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ABSTRACT

By constructing a "financial accelerator" model that combines real estate assets and heterogenous enterprises, we use China's housing price data to explore the effect of real estate assets on corporate debt and macroeconomic stability in the context of the Chinese economy. Based on the dynamic economic characteristics of the model, we find that the financial accelerator mechanism of housing prices further amplifies the various effects of housing price fluctuations when transmitted to the macroeconomic system, resulting in the size of corporate debt closely related to the economic boom–bust cycles. However, owing to the institutional factors, heterogenous firms have some differences in debt stability under the influence of asset price fluctuations. There is an obvious crowding-out effect of state-owned enterprise (SOE) credit on private-owned enterprise (POE) credit, and the existence of the implicit guarantee ratio of SOE credit will weaken the external financing constraints on the SOE and promote the expansion of SOE credit. Finally, the effect of fiscal and monetary policies on corporate debt stability is somewhat divergent, institutional factors can similarly weaken policy effects.

KEYWORDS

Corporate debt; fiscal and monetary policy; heterogenous enterprises; real estate assets

SUBJECT CLASSIFICATION CODES

G32; R31; G17

Introduction

Since the 21st century, as the weight of financial attributes increases, the fluctuation of real estate prices affects macro-financial stability more greatly. Entering the "Post-Crisis Era," with the impact of emergencies in recent years, global real estate prices have risen significantly. In China, the average price of commercial housing has grown rapidly since 2003 (CEIC database). Even if the central government have introduced policies in the second half of 2021 to cool, the real estate price growth is still expected to reach 3% (Chinese Academy of Social Sciences 2020–2021). Furthermore, China's corporate debt tends to rise rapidly—for instance, the number, non-financial corporate sector debt of the GDP, rose from 95.2% in 2008 to 154.8% in 2021, increasing by 62.61% (source: iFind database). Corporate debt plays an important role in the transmission of real estate

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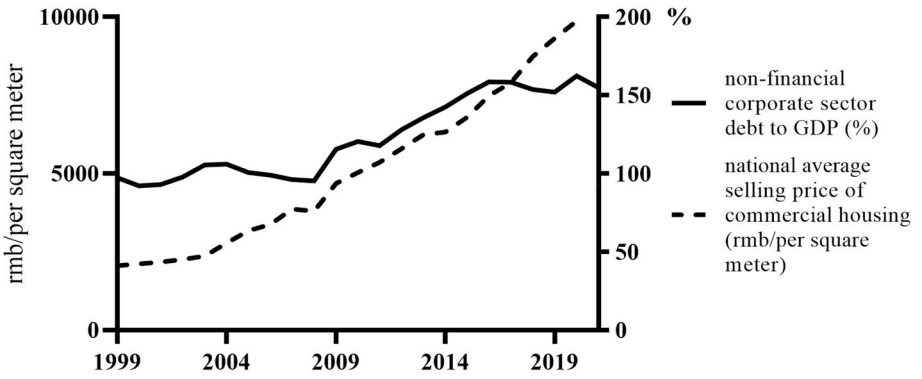

Figure 1. House price and corporate debt.

price volatility to macro-financial stability, mainly based on the debt-deflation theory, financial instability hypothesis, financial deepening theory, and balance sheet recession theory. What is more, the financial accelerator effect further amplifies the effect of house price volatility on systemic financial stability. Figure 1 illustrates China's housing prices and non-financial corporate debt.

Therefore, the innovations of this paper are as follows. First, this paper introduces real estate assets, including the financial accelerator of assets, to discuss the financial accelerator effect of real estate assets, and the link between real estate assets and corporate debt stability. This highlights the various effects of real estate assets in macroeconomic fluctuations, which is more in line with the real economic characteristics.

Second, to explore more deeply the differentiation phenomenon of heterogenous enterprise debt and make the model better reflect the institutional factors behind the stability of local government debt, we divide enterprises into SOEs and POEs. The numerical simulation results demonstrate that SOEs will significantly crowd out POEs credit. The existence of an implicit guarantee ratio will weaken the external financing constraints of SOEs and promote the SOEs' credit expansion.

Finally, considering corporate debt expansion is closely related to macroeconomic stability, we explore the effect of fiscal and monetary policies on heterogenous corporate debt. We find that the effect on corporate debt diverges with the presence of institutional factors, and weakens the policy effect.

Literature review

Real estate and corporate debt

Many scholars have studied the role of asset price bubbles in credit expansion and macroeconomic crises (Bernanke and Gertler 2001;

Mian and Sufi 2009; Aliber and Kindleberger 2015), which mainly focused on the transmission channels and the diffusion effects of asset price volatility. Minsky (1976) argued that, while Keynes mentioned the instability of the financial system and the emergence of financial bubbles, there was no systematic analysis of the role of financial factors in cyclical changes, especially ignoring the effect of debt structure on the economy. Although Minsky does not explicitly use the term "bubble" in his analysis, his famous financial instability hypothesis is essentially the theoretical framework for "financial bubbles." Later, in 1982, Minsky defined financial stability as "a process in which the prices of assets (financial and capital assets) change rapidly and rapidly relative to the prices of current output"—that is, a process by which financial bubbles form and burst. Based on the financial theory of investment and combined with the Kalecki profit equation, Minsky proposed a mechanism whereby the deviations that make up financial bubbles are amplified; central to this mechanism is the interdependence between profit and investment and the positive feedback loop between asset prices and debt. This amplification mechanism shows that the economic system itself has the dynamic of forming financial bubbles: as the economic boom continues, the mutually reinforcing relationship between profits and investment leads to a positive feedback dynamic between asset prices and debt. Debt accumulation and asset price inflation go hand in hand and reinforce each other, making the financial system increasingly fragile, and eventually bursting bubbles and collapsing economies (Minsky and Kaufman 2008).

Chaney, Sraer, and Thesmar (2012) argued that real estate price volatility affects business investment through the collateral channel; when the price rise, the value of collateral for firms that holding real estate industrial assets rises, and firms may use this as a basis to borrow more from the bank to invest more. Flannery and Lin (2015) found that real estate price volatility is transmitted to firms through the bank balance sheet channel. By constructing a DSGE model incorporating land price volatility, Liu, Wang, and Zha (2013) found that real estate price and land price volatility are transmitted to the credit sector through the corporate financing constraint channel, which further expands to the entire macroeconomy. Herring and Wachter (1999) analyzed housing prices and debt from two perspectives: firstly, rising real estate price will cost less for screening customers for bank loans, loosen credit standards, and lead to the expansion of corporate debt, which, in turn, generates bank credit risk; secondly, the increase in the value of corporate collateral brought about by rising real estate price triggers the phenomenon of "disaster myopia," which leads to an increase in corporate borrowing collateral and bank credit risk.

Structural issues with corporate debt

In the modern capitalist economy, investment mainly takes the form of indirect financing of external debt; hence, corporate debt constitutes the basic characteristic of the capitalist economy. An investment decision is basically a decision to issue debt, and debt contains commitments to pay and financing costs (Keen 2015; Keen 2013). In terms of financing constraints, post-Keynesian economics places great emphasis on two different channels: internal financing, that is, investment with retained earnings; and external financing, that is, debt and equity financing. Among them, retained earnings are used directly for investment on the one hand, and on the other hand, they are also the basis for external financing. According to Kalecki's (1972) increasing risk principle, the amount of external funds that a business can and is willing to obtain is closely related to retained earnings. Thus, the cost of external financing relates not only to interest rates, but also to the terms of the financing contract, including repayment terms and various conditional requirements, which are closely related to macroeconomic fluctuations.

Through the two-way guidance mechanism of real estate price volatility and credit expansion (Collyns and Senhadji 2003), the real estate market bubble will loosen the mortgage constraints on corporate loans and further ease credit (Miao and Wang 2014). Over time, if the bubble persists, firms will have to repay higher loans (Martin, Moral-Benito, and Schmitz 2018). Such a mechanism determines that corporate leverage amplifies and transmits adverse economic shocks through the financial accelerator mechanism, increasing the economy's vulnerability and affecting systemic financial stability (Bernanke, Gertler, and Gilchrist 1999).

While the problem of corporate leverage needs to be addressed, the structural problems exposed by high leverage cannot be ignored. For the leverage problem of firms of different natures, studies mainly distinguish between zombie firms and normal firms. Zombie firms are less productive than normal firms and have significantly lower exit thresholds, which distorts market competition and disrupts the reallocation of resources within the industry (Gouveia and Osterhold 2018). As a result, resource mismatch is exacerbated (McGowan et al. 2017) and the leverage profiles of zombie and normal firms diverge.

The peculiarities of China's economic system and financial market have led domestic scholars to pay more attention to the fiscal and policy factors behind the divergence of corporate leverage. Zhong et al. (2016) argued that the bank in China has a credit preference for inefficient SOEs, because they usually have more tangible assets, such as real estate assets for collateral. Jiang and Lu (2018) constructed a DID model to demonstrate that the soft budget constraint that the bank has on the SOE pushes up their

leverage, protects inefficient SOEs, and is detrimental to the exit of zombie enterprises in the SOE. Therefore, the "non-market" institutional root behind the long-term survival of state-owned zombie enterprises (Wang and Liu, 2018) makes them remain resilient owing to a series of reasons such as government-enterprise collusion and credit discrimination (Nie, Jiang, and Yang 2012).

Policy effects of maintaining the stability of corporate debt

Minsky (1957) argued that, along with an increase in economic activity, the debt burden of firms (the equity-liability ratio of firms) also increases. Increasing levels of corporate leverage are strongly associated with "boom-bust" cycles (Giroud and Mueller 2018), and high leverage can boost employment and improve welfare in the short run (Cecchetti, Mohanty, and Zampolli 2011). However, excessive leverage can significantly reduce firms' total factor productivity (Coricelli et al. 2012), increase firms' debt vulnerability and financial frictions, finally threaten systemic financial stability (Brunnermeier, Eisenbach and Sannikov 2012; Gou, Yuan, and Qi 2016).

