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State-owned enterprises and entrusted lending: Economic growth and business cycles in China

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Abstract

A key economic structure in China is the co-existence of state-owned enterprises (SOEs) being bank-favored firms as well as policy tools, and more productive private firms who can borrow from SOEs through entrusted lending. We explore macroeconomic implications of such a structure in China. Our findings suggest SOEs dampen output volatility at the cost of productivity volatility. In contrast, the healthy development of entrusted lending dampens variations of both output and productivity by reallocating credits between firms. Focusing on the recent growth slowdown in China, we further show conducive effects of entrusted lending on economic growth by mitigating capital misallocation.

KEYWORDS
DSGE, financial friction, resource allocation, shadow lending, SOEs

JEL CLASSIFICATION
C32, E32, E44

1 | INTRODUCTION

A pronounced economic phenomenon in the last decade has been a sharp rising of a shadow banking system in China which accounts for 80% of its gross domestic product (GDP) in 2016 (Moody's, 2017). Unlike market-based shadow banking in the US, the Chinese counterpart is characterized as bank-like credit intermediation (Ehlers et al., 2018). In particular, a major and long-lasting form of Chinese shadow banking activity is *entrusted lending* (Chen et al., 2018), a borrowing activity between non-financial firms. Firms with privileged access to credit such as state-owned enterprises (SOEs) channel funds to financially constrained but more productive firms such as private-owned enterprises (POEs) (Allen et al., 2019; Bleck & Liu, 2018; Ehlers et al., 2018). Moreover, entrusted lending is a typical form of re-lending activity which complements the official financial system in China. We argue that accounting for entrusted lending has

Abbreviations: AFC, Asian financial crisis; DSGE, dynamic stochastic general equilibrium; FD, financial development; GDP, gross domestic product; GFC, global financial crisis; IRFs, impulse response functions; POEs, private-owned enterprises; SOEs, state-owned enterprises; TFP, total factor productivity.

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important implications for growth and business cycles, and provides new insights into roles of SOEs played in the Chinese economy.

In this study, we quantitatively investigate the effects of SOEs and entrusted lending on growth and macroeconomic fluctuation using a dynamic stochastic general equilibrium (DSGE) model. We incorporate two different entrepreneurs (SOEs and POEs) with two sources of finance (official credits and entrusted loans). In line with existing literature (Chang et al., 2019; Song et al., 2011), we assume that SOEs receive preferential financial arrangements whereas POEs are subject to a borrowing constraint despite higher productivity.

Our model provides two essential departures compared with existing literature. First, we incorporate entrusted lending as inter-firm borrowing. This is motivated by empirical evidence (Allen et al., 2019; Chen et al., 2018) that entrusted loan contracts are directly determined by lenders and borrowers while banks only act as passive facilitators.[1] Moreover, our model captures key facts that SOEs are the major lenders on this market and significant amount of entrusted loans are channeled to POEs. In the model, we consider that entrusted lending is subject to price-based and/or quantity-based financial frictions. As a form of shadow banking, entrusted loans are risky and hence costly, but complementary to the official bank loans by relaxing the borrowing constraints of POEs. The presence of entrusted loans provides a credit reallocation channel between the two types of firms, and hence is important for variation of total factor productivity (TFP).

Second, we consider two forms of SOE preferential arrangements–investment subsidies (a fiscal support) and privileged access to credits (a credit support). The investment subsidy[2] is a fiscal support (Cong et al., 2019; Zilibotti, 2017) for SOEs who internalize its effects on business decisions; heavy use of investment subsidies is able to reverse movement of SOE investment, creating a state-dependent cyclical pattern that is consistent with data. In contrast, the privileged access to credits is a business advantage which is unnecessary to reflect government intervention. Accounting for this differentiation helps us isolate roles played by SOEs as policy vehicles or bank-favored firms.

To quantitatively evaluate the implications of our model, we conduct structural estimation using Bayesian techniques over 1997Q1–2017Q4. We also adjust model parameters and conduct robustness checks, aiming to account for measurement errors of entrusted loans and hence avoid overestimating effects of entrusted lending. Following impulse response analysis, we find a trade-off between output variation and TFP variation due to the presence of the SOEs. With the preferential arrangements and low productivity, SOEs are muted from a financial acceleration mechanism but trigger a capital misallocation effect. Consequently, SOEs dampen output variation but amplify that of TFP. Comparing the two roles, SOEs as policy tools significantly distort capital allocation, leading to steep trade-off between output and TFP; while the trade-off becomes milder when SOEs play as bank-favored firms.

In contrast, entrusted lending can weaken both the financial acceleration and the capital misallocation effects. The presence of entrusted loans provides a channel to shift credits from SOEs to POEs, diversifying POE finance and improving allocation efficiency. The presence of entrusted loans weakens the importance of cash flow for POEs, which dampens POEs' sensitivity to internal finance (*an indirect effect*). In addition, entrusted loans are relatively risky and costly finance, implying that the effects are less effective than those of traditional finance. Thus, the presence of entrusted loans further attenuate the overall effects of external finance (*a direct effect*). The two forces together lead to reduced volatility of both output and TFP. This finding implies an essential role of entrusted loans in breaking the trade-off results from SOEs.

In light of model mechanisms, we proceed to assess the consequences of SOEs or entrusted lending on recovery and growth slowdown in China respectively. Focusing on two recent recessions in 1998–1999 and 2008–2009, we find that SOEs impaired TFP as a side effect of rescuing the economy. The cost was mainly due to privileged access to credits in the former period while investment intervention was the major cause in the latter period. Not surprisingly, loss on TFP is larger in the 2008 recession. Furthermore, by focusing on entrusted lending, we also study its implication for the recent economic slowdown in China. In the post-crisis period, China entered a new era with relatively low economic and TFP growth. In the meanwhile, tightened monetary policies were implemented to curb credit growth but shadow banking sectors expanded rapidly. However, regulations regarding shadow banking activities were gradually strengthened and POEs found it harder to obtain external finance. We show that the healthy development of entrusted lending mitigated capital misallocation, and hence contributed to both economic growth and TFP in the 2010s.

This study provides a crossroad to two strands of literature, namely macroeconomic implications of SOEs and shadow banking in China. Within the area of SOEs, its growth effects (Brandt et al., 2008; Curtis, 2016; Song et al., 2011) are extensively studied but business cycle effects have been paid insufficient attention.[3] In terms of shadow banking, its causes and consequences have drawn discussions (Allen et al., 2019; Lu et al., 2015) yet there is no consensus. We

extend the two strands of literature by showing how and to what extent SOEs lead to a business cycle trade-off between output and TFP, how entrusted lending interacts with this trade-off, and empirical implications for recovery and growth slowdown. Our study is related to those by Chen et al. (2018) and Chang et al. (2019),[4] both of which analyze implications of shadow banking for the effectiveness of monetary policies using calibrated models. Departing from the policy evaluation, we study the effects of entrusted lending on the propagation of major driven forces of the Chinese business cycles. By doing so, we also stress the importance of entrusted lending for maintaining productivity-based growth in recent China. Moreover, our analysis is based on a Bayesian DSGE model which allows data to help us identify some China-specific features in addition to our theoretical model.[5]

In addition to China-specific studies, this paper is generally related to financial development (FD) literature regarding the FD-volatility relationship (see Aghion et al., 2010; Wang et al., 2018 among others), by studying a unconventional form of financial intermediation-entrusted lending or more broadly inter-firm lending. We show that entrusted lending is similar to traditional finance in that both improve allocation efficiency, weaken firm's dependence on internal finance and hence reduces aggregate volatility. However, the entrusted lending development accumulates risks which increase the cost of finance. The costly nature of entrusted loans makes it a second-best finance which should complement rather than dominate traditional finance.

Broadly, this paper is also related to several strands of literature, including the macroeconomic consequences of a fiscal stimulus (Cong et al., 2019; Melina & Villa, 2014; Wen & Wu, 2019), the role of financial frictions in resource allocation (Chen & Song, 2013; Zetlin-Jones & Shourideh, 2017), and connections between growth and business cycles (Annicchiarico & Pelloni, 2014; Anzoategui et al., 2019). We complement them by distinguishing two types of preferential financial arrangements of SOEs, and developing a model with inter-firm loans. This model can be applied to other emerging economies where inter-firm lending is a typical structure (Avdjiev et al., 2014).

The rest of the paper is organized as follows. Section 2 presents some empirical facts about SOE investment, POE investment and entrusted lending. Section 3 presents the DSGE model with SOEs and entrusted lending. Section 4 presents our estimation results. In Section 5, we make use of the estimated model parameters for impulse response analyses. Section 6 studies growth in 1998–1999, 2008–2009 and recent slowdown in light of our model. Section 7 checks robustness before Section 8 concludes with comments.

2 | STATE-OWNED ENTERPRISES AND SHADOW BANKING

This section provides empirical facts and a descriptive analysis of some Chinese macroeconomic variables over the last few decades. We focus on two aspects–SOE investment and entrusted credits.

Figure 1a shows different properties between SOEs and POEs in terms of investment growth. While POE investment growth shows a positive correlation with output growth (0.457), the relationship between SOE investment and output growth tends to be time-varying; during recessions such as the Asian Financial Crisis (AFC) and the Global Financial

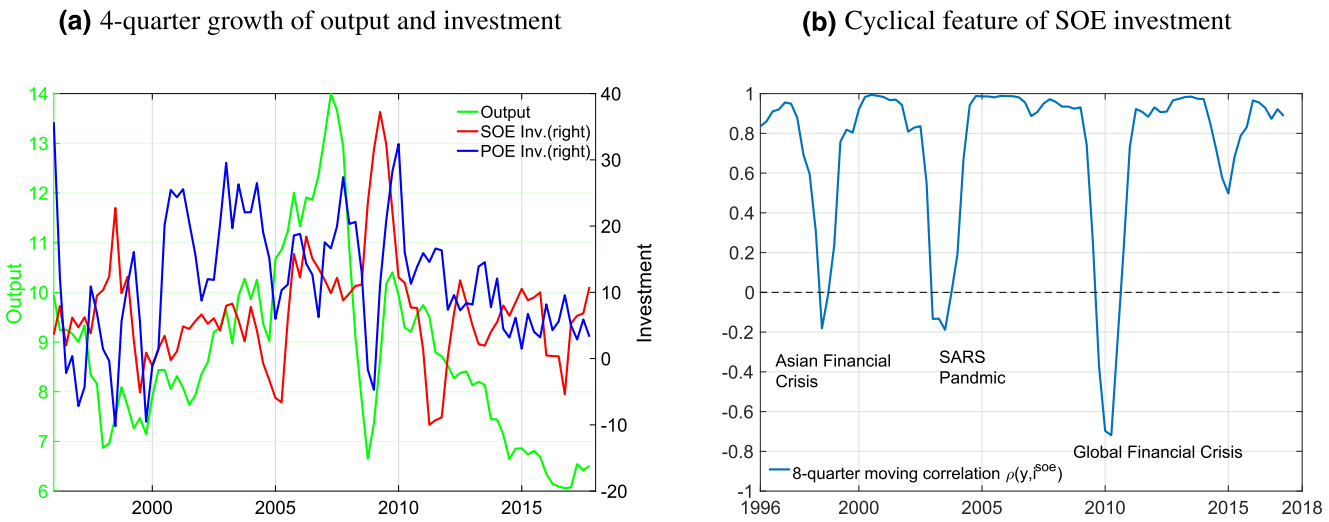

FIGURE 1 SOE investment growth. SOEs, state-owned enterprises.

TABLE 1 Relative volatility of POE investment and output.

	$\sigma(I^{poe})/\sigma(I^{soe})$	$\sigma(Y^{poe})/\sigma(Y^{soe})$	$\sigma(IP^{poe})/\sigma(IP^{soe})$
Overall	1.34	1.57	1.53
Pre-2008	1.53	2.07	2.16
2008–2017	1.12	1.32	1.02
2008–2022	\	\	1.15

Note: This table shows volatility of POE investment, output, and industrial production (IP) relative to SOE counterparts. The sample periods are 1996Q1–2017Q4 for investment at quarterly frequency, 2000–2016 for output at annual frequency, and 2005M2–2022M9 at monthly frequency. Output and investment data classified by ownership are only available until 2016 and 2017Q4, respectively.

Abbreviations: POE, private-owned enterprise; SOE, state-owned enterprise.

