi_K^{\text{SOE}}\right) \times \tilde{e}_t^{\text{SOE}}$$

Capital supply

$$\tilde{K}_t^{\text{POE}} = \delta^{\text{POE}} \times \tilde{I}_t^{\text{POE}} + \left(1 - \delta^{\text{POE}}\right) \times K_t^{\text{POE}} + \delta^{\text{POE}} \times \tilde{e}_t^{\text{iPOE}}$$

$$\tilde{K}_t^{\text{SOE}} = \delta^{\text{SOE}} \times \tilde{I}_t^{\text{SOE}} + \left(1 - \delta^{\text{SOE}}\right) \times \tilde{K}_t^{\text{SOE}} + \delta^{\text{SOE}} \times \tilde{e}_t^{\text{iSOE}}$$

$$\tilde{K}_t = \frac{K^{\text{POE}}}{K} \times \tilde{K}_t^{\text{POE}} + \frac{K^{\text{SOE}}}{K} \times \tilde{K}_t^{\text{SOE}}$$

$$\tilde{I}_t = \frac{I^{\text{POE}}}{I} \times \tilde{I}_t^{\text{POE}} + \frac{I^{\text{SOE}}}{I} \times \tilde{I}_t^{\text{SOE}}$$

Loan market

$$E_t \tilde{R}_{t+1}^K - \tilde{R}_{t+1}^L = -\nu \times \left(\widetilde{Net}_t - \tilde{Q}_t^{\text{POE}} - \tilde{K}_t^{\text{POE}}\right) + \tilde{e}_t^S$$

$$\widetilde{Net}_{t+1} = \gamma \times R^L \times \frac{K^{\text{POE}}}{Net} \times \left(\tilde{R}_t^K - \tilde{R}_t^L\right) + \tilde{R}_t^L + \widetilde{Net}_t$$

$$\tilde{s}_t = E_t \tilde{R}_{t+1}^K - \tilde{R}_{t+1}^L + \tilde{e}_t^S$$

$$\tilde{R}_{t+1}^L = \tilde{R}_{t+1}^D + \frac{\tau}{(1-\tau)} \times \tilde{e}_t^\tau$$

Taylor rule and Fisher equation

$$\tilde{R}_t = \rho_D \times \tilde{R}_{t-1} + \left(1 - \rho_D\right) \times \left(a_\pi \times \tilde{\pi}_t + a_y \times \tilde{Y}_t\right) + \tilde{e}_t^m$$

$$\tilde{R}_t = \tilde{R}_t^D + E_t \tilde{\pi}_{t+1}$$

New Keynesian Philips Curve

$$\tilde{\pi}_t = \beta E_t \tilde{\pi}_{t+1} + \frac{(1-\theta)(1-\theta\beta)}{\theta} \left(-\tilde{\pi}_t\right)$$

AR (1) shock processes

$$\tilde{G}_t = \rho^G \times \tilde{G}_{t-1} + \tilde{\varepsilon}_t^G$$
$$\tilde{A}_t^{\text{POE}} = \rho_A^{\text{POE}} \times \tilde{A}_{t-1}^{\text{POE}} + \varepsilon_t^{\text{aPOE}}$$

$$\tilde{A}_t^{\mathrm{SOE}} = \rho_A^{\mathrm{SOE}} \times \tilde{A}_{t-1}^{\mathrm{SOE}} + \tilde{\varepsilon}_t^{\mathrm{aSOE}}$$

$$\tilde{e}_t^{\tau} = \rho_{\tau} \times \tilde{e}_{t-1}^{\tau} + \tilde{\varepsilon}_t^{\tau}$$

$$\tilde{e}_t^{\mathrm{iPOE}} = \rho_k^{\mathrm{POE}} \times \tilde{e}_{t-1}^{\mathrm{iPOE}} + \tilde{\varepsilon}_t^{\mathrm{iPOE}}$$

$$\tilde{e}_t^{\mathrm{iSOE}} = \rho_k^{\mathrm{SOE}} \times \tilde{e}_{t-1}^{\mathrm{iSOE}} + \tilde{\varepsilon}_t^{\mathrm{iSOE}}$$

$$\tilde{e}_t^{S} = \rho^{s} \times \tilde{e}_{t-1}^{S} + \tilde{\varepsilon}_t^{S}$$

APPENDIX B.SOURCESOFTHEDATA

Nominal GDP: Datastream (code: CHOEXP03A);

Nominal consumption: Datastream (code: CHCNPER.);

Inflation: Datastream (code: CHOCFCPIE);

Total employment: Datastream (CHXEMPT.P);

Output in SOEs: Total output multiplied by SOE output share;

SOE output share: Total State-Owned Industrial Output over total Industrial Output. (From Fudan University);

Total investment: From Fudan University or Quandl (GDP multiplied by Investment to GDP ratio);

Risk premium: CEIC and city of Wenzhou;

Capital return in SMEs: Lending rate of the commercial bank plus the risk premium.