Recognizing the regularity of economic cycles owing to fluctuations in investment and aggregate demand, Kalecki (1935) argued that it is absurd to think that the government can achieve and maintain full employment for a long time by ironing out cyclical fluctuations in the economy by expanding public investment and providing consumption subsidies to the general public. Eggertsson and Krugman (2012) proposed a debt-driven recession model that adopts forced deleveraging behavior to dampen aggregate demand and release the stock of debt. Pesaran and Xu (2011) found that the effect of credit shocks are more persistent and profound than technology shocks and that the recessions associated with credit shocks are more severe, while the findings of Mendoza and Terrones (2012) emphasize the importance of corrective policy actions to prevent credit booms. Gerlach and Peng (2005) found that monetary policy cannot be used to guard against asset price volatility and reduce leverage levels when real estate price significantly affect bank credit. Therefore, we find that the deleveraging behavior of most countries internationally is passive after experiencing a financial crisis.

Basic model

The model created in our study (hereinafter "the model") is an extension of the BGG (1999) model. As in BGG (1999), there are six sectors in the model, namely, the household sector, the entrepreneurs, the bank, local

government, retailers, and capital goods producers. Unlike BGG (1999), we introduce real estate assets into the model and set a demanding shock for real estate in the household sector to determine whether the effect of house prices on the real economy has the "financial accelerator" effect.

Second, to make the study more consistent with the realistic characteristics of the Chinese economy, the types of entrepreneurs set in the model are the SOE and POE. In addition to certain differences in productivity and capital stock between the SOE and the POE, it is more crucial that the SOE is "implicitly guaranteed" by the local government in the credit allocation process. All the facts demonstrate that the existence of "soft budget constraint" and "implicit guarantee" will reduce the fairness and effectiveness of the banking credit allocation process, weaken the effect of "leverage reduction policy" and supply-side reform, and affect macroeconomic and financial stability. Therefore, we embed the "implicit guarantee ratio" in the model to analyze whether institutional problems in the economy and society significantly affect corporate debt stability and corporate risk-taking capacity and whether such problems further affect macro-financial stability. For conciseness, we have placed the optimization conditions (first-order conditions) of each sector in the Appendix section (A1).

Households

Representative households maximize their utility by consuming, improving housing conditions, and providing labor:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left\{ ln(C_t) + j_t ln(H_{h,t}) + \xi ln(1 - N_t) \right\} \tag{1}$$

where C_t denotes the consumption of the household sector for general goods, $H_{h,t}$ is the real estate assets purchased by the household sector to improve housing conditions,[1] and labor hours are given by N_t. $\beta \in (0,\ 1)$ is the discount factor of household sector, and ξ is the relative importance coefficient of labor in the household's utility function. We denote j_t as the shock to a household's taste for housing services. Given the central role of housing demand shock in our model, it is critical to discuss what might financial shock represent. We assume that the housing demand shock, like any other shocks in our model, such as including technology shock and monetary policy shock, is a simplified form representation of friction or some "deeper" shock that is outside of the standardized model. It follows the autoregressive (AR [1]) process as follows:

$$\log j_t - logj = \rho_j(\log j_{t-1} - logj) + \varepsilon_{j,t} \tag{2}$$

where $j > 0$ indicates that households' demand for real estate is constantly

greater than zero in the steady state; and ρ_j measures the persistence of housing demand shock. Cash flows of household are subject to the following budgetary constraints:

$$s.t.\ C_t + Q_{h,t}\left[H_{h,t+1} - (1-\delta_h)H_{h,t}\right] + T_t + D_{t+1} \leq R_t D_t + W_t N_t \tag{3}$$

From the income side, the source of income in the household sector is mainly composed of interest income from current savings $R_t D_t$ and wage income $W_t N_t$ by providing labors. Where R_t is the risk-free saving rate, D_t is the amount of savings currently owned by the household sector, and W_t is the wage level. From the expenditure side, the household sector's funds are mainly used to consume general goods, purchase real estate assets, pay taxes, and save. Where $Q_{h,t}$ is the house price, $H_{h,t}$ is the number of real estate assets held by the household sector, δ_h is the depreciation factor of real estate assets, T_t is the taxes paid by the households, and D_{t+1} is the savings for households.

Heterogenous entrepreneurs and bank loan contracts

Entrepreneurs in our model are divided into two types: SOE and POE. Heterogenous entrepreneurs both produce general goods by investing in physical assets, real estate assets, and labor. Their production function is presented in Cobb-Douglas form as follows:

$$Y_{i,t} = A_{i,t}\left[(1-a)(K_{i,t})^{-\nu} + a(H_{i,t})^{-\nu}\right]^{-\frac{\alpha}{\nu}}(N_{i,t})^{1-\alpha} \tag{4}$$

where $i = \{s, ns\}$, s represents the SOE, and ns represents the POE. $Y_{i,t}$ represents the output of heterogenous enterprises, and $A_{i,t}$ is the total factor productivity (TFP) of heterogenous enterprises. Since the SOE is usually considered an overcapacity and more inefficient in the market (Brandt et al. 2020), we assume that the total factor productivity of the SOE in the steady state is lower than POE. Generally, the total factor productivity of enterprises in the steady state is set to 1. However, to highlight the divergence between the TFP of the SOE and POE, we set the total factor productivity A_s of the SOE to 0.8 according to the steady state. $K_{i,t}$ represents the other physical assets that heterogenous entrepreneurs invested in the production activities, $H_{i,t}$ is the real estate assets required by heterogenous entrepreneurs to put in production, and $N_{i,t}$ is the labor force required by heterogenous entrepreneurs. $\nu = (1-\xi)/\xi$, where ξ is the elasticity of substitution between physical assets and real estate assets, and a reflects the importance of real estate assets in production process. Heterogenous entrepreneurs purchase real assets for production at the end of period $t-1$ and sell undepreciated assets to producers of capital goods in period t. $Q_{h,t}H_{i,t}$ is the real estate assets purchased by heterogenous entrepreneurs, $W_{i,t}N_{i,t}$

is the compensation for labor paid by entrepreneurs to households. The objective of heterogenous entrepreneurs is to maximize their profits:

$$\max\left\{ Y_{i,t} + (1-\delta_k)Q_{k,t}K_{i,t} - R^k_{i,t}Q_{k,t-1}K_{i,t} - Q_{h,t}H_{i,t} - W_{i,t}N_{i,t} \right\} \tag{5}$$

where $Q_{k,t}$ is the price of physical capital and δ_k is the depreciation factor of physical capital. Thus, the first-order condition on the rate of return on physical capital held by heterogenous entrepreneurs is

$$R^k_{i,t} = \frac{\alpha(1-a)(K_{i,t})^{-\nu-1}\frac{Y_{i,t}}{X_t\left[(1-a)(K_{i,t})^{-\nu}+a(H_{i,t})^{-\nu}\right]} + (1-\delta_k)Q_{k,t}}{Q_{k,t-1}} \tag{6}$$

At the same time, heterogenous entrepreneurs purchase new real estate assets in period t and sell them in period $t+1$. Therefore, the rate of return for heterogenous entrepreneurs holding real estate assets is

$$E_t\left\{R^h_{t+1}\right\} = \frac{Q_{h,t+1}}{Q_{h,t}} + \Delta \tag{7}$$

The first-order conditions for heterogenous entrepreneurs to hold real estate assets is

$$Q_{h,t} = a\alpha(H_{i,t})^{-\nu-1}\frac{Y_{i,t}}{X_t\left[(1-a)(K_{i,t})^{-\nu}+a(H_{i,t})^{-\nu}\right]} \tag{8}$$

The total return on the entrepreneurs' asset holdings is weighted by the rate of return on the capital and real estate assets held separately:

$$R_{i,t+1} = \frac{Q_{k,t}K_{i,t+1}}{Q_{k,t}K_{i,t+1}+Q_{h,t}H_{i,t}}R^k_{i,t+1} + \frac{Q_{h,t}H_{i,t}}{Q_{k,t}K_{i,t+1}+Q_{h,t}H_{i,t}}R^h_{t+1} \tag{9}$$

At the end of each period, entrepreneurs take loans from financial intermediaries and add their funds, $Net_{i,t+1}$, to purchase the physical assets needed for the next period as well as to make real estate investments. The loan size $B_{i,t+1}$ for heterogenous entrepreneurs is

$$B_{i,t+1} = Q_{k,t}K_{i,t+1} + Q_{h,t}H_{i,t} - Net_{i,t+1} \tag{10}$$

Therefore, the leverage ratio of the entrepreneurs is

$$L_{i,t} = \frac{Q_{k,t}K_{i,t+1}+Q_{h,t}H_{i,t}}{Net_{i,t+1}} \tag{11}$$

However, entrepreneurs' investment returns are subject to exogenous heterogeneity shocks, which will directly cause fluctuations in entrepreneurs' investment returns, exacerbate entrepreneurs' investment risk, make changes in the value of entrepreneurs' assets, and threaten entrepreneurs' sources to pay debt. Therefore, the bank sets up loan contracts based on the value of the entrepreneur's assets, the net worth of them, and the

heterogenous shocks to which the entrepreneur was subjected in the previous period:

$$\overline{\omega}_i R_{i,t+1}(Q_{k,t}K_{i,t+1} + Q_{h,t}H_{i,t}) = Z_{i,t+1}(Q_{k,t}K_{i,t+1} + Q_{h,t}H_{i,t} - Net_{i,t+1}) \tag{12}$$

where $\overline{\omega}_i$ is the bankruptcy threshold for heterogenous entrepreneurs, which can be interpreted as a risk shock in the economy. If the heterogeneity shock to the entrepreneur in the next period is greater than $\overline{\omega}_i$, the entrepreneur's investment is successful, and the entrepreneur can take the remainder of the investment return in addition to the loan repayment. If the heterogeneity shock received by the entrepreneur in the next period is less than $\overline{\omega}_i$, the entrepreneur faces bankruptcy and becomes "insolvent," the entrepreneur defaults on the loan and the bank repossesses the assets held by the entrepreneur. $Z_{i,t+1}$ is the interest rate on the loan faced by the entrepreneur and can be expressed as

$$Z_{i,t+1} = \overline{\omega}_i R_{i,t+1} \frac{L_{i,t}}{L_{i,t} - 1} \tag{13}$$