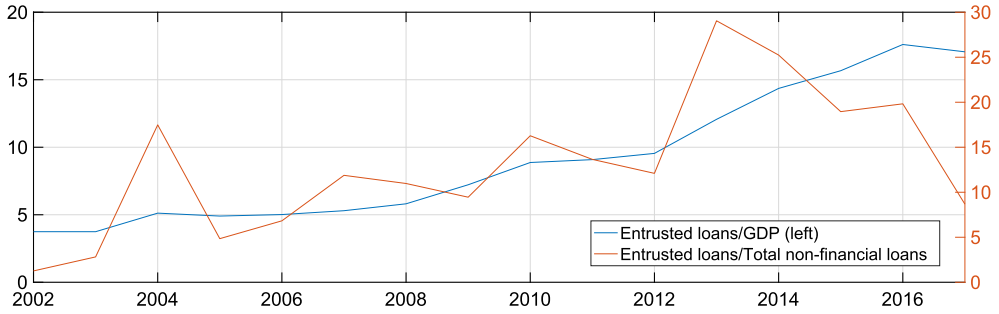

FIGURE 2 Entrusted loans: depth and share. The *entrusted loans/Total loans* is the ratio of entrusted loans to the sum of entrusted loans and bank loans. Data are in annual frequency.

Crisis (GFC), output growth and SOE investment growth are negatively correlated, while in normal time they are more likely to positively co-move. In order to further corroborate this time-varying pattern, we calculate moving correlations between output and SOE investment over 8-quarter windows. Figure 1b indeed shows that the moving correlation is positive in normal times but becomes negative in recessions. Considering that SOEs were heavily intervened in recessions, the time-varying cyclical pattern of SOE investment could be due to government policies such as SOE investment subsidies. These facts imply double roles of SOEs: business enterprises in normal times and intervention vehicles in recession times.

To further understand different business cycle patterns between SOEs and POEs, we compare the volatility of POE investment, and output relative to SOEs. Overall, Table 1 shows that POE investment, output, and industrial production are more volatile than their SOE counterparts, implying that POEs are more likely to be subject to external disturbances. One reason behind this data pattern could be the different financial positions of the two types of firms; POEs generally have tighter financial constraints and hence they are more sensitive to business cycle conditions. Moreover, we further investigate if the volatility of the POE variables change over time. Interestingly, Table 1 suggests that relative volatility of POE investment and output declines in the aftermath of the GFC. This change coincides with the rapid development period of entrusted loans. Based on industrial production, we further find that the relative volatility slightly increases if we expand the sample to 2022. The extended period corresponds to tightened regulation of shadow banking, and the development of entrusted lending is stagnated. Overall, the changes of relative volatility over time suggest that development of entrusted lending seems to contribute to a more stabilized POE activities.

Entrusted lending is a borrowing activity between two non-financial firms and commercial banks only play as trustees (Chen et al., 2018). Lenders on this market are privileged firms, for example, SOEs, with access to cheap credit and they lend entrusted loans to firms subject to severe financial constraints, for example, POEs (Allen et al., 2019). These privileged firms engage in entrusted lending for two major purposes. They either have extra funds to seek for profit opportunities, or have business connections with the borrowers to help them raise funds. Since the beginning of the 2000s, entrusted loans emerged in China due to financial distortions[6] and they developed rapidly especially after the GFC. Figure 2 shows that the entrusted loans-to-GDP ratio climbed to 18% in 2017. Moreover, entrusted loans account for 22% of total non-financial loans, on average, between 2010 and 2017. Bleck and Liu (2018) and Ehlers et al. (2018) document that SOEs or broadly state-linked companies are dominant lenders on this market and a substantial amount

TABLE 2 POE entrusted loans.

	2002–2009	2010–2017	2002–2017
POE entrusted loans/GDP	2.10%	5.18%	3.58%
POE entrusted loans/total non-financial loans	5.04%	10.83%	8.08%
POE entrusted loans/POE loans	11.77%	26.47%	19.83%

Abbreviations: GDP, gross domestic product; POE, private-owned enterprise.

of entrusted loans are channeled toward POEs. In order to conduct quantitative analysis, it is important to know the amount of entrusted loans devoted to POEs. However, such data are not directly available at macro-level. We borrow micro-level evidence to calculate the share of entrusted loans obtained by POEs. Based on Allen et al. (2019), we find that the share is 38%.[7]

We further calculate some statistics to measure the depth of POE entrusted loans, summarized in Table 2. It shows that POE entrusted loans accounted for 20% of POE loans, 8.08% of total non-financial loans, and 3.58% of GDP between 2002 and 2017 on average. If we focus on the post-2010 period, these three measures go up to 5.18%, 10.83%, and 26.47%, respectively. Given that POEs are financially constrained but more productive, an entrusted lending market may provide a credit reallocation channel and hence potentially correct the financial distortion. Furthermore, entrusted lending is the major form of shadow banking in China, accounting for almost half of shadow loans between 2009 and 2015 (Chen et al., 2018). Therefore, given the importance of entrusted lending, it is essential to understand the macroeconomic implications of a shadow banking activity like entrusted lending.

3 | THE MODEL

We expand the Smets and Wouters (2007)'s model, incorporating SOEs, quantity-based financial friction (borrowing constraint) similar to Jermann and Quadrini (2012), Chen and Song (2013) and Wang et al. (2018), and a shadow lending activity in the form of entrusted loans. We adopt the quantity-based financial friction for POEs, consistent with both theoretical modeling of Chinese economy (see Curtis, 2016 among others) and firm-level evidence (Ayyagari et al., 2010).[8] Motivated by the role of banks as passive facilitators in channeling entrusted loans (Chen et al., 2018), we focus on production sectors to model entrusted lending.[9] Following Chang et al. (2019), the term SOEs might be broadly interpreted as firms receiving preferential financial arrangements while the term POEs are those that do not receive these arrangements. In this section, we describe the structure and key conditions of the model. A detailed derivation of the model is available in Supporting Information S2.

3.1 | Entrepreneur

Monopolistic intermediate goods producers use labor hour H_t and capital K_t to produce intermediate goods.

$$Y_{jt}^{o} = A_t^{o}\left(K_{jt}^{o}\right)^{\alpha}\left(H_{jt}^{o}\right)^{1-\alpha}, \quad o = SOE, POE \tag{1}$$

where productivity A_t^o has three components

$$A_t^{o} = A^{o}(1+g^{y})^{t}\varepsilon_t^{a}, \quad o = SOE, POE \tag{2}$$

The first component A^o captures productivity associated with each type of intermediate goods producers. The second component $(1+g^y)^t$ is the trend growth. The third component ε_t^a is an aggregate productivity shock following an AR(1) process as follows: $ln\varepsilon_t^a = \rho_a ln\varepsilon_{t-1}^a + \eta_t^a$. η_t^a follows i.i.d $N\left(0,\sigma_A^2\right)$.

The following CES technology is used to aggregate differentiated intermediate goods into an intermediate goods composite Y_t^m:

$$Y_t^m = \left\{ \int_0^{\omega} \left[Y_{jt}^{SOE} \right]^{1/\lambda^m} dj + \int_{\omega}^{1} \left[Y_{jt}^{POE} \right]^{1/\lambda^m} dj \right\}^{\lambda^m} \tag{3}$$

where $\omega \in [0, 1]$ is the steady-state share of SOEs' production in aggregate intermediate goods and λ^m is the intermediate goods mark-up. In the following subsections, we describe problems for SOEs and POEs, followed by equilibrium conditions of entrusted loans.

3.1.1 | State-owned entrepreneur

The SOE j maximizes expected utility[10] V_{jt}^{SOE}

$$V_{jt}^{SOE} = \max\left\{ \log\left(Div_{jt}^{SOE} \right) + \beta E_t\left(V_{jt+1}^{SOE} \right) \right\} \tag{4}$$

subject to a budget constraint (5), law of motion of capital (6) and demands of SOE intermediate goods (7).

$$P_t Div_{jt}^{SOE} + W_t H_{jt}^{SOE} + \frac{P_t}{\varepsilon_t^{soe}} I_{jt}^{SOE} + R_{t-1}^b B_{jt-1}^{SOE} + S_{jt}^{SOE} + \phi_t S_{jt}^{SOE} = B_{jt}^{SOE} + R_{t-1}^s S_{jt-1}^{SOE} + P_{jt}^{SOE} Y_{jt}^{SOE} \tag{5}$$

$$K_{jt+1}^{SOE} = (1-\delta) K_{jt}^{SOE} + \varepsilon_t^i \left[1 - \Omega\left(\frac{I_{jt}^{SOE}}{(1+g^y) I_{jt-1}^{SOE}} \right) \right] I_{jt}^{SOE} \tag{6}$$

$$Y_{jt}^{SOE} = Y_t \left(\frac{P_{jt}^{SOE}}{P_t^m} \right)^{\lambda^m/(1-\lambda^m)} \tag{7}$$

where β is the SOE subjective discount factor, Div_{jt}^{SOE} the SOE dividend, P_t aggregate price level, W_t nominal wage, H_{jt}^{SOE} the SOE labor hour, I_{jt}^{SOE} the SOE investment, P_{jt}^{SOE} price of the SOE intermediate goods, R_t^b gross borrowing rate, R_t^s gross entrusted lending rate, B_{jt}^{SOE} the SOE bank loans, K_{jt}^{SOE} the SOE capital, and δ is the depreciation rate. S_{jt}^{SOE} is entrusted loans supplied by the SOE j and ϕ_t is the intermediation cost which is specified in Section 3.1.3.

$\Omega()$ is the adjustment cost function with $\Omega(1) = 0$, $\Omega'(1) = 0$ and $\Omega''() > 0$. ε_t^i is an investment efficiency shock common to both types of entrepreneur. ε_t^i follows an AR(1) process: $ln\varepsilon_t^i = \rho_b ln\varepsilon_{t-1}^i + \eta_t^i$ and η_t^i follows an i.i.d $N\left(0, \sigma_I^2\right)$.

Given that the investment subsidy reflects degree of government intervention through SOEs, we model it $\left(\varepsilon_t^{soe}\right)$ using an AR(1) shock process as follows: $ln\varepsilon_t^{soe} = (1-\rho_{soe}) ln\varepsilon^{soe} + \rho_{soe} ln\varepsilon_{t-1}^{soe} + \eta_t^{soe}$. Such a reduced form specification provides a shortcut to capture fiscal support for SOEs. In practise, ε_t^{soe} propagates as a SOE specific investment shock after log-linearization. Note that an increase in ε_t^{soe} will stimulate investment, increase adjustment cost and hence investment efficiency will decrease. This effect is consistent with empirical finding that government interventions inversely affect investment efficiency (Chen et al., 2011).

3.1.2 | Private entrepreneur

Compared with SOEs, there are four major differences incorporated in the model: (a) POEs have limited access to external finance, (b) POEs do not receive investment subsidies, (c) POEs have higher productivity, and (d) POEs are borrowers in entrusted lending market. The POE j maximizes expected utility

$$V_{jt}^{POE} = \max\left\{ log\left(Div_{jt}^{POE} \right) + \gamma E_t\left(V_{jt+1}^{POE} \right) \right\} \tag{8}$$

subject to a budget constraint (9), borrowing constraints for bank loans[11] (10) and entrusted loans (11), law of motion of capital (12) and demands of POE intermediate goods (13).

$$P_t Div_{jt}^{POE} + W_t H_{jt}^{POE} + P_t I_{jt}^{POE} + R_{t-1}^b B_{jt-1}^{POE} + R_{t-1}^s S_{jt-1}^{POE} = \underbrace{B_{jt}^{POE}}_{\text{bank loans}} + \underbrace{S_{jt}^{POE}}_{\text{entrusted loans}} + \underbrace{P_{jt}^{POE} Y_{jt}^{POE}}_{\text{cash flow}} \tag{9}$$

$$B_{jt}^{POE} \leqslant \varepsilon_t^f P_t K_{jt}^{POE} \tag{10}$$

$$S_{jt}^{POE} \leqslant \varepsilon_t^s P_t K_{jt}^{POE} \tag{11}$$

$$K_{jt+1}^{POE} = (1-\delta) K_{jt}^{POE} + \varepsilon_t^i \left[1 - \Omega\left(\frac{I_{jt}^{POE}}{(1+g^y) I_{jt-1}^{POE}}\right)\right] I_{jt}^{POE} \tag{12}$$

$$Y_{jt}^{POE} = Y_t \left(\frac{P_{jt}^{POE}}{P_t^m}\right)^{\lambda^m/(1-\lambda^m)} \tag{13}$$

where γ is the POE subjective discount factor. Variables with *POE* superscript are POE-specific counterparts to SOE variables. Our modeling of borrowing implies that private firms can only borrow limited amount equal to a fraction of its capital either from banks or SOEs. This assumption is similar to other financial constraint literature such as Chen and Song (2013) and Wang et al. (2018). Further, we assume ε_t^f and ε_t^s are exogenous shocks[12] following AR(1) processes as follows: $ln\varepsilon_t^n = (1-\rho_n) ln\varepsilon + \rho_n ln\varepsilon_{t-1}^n + \eta_t^n$ where $n = f, s$. ε^n are tightness of the two borrowing constraints in the steady state and η_t^n follows i.i.d $N(0, \sigma_N^2)$ where $N = F, S$.