The above equation illustrates that the cost of external financing for entrepreneurs is closely related to the level of risk shocks and leverage to which they are opposed to. An overall increase in the bankruptcy threshold indicates that the likelihood of entrepreneurs defaulting increases, and therefore the bank tightens credit, while the creation of leverage by firms also simultaneously implies an increase in the likelihood of corporate debt defaults, which also forces the bank to raise lending rates and reduce losses from corporate defaults. Given the loan contract, the POE's expected return is

$$E_{t+1}\left\{\left[\int_{\overline{\omega}_{ns}}^{\infty} \omega_{ns} f(\omega_{ns}) d\omega_{ns} - [1 - F(\overline{\omega}_{ns})]\overline{\omega}_{ns}\right] R_{ns,t+1}(Q_{k,t}K_{ns,t+1} + Q_{h,t}H_{ns,t})\right\} \tag{14}$$

where $f(\omega_{ns})$ is the probability density function of ω_{ns}, and $F(\overline{\omega}_{ns})$ is the probability of bankruptcy of the POE. $\left[\int_{\overline{\omega}_{ns}}^{\infty} \omega_{ns} f(\omega_{ns}) d\omega_{ns} - [1 - F(\overline{\omega}_{ns})]\ \overline{\omega}_{ns}\right]$ is the proportion of investment income held by the POE, defined as $\emptyset(\overline{\omega}_{ns})$. In sum, the POE uses net assets $Net_{ns,t+1}$ to create leverage. We use leverage to represent the expected returns of POE as

$$E_{t+1}\left[\emptyset(\overline{\omega}_{ns}) R_{ns,t+1} L_{ns,t}\right] \tag{15}$$

In contrast to the POE, the expected return to the bank holding the loan contract consists of two components: the return to the bank from recovering the entrepreneur's assets in the event of the entrepreneur's bankruptcy and the interest income from the loan if the entrepreneur

continues to operate. It is worth noting that due to the existence of information asymmetry, banks cannot directly know the operation of private entrepreneurs and the possibility of bankruptcy, and must pay μ proportion of the supervision cost to observe the return on assets of entrepreneurs, which can be regarded as bankruptcy costs and deducted from the recoverable asset value of entrepreneurs. Thus, the bank's expected return can be expressed as

$$\left[(1-\mu)\int_0^{\overline{\omega}_{ns}} \omega_{ns} f(\omega_{ns}) d\omega_{ns} + [1-F(\overline{\omega}_{ns})]\overline{\omega}_{ns}\right] R_{ns,t+1}(Q_{k,t}K_{ns,t+1} + Q_{h,t}H_{ns,t}) \tag{16}$$

where $\left[(1-\mu)\int_0^{\overline{\omega}_{ns}} \omega_{ns} f(\omega_{ns}) d\omega_{ns} + [1-F(\overline{\omega}_{ns})]\overline{\omega}_{ns}\right]$ is the bank's share of earnings, defined as $g(\overline{\omega}_{ns})$, so that the bank's earnings, expressed in terms of corporate leverage, are

$$g(\overline{\omega}_{ns}) R_{ns,t+1} \frac{L_{ns,t}}{L_{ns,t}-1} \tag{17}$$

In summary, the loan contract can be represented as one in which the POE maximizes their expected return through leverage $L_{ns,t}$ as well as $\overline{\omega}_{ns}$ while bounding by the loan contract. Banks are risk neutral, and the opportunity cost is the risk-free rate R_{t+1}, and their return must greater than the opportunity cost. Thus, the utility function of the POE can be expressed as

$$\max_{L_{ns,t},\overline{\omega}_{ns}} E_{t+1}\left[\emptyset(\overline{\omega}_{ns}) R_{ns,t+1} L_{ns,t}\right] \tag{18}$$

$$st.\ g(\overline{\omega}_{ns}) R_{ns,t+1} \frac{L_{ns,t}}{L_{ns,t}-1} \geq R_{t+1} \tag{19}$$

The biggest difference between the SOE's and the POE's loan contracts is that the SOE's credit is "implicitly guaranteed" by government departments, denoted by S_{t+1}, that is, the government will underwrite SOEs when the SOE faces bankruptcy and insolvency. Given the loan contract, the expected return to the SOE is

$$E_{t+1}\left\{\int_{\overline{\omega}_s}^{\infty} \omega_s f(\omega_s) d\omega_s [R_{s,t+1}(Q_{k,t}K_{s,t+1} + Q_{h,t}H_{s,t})] - (1-F(\overline{\omega}_s))\overline{\omega}_s R_{s,t+1}(Q_{k,t}K_{s,t+1} + Q_{h,t}H_{s,t}) - F(\overline{\omega}_s) S_{t+1}\right\} \tag{20}$$

where $b_{t+1} = \frac{S_{t+1}}{R_{s,t+1}(Q_{k,t}K_{s,t+1}+Q_{h,t}H_{s,t})}$ is the "implicit guarantee" ratio, which is the ratio of the guarantee amount to the return on the SOE's assets, measures the degree of government guarantee of the SOE's debt. Therefore, the

above equation can be reduced to:

$$E_{t+1}\left\{\left[\int_{\overline{\omega}_s}^{\infty}\omega_s f(\omega_s)d\omega_s-[1-F(\overline{\omega}_s)]\overline{\omega}_s-b_{t+1}\right]R_{s,t+1}(Q_{k,t}K_{s,t+1}+Q_{h,t}H_{s,t})\right\} \tag{21}$$

where $\emptyset(\overline{\omega}_s)=\left[\int_{\overline{\omega}_s}^{\infty}\omega_s f(\omega_s)d\omega_s-[1-F(\overline{\omega}_s)]\overline{\omega}_s-b_{t+1}\right]$ is the share of earnings of the SOE. In summary, the SOE uses net assets $Net_{s,t+1}$ to create leverage, with expected returns expressed as

$$E_{t+1}\left[\emptyset(\overline{\omega}_s)-b_{t+1}\right]R_{s,t+1}L_{s,t} \tag{22}$$

Similarly, banks' expected returns are made up of two components. When the heterogeneity shock to the SOE is less than the bankruptcy threshold $\overline{\omega}_s$, the SOE surrenders its assets, and the implicit guarantee S_{t+1} provided by the government is used to repay the debt and avoid the bankruptcy of the SOE. Banks' expected returns can be expressed as

$$\left\{b_{t+1}+(1-\mu)\int_0^{\overline{\omega}_s}\omega_s f(\omega_s)d\omega_s+[1-F(\overline{\omega}_s)]\overline{\omega}_s\right\}R_{s,t+1}(Q_{k,t}K_{s,t+1}+Q_{h,t}H_{s,t}) \tag{23}$$

We define $g(\overline{\omega}_s)=(1-\mu)\int_0^{\overline{\omega}_s}\omega_s f(\omega_s)d\omega_s+[1-F(\overline{\omega}_s)]\overline{\omega}_s$ as the bank's share of earnings, so that the bank's expected rate of return is

$$\frac{\left[g(\overline{\omega}_s)+b_{t+1}\right]R_{s,t+1}L_{s,t}}{L_{s,t}-1} \tag{24}$$

In sum, the loan contract problem can be represented as one in which the SOE maximizes its expected return through leverage $L_{ns,t}$, the implicit guarantee ratio b_{t+1}, and $\overline{\omega}_{ns}$, and is bounded by the loan contract. Thus, the utility function of the SOE can be expressed as

$$\max_{\overline{\omega}_s,L_{s,t}} E_{t+1}\left[\emptyset(\overline{\omega}_s)-b_{t+1}\right]R_{s,t+1}L_{s,t} \tag{25}$$

$$s.t.\frac{\left[g(\overline{\omega}_s)+b_{t+1}\right]R_{s,t+1}L_{s,t}}{L_{s,t}-1}\geq R_{t+1} \tag{26}$$

There are more comparisons between POE and SOE, we discussed them in A2.

Finally, defining $V_{i,t}$ as the entrepreneurial capital of a heterogenous entrepreneur, the entrepreneur's net worth in period t is given by the following equation:

$$Net_{i,t+1}=\gamma_i V_{i,t} \tag{27}$$

where γ_i is the survival rate of heterogenous entrepreneurs, $\gamma_i V_{i,t}$ is the

equity of entrepreneurs who are still in business, and entrepreneurs that failed in period t will consume the residual value of entrepreneurial assets at

$$C_{i,t}^{e} = (1-\gamma_i)V_{i,t} \tag{28}$$

The equation for the accumulation of net assets of the entrepreneurs is

$$\begin{aligned} Net_{i,t+1} =& \gamma_{ns}[(R_{i,t}-R_t)(Q_{k,t-1}K_{i,t}+Q_{h,t-1}H_{i,t-1}) \\ &+ \iota_{i,t}(Q_{k,t-1}K_{i,t}+Q_{h,t-1}H_{i,t-1}-Net_{i,t})+R_tNet_{i,t}] \end{aligned} \tag{29}$$

where $\iota_{i,t} = \mu\int_0^{\overline{\omega}_i}\omega_i f(\omega_i)R_{i,t}(Q_{k,t-1}K_{i,t}+Q_{h,t-1}H_{i,t-1})d\omega_i$ represents the cost of bankruptcy for heterogenous entrepreneurs.

Government

Government expenditures are financed by taxes paid by the household and satisfy the following budget constraints:

$$G_t = T_t \tag{30}$$

where government spending G_t is set as an exogenous shock variable in the model and obeys the AR(1) process:

$$\begin{gathered} \log G_t - logG = \rho_g(\log G_{t-1} - logG) + \varepsilon_{g,t} \\ \varepsilon_{g,t} \sim N(0,\sigma_g^2) \end{gathered} \tag{31}$$

Monetary Authority

The monetary authority sets the policy interest rate R_t^n according to the Taylor rule:

$$\begin{gathered} \frac{R_t^n}{\overline{R^n}} = \left(\frac{R_{t-1}^n}{\overline{R^n}}\right)^{\rho_n}\left[\left(\frac{Y_t}{\overline{Y}}\right)^{\nu_y}\left(\frac{E_tP_{t+1}}{\overline{P}}\right)^{\nu_\pi}\right]^{1-\rho_n}\exp(\varepsilon_{n,t}) \\ \varepsilon_{n,t} \sim N(0,\sigma_n^2) \end{gathered} \tag{32}$$

where $\overline{R^n}$, $\overline{Y}$, and $\overline{P}$ are the nominal interest rate, output, and price at a steady state, respectively. $\pi_t = \frac{P_t}{P_{t-1}}$ is defined as the inflation rate, ν_π and ν_y are the Taylor rule response coefficients for inflation and output, ρ_n is the interest rate smoothing coefficient, and ε_t^r is the monetary policy shock.

Capital Goods producers

The producer of capital goods produces two separate capital goods—real estate assets and physical assets. They purchase depreciated assets from the entrepreneurial sector at the end of period t, and increase investment to

produce capital goods that are available for use in the next period. The production function is

$$K_{t+1} = \phi\left(\frac{I_{k,t}}{K_t}\right)K_t + (1-\delta_k)K_t \tag{33}$$

$$H_{t+1} = \phi\left(\frac{I_{h,t}}{H_t}\right)H_t + (1-\delta_h)H_t \tag{34}$$

where $\phi(\cdot)$ means the investment adjustment cost.

Retailer

We introduce price stickiness in the retailer sector following the Calvo (1983) pricing model. The pricing equation for the final product is

$$P_t = \left[(1-\theta)P_t^{*1-\varepsilon} + \theta {P_{t-1}}^{\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{35}$$

Market clearing conditions

Total supply-side output is co-added by the output of heterogenous firms:

$$Y_t = \left[P_s {Y_{s,t}}^{\lambda} + (1-P_s){Y_{ns,t}}^{\lambda}\right]^{\frac{1}{\lambda}} \tag{36}$$

where P_s is the share of the SOE in the market and λ is the elasticity of substitution of the output of the heterogenous entrepreneurs. The sum of physical assets and real estate assets is

$$K_t = P_s K_{s,t} + (1-P_s)K_{ns,t} \tag{37}$$

$$H_t = H_{h,t} + P_s H_{s,t} + (1-P_s)H_{ns,t} \tag{38}$$

In the labor market, we assume that there is no difference in labor supply between the SOE and the POE:

$$N_{s,t} = N_{ns,t} = N_t \tag{39}$$

The real wage level is determined by weighting the respective real wages of heterogenous firms:

$$W_t = P_s W_{s,t} + (1-P_s)W_{ns,t} \tag{40}$$

where $W_{i,t} = \frac{(1-\alpha)Y_{i,t}}{X_t N_{i,t}}$ is the respective real wage level of the heterogenous enterprises. Finally, total output is summed based on expenditure method:

$$Y_t = C_t + I_{k,t} + I_{h,t} + C^e_{ns,t} + C^e_{s,t} + G_{t+1} \tag{41}$$

Table 1. Calibrated parameters.

Parameter	Description	Value
β	Discount factor households	0.993
j	Real estate demand shock in steady state	0.2
$\frac{I_k}{Y}$	Proportion of physical capital investment in total output	0.25
$\frac{I_h}{Y}$	Proportion of real estate investment in total output	0.1
$\frac{G}{Y}$	Proportion of government expenditure in total output	0.15
$\frac{C}{Y}$	Proportion of household consumption in total output	0.36
$\frac{C^e}{Y}$	Proportion of enterprise consumption in total output	0.14
δ_h	Depreciation rate real estate	0.01
γ_{ns}	Survival rate of the POE	0.97
γ_s	Survival rate of the SOE	0.98
Δ	Expected rate of return on holding real estate	0.02
δ_k	Depreciation rate physical capital	0.025
v	Elasticity of substitution between real estate assets and physical capital	0.7
$1-\alpha$	Labor output coefficient	0.55
a	Importance of real estate aassets to enterprise production	0.7
$\frac{Y_s}{K_s}$	Reciprocal of capital output ratio of the SOE	1/4
$\frac{Y_{ns}}{K_{ns}}$	Reciprocal of capital output ratio of the POE	1/3
μ	Proportion of supervision and disposal costs of commercial banks	0.21
$F(\bar{\omega}_{ns})$	Steady state value of bankruptcy probability of the POE	0.01
$F(\bar{\omega}_s)$	Steady state value of bankruptcy probability of the SOE	0.007
$\bar{\omega}_{ns}$	Threshold of external risk effect on the POE	0.5193
$\bar{\omega}_s$	Threshold of external risk effect on the SOE	0.4947
$\emptyset(\bar{\omega}_{ns})$	Income share of the POE	0.4811
$g(\bar{\omega}_{ns})$	Income share of commercial banks to the POE	0.5121
$\emptyset(\bar{\omega}_s)$	Income share of the SOE	0.5035
$g(\bar{\omega}_s)$	Income share of commercial banks to the SOE	0.4920
φ_k	Adjusted cost coefficient of physical capital investment	0.5
φ_h	Adjusted cost coefficient of real estate investment	0.3
P_s	Proportion of the SOE	0.5
λ	Substitution elasticity of heterogenous enterprise output	1.5
N	Steady state labor	1/3
v_y	Response coefficient to total output	0.78
v_π	Response coefficient to inflation	1.1

Estimation

Following the convention of the DSGE model, the equations around the equilibrium growth path of the outlined model are log-linearized, and the parameters involved in the model are calibrated in this section.

For the calibration of parameters, most parameters are extrapolated based on real macroeconomic data and the steady-state model to match the steady-state values of variables in the model with actual economic data, and the remaining parameters are calibrated based on authoritative literature. The parameter calibration results are shown in Table 1, and the specific solution process is shown in the Appendix (A3).

Dynamic feature simulation

Impact of house price fluctuations on key economic variables

In analyzing the dynamic economic characteristics of the model, we use housing price fluctuations caused by housing demand shock as a

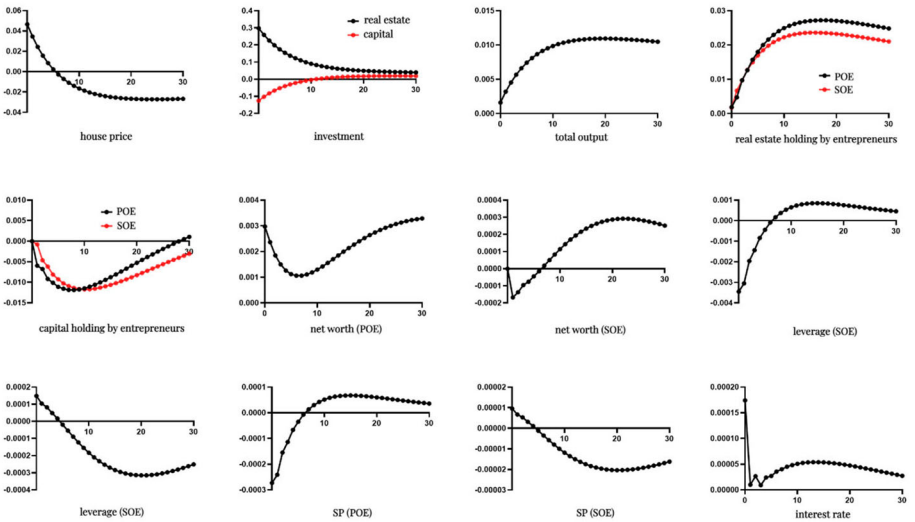

Figure 2. Real estate demanding shock.

benchmark to explore the transmission mechanism of housing price fluctuations on corporate debt stability and other economic variables.[2] The horizontal coordinate of all impulse response figures in this paper is quarters, and vertical coordinate is the percent deviation from the steady-state values of variables. Figure 2 illustrates the impulse responses of the main economic variables under a one-unit positive housing demand shock in the household sector. From Figure 2, it can be seen that a one-unit positive housing demand shock in the household sector will further boost investment in real estate assets by increasing demand in the real estate market and pulling up house prices. Since we assume that real estate assets take an important role in of enterprises' production operations, real estate investment will initially squeeze out physical capital investment.

Specifically, heterogenous entrepreneurs under housing demand shock differ in their holding behavior for two different assets. Owing to the current strong demand for real estate assets, heterogenous entrepreneurs will increase their holdings of real estate assets and decrease their holdings of physical assets in the short term. According to the model setting and the real economic characteristics, the amount of all kinds of assets held by SOEs are greater than those held by POEs, therefore the increase of real estate assets held by the SOE is larger than that of the POE, while the decrease of physical assets held by the SOE is smaller than that of the POE. Owing to the increase in housing prices and the increase in real estate assets held by enterprises, the net value of the POE increased significantly. At the same time, because of the large amount of physical assets held by the SOE and the serious value shrinkage caused by the decline in the prices of physical assets, which, in turn, reduced the net value of SOEs to a

certain extent. However, in the medium and long term, as the prices of physical assets are no longer significantly squeezed by housing prices, the net value of the SOE gradually increases.

The effect of housing price fluctuations on the leverage ratio of the heterogenous enterprises is differentiated. For POE, as their asset size is not large, the increase in corporate net worth brought about by rising housing prices exceeds the increase in total assets, the leverage ratio will fall in the short term, and the external financing premium of POE affected by corporate leverage ratio will also decline. At this time, POE's demand for credit increases, and they will choose to further expand the size of debt. Hence, in the medium and long term, the leverage level of POE is driven by the size of corporate debt to increase further. For SOE, because their asset size is very large, increased housing price in the short term makes the value of the SOE's total assets grow faster than the net value, therefore, the level of SOE leverage increases in the short term, making the SOE external financing premium increase in response to the leverage level. As demand continues to increase, the net worth of the SOE will gradually increase, causing the bank to loosen their credit constraints on the SOE, and the credit demand of the SOE will further expand. Figure 2 also illustrates that the decline in external financing constraints for heterogenous entrepreneurs following a housing demand shock is significantly larger than its degree of rise, so that for the whole enterprise sector, more relaxed external financing constraints will lead to an expansion in credit demand in both the short and long run.