The right-hand side of Equation (9) shows three sources of funds for POEs, including internal cash flow $P_{jt}^{POE} Y_{jt}^{POE}$, bank loans, and entrusted loans. The last type of fund provides alternative finance for POEs and weakens their dependence on both internal funds and bank loans.

3.1.3 | Entrusted lending

The entrusted intermediation cost ϕ_t, is modeled as a function in aggregate amount of entrusted credits with $\phi()' > 0$ and $\phi()'' > 0$. Such a convex function implies that the more entrusted credits supplied, the more marginal cost of this kind of credits. In details, we assume the following functional form of ϕ_t.

$$\phi_t = \frac{\epsilon^s}{1+\xi}\left[\frac{S_t}{P_t(1+g^y)^t}\right]^{1+\xi}, \qquad \xi > 0 \tag{14}$$

where ξ is elasticity of intermediation cost with respect to entrusted credits. $P_t(1+g^y)^t$ is a scaling factor to ensure balanced growth path.

As will be shown shortly in Equation (15), one can interpret ϕ_t as a component of risk premium associated with entrusted lending. The larger amount of entrusted credits borrowed, the higher degree of information asymmetry faced by their lenders, more risks are accumulated, and hence higher risk premium is required. Our model implies that entrusted lending is a risky loan, consistent with literature concerning risks of shadow banking in China (Allen et al., 2019; Chang et al., 2019). More generally, the way of modeling financial risk is consistent with other business cycle models for developing countries (see Özbilgin, 2010 among others).

In equilibrium, the entrusted lending rate and tightness of entrusted lending constraint are jointly determined by the optimal decisions from SOEs and POEs.[13] From SOE decisions

$$R_t^s = R_t^b + \phi_t R_t^b \tag{15}$$

Equation (15) implies that entrusted lending rate is higher than bank lending rate, consistent with data. In the baseline specification, we assume that SOEs incur the intermediation cost which leads to $R_t^s > R_t^b$. In an alternative

specification, we also consider that the intermediation cost is instead incurred by POEs. In this alternative case, we will have $R_t^s = R_t^b$ which is inconsistent with data. Given that SOEs play as de facto financial intermediary in the entrusted lending market (Bleck & Liu, 2018), it is reasonable to assume that SOEs incur the intermediation cost.

From POE decisions

$$\frac{R_t^s}{R_t^b} = \frac{1-\lambda_t^{s',POE}}{1-\lambda_t^{b',POE}} \tag{16}$$

where $\lambda_t^{b',POE}$ and $\lambda_t^{s',POE}$ are Lagrange multipliers attached to the two borrowing constraints. Following Jermann and Quadrini (2012), the two multipliers can be interpreted as effective tightness of the two borrowing constraints. With $R_t^s > R_t^b$ as established in Equation (15), Equation (16) implies that $\lambda_t^{b',POE} > \lambda_t^{s',POE}$. This result deliver three important implications. Since entrusted loans are more expensive than bank (or formal) credits, POEs will always use up all credit rations before approaching the entrusted lending market. Hence, the official borrowing constraint is tighter than the entrusted lending constraint. In addition, Equations (15) and (16) imply a pecking order between the two types of finance, with formal credits prior to entrusted loans.

Furthermore, different tightness of the financial constraints also implies different effects of the two types of finance. To explain this point, it is convenient to focus on the steady state, and we can derive marginal effects of the two constraints on POE capital.

$$\frac{\partial K^{POE}}{\partial \varepsilon^f} = \Theta\lambda^{b',POE} > \frac{\partial K^{POE}}{\partial \varepsilon^s} = \Theta\lambda^{s',POE}, \qquad \Theta > 0 \tag{17}$$

where Θ is a positive constant[14] common to the two marginal effects. Following Wang et al. (2018), ε^f and ε^s can be interpreted as degree of FD. With $\lambda^{b',POE} > \lambda^{s',POE}$, Equation (17) suggests that the marginal effect of official banking development is greater than that of entrusted lending development.

If $\lambda_t^{s',POE}$ becomes zero, the entrusted lending constraint becomes slack and the POEs' maximization problem is not subject to Equation (11). Equation (16), combined with Equation (15), can be rewritten as

$$1 + \phi(S_t) = \frac{1}{1-\lambda_t^{b',POE}} \tag{18}$$

Equation (18) yields the optimal condition of entrusted loan amount[15] in this case. It suggests a positive relationship between entrusted loans and tightness of the formal borrowing constraint. With a tighter borrowing constraint (higher value of $\lambda_t^{b',POE}$), POEs will resort to SOEs to borrow more entrusted loans. Consequently, there is a credit reallocation to POEs. This implication is consistent with a key reason motivating entrusted lending development–POEs are discriminated by the formal financial system in China and shadow banking like the entrusted loan provides them an alternative finance (Bleck & Liu, 2018).

3.2 | Final goods producer

There are a continuum of monopolistic competitive final goods producers, measuring unity, each of which is like a retailer, who buys intermediate goods composite Y_t^m and transfers them into differentiated final goods Y_t (Anzoategui et al., 2019).

In practice, the final goods sector is used to introduce nominal rigidity into this economy. Following Calvo (1983), we assume each final goods producer sets price on a staggered basis. In each period there is a probability $1-\epsilon_p$ that a final goods firm can reset its optimal price P_{it}^* otherwise firms set prices according to the following index rule $P_{it} = P_{i,t-1}\pi^{1-\iota_p}\pi_{t-1}^{\iota_p}$ where π is steady state inflation and ι_p is the degree of indexation.

3.3 | Financial intermediary

Competitive financial intermediaries collect money at the savings rate (R_t) from households. Financial intermediaries conducts business with both types of intermediate goods producer. Due to interest rate ceiling, lending rate moves tightly with saving rate and credit premium do not have substantial fluctuations in China. Hence, we assume that lending rate is equal to saving rate $R_t^b = R_t$.

3.4 | Household

The representative household derives utility from consumption and leisure, consumes and saves money with the financial intermediaries. Households supply labor measured in hours H_t, used for the production of intermediate goods.

The household faces the following problem:

$$\max E_t \sum_{l=0}^{\infty} \beta^l \varepsilon_{t+l}^d \left[\log(C_{t+l} - bC_{t+l-1}) - \frac{\psi^s \left(H_{t+l}^{SOE}\right)^{1+\eta} + \psi^p \left(H_{t+l}^{POE}\right)^{1+\eta}}{1+\eta} \right] \tag{19}$$

subject to the budget constraint

$$P_t C_t + D_t = R_{t-1} D_{t-1} + W_t \left(H_t^{SOE} + H_t^{POE}\right) + \Pi_t^f \tag{20}$$

where C_t denotes consumption, D_t saving, R_t gross interest rate, and Π_t^f profit from the ownership of monopolistic competitive firms, b measures degree of external habits in consumption and η measures the elasticity of labor supply with respect to wage. ε_t^d is a preference shock following an AR(1) process: $ln\varepsilon_t^d = \rho_d ln\varepsilon_{t-1}^d + \eta_t^d$ and η_t^d follows an i.i.d $N\left(0, \sigma_D^2\right)$.

With regard to wage setting, the household supplies differentiated labor to a competitive labor agency which differentiates it, packs it into labor services, and sells labor services to intermediate goods producers. As standard in the New Keynesian literature, there is a wage rigidity and wage adjustment, based on the Calvo scheme. Households re-optimize wages with probability $1 - \epsilon_w$ in each period. With probability ϵ_w households cannot re-optimize and index past inflation to adjust the wage, $W_t = W_{t-1} \pi^{1-\iota_p} \pi_{t-1}^{\iota_p} (1 + g^y)$, where ι_w is the degree of wage indexation.

3.5 | Aggregation and equilibrium

With symmetric equilibrium, we obtain the aggregate output, SOE output, private output as follows:

$$Y_t = Y_t^m = \left[\omega \left(Y_t^{SOE}\right)^{1/\lambda^m} + (1-\omega) \left(Y_t^{POE}\right)^{1/\lambda^m} \right]^{\lambda^m} \tag{21}$$

$$Y_t^o = A_t^o \left(K_t^o\right)^{\alpha} \left(H_t^o\right)^{1-\alpha}, \quad o = SOE, POE \tag{22}$$

To complete the model, the capital, labor, formal credit and entrusted lending markets must clear. $K_t = K_t^{SOE} + K_t^{POE}$, $H_t = H_t^{SOE} + H_t^{POE}$, $D_t = B_t = B_t^{SOE} + B_t^{POE}$ and $S_t^{SOE} = S_t^{POE} = S_t$. The resource constraint and GDP are

$$Y_t = C_t + I_t + G_t + S_t \phi_t \tag{23}$$

$$GDP_t = C_t + I_t + G_t \tag{24}$$

G_t[16] is a exogenous spending shock following AR(1) process: $ln\varepsilon_t^g = \left(1 - \rho_g\right) g + \rho_g ln\varepsilon_{t-1}^g + \eta_t^g$ and η_t^g follows i.i.d $N\left(0, \sigma_G^2\right)$. The policy rate which is also the savings rate is given by the Taylor rule

$$R_t = R_{t-1}^{\rho_r}\left[R\left(\frac{\pi_t}{\overline{\pi}}\right)^{\rho_\pi}\left(\frac{Y_t}{Y_{t-1}}\right)^{\rho_y}\right]^{1-\rho_r}\varepsilon_t^m \tag{25}$$

where ε_t^m is a monetary policy shock following an AR(1) process: $ln\varepsilon_t^m = \rho_m ln\varepsilon_{t-1}^m + \eta_t^m$ and η_t^m follows an i.i.d $N\left(0,\sigma_M^2\right)$.[17]

Following Chen and Song (2013), we can derive TFP using the concept of Solow Residual

$$TFP_t = (1+g^y)^t\varepsilon_t^a\underbrace{\left\{\left[\omega A^{SOE}\left(\frac{K_t^{SOE}}{K_t}\right)^{\alpha}\left(\frac{H_t^{SOE}}{H_t}\right)^{1-\alpha}\right]^{1/\lambda^m} + \left[(1-\omega)A^{POE}\left(\frac{K_t^{POE}}{K_t}\right)^{\alpha}\left(\frac{H_t^{POE}}{H_t}\right)^{1-\alpha}\right]^{1/\lambda^m}\right\}^{\lambda^m}}_{\text{the reallocation effect}} \tag{26}$$

TFP can be decomposed into three components: a trend component, a TFP shock and a reallocation effect. We can interpret $\left(\frac{K_t^o}{K_t}\right)^{\alpha}\left(\frac{H_t^o}{H_t}\right)^{1-\alpha}$ $o = SOE, POE$ as weights attached to sector-specific productivity and the reallocation effect captures weighted averaged productivity across different types of producers. With $A^{POE} > A^{SOE}$, the reallocation effect suggests that larger SOE (POE) capital share leads to more losses (gains) on production efficiency. Thus, changes of SOE or POE capital share add an additional source of TFP fluctuation through the capital allocation channel. To further illustrate this, we can rewrite Equation (26) in the absence of SOEs ($\omega = 0$) as follows:

$$TFP_t = (1+g^y)^t\varepsilon_t^a\left\{\left[A^{POE}\left(\frac{K_t^{POE}}{K_t}\right)^{\alpha}\left(\frac{H_t^{POE}}{H_t}\right)^{1-\alpha}\right]^{1/\lambda^m}\right\}^{\lambda^m} = (1+g^y)^t\varepsilon_t^a A^{POE} \tag{27}$$

The second equality can be obtained since $K_t^{POE} = K_t$ and $H_t^{POE} = H_t$ when $\omega = 0$. In this case, the reallocation effect becomes constant and the expression of TFP converges to a standard form. Compared to Equation (26), Equation (27) suggests that fluctuations of TFP through the capital allocation channel would be shut down in the absence of SOEs, leading to smaller magnitude of TFP variations.

4 | ESTIMATION

In this section, we report our results for the Bayesian estimation of our DSGE model. This framework allows data to assist in the determination of the structural parameters. Simulations are then carried out, using the estimated parameters to measure the different responses from the economies to multiple shocks.

4.1 | Data

Our sample period is 1997Q1–2017Q4.[18] This period[19] is selected for two reasons. Firstly, China's quarterly time-series for major macroeconomic indicators are notoriously rare, with availability beginning in the mid-1990s. Secondly, in terms of economic structure, China has become a more market-oriented economy since the late 1990s, with significant growth in the private sector. We use 10 macroeconomic variables as observables for estimation: GDP, consumption, investment, SOE investment, hours worked, wages, GDP deflator inflation, the policy interest rate, non-financial corporate loans and entrusted loans.[20] We acknowledge that there is no time-series perfectly measuring entrusted loans toward POEs. In order to account for the role of entrusted lending, we set the model parameters to match adjusted entrusted loan shares, aiming to eliminate effects of entrusted loans channeled to SOEs. Details can be found from Table 3 and Section 4.2.

TABLE 3 Calibrated parameters.

	Description	Value
Parameters		
α	Capital share	0.5
β	SOE and household discount factor	0.995
γ	POE discount factor	0.97
δ	Capital depreciation	0.02
λ^m	Intermediate good mark-up	1.1
λ^w	Wage mark-up	1.1
Steady-state		
$1 + g^y$	ss per capita GDP growth	1.022
G/Y	ss exo. demand share	0.18
ω	ss SOE output share	1/3
H	ss aggregate working hour	1/3
$S/(S + B)$	ss entrusted lending share	0.08
A^{SOE}	SOE productivity	1
A^{POE}	POE productivity	1.67

Abbreviations: GDP, gross domestic product; POE, private-owned enterprise; SOE, state-owned enterprise.

4.2 | Calibration

In this section, we present our calibration of the structural parameters. Calibration is carried out where values of certain structural parameters are considered "known" in the literature, and has the benefit of limiting the number of parameters that we are required to estimate through Bayesian techniques.

Table 3 shows the calibrated parameters. These parameters are well-identified in existing literature, for example, Chang et al. (2015). Capital share α is set as 0.5, in line with Hsieh and Klenow (2009). The discount factor β is calibrated as 0.995 to match the averaged 3-month policy saving rate in China. We give the POE discount factor γ 0.97. This value implies that the internal rate of return for POEs is almost doubled as SOEs, consistent with firm-level evidence (see Wu, 2018 among others).[21] The two discounting factors imply 2.6% of entrusted lending premium ϕ', falling in the range (0.3%–7.9%) suggested by empirical evidence (Allen et al., 2019). The intermediate goods mark-up and wage mark-up are calibrated as 1.1 respectively, which is in line with existing literature–for example, Chang et al. (2015). We set the capital depreciation rate equal to 0.02, which is the median level in existing studies.

The lower part of Table 3 shows the calibrated value of steady-state parameters based on data over 1997–2017. The average per capita GDP growth rate is about 2.2% for China and hence we calibrate g^y as 2.2%. The exogenous demand-to-output ratio is calibrated as 18%.[22] The SOE production share ω is calibrated as 1/3 based on industrial output data.[23] The aggregate working hour H in the steady state is calibrated as 1/3. In terms of two productivity parameters, we normalize A^{SOE} to unity and calibrate A^{POE} as 1.67. These two values are consistent with relative productivity between POEs and SOEs based on the Chinese Industrial Enterprises Database. Moreover, our calibration of TFP difference falls in the range (1.4–2.3) suggested by existing literature.[24] The share of entrusted loans to total loans is set as 8%, consistent with the data (see Table 2). We also check the sensitivity of our results to different entrusted loan shares in Section 7.1.

4.3 | Estimation results

The choice of prior distributions is similar to those used in Smets and Wouters (2007), Jermann and Quadrini (2012) and Bianchi et al. (2019) except for ξ, which is not presented in their model. We use a gamma distribution with a mean of 1 and a standard deviation of 0.4. The unity prior mean implies a quadratic function of entrusted lending rate in the

TABLE 4 Marginal likelihood of alternative models.

Model descriptions	Label	Marginal likelihood
No entrusted loans		
No capital price in the borrowing constraint	Model SOE	−1493.35
With capital price in the borrowing constraint	Model SOE Q	−1880.61
With entrusted loans		
With entrusted loan premium	Model premium	−1586.82
With shadow borrowing constraint	Model constraint	−1520.52
With both entrusted loan premium and shadow borrowing constraint	Model main	−1501.25

Note: There are two sets of comparisons. Based on the dataset without entrusted lending, we first estimate two models differing in modeling of the official borrowing constraint. In these two models, entrusted lending is not included. In the second set of comparison, we estimate three models differing in modeling of entrusted lending. The second set of comparison is based on the dataset including entrusted loans.

Abbreviation: SOE, state-owned enterprise.

amount of entrusted credits. A quadratic function is often used to model financial costs and hence unity should be a reasonable prior mean of ξ. For the standard deviation of ξ, we choose 0.4, which is quite loose so that we can "let the data speak." Given that we consider different specifications on the official borrowing constraint and entrusted lending, we estimate several versions of the model. Following Christiano et al. (2014), we conduct Bayesian model comparisons to select a version with the best data fit. In general, a version with larger marginal likelihood indicates better data fit and hence we favor this model specification.

In the first step, we estimate models without entrusted lending but with different borrowing constraints based on the dataset without entrusted loans. Table 4 shows that there is a larger marginal likelihood for Model SOE than Model SOE Q, indicating that dropping capital price from the official borrowing constraint improve data fit. Hence, we chose Model SOE as a benchmark to further incorporate entrusted lending. Moreover, existing studies incorporating asset price in the borrowing constraint is supported by positive co-movement between asset price and output (Iacoviello, 2005). However, this may not be the case for China, as we find weak correlations between output and capital good price (0.11), stock market index (0.21) or housing price (−0.09).

In the second step, we estimate three versions of the model with different ways to model entrusted lending, based on the extended dataset with entrusted loans. The second set of comparison suggests that the model with two types of shadow borrowing frictions (i.e., Model Main, with entrusted loan premium and the shadow borrowing constraint) deliver the best data fit over the other two specifications. Thus, we focus on Model Main to conduct major analysis. Table 5 reports Bayesian estimation results based on Model Main.

Overall, our estimation results (see Table 5) are similar to those in the literature. The borrowing constraint parameter ε^f is estimate to be 0.88, implying a private credit to GDP ratio as 4.18 and entrusted loan to GDP ratio as 0.33 which are consistent with data over the sample period at quarterly frequency. With regards to shock processes, Table 5 suggests that volatile shocks hit the Chinese economy including particularly two investment shocks and the private financial shock.

Next, we show the relative importance of shocks for our sample period, using historical decomposition for output growth in Figure 3. By visual check, we find TFP and investment shocks are the two most important shocks driving economic growth in China. The importance of these two shocks in the Chinese business cycles is also identified using unconditional variance decomposition. Specifically, these two shocks together account for 68% of output variation, 72% investment variations, 56% of consumption variation and 93% of TFP variation.[25] In addition, the exogenous demand shock also makes significant contributions to variations of output growth.

Focusing on some specific periods, we also highlight contributions of the SOE investment and the POE financial shocks. In the AFC (1998–1999) and the GFC (2008–2009) periods, the SOE investment shock shows positive contributions to the output growth. For example, Figure 3 shows that the contribution of the SOE investment shock rose up from 2008Q4. This timing is consistent with the implementation of the China investment stimulus plan. Regarding the POE financial shock, it has persistent and negative contributions to the output growth since the GFC. Such a negative contribution captures the effect of a deleverage process in China since the early 2010s. In particular, the average growth

TABLE 5 Prior and posterior distribution of structural parameters and shock processes.

Parameters	Prior			Posterior
	Distribution	Mean	St. Dev.	Mean [5, 95]
b habit	Beta	0.7	0.1	0.84 [0.75, 0.93]
ϵ_p calvo price	Beta	0.5	0.1	0.75 [0.70, 0.81]
ι_p price indexation	Beta	0.5	0.15	0.40 [0.21, 0.60]
ϵ_w calvo wage	Beta	0.7	0.1	0.85 [0.81, 0.89]
ι_w wage indexation	Beta	0.5	0.15	0.49 [0.27, 0.71]
η labor elasticity	Gamma	2	0.5	2.10 [1.41, 2.79]
Ω" invest. adj. cost	Gamma	5	1	6.97 [5.12, 8.80]
ρ_r taylor smoothing	Beta	0.7	0.15	0.97 [0.96, 0.98]
ρ_π taylor parameter	Normal	1.5	0.25	1.85 [1.54, 2.17]
ρ_y taylor parameter	Normal	0.3	0.1	0.27 [0.11, 0.42]
ε^f ss borrowing constraint	Beta	0.6	0.1	0.88 [0.86, 0.93]
ξ entrusted credit elasticity	Gamma	1	0.4	0.98 [0.38, 1.58]
ρ_a per. of exo. TFP	Beta	0.5	0.2	0.98 [0.97, 0.99]
ρ_d per. of preference	Beta	0.5	0.2	0.35 [0.07, 0.63]
ρ_m per. of mon. policy	Beta	0.5	0.2	0.36 [0.21, 0.50]
ρ_p per. of price mark-up	Beta	0.5	0.2	0.85 [0.79, 0.92]
ρ_w per. of wage mark-up	Beta	0.5	0.2	0.30 [0.12, 0.49]
ρ_i per. of inv. efficiency	Beta	0.5	0.2	0.83 [0.73, 0.93]
ρ_g per. of exo. demand	Beta	0.5	0.2	0.97 [0.95, 0.99]
ρ_{soe} per. of soe inv.	Beta	0.5	0.2	0.13 [0.03, 0.21]
ρ_f per. of financial	Beta	0.5	0.2	0.97 [0.94, 0.99]
ρ_s per. of entrusted credit	Beta	0.5	0.2	0.93 [0.88, 0.98]
σ_A std. of exo. TFP	Inv_Gamma	0.1	2	0.83 [0.72, 0.93]
σ_D std. of preference	Inv_Gamma	0.1	2	5.56 [0.82, 9.04]
σ_M std. of mon. policy	Inv_Gamma	0.1	2	0.04 [0.04, 0.05]
σ_P std. of price mark-up	Inv_Gamma	0.1	2	0.36 [0.27, 0.45]
σ_W std. of wage mark-up	Inv_Gamma	0.1	2	0.68 [0.54, 0.81]
σ_I std. of inv. efficiency	Inv_Gamma	0.1	2	0.85 [0.61, 1.09]
σ_G std. of exo. demand	Inv_Gamma	0.1	2	1.38 [1.21, 1.56]
σ_{SOE} std. of soe inv.	Inv_Gamma	0.1	2	2.94 [2.51, 3.41]
σ_F std. of financial	Inv_Gamma	0.1	2	3.15 [2.70, 3.57]
σ_S std. of entrusted credit	Inv_Gamma	0.1	2	3.37 [2.86, 3.34]

Note: 90% HPD in brackets.

rate of loans dropped from 14.42% over 2001–2007 to 13.49% over 2011–2018.[26] The tightened liquidity could significantly bind financial constraint for POEs, leading to more loss of output for POEs than SOEs (Chen, Li & Tillmann, 2019). Consequently, the financial shock generated persistent contributions to the recent growth slowdown as identified in Figure 3.

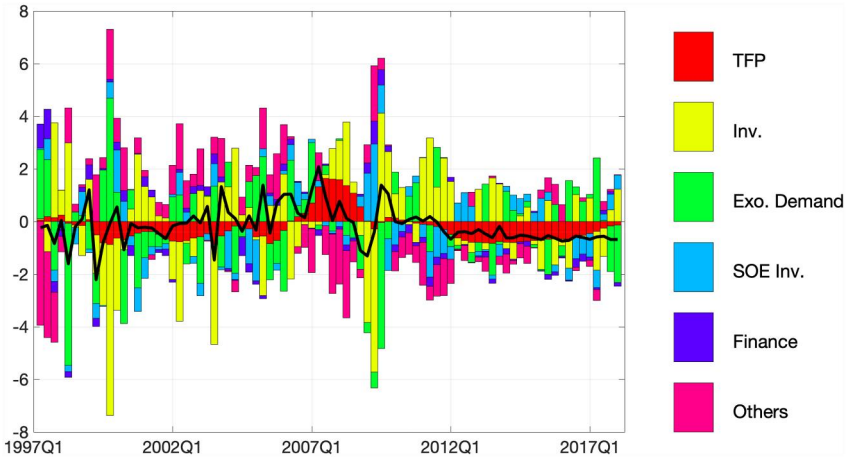

FIGURE 3 Historical variance decomposition of quarterly output growth.