The decline in the external financing premium for heterogenous enterprises brought about by rising housing prices will further stimulate investment in the economy as well as the rise in asset prices, resulting in a significant increase in aggregate output and the economy enters a boom cycle, which is the "financial accelerator" effect of housing prices. Once the housing bubble bursts, the net asset value of the enterprises will shrink rapidly, and if the asset value is not enough to repay the bank loan, enterprises will face bankruptcy. A massive bankruptcy of enterprises in the economy would lead not only to massive unemployment but also to a large effect on the financial stability. The existence of the "financial accelerator" mechanism would eventually make the production level suffer a severe blow from the effect of asset prices. Therefore, the fluctuation of housing prices will significantly affect corporate debt and will be further transmitted to the macroeconomic and financial system. Because of the existence of the "financial accelerator" mechanism, the various effects of house price fluctuations will be further amplified when transmitted to the macroeconomic system, resulting in the stability of corporate debt under the effect of house prices closely related to the economic "boom-bust" cycle.

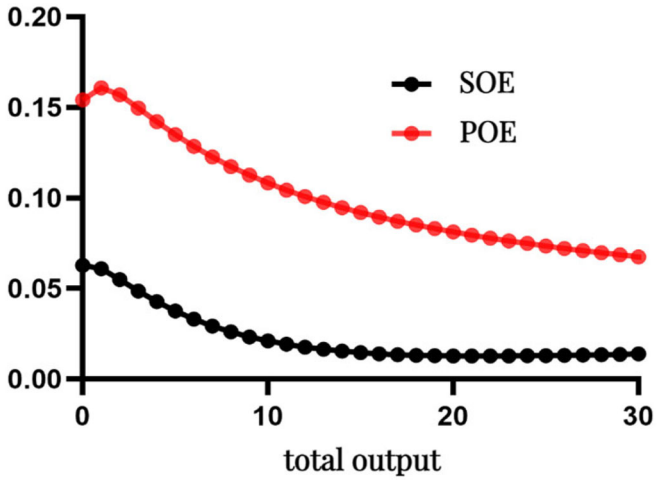

Figure 3. POE's and SOE's contribution to total output.

Finally, owing to the expansion of aggregate demand, the central bank will tighten monetary policy to curb demand and avoid a series of problems associated with an overheated economy, which will eventually lead to an increase in the level of interest rates. Moreover, a series of housing price related regulatory policies adopted by policymakers, which can be seen as negative shocks to housing demand, can effectively reduce real estate demand and avoid the risk of economic bubbles brought by excessive housing price growth. However, it will also simultaneously make corporate net worth shrink, affect corporate debt stability, and reduce the level of aggregate output. Therefore, the implementation of strict housing price regulation policies during economic crisis may further exacerbate the difficulties of the real economy.

Institutional factors underpinning corporate debt stability

According to the model construction part and the impulse response analysis of economic variables under housing demand shocks, there is a significant divergence between the debt situation of the SOE and the POE. The difference between the POE and the SOE is often reflected in productivity, SOE is usually considered to be operating inefficiently and with excess capacity. As illustrated in Figure 3, the contribution of one-unit positive TFP shock of the POE to the level of total output is significantly higher than that of the SOE, indicating that the efficiency problems of the SOE are detrimental to economic growth.

However, as the available resources in the market are limited, SOEs and POEs compete in the factor market. In particular, in the credit market, SOEs have significant advantages over POE. Although the productivity of

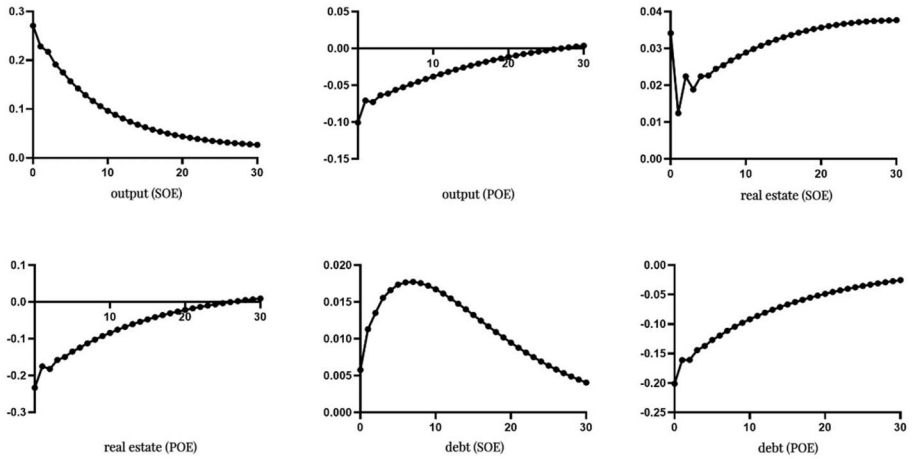

Figure 4. TFP shock of SOE.

SOE is lower than that of POE, SOE still occupy more credit resources, causing crowding out of POE's credit resources. As illustrated in Figure 4, under one unit positive TFP shock of SOEs, the output of SOE will increase owing to the improvement of SOE's total factor productivity, SOE will expand their production size and increase their investment in real estate assets. Due to the size expansion needs of SOEs, the credit demand for SOE will increase, and the size of corporate debt will further expand, which makes credit resources flow significantly to the SOE, and the POE credit resources are squeezed out. As POE's credit funds are squeezed, their investment capacity is also limited, the real estate assets held by POEs declined, which can ultimately lead to a decline in the level of POE's output, resulting in an increased possibility of insolvency dilemma in the POE and causes a debt crisis.

In contrast, as shown in Figure 5, when the total factor productivity of the POE is subject to a one-unit positive shock, thanks to technological progress, the POE will increase its investment in real estate assets, and the level of output of the POE will increase more significantly. Owing to the expansion credit needs of the POE, credit resources will flow more to the POE. However, there is no credit crowding out effect of the POE for the SOE, and the credit size of the SOE will still increase.

Combining the three graphs above, we can find that the economic growth effects on the increase in total factor productivity of the SOE and the POE are not exactly the same, the POE's efficiency improvements and technological progress contributes more to total output. However, when the total factor productivity of the SOE increases, there will be an apparent crowding-out effect on the POE, even though that the contribution of the SOE's efficiency improvement to output is no more than that of the POE. Moreover because of bank's preference for the SOE, SOE will severely

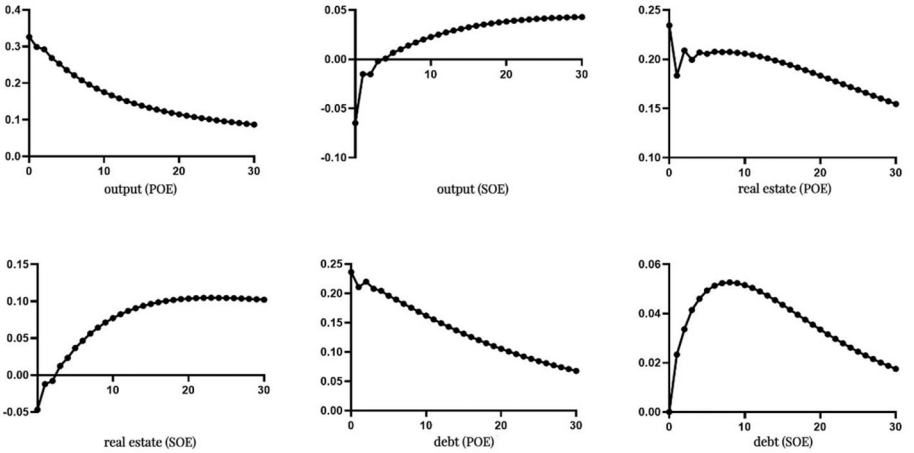

Figure 5. TFP shock of POE.

crowd out the credit resources of the POE and further crowd out the investment and output of the POE. The crowding-out effect is long-lasting, which means that the efficient and contributing POE will be forced out of the market, and the higher the proportion of the SOE in the economy, the more severe the crowding-out effect will be.

In contrast, the increase in the total factor productivity level of the POE will bring more substantial output growth. Credit resources will flow more to the POE at the beginning, however he credit resources of the POE will not have a crowding-out effect on the credit of the SOE, and the bank will still choose to keep lending to the SOE. Since the credit funds of the SOE will not be significantly squeezed out, the production and investment of the SOE will not be greatly affected. Although the POE investment and production will crowd out SOE's production investment in the short term, this crowding-out effect is minimal and will not persist in the medium or long term. Therefore, only by optimizing the economic structure, reducing the proportion of inefficient SOEs in the economy and increasing the proportion of highly efficient POEs, can we help to improve the total factor productivity of the overall economy and achieve long-term high economic growth.

The credit resource crowding-out effect of the SOE on the POE, the credit preference of commercial banks for the SOE, and the problem of difficult and expensive financing for the POE are closely related to the implicit guarantee of credit provided by the government for the SOE. According to the comparison between the POE and the SOE, an increase in the proportion of implicit guarantees of credit for the SOE weakens the sensitivity of the external financing premium of the SOE to the level of leverage, that is, an increase in the proportion of implicit guarantees reduces the increase

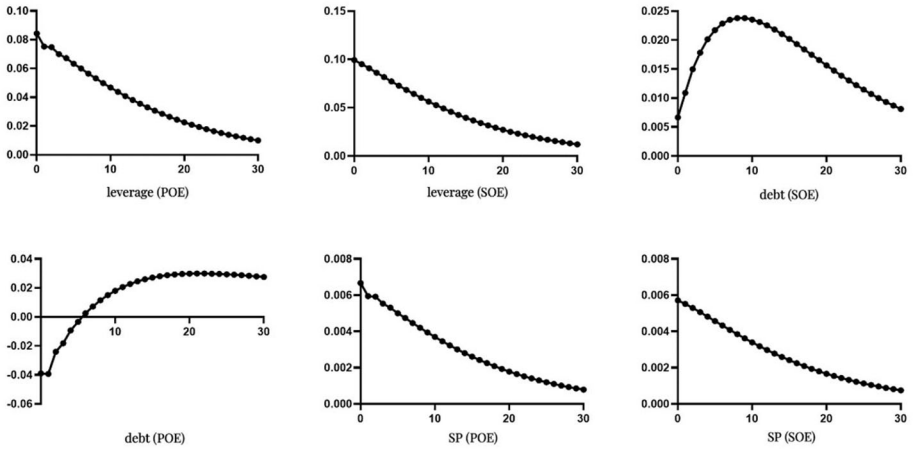

Figure 6. Implicit guarantee shock of SOE credit.

in the external financing premium in response to an increase in the leverage of the SOE. Furthermore, an increase in the proportion of implicit guarantees by the SOE increases the willingness of the SOE to create leverage.