5 | IMPULSE RESPONSE ANALYSIS

In this section, we use impulse response functions (IRFs) to show mechanisms of how the two roles of SOEs affect business cycles in China, and how entrusted lending interacts with the implications of SOEs.

5.1 | SOEs as policy vehicles–SOE investment shock

We start the explanation by focusing on the role of SOEs as policy vehicles–the SOE investment shock.

Figure 4 shows that, following a positive SOE investment shock, SOE investment and output dramatically increase in the short run. The increase of SOE output boosts aggregate labor hours, which produce a positive spillover effect on the private sector, increasing POE output in the short run. However, POE investment is crowded out, dragging POE output below zero in the mid-to-long run. As a result, there is significant capital misallocation which leads to a persistent slowdown in TFP. Our results imply distinct movement of output and TFP. Suppose that implementation of investment subsidies is on a counter-cyclical basis, the SOE investment shock might rescue the economy in a recession to prevent decline of output, but on the other hand reduce TFP, leading to a trade-off between output and TFP.

5.2 | SOEs as firms with privileged access to credits

This subsection discusses another role of SOE–firms with privileged access to credit. We focus on TFP, investment and private financial shocks to explain the mechanism. These three shocks are selected because Section 4.3 has established their importance in driven macroeconomic fluctuations in China.

Figure 5 plots impulse responses of some key variables to a positive TFP shock. An increase in aggregate TFP encourages both SOEs and POEs to rise output and investment. For POEs, increased productivity stimulates their capital, which expands debt capacity. With more debts, POEs can further expand production and accumulate more capital, thus entering an upward spiral. This creates a financial acceleration effect on POE output and investment. While SOEs are not subject to the borrowing constraint and hence their output and investment are less responsive. Since POEs invest more than SOEs, private capital share $\frac{K_t^{POE}}{K_t}$ increases, resulting in a positive reallocation effect (the gap between the green line and the black dashed line in the right panel of Figure 5). Hence the TFP response is amplified compared to the case where there are no SOEs. Moreover, our findings are in line with existing literature in terms of financial acceleration effect (e.g., Wang et al., 2018) and reallocation effect (e.g., Chen & Song 2013). Overall, the fluctuation of aggregate output is dampened but that of TFP is magnified due to SOEs' privileged access to credits and lower productivity.

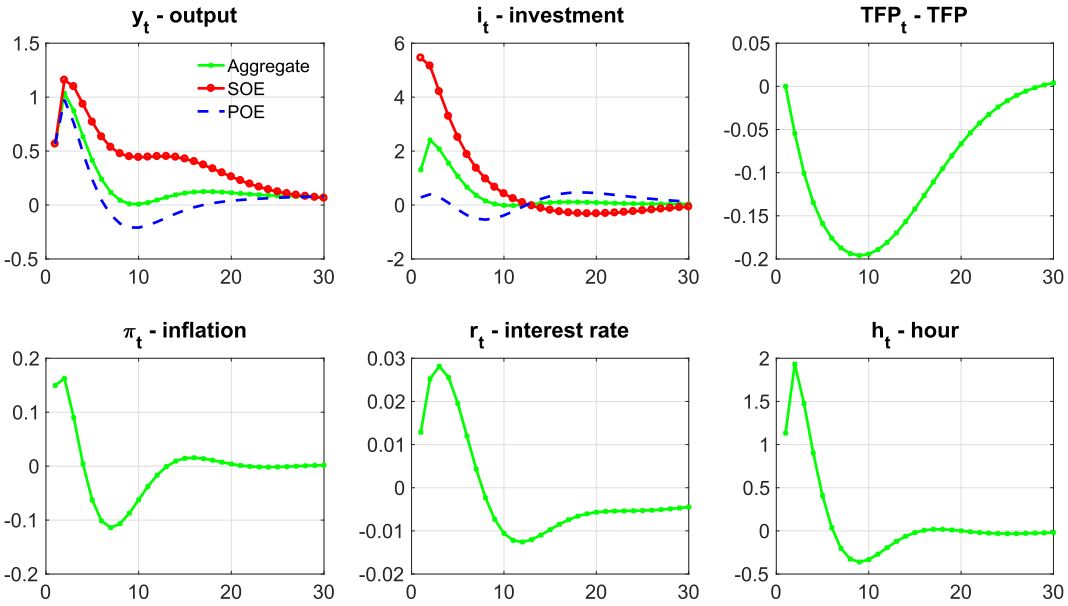

FIGURE 4 Impulse response to SOE investment shock (1 std). POE, private-owned enterprise; SOE, state-owned enterprise; TFP, total factor productivity.

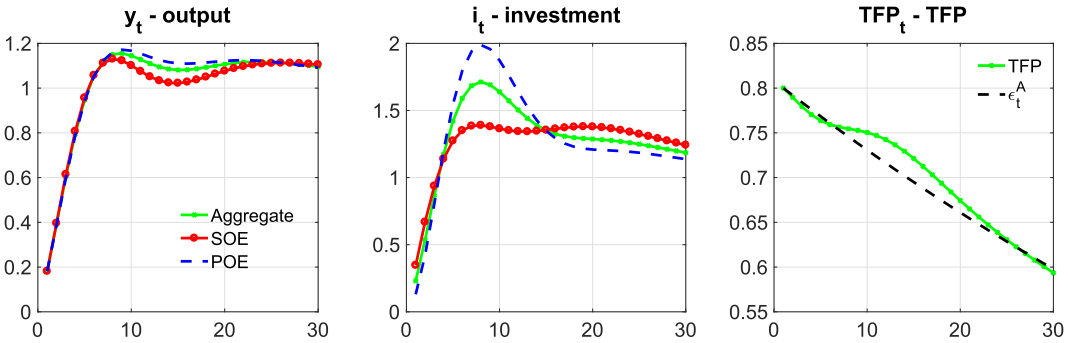

FIGURE 5 Impulse response to TFP shock (1 std). POE, private-owned enterprise; SOE, state-owned enterprise; TFP, total factor productivity.

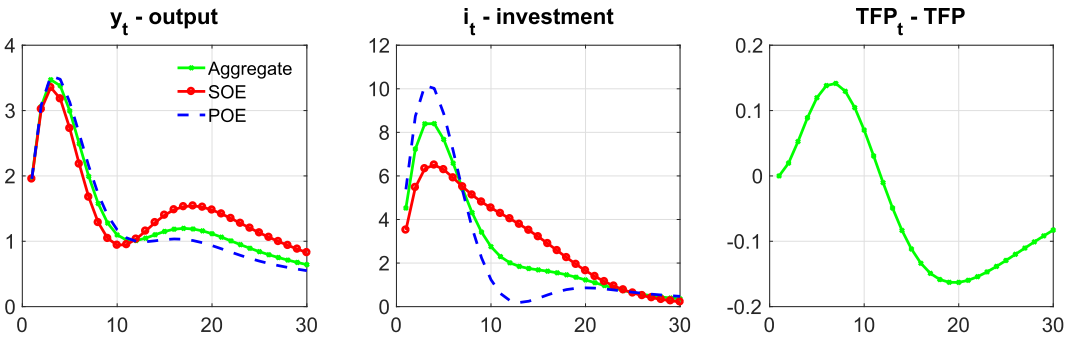

FIGURE 6 Impulse response to investment shock (1 std). POE, private-owned enterprise; SOE, state-owned enterprise; TFP, total factor productivity.

In terms of a positive investment shock, Figure 6 shows that SOE output and investment have positive but less significant responses than POEs in the short term. This is similar to the IRFs of the TFP shock because SOEs are not subject to the financial acceleration effect. Moreover, POE investment share increases, which leads to a positive reallocation effect and TFP increases.

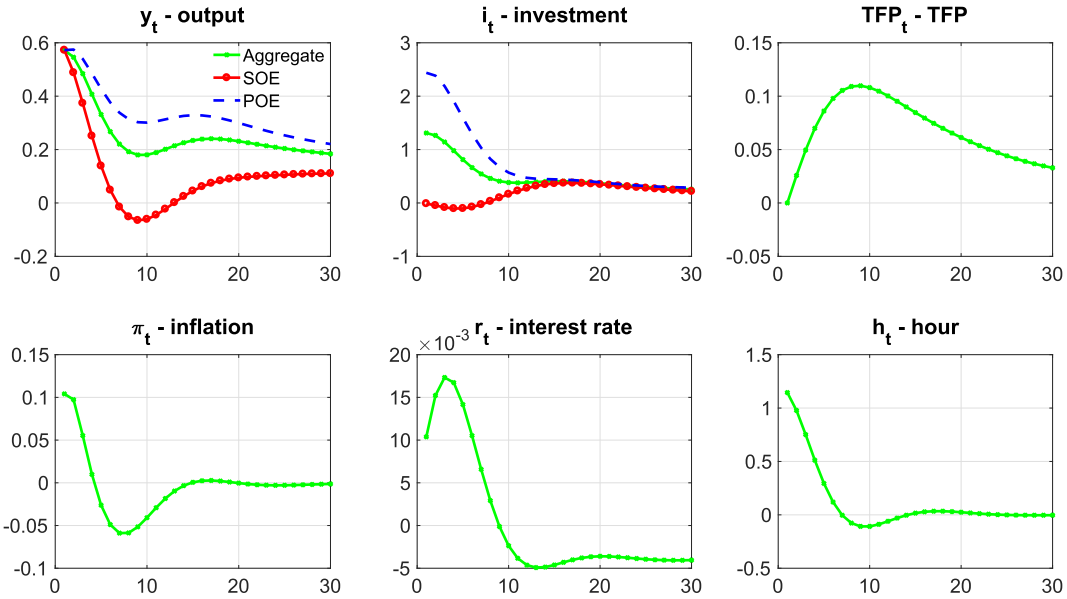

FIGURE 7 Impulse response to POE financial shock (1 std). POE, private-owned enterprise; SOE, state-owned enterprise; TFP, total factor productivity.

With regard to a POE financial shock, Figure 7 shows the different responses of SOEs and POEs. A positive private financial shock releases financial constraint for POEs. Consequently, POEs borrow more credits to produce and invest; the economy enters an expansion but crowd-out output and investment for SOEs. Moreover, different movement of investment between SOEs and POEs triggers positive reallocation effect which significantly raises TFP. Note that in the case without SOEs, the capital allocation channel is shut down and the TFP shock is the only source of variation for TFP. This implies that responses of TFP to the investment and POE finance shocks become zero.

5.3 | Entrusted lending

Next, we investigate the role of entrusted loans and compare it with the roles of SOEs in the business cycle in China. To this end, we first show impulse responses of a positive entrusted lending shock. We also compare it with the POE financial shock to draw different implications of the two types of FD, that is, the shadow banking development and the official financial development.

The black dashed lines in Figure 8 show that the entrusted lending shock has expansionary effects, leading to increases in output and investment particularly for POEs. Hence, the POE share in the economy expands, causing TFP to rise. Considering that releasing the constraint of entrusted loans is a kind of financial access, the effects of entrusted lending shock is consistent with FD literature (e.g., Wang et al., 2018). However, Figure 8 also shows that the entrusted lending shock is less able to stimulate the economy compared to the formal financial shock (the green dashed lines). This is because that entrusted loans are a more expensive credit and using it is subject to severe financial frictions. In particular, the steady state value of entrusted lending rate R^s is higher than the official lending rate R. Moreover, lending through entrusted loans is subject to the debt congestion effect ϕ_t as modeled in Section 3.1.3. These two factors together weaken the stimulation effect of entrusted loans. The results also indicate that entrusted lending, as a form of shadow banking, is a second-best financial arrangement; entrusted loans can be alternative finance for POEs but it is costly.

After establishing the effect of entrusted loans, we proceed to investigate how this type of lending affects propagation of other shocks focusing on TFP, investment, and POE financial shocks. Figure 9 compares IRFs of the TFP shock conditional on different levels of entrusted loan shares in the economy. With entrusted lending as an alternative funding channel, the effects of the TFP shock is dampened compared with the case without entrusted loans (black dash-dot lines). Moreover, with a larger entrusted loan share (e.g., the red dashed lines), the dampening effect becomes larger.

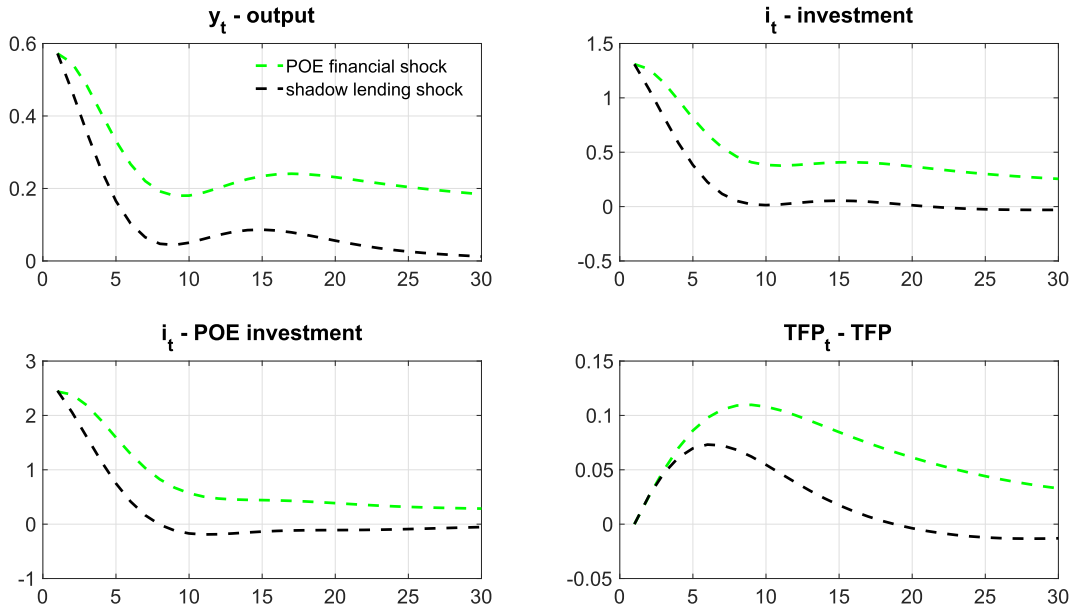

FIGURE 8 Comparing the POE financial shock and the entrusted lending shock. Size of the two shocks are normalized so that they deliver the same effects on output in the first quarter. POE, private-owned enterprise; TFP, total factor productivity.

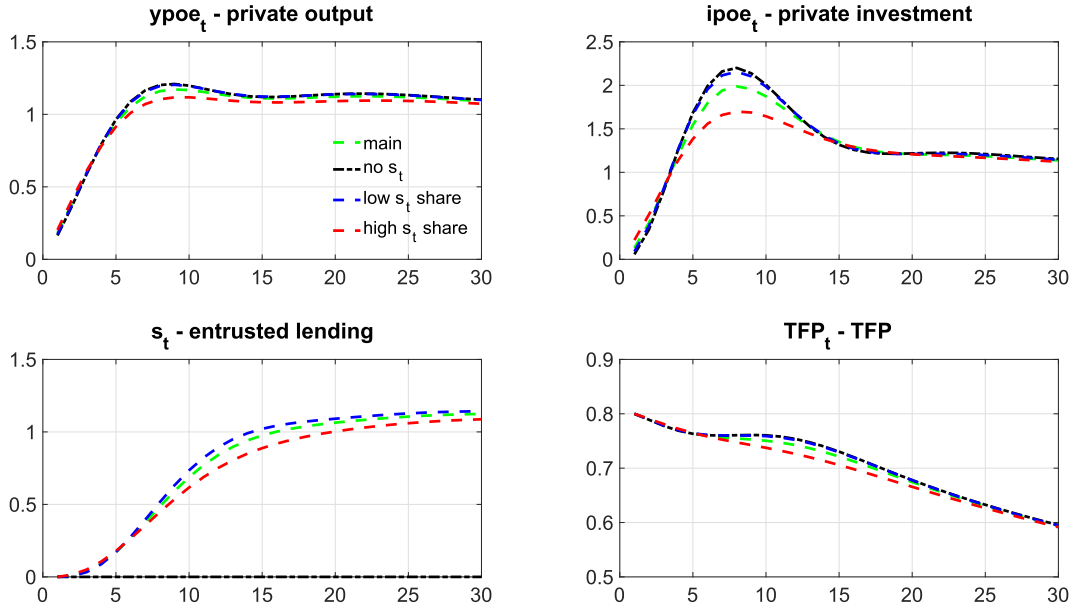

FIGURE 9 TFP shock: the role of entrusted lending. We compare IRFs without entrusted loans (black lines), with a low entrusted loan share (0.04, blue lines), the benchmark share (0.08, green line), and a high share case (0.16, red line). IRFs, impulse response functions; TFP, total factor productivity.

Regarding the investment shock (Figure 10) and the POE financial shock (Figure 11), we find the similar dampening pattern; the presence of entrusted lending as an alternative but costly finance dampens propagation of the other two shocks particularly in the short run.

Two major forces are at work for entrusted loans to dampen the movement of POE variables which further leads to reduced variations of aggregate volatility. First, the presence of entrusted loans enable POEs to diversify their sources of finance. The importance of internal cash flow become weakened, which leads to less responsive POE investment. Second, the responsiveness can be further decreased since entrusted loans are less able to stimulate the economy than formal finance, as suggested by Figure 8. That is to say, the overall effects of external finance are attenuated due to the presence of entrusted loans.

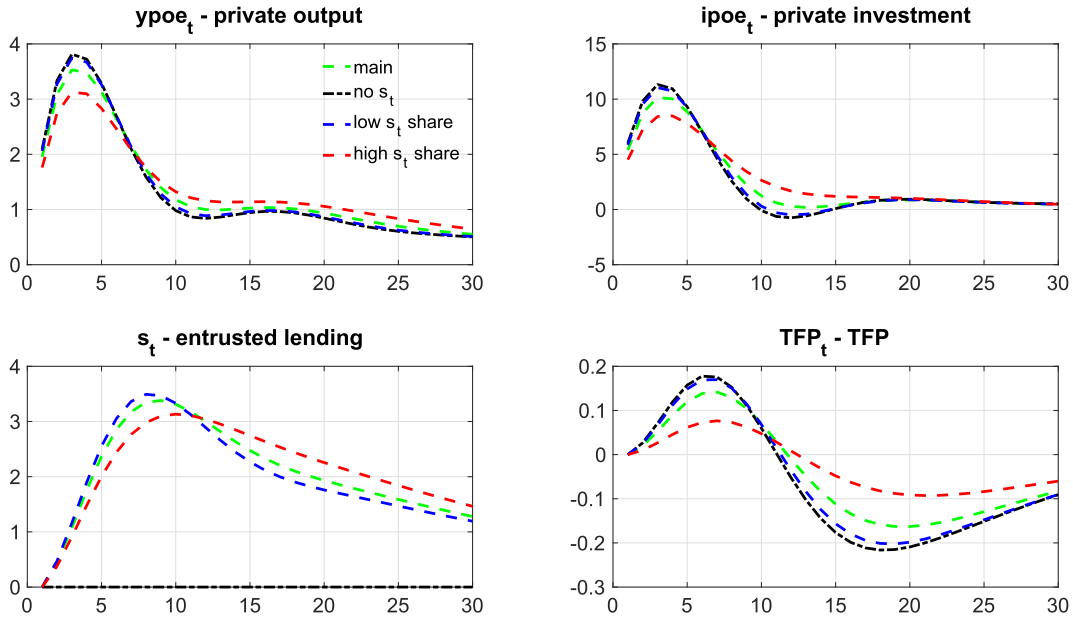

FIGURE 10 Investment shock: the role of entrusted lending. *Note*: we compare IRFs without entrusted loans (black lines), with a low entrusted loan share (0.04, blue lines), the benchmark share (0.08, green line), and a high share case (0.16, red line). IRFs, impulse response functions; TFP, total factor productivity.

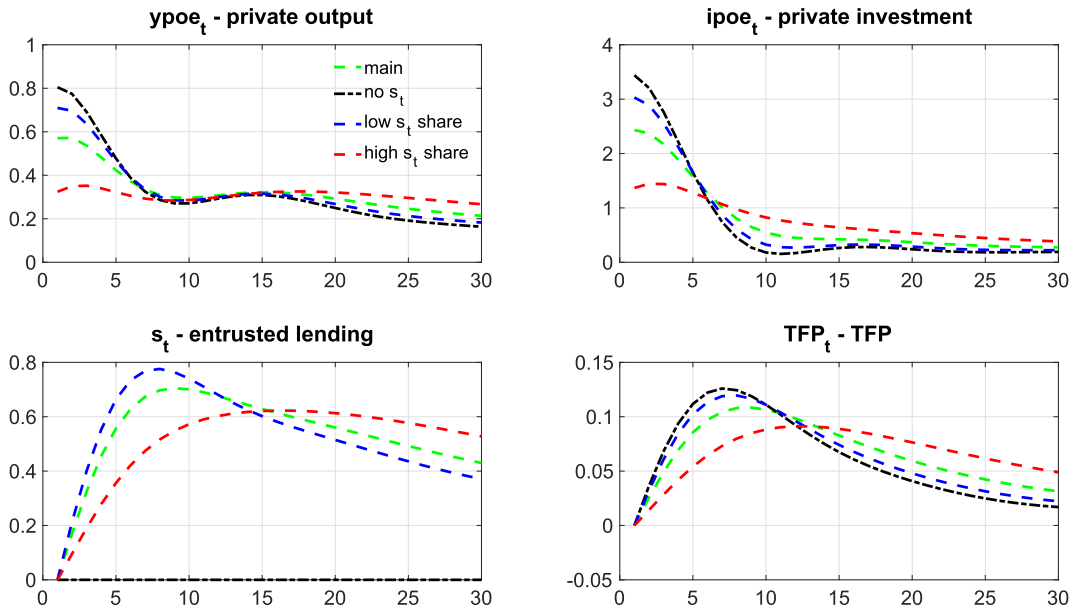

FIGURE 11 Financial shock: the role of entrusted lending. we compare IRFs without entrusted loans (black lines), with a low entrusted loan share (0.04, blue lines), the benchmark share (0.08, green line), and a high share case (0.16, red line). IRFs, impulse response functions; TFP, total factor productivity.

Furthermore, the impulse response analysis in this section suggests different roles of SOEs and entrusted loans, particularly for credit allocation. Although both elements dampen responses of output and investment, only entrusted lending further reduces the responses of TFP. The expansion of SOEs overall concentrate more resources on less productive sectors which exacerbate the misallocation, while entrusted lending leads credits to POEs which mitigates misallocation. Hence, the two important elements in the Chinese economy deliver distinct implications for allocation efficiency.

In order to further understand the quantitative importance of SOEs and entrusted credits, we compare macroeconomic volatility in the baseline model with two cases: one without SOEs[27] and another one without entrusted

TABLE 6 Comparing volatility.

	Effects of SOEs	Effects of entrusted lending			
Variables	Model SOE (i)	Model main (ii)	Low s_t share (iii)	High s_t share (iv)	Model Constraint (v)
y	0.938	0.968	0.990	0.929	0.987
i	0.799	0.958	0.987	0.906	0.969
tfp	1.047	0.987	0.996	0.977	0.990

Note: This table shows two sets of comparison. Statistics in column (i) represent the standard deviation of the variable in Model SOE relative to that in the model without SOE. Statistics in column (ii–v) represent the standard deviation of the variable in the models with entrusted lending relative to that without entrusted lending. An entry above (below) 1 implies that SOEs or entrusted lending amplifies (dampens) the volatility of the variable.

Abbreviation: SOE, state-owned enterprises.

credits. Table 6 reports relative volatility between the benchmark and the two counterfactual cases for output, investment and TFP. Column (i) in Table 6 shows that the presence of SOE decreases overall volatility of output and investment but increases that of TFP; SOEs reduce 6% and 20% standard deviation in output and investment respectively but amplifies 5% of standard deviation in TFP.