Figure 6 illustrates the impulse response of the debt level of the heterogenous enterprise after a one-unit positive shock to the "implicit guarantee" ratio of SOE credit. As shown in the figure, with the increase in the ratio of hidden guarantees of the SOE, the increase of the leverage level of the SOE is larger than that of the POE, and the increase in external financing of the SOE driven by increased leverage ratio is smaller than that of the POE, indicating that the existence of "implicit guarantee" will weaken the external financing constraint and offset the "financial accelerator" effect. Since the increase in the implicit guarantee ratio weakens the sensitivity of the external financing premium to the leverage level of the SOE, the debt size of the SOE will further expand with the increase in the "implicit guarantee" ratio and will not be significantly constrained by the external financing premium. The POE's debt size will drop significantly in the short term owing to increased external financing premium constraints, put POE in a situation where financing is difficult and expensive. Therefore, the increase in the "implicit guarantees" ratio will hinder the effective allocation of credit resources and aggravate the current situation of financing difficulties for the POE. To maintain the stability of corporate debt, it is necessary to eliminate the government's implicit guarantee for the SOE so that they can maximize the effectiveness of credit resources for the promotion of the real economy and avoid institutional factors that lead to the distortion of the corporate debt structure and further damage macroeconomic stability.

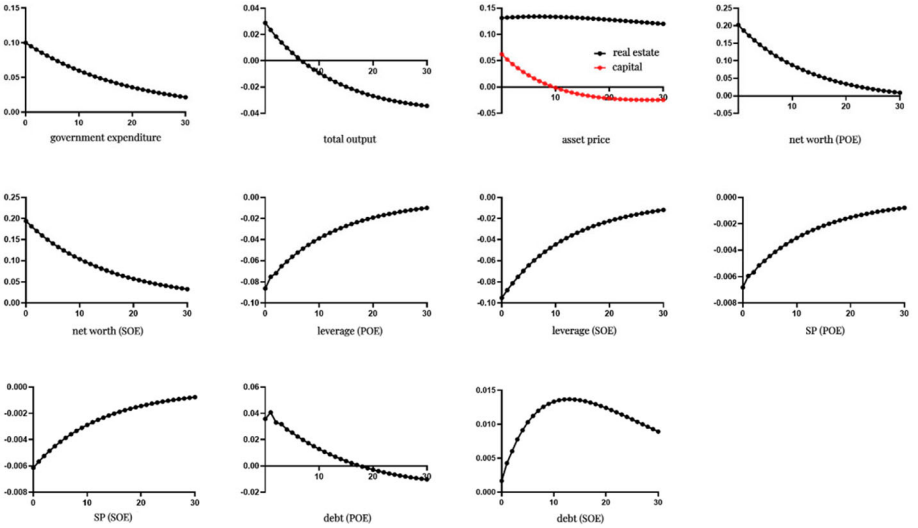

Figure 7. Government spending shock.

Fiscal and monetary policy and corporate debt stability

Owing to the close relationship between corporate debt and the stability of the real economy, policymakers have taken several measures in recent years to cope with the problem of corporate debt stability, including fiscal and monetary policies. These coordinated policies will not only directly affect corporate debt but also the real economy. As an important asset in the market, real estate assets may have some effect on the policy transmission process. Figure 7 illustrates the changes in corporate debt-related and other economic variables after a positive shock to government spending.

As shown in Figure 7, a government spending shock directly leads to an increase in government spending in the current period, which can be seen as an expansionary fiscal policy. Thus aggregate demand increases, and asset prices are further boosted by the demand. The significant increase in housing prices indicate that housing prices are more affected by demand, and the price of physical asset has not been squeezed by housing prices in the short term, both assets' prices have increased . The leverage level of the heterogenous enterprises decline as asset prices rise significantly, the net worth of the heterogenous enterprises increases significantly and outpaces the expansion of asset size in the short run. As the leverage ratio drives the external financing premium for firms, the decline in the leverage ratio leads to the relax of external financing constraints on firms and an expansion in the size of heterogenous corporate debt in all cases, suggesting that the rising demand brought by active fiscal polices will lead to a boost in social credit demand.

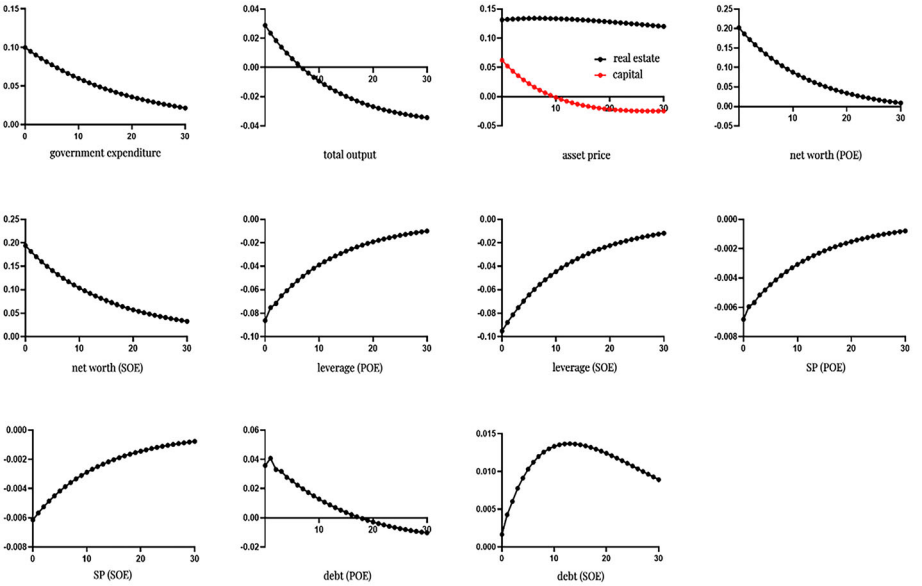

Figure 8. Monetary policy shock.

However, for the heterogenous enterprises, the expansion of government spending will make the debt size of the SOE continue to expand, while the debt size of the POE will only expand in the short term, and there will still be a credit crowding out effect of the SOE on the POE in the medium to long term. Connected to the implicit guarantee of credit provided by the government to the SOE in our model, it can be argued that the correlation of interests between the government and the SOE makes the SOE's debt stability more influenced by fiscal spending.

In sum, the expansion in government spending leads to an increase in aggregate demand and a corresponding increase in aggregate output, with asset prices especially housing prices rising significantly. Driven by asset prices, the net value of heterogenous enterprises increases, and the leverage level subsequently decreases. The external financing constraints of heterogenous enterprises determined by the leverage ratio are relaxed, and the size of corporate debt further expands. Expanding government spending will lead to credit expansion through demand-driven asset prices. The existence of the government's implicit guarantee allows SOE credit to crowd out POE credit in the medium to long term, and SOE credit demand is less constrained.

In terms of monetary policy, our study focuses on the policy transmission mechanism for a tightening monetary policy, that is, an increase in the policy rate. Figure 8 illustrates the changes in the main economic variables after a one-unit positive shock to the policy interest rate. First, a rise in the interest rate decreases social investment demand, and investment in

Table 2. Variance decomposition.

	Real estate demanding shock	TFP shocks	Monetary policy shocks	Government spending shock
House price	72.45	23.41	4.07	0.07
Real estate investment	56.96	36.76	6.15	0.12
Physical capital investment	21.35	49.38	19.23	10.04
Leverage level of the SOE	21.10	14.51	34.36	30.03
Leverage level of the POE	23.73	13.84	42.40	20.03
External financing premium for the POE	19.26	13.99	51.7	15.05
External financing premium for the SOE	18.23	14.27	52.46	15.04
Total output	14.61	26.55	30.83	28.01

both real estate and physical assets declines; however, the decline in real estate assets is smaller than that in physical assets, real estate investment is significantly affected by the interest rate shock. Second, as demand and investment decline, aggregate output subsequently declines, and heterogenous enterprises' net worth depreciates significantly as a result of declining asset prices. As the rate of decline in enterprise net value exceeds the rate of depreciation in total assets, heterogenous enterprises' leverage ratios have increased, and external financing constraints for firms driven by leverage and interest rates have further tightened. Owing to the tightening of the external financing constraints of the POE, the size of POE debt has declined, that is tightening monetary policy is conducive to control the size of POE debt. On the contrary, although the external financing constraints on the SOE are also tightened, the implicit guarantee ratio of SOE credit will weaken the external financing constraints, and the size of SOE debt will not be affected by monetary policy shocks but will expand further, and the credit crowding out effect on the heterogenous enterprises will be more pronounced.

In sum, the tightening monetary policy has led to a contraction in social demand and a subsequent decline in investment and output, with real estate investment falling more significantly. Heterogenous enterprises' net worth shrinks, leading to higher corporate leverage and further tightening of external financing constraints. The credit size of the POE is decreased under tighter financing constraints, while the credit size of the SOE is not sensitive to external financing constraints owing to the existence of the implicit guarantee, and the credit of the SOE has a serious crowding-out effect on the credit of the POE.

Variance decomposition of the main economic variables

Combined with the qualitative findings from the impulse response analysis of the main economic variables above, the results of the variance decomposition of the main economic variables are presented in Table 2.

The role of house price fluctuations in the above process is further corroborated by the analysis of the variance decomposition results. Housing demand shocks can explain about 70% of the fluctuations in housing prices, further suggesting that fluctuations in housing prices are more demand-driven. Housing demand shocks explain about 60% of the fluctuations in real estate investment, and the other major source of shocks causing fluctuations in real estate investment is TFP shocks. As real estate investment has a crowding-out effect on physical capital investment, housing demand shocks explain 20% of the fluctuations in physical capital investment, and TFP shocks explain about 50% of the fluctuations in physical capital investment, suggesting that increases in total factor productivity and the need for enterprises to expand their production size will further stimulate firms to increase investment.

As real estate assets are relatively important for enterprises, housing demand shocks explain about 20% of the fluctuation in leverage ratio of heterogenous enterprises, with housing demand shocks having a greater effect on the POE. Other major sources of shocks that affect the level of corporate leverage are monetary policy and government spending shocks. The level of leverage is significantly affected by monetary policy shocks, regardless of the type of firm, because monetary policy can influence the opportunity cost of external financing for firms through direct regulation of interest rates. However, the effect of government spending shocks on the leverage level of the SOE is greater than that on the leverage level of the POE because the existence of implicit government guarantees for the SOE is essentially part of government spending, and the SOE and government interests are highly correlated. The source of shocks affecting the external financing premium of heterogenous enterprises is mainly monetary policy shocks, and similarly, the effect of housing price fluctuations on the external financing premium of the POE is higher than that of the SOE.

As housing demand stimulates aggregate demand and drives investment, it can ultimately explain 14.61% of the fluctuations in total output. Technology explains 26.55% of total output fluctuations, monetary policy shocks explain 30.83% of total output fluctuations, and government spending shocks explain 28.01% of total output fluctuations.

Conclusions and policy recommendations

Main conclusions

Our study examines the effect of real estate assets on the stability of heterogenous corporate debt and the macroeconomy through a BGG model that embeds real estate assets and heterogenous enterprises. Based on the

dynamic economic simulation of the model, the main conclusions of our study are as follows.

Firstly, real estate demanding shocks are the main cause of house price fluctuations. House price fluctuations from the demand side stimulates real estate investment and total output. For heterogenous entrepreneurs, they choose to hold more real estate assets and increase their net worth significantly. The degree of declining in external financing premium for heterogenous enterprises following a real estate demand shock is significantly larger than the degree of rising. Therefore, for the whole corporate sector, more relaxed external financing constraints lead to an expansion in credit market demand in both the short and long run. The decline in the external financing premium for heterogenous enterprises brought about by rising housing prices will further stimulate investment in the economy as well as the rise in asset prices, resulting in a significant increase in aggregate output, economy enters a boom cycle, this is the financial accelerator effect of housing prices. Once the housing bubble bursts, the net asset value of the enterprise will shrink rapidly, and if the asset is not enough to repay the bank loan, the enterprise will face bankruptcy. Therefore, the fluctuation of housing prices will significantly affect corporate debt and will be further transmitted to the macroeconomic and financial system, and owing to the existence of the "financial accelerator" mechanism, the various effects of housing price fluctuations will be further amplified when transmitted to the macroeconomic system. Resulting in the stability of corporate debt and the economy closely related to the "boom-bust" cycle under the action of house prices.

Secondly, the stability of heterogenous corporate debt are influenced by institutional factors. Since the government provides an implicit guarantee of credit to the SOE, there is a preference for the SOE in the credit allocation process, the SOE will severely crowd out the POE's credit resources and further the investment and output, and this crowding-out effect is long-lasting. The existence of implicit guarantee weakens the external financing constraints, offsets the "financial accelerator" effect, and weakens the sensitivity of the SOE's external financing premium to the leverage level. The debt size of the SOE will further expand with the increase in the implicit guarantee ratio without being significantly constrained by the external financing premium. The POE will see a significant decline in debt size in the short term owing to increased external financing premium constraints, and they are caught in a situation where financing is difficult and expensive. Therefore, the increase in the implicit guarantee ratio will hinder the effective allocation of credit resources and exaggerate the current situation of financing difficulties for the POE. To maintain the stability of corporate debt, it is necessary to eliminate the government's implicit guarantee

for the SOE. This can maximize the effectiveness of credit resources, avoid leading to the distortion of the corporate debt structure in the economy, and further affect macroeconomic and financial stability.

Finally, the effect of fiscal and monetary policies on the stability of corporate debt has diverged. Fiscal policy, dominated by expansionary government spending, leads to an increase in aggregate demand and a corresponding increase in aggregate output and can lead to an expansion of credit through demand-driven asset prices. However, the existence of the government's implicit guarantee for the SOE makes SOE's credit crowd out POE's credit in the medium to long term, and SOE credit demand is less constrained. The tighter monetary policy led to a contraction in social demand and a subsequent decline in investment and output, with real estate investment decreasing more significantly. Heterogenous enterprises' net worth shrinks, leading to higher corporate leverage level and further tightened the external financing constraints. The credit of the POE downsized under the tighter financing constraints, while the credit size of the SOE is not sensitive to external financing constraints owing to the existence of the implicit guarantee ratio of credit. Meanwhile, the credit of the SOE had a severe crowding-out effect on the credit of the POE.

Policy recommendations

First, because housing price is significantly driven by demand, there should be an increase in housing supply and improved housing conditions for residents from the supply side to prevent the housing prices growing too fast. This would help release the remaining demand for real estate assets and curb speculative housing purchases. Furthermore, the rise in housing prices brings about an expansion in the size of corporate debt and an increase in aggregate output. Thus, implementing rigid house price regulation policies may accelerate the economy into a recessionary cycle during the economic downturn. Therefore, it is necessary to clarify the transmission mechanism of house price fluctuations, synergize housing regulations and corporate debt stabilization regulations, closely link housing regulations and those regulatory polycies with macroeconomic fluctuation cycles, and implement counter-cyclical asset price regulatory polycies to avoid amplification effects from housing price fluctuations.

Second, the institutional factors behind the problem heterogenous corporate debt's stability must be eliminated. Because the inefficient SOE can significantly squeeze the POE in terms of output and credit, it is necessary to reduce the proportion of the SOE in the economy, increase the proportion of the POE, effectively release excess capacity, optimize the economic structure and market mechanism, and further deepen supply-side reform.

In addition, the implicit guarantee of SOE credit will promote the expansion of SOE credit, exacerbate the financing difficulties and expensive problems faced by POEs, and weaken the effect of tight monetary policy to improve debt stability. Thus, it is necessary to fundamentally eliminate government guarantees for the SOE, cut off the correlation of interests between the SOE and the government, optimize commercial bank credit channels, improve resource misallocation, and increase the economic production efficiency and the total output level.

Finally, control the size of government spending. It could help to avoid the blind expansion of spending that brings about excessive expansion of corporate credit demand and intensifies the correlation of interests between the SOE and the government. Active fiscal policies should be implemented from the revenue-side to increase corporate profit through tax cuts, improve corporate operating capacity, maintain corporate debt stability, and prevent enterprises from falling into the dilemma of difficult and expensive financing. Furthermore, counter-cyclical and tight monetary policies must be implemented to downsize the corporate debt and avoid excessive expansion of corporate debt. Implementing fiscal and monetary policies must go hand in hand with eliminating institutional factors, avoiding institutional factors affecting the effectiveness of policy implementation and thus leading to structural contradictions in the real economy.

Notes

1. In our model, housing or real estate assets held by households and entrepreneurs are represented as special consumption goods and factors of production, respectively, which implies that housing is an endogenously determined variable.
2. We use the impact of housing demand shocks to approximately represent the impact of house price fluctuations, the reason for this we explained in the A4.

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We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled, “Real estate assets, heterogeneous firms, and debt stability.”

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Appendix

A1. The first-order conditions

(1) Household

Using the utility maximization function for the household sector and the budget constraint, the Lagrange equation is constructed to solve the first-order conditions faced by the household sector:

$$\frac{1}{C_t} = E_t \frac{\beta}{C_{t+1}} R_{t+1} \tag{42}$$

$$\frac{W_t}{C_t} = \frac{\xi}{1 - N_t} \tag{43}$$

$$\frac{Q_{h,t}}{C_t} = \beta E_t \left\{ \frac{j_{t+1}}{H_{h,t+1}} + \frac{1}{C_{t+1}} Q_{h,t+1}(1 - \delta_h) \right\} \tag{44}$$

where Equation (42) is the Euro equation of consumption, Equation (43) is the labor supply equation, and Equation (44) is the housing demand equation.

(2) Poe

The first-order conditions for the loan contracts of the POE can be obtained by constructing the Lagrangian equation as follows:

$$E_{t+1}\left\{ \emptyset'(\overline{\omega}_{ns}) R_{ns,t+1} L_{ns,t} + \Lambda_{ns,t+1} g'(\overline{\omega}_{ns}) R_{ns,t+1} L_{ns,t} \right\} = 0 \tag{45}$$

$$E_{t+1}\left\{ \emptyset(\overline{\omega}_{ns}) R_{ns,t+1} + \Lambda_{ns,t+1} \left[g(\overline{\omega}_{ns}) R_{ns,t+1} - R_{t+1} \right] \right\} = 0 \tag{46}$$

$$g(\overline{\omega}_{ns}) R_{ns,t+1} L_{ns,t} - R_{t+1}(L_{ns,t} - 1) = 0 \tag{47}$$

(3) Soe

The first-order conditions for the loan contracts of the SOE can be obtained by constructing the Lagrangian equation as follows:

$$E_{t+1}\left\{ \emptyset'(\overline{\omega}_s) R_{s,t+1} L_{s,t} + \Lambda_{s,t+1} g'(\overline{\omega}_s) R_{s,t+1} L_{s,t} \right\} = 0 \tag{48}$$

$$E_{t+1}\left\{ \left(\emptyset(\overline{\omega}_s) - b_{t+1} \right) R_{s,t+1} + \Lambda_{s,t+1} \left[\left(g(\overline{\omega}_s) + b_{t+1} \right) R_{s,t+1} - R_t \right] \right\} = 0 \tag{49}$$

$$\left[g(\overline{\omega}_s) + b_{t+1} \right] R_{s,t+1} L_{s,t} - R_t(L_{s,t} - 1) = 0 \tag{50}$$