Shifting attention to another comparison between the benchmark and the case without entrusted lending, columns (ii–v) in Table 6 show that the presence of entrusted loans decreases volatility of output, investment and TFP. Based on Model Main, entrusted lending reduces 1.3%–5% standard deviation in the output, investment and TFP. Moreover, the differences become more significant if entrusted loan share become large. If the entrusted loan share is twice as large as in Model Main, the volatility reduction effects can go up to 2.3%–10% on the three selected variables, respectively. Given the rapid development of entrusted loans in the 2010s, we further assess the impacts of entrusted loans on the growth slowdown in China since 2010, as explored in Section 6.1.

6 | SOEs, ENTRUSTED LENDING AND GROWTH

Over the last 2 decades, there were three periods with relatively low growth rates in China, including the AFC period (1998–1999), the GFC period (2008–2009) and the 2010s. In the first two periods, China experienced recessions and SOEs' investment was intervened for recovery. In the third period, China entered a "New Normality" with relatively low growth, and at the same time, there was rapid development of shadow banking activities. It is interesting to study implications of SOEs or entrusted lending for growth in the three periods in light of our model features.

6.1 | Entrusted lending and growth slowdown

Since the beginning of the 2010s, economic growth in China has slowed with a number of factors (such as declined TFP and tightened liquidity) persistently contributing to the process. On the contrary, the entrusted loan market developed rapidly in this period. Given the dampening effects provided by entrusted lending as suggested by Section 5.3, we further investigate how entrusted lending have affected the growth in China since 2010.

In order to understand the effects of entrusted lending, we perform counterfactual experiments to compare the actual economy with a counterfactual case without entrusted lending. In this experiment, we fix the parameter value as in the benchmark case. This allow us to concentrate on effects of entrusted lending given others as constant. Some key variables including output growth, investment growth and TFP are reported in Figure 12.[28] Overall, Figure 12 suggest that output growth, investment growth and TFP could be lower in the absence of entrusted credits. In particularly, we find that output growth could be reduced by about 0.4% annually on average over 2011–2016. This magnitude is by no means trivial because such a decrease is able to move economic growth away from the growth target.[29] For example, the actual growth rate was 6.7% in 2016 and a 0.4% decrease would depress the growth rate below the lower bound of the growth target (6.5%). The failure to achieve the target could further give rise to panic among investors and pose threats to social stability (Chen et al., 2018). Moreover, since the absence of entrusted lending reduces TFP, China's transition to a productivity-driven economy could be delayed. Thus, the presence of entrusted lending is important for channeling credits to productive POEs and contributes to maintaining productivity-based economic growth. In this sense, our

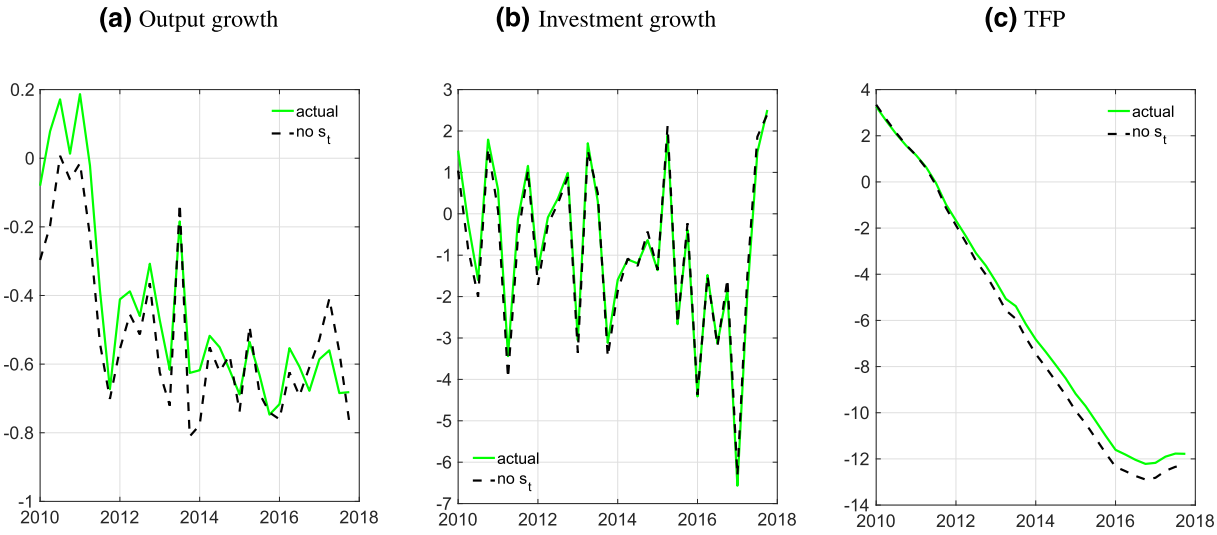

FIGURE 12 Growth slowdown: effects of entrusted lending. The paths of each variable in the counterfactual case (no s_t) are simulated by feeding in the consequence of exogenous shocks in Model Main. TFP, total factor productivity.

model provides a useful framework to address the issue of how to alleviate the downward pressure on China's economic growth.

6.2 | SOEs and growth in recessions

In this section, we investigate the effects of SOEs on China's economic recovery, with a particular focus on two recessions in the AFC and GFC, based on mechanisms provided in the above analyses. To this end, we compare output growth, investment growth and TFP with their counterparts in two counterfactual cases: one without SOE investment shock and another without the SOE sector.[30] These results are reported in Figures 13 and 14. The solid green lines refer to the case with all SOE elements while the red dash lines and blue dot dash line refer to the two counterfactual cases, respectively. We interpret the difference between the red and the blue lines as effects of privileged access to credits.

Overall, Figures 13 and 14 suggest that the presence of SOEs prevented China from a deep recession at the cost of TFP. In terms of the GFC period, Figure 13 shows that SOEs largely contribute to maintaining output growth and investment growth, especially through investment subsidies. If SOEs were removed from the economy, loss of both output growth and investment growth could be more than doubled. For example, the output growth would be reduced by 3.3% over 2008Q1–2008Q4 in the case without SOEs while the actual loss was 1.3%. Despite the dampening effects provided by SOEs, Figure 13c shows that TFP in the actual case was lower than the two counterfactual cases and the divergences became significant from 2008Q4. This timing coincided with the implementation of the Chinese economic stimulus plan, including subsidies for SOE investment. Moreover, Figure 13c shows that TFP gaps (between the green and two other lines) were gradually widened over time. This is because, on the one hand, the SOE investment shock has persistent effects on TFP growth, as suggested by the impulse response analysis. On the other hand, there were several rounds of stimulus measures (Zilibotti, 2017), which further exacerbated the loss on TFP.

For the AFC recession over 1998–1999, similar effects of SOEs can be found from Figure 14. A major difference is that investment subsidies played a dominant role in the GFC recession while privileged access to credits was more important in the AFC recession. This difference is particularly pronounced for TFP comparing the two recessions; the loss of TFP in the AFC period is almost entirely owing to SOEs' privileged access to credits (see the difference between blue dash-dot and red dash lines in Figure 14c). These results suggest that SOE intervention in the AFC recession was less heavier than in the GFC one. This is also confirmed by Figure 3 indicating smaller contributions of SOE investment shock to output growth in 1998–1999 than in 2008–2010. Although the Chinese government implemented some SOE investment subsidies in 1998 (WorldBank, 1999), government spending was more heavily used over 1998–1999.

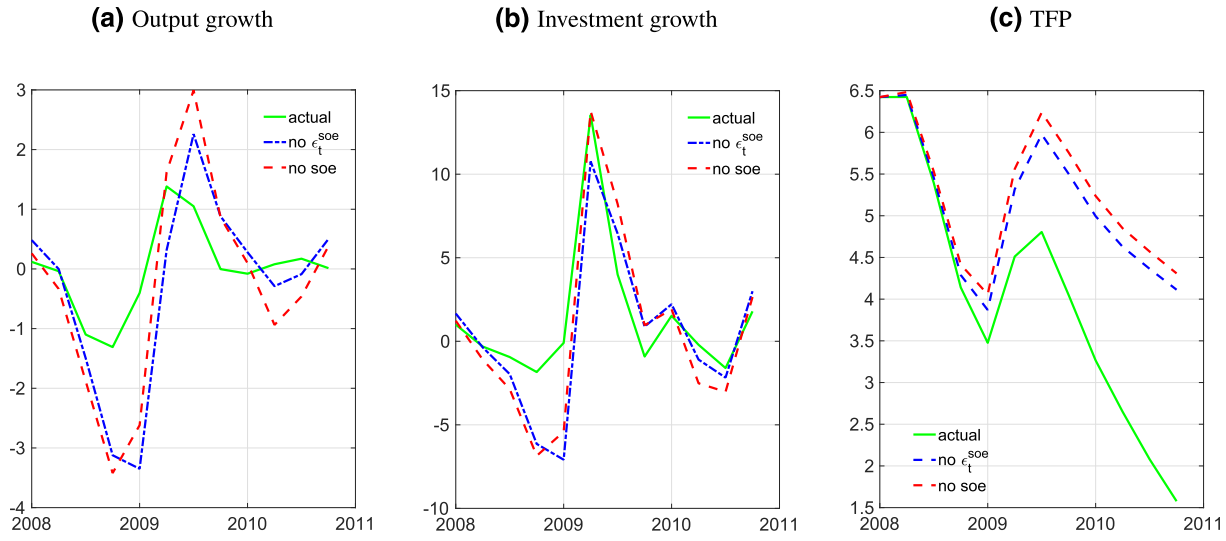

FIGURE 13 Global financial crisis: effects of SOEs. The paths of each variable in the two counterfactual cases are simulated by feeding in the consequence of exogenous shocks in Model Main. SOEs, state-owned enterprises; TFP, total factor productivity.

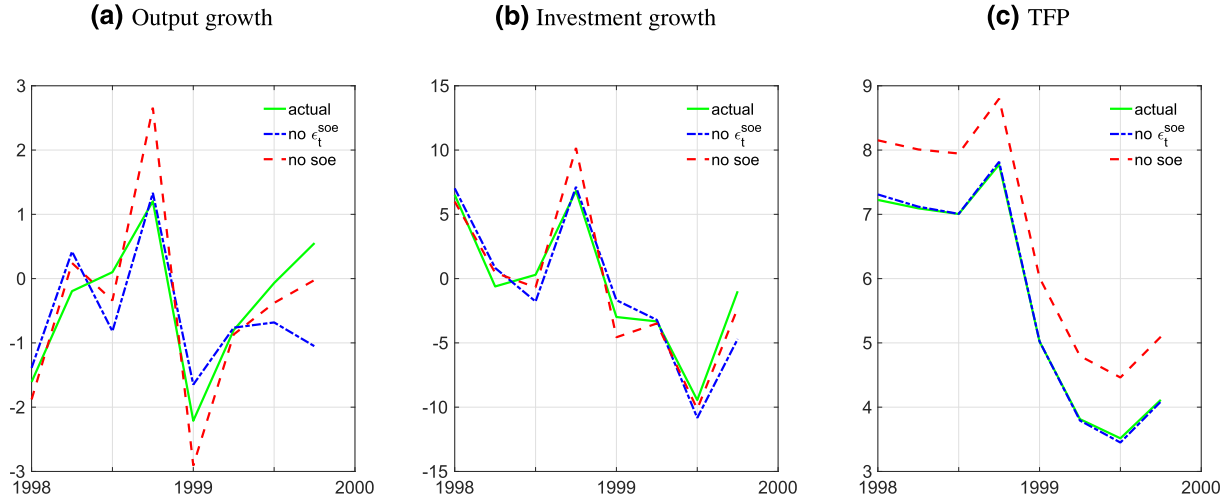

FIGURE 14 Asian financial crisis: effects of SOEs. The paths of each variable in the two counterfactual cases are simulated by feeding in the consequence of exogenous shocks in Model Main. SOEs, state-owned enterprises; TFP, total factor productivity.