(4) Retailer

We suppose that a single retailer (z) buys an intermediate good at price P_t^w in a perfectly competitive market and can sell product $Y_t(z)$ at price $P_t(z)$ at no cost. The final product is determined by equation $Y_t^f = \left(\int_0^1 Y_t(z)^{\frac{\varepsilon-1}{\varepsilon}} dz \right)^{\frac{\varepsilon}{\varepsilon-1}}$, where $\varepsilon > 1$, and the final product is

priced at $P_t = \left(\int_0^1 P_t(z)^{1-\varepsilon} dz\right)^{\frac{1}{1-\varepsilon}}$ accordingly. Therefore, each retailer is faced with the following demand function:

$$Y_t(z) = \left(\frac{P_t(z)}{P_t}\right)^{-\varepsilon} Y_t^f \tag{51}$$

All retailers purchase intermediate goods at price P_t^w and sell final goods at price $P_t(z)$ and face the demand constraint as above. The retailer has a $(1-\theta)$ probability of being able to adjust the price each period, defining $P_t^*(z)$ as the adjusted price and $Y_{t+k}^*(z) = \left(P_t^*(z)/P_t\right)^{-\varepsilon} Y_{t+k}^f$ as the adjusted demand function. The adjusted optimal price $P_t^*(z)$ needs to satisfy the following equation:

$$\sum\nolimits_{k=0}^{\infty} \theta^k E_t \left\{ \Lambda_{t,k} \left(\frac{P_t^*(z)}{P_{t+k}} - \frac{x_t}{x_{t+k}} \right) Y_{t+k}^*(z) \right\} = 0 \tag{52}$$

where $\Lambda_{t,k} = \beta \frac{C_t}{C_{t+k}}$ is the stochastic discount factor, x_t is the price addition factor, which is equal to $\frac{\varepsilon}{\varepsilon-1}$ in steady state, and ε is the elasticity of substitution between the two goods. The above equation indicates that the retailer prices the product so that the expected discounted revenue equals the expected discounted cost.

A2. POE vs. SOE

First, the external financing premiums for the POE and the SOE, respectively, are rewritten as:

$$\frac{E_t R_{ns,t+1}}{R_t} = \left(1 - \frac{1}{L_{ns,t}}\right) \frac{1}{g(\overline{\omega}_{ns})} \tag{53}$$

$$\frac{E_t R_{s,t+1}}{R_t} = \left(1 - \frac{1}{L_{s,t}}\right) \frac{1}{g(\overline{\omega}_s) + b_{t+1}} \tag{54}$$

According to the above equations, compared with the POE, the level of external financing premium of the SOE is higher at the denominator than the proportion of implicit guarantees provided by local governments for them (b_{t+1}), and is negatively related to the external financing premium. In turn, the level of the external financing premium is positively correlated with corporate leverage, suggesting that the implicit guarantee makes the SOE's external financing premium level less sensitive to their leverage than the POE and that the soft budget constraint of the implicit guarantee weakens the SOE's external financing constraints.

Meanwhile, the leverage ratio of heterogenous firms can be expressed as:

$$L_{ns,t} = \frac{1}{1 - \frac{R_{ns,t+1}}{R_t} g(\overline{\omega}_{ns})} \tag{55}$$

$$L_{s,t} = \frac{1}{1 - \frac{R_{s,t+1}}{R_t} \left[g(\overline{\omega}_s) + b_{t+1} \right]} \tag{56}$$

Compared with the POE, the leverage of the SOE has an additional implicit guarantee ratio (b_{t+1}) at the denominator and is positively correlated with the leverage ratio, making the leverage ratio of the SOE higher than that of the POE.

A3. Parameter estimation

The discount factor β for the household sector is derived from the risk-free rate and the steady-state calibration of the model. According to Equation (42), the steady-state case shows that:

$$\beta = 1/R$$

In this case, the risk-free rate R is calibrated to 2.5398% using the mean 1-year Treasury bond yield to maturity, and the data is selected from January 4, 2002, to December 31, 2021. Since the time scale in the model is quarterly, and the actual interest rate data are annualized yields, quarterly yields need to be obtained by 1⁄4th power. Therefore, the value of β is taken as:

$$\beta = \frac{1}{(1 + 2.5398\%)^{\frac{1}{4}}} \approx 0.993$$

Total output is accounted for under the expenditure method. Since the model in this study does not involve the open economy, the contribution of gross net exports is deducted from the total output data to ensure that the parameters calibrated are more in line with the model setup. The model involves two types of assets, real estate assets H and fixed capital K. Based on GDP data from previous years and the addition of inventory increases to fixed capital in gross capital formation, the share of fixed capital investment in total output $\frac{I_k}{Y}$ is calibrated to 0.25; the share of real estate investment in total output $\frac{I_h}{Y}$ is calibrated to 0.1 based on total output data and real estate development investment data; and the share of government spending in total output $\frac{G}{Y}$ is calibrated to 0.15.

According to Equation (44), the situation at a steady state is as follows:

$$\frac{1}{C} = \beta\left[\frac{j}{H_h} + \frac{1}{C}(1 - \delta_h)\right]$$

The housing demand shock j is calibrated to 0.2 with reference to He et al. (2015). The ratio of household holdings of real estate assets to total output H_h/Y is set to 1.11 with reference to Jin et al. (2012) and calibrated to 1.125 after adjusting for total output net of net exports. The housing depreciation coefficient δ_h is calibrated to 0.01 according to Iacoviello (2005). The ratio of residential consumption to the amount of housing held by households C/H_h is calibrated to 0.32 according to the steady-state equation. Therefore, the share of residential consumption net of entrepreneurial consumption in total output, C/Y, can be derived as 0.36. According to macroeconomic data, the share of final consumption of the population in total output is about 0.5. Therefore, the share of consumption of non-state entrepreneurs in total output C^e_{ns}/Y and the share of state entrepreneurs in total output C^e_s/Y are calibrated to be 0.07, respectively. The rate of return for holding or investing in real estate assets in the steady state case is:

$$R^h = 1 + \Delta$$

House price data for the time interval 2008 to 2021 were selected to calculate the average return, and the Δ was calibrated to 2%.

For the loan-weighted interest rate of heterogenous enterprises, owing to the lack of data in recent years, this study sets the annualized loan-weighted interest rate of SOEs to 5.77% based on the findings of the "Cost Reduction" Research Team of CAFS (2017) and therefore calibrates the steady-state value of external financing cost of the SOE, R_s, to $(1 + 5.77\%)^{1/4}$. We set the annualized loan weighted interest rate for the POE at 7.28%.

The steady-state value of R_{ns} for the external financing cost of the POE is calibrated to $(1+7.28\%)^{1/4}$.

The steady-state value of the return on capital held by the SOE in the steady-state case satisfies the following conditions:

$$R_s^k-(1-\delta_k)=\frac{\alpha Y_s}{XK_s}\frac{1}{1+\frac{a}{1-a}\left(\frac{K_s}{H_s}\right)^{-v}}$$

$$R_s=\frac{K_s}{K_s+H_s}R_s^k+\frac{H_s}{K_s+H_s}R^h$$

Based on the study by the People's Bank of China Business Administration Department Group (2017), we calibrate the labor output elasticity coefficient $1-\alpha$ to 0.45, which leads to a derivation of α of 0.55. Quarterly data for the capital depreciation rate δ_k are calibrated to 0.025 following research practice. The importance factor a of real estate assets in the production of the enterprise is calibrated to 0.7, thus highlighting the importance of real estate assets to the enterprise. Y_s/K_s is calibrated to 1/4, that is, the capital-output ratio of the SOE is 4. The steady-state value of R_s^k for the quarterly rate of return on capital held by the SOE is 1.0061, and the real estate asset-to-capital ratio H_s/K_s is calibrated to 1.315. Regarding the SOE, the steady-state value of R_{ns}^k for the rate of return on capital held by the POE is calibrated to 1.0152, and the ratio of real estate assets held to capital, H_{ns}/K_{ns}, is 1.3964.

For the parameters involved in the debt contract between the firm and the bank, the study is mainly derived using Matlab solutions. The supervised disposal cost ratio μ of the commercial bank is calibrated to 0.21. The steady-state value of $F(\overline{\omega}_{ns})$ for the bankruptcy probability of the POE is calibrated to 0.01, and the steady-state value of $F(\overline{\omega}_s)$ for the bankruptcy probability of the SOE is calibrated to 0.007. The threshold $\overline{\omega}_{ns}$ for external risk shocks received by the POE is calibrated to 0.5193, and the threshold $\overline{\omega}_s$ for external risk shocks received by the SOE is calibrated to 0.4947. In the loan contract between the POE and the commercial bank, the POE's share of proceeds $\emptyset(\overline{\omega}_{ns})$ is calibrated to 0.4811, and the commercial bank's share of proceeds $g(\overline{\omega}_{ns})$ is calibrated to 0.5121; in the loan contract between the SOE and the commercial bank, the SOE's revenue share $\emptyset(\overline{\omega}_s)$ is calibrated to 0.5035, and the commercial bank's revenue share $g(\overline{\omega}_s)$ is calibrated to 0.4920. Referring to the study of the People's Bank of China Business Management Department group (2017), the survival probability γ_s for the SOE is calibrated to 0.98, and the survival probability γ_{ns} for the POE is calibrated to 0.97.

Referring to Jin et al. (2012), the adjustment cost coefficient φ_k for calibrated physical capital is 0.5, and the adjustment cost coefficient φ_h for calibrated real estate investment is 0.3, implying that real estate investment is more volatile than physical capital investment during the economic cycle. The share of the SOE in the economy, P_s, is set to 0.5, and the elasticity of substitution of the output of heterogenous firms, λ, is set to 1.5.

A4. Housing demand shock

To clarify the mechanisms influencing house price volatility, it is necessary first to explain why housing demand shocks drive up house prices and further cause fluctuations in other economic variables. We assume that households have linear utility in both consumption and improved housing conditions, that is, $U(C,H_h)=C+jH_h$ and assume that real estate demand j is constant. The housing demand function implies that the price of housing is

the present value of the future marginal rate of substitution between consumption and housing when the marginal rate of substitution is constantly equal to j. Since the interest rate level is constant at a steady state, the house price $q_{h,t} = j/(1-\beta)$ is similarly constant unless j changes. As a result, house prices do not respond to any shocks other than real estate demand shocks. Further extensions to the benchmark model allow the effect of real estate demand shocks to be used as an approximate proxy for the effect of house price fluctuations.