7 | ROBUSTNESS CHECKS

In this section, we check robustness of our results by considering entrusted lending data in estimation and two trend variations including permanent TFP changes and SOE reforms.[31]

7.1 | Different entrusted loan shares

A key implication delivered in this paper is that entrusted lending can reduce aggregate volatility. This subsection investigates sensitivity of the result with respect to different entrusted loan shares in total loan. We conduct this investigation for four reasons. Firstly, the calibrated entrusted loan share might be subject to measurement errors as accounting shadow banking data at macro level is difficult. Secondly, there is a key concern that entrusted loans are also channeled to unproductive sectors in China, such as real estate sectors. This proportion[32] of entrusted loans may not provide reallocation effects and hence we want to remove this proportion in our exercises. Thirdly, entrusted lending developed rapidly and its share increased significantly during the last two decades. It is possible that the effects of

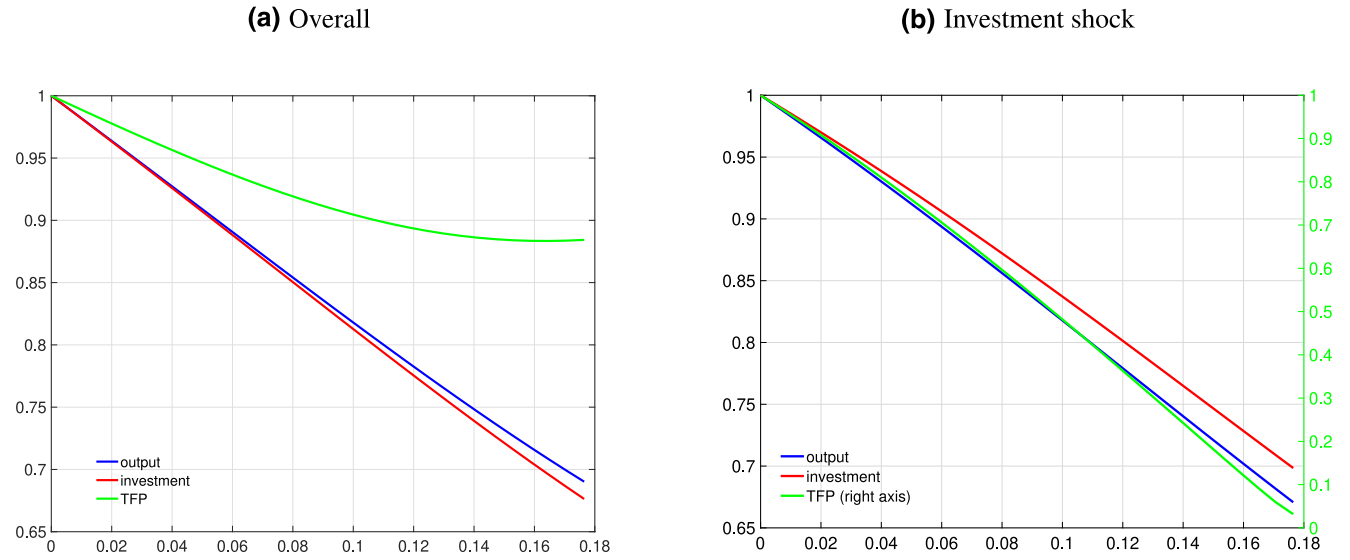

FIGURE 15 Entrusted loan share and volatility reduction. (a) This figure shows volatility reduction effects when all shocks are included. (b) This figure shows volatility reduction effects for the investment shock.

entrusted loans are conditional on the entrusted loan share. Last but not least, entrusted lending is part of inter-firm lending in China and the latter can be more sizable. By varying the entrusted loan share, we are able to shed light on the relationship between aggregate volatility and inter-firm lending.

Figure 15 shows that the aggregate volatility for output, investment and TFP is negatively related to the entrusted loan share. This result confirms the volatility reduction effect of entrusted lending, as shown in Section 5.3. Moreover, Figure 15 also shows that the volatility reduction effect becomes more significant if the entrusted loan share is larger, indicating a more important role of entrusted lending in the recent decade in China than before. Considering that entrusted loans account for up to 10% of total loans in the recent decade (see Table 2), Figure 15a implies a range of aggregate volatility reduction effect reaching up to 20% for output and investment, and 10% for TFP. The volatility reduction effect can be more pronounced for investment shocks, as shown by Figure 15b.

The analysis in this subsection provides an open answer to the effect of entrusted loans. Pessimist about the allocation efficiency provided by entrusted lending would tend to trust the effect closer to the lower bound. Whereas, optimists would tend to trust the effect closer to the upper bound.

7.2 | Trend TFP shock

In the post-crisis period, China entered a new era with relatively low economic and TFP growth. The above analyze suggest that persistent low TFP growth contributed to lower economic growth in the 2010s. Given that changes of TFP in China may have a permanent nature, we replace the temporary TFP shock ε_t^a in the model with a permanent TFP shock similar to Christiano et al. (2014). Equation (2) becomes $A_t^p = A^p(1+g^y)^t\varepsilon_t^z$, $p = SOE, POE$ where ε_t^z is the permanent TFP shock and its growth rate $(g_t^z = \Delta ln\varepsilon_t^z)$ follows a stationary AR(1) process: $lng_t^z = \rho_z lng_{t-1}^z + \eta_t^z$. η_t^z follows i.i.d $N(0, \sigma_Z^2)$.

Then we estimate the model based on the same dataset. Overall, we do not find fundamental changes in our major results. More importantly, the presence of trend TFP shock does not alter the important role of entrusted lending for maintaining economic growth in recent China (see Figure 3 in the Supporting Information S2).

7.3 | Time-varying SOE share

In this subsection, we focus on the SOE sector to address an issue of whether our results are sensitive to SOE reforms in China. Our baseline calibration suggests the share of the SOE sector in the economy is one-third. However, data suggest that this share has a downward trend. A potential impact is that the model might not be fully consistent with data,

which may lead to inaccurate estimation results for SOE investment shock. With this concern, we adjust the SOE investment data using SOE investment share. Based on the share-adjusted SOE investment growth, we rerun estimation. Overall, we do not find fundamental changes in our results.

8 | CONCLUSION

In this study we investigate macroeconomic implications of a key economic structure in China, namely the coexistence of SOEs and entrusted loan-based shadow lending. To this end, we build and estimate a DSGE model with SOEs who receive investment subsidies and privileged access to credits, but also direct credits to financially constrained POEs. Our findings suggest that SOEs lead to a trade-off in business cycles by dampening variation of output but amplifying that of TFP while the presence of entrusted lending could dampen variation of both output and TFP, hence mitigating the cost of SOEs.

In light of model features, we further interpret two recent recessions (1998–1999 and 2008–2009) and economic slowdown in China. Based on counterfactual experiments, we show that SOEs prevented the economy from a deep recession in both financial crisis periods at the cost of TFP. The loss in 1998–1999 was mainly caused by privileged access to credits, which creates a moderate trade-off between output and TFP. Hence TFP loss was relatively insignificant. Whilst the cost in 2008–2009 was primarily due to investment subsidies, which led to the TFP loss being more significant and persistent. Focusing on the recent growth slowdown in the 2010s, we further show that the healthy development of entrusted lending was able to improve allocation efficiency, and hence in recent years contribute to maintaining both economic growth and TFP in China.

Finally, our analysis sheds light on the development strategy of China's transition to a productivity-driven economy. In order to attain this target, stable macroeconomic environment and sustained TFP growth are indispensable. Although they could be achieved by developing the official financial system and private firms, yet this strategy alone requires long-term efforts with great challenges. Taking into this account, it is complementary for the Chinese economy to also maintain the coexistence of SOEs as business entities and the healthy components of shadow finance, to exploit their benefits through stabilization and reallocation effects.

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ENDNOTES

[1] Chen et al. (2018) show that banks actively bring shadow banking products onto the balance sheet and hence bear the risks.

[2] As examples, some common forms of investment subsidy include tax cuts, grants and assets transfer through the State-owned Assets Supervision and Administration Commission (Zilibotti, 2017).

[3] Specifically, business cycle studies about SOEs mainly focus on their links with the Chinese economic stimulus plan during the Financial Crisis period. Cong et al. (2019) show that the stimulus plan reversed the process of capital allocation toward POEs before 2008 based on loan-level data. Wen and Wu (2019) show a stabilization effect on employment through SOEs.

[4] Chang et al. (2019) also draw attention to resource allocation between SOEs and POEs due to adjustment of required reserve rate.

[5] Unlike Chang et al. (2019), who adopt a BGG framework and assume shadow borrowing as the only source of external finance for POEs, our model is based on a borrowing constraint (for official credits) and allows POEs to have limited access to official credits.

[6] It refers to the fact that funds are largely channeled to SOEs who are less productive. On the contrary, POEs, who are more productive, are discriminated by the formal financial system.

[7] Our calculation is based on the weighted averaged numbers of POE entrusted loan contracts. We use loan amount as weights.

[8] Alternatively, a price-based financial friction à la Bernanke et al. (1999) could be adopted. In Bernanke et al. (1999), credit premium is determined by firms' financial conditions. However, due to interest rate ceilings, the official lending rate in China is only allowed to fluctuate within a restricted interval, implying an ambiguous relationship between credit premium and firms' financial conditions.

[9] Although banks bring shadow banking products onto their balance sheets, the making of entrusted loans is still determined by non-financial firms (Chen et al., 2018).

[10] See Zetlin-Jones and Shourideh (2017) among others as an example of using a logarithmic function to model firm utility.

[11] In the main model, borrowing constraint is valued at the replacement cost. We also consider that capital price may affect the borrowing capacity such that $B_{jt}^{POE} \leqslant \varepsilon_t^f P_t q_t^{POE} K_{jt}^{POE}$. However, the capital market in China is less developed in early periods. The Bayesian model selection results in Section 4.3 also support the constraint without capital price.

[12] In practice, ε_t^s may capture factors that affect entrusted loans but unaccounted by the mode such as some regulatory changes, for example, Measures on the Administration of Entrusted Loans by Commercial Banks issued in 2018.

[13] See the Supporting Information S2: Appendix A for more details.

[14] $\Theta = H^{POE}\left(\alpha\lambda^{c,POE}A^{POE}\right)^{(1/(1-\alpha))}\left(r^{k,POE}\right)^{(2-\alpha)/(1-\alpha)}/[\gamma(1-\alpha)] > 0$

[15] In the main case that entrusted loan constraint is tight, entrusted loan amount is determined by entrusted lending constraint (Equation 11).

[16] For later analysis, we focus on the efficiency unit of G_t which is defined as $\varepsilon_t^g = G_t/(1+g^y)^t$. Government spending is anchored with output so that it is unnecessary to specify government expenditure separately.

[17] The full set of equilibrium conditions are reported in the Supporting Information S2: Appendix B.

[18] Note that the entrusted loans data are only available from 2001Q4. We also estimate the model for a sub-sample between 2001Q4 and 2017Q4. That results are similar to the benchmark one.

[19] Note that quarterly SOE investment data are only available until 2017Q4.

[20] GDP, consumption, two investment variables, wages, and two loan variables are expressed as first-difference. For more details of the observable variables used in our estimation, please refer to the Supporting Information S2: Appendix C2.

[21] A lower value of γ than β also implies POEs have binding borrowing constraint at steady state even when entrusted lending is shut down.

[22] The exogenous demand includes government spending and net export.

[23] The total SOE output data is not available for the whole sample period. Chang et al. (2019) calibrates SOE share as 0.3, which is not significantly different from us.

[24] Brandt et al. (2008) and Brandt and Zhu (2010) find relatively high TFP gap which is 1.8 and 2.3 respectively. Bajona and Chu (2010) and Chang et al. (2019) use relatively low values (about 1.4). Hsieh and Klenow (2009) find that productivity for SOEs is 42% lower than POEs in China, implying A^{POE} as 1.72 which does not significantly differ from our calibration.

[25] More details can be found from Table 2 in Supporting Information S2: Appendix D.

[26] See Figure 1b in Supporting Information S2: Appendix D.

[27] When comparing effects of SOEs, the entrusted loan market is shut down in the baseline model (i.e., Model SOE) which is then compared to the case that removes the SOE elements (which is labeled as Model NO SOE). This allows us to interpret the differences between the two models as the effects of SOEs.

[28] Figure 12c shows that Chinese TFP in the 2010s is persistently lower than the sample average. Such a pattern of TFP slowdown is found in other studies, for example, Chen, Chen, et al. (2019).

[29] The growth target is a interval planned by the government such that the growth is not too high (the economy is overheated) or too low. For instance the targeted interval was 6.5%–7% in 2016.

[30] Similar to the exercise in Table 6, we first shut down entrusted loan market in the baseline model and then further remove SOE elements in the counterfactual cases.

[31] Some key results are reported in the Supporting Information S2. For the reason of brevity, we do not report full results of the robustness check but they are available upon request.

[32] Based on loan amounts, Allen et al. (2019) suggest that this proportion is about 7%–14%.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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