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IS THE HOUSEHOLD SECTOR OVER-INDEBTED IN CHINA? – THE PERSPECTIVE OF ECONOMIC GROWTH AND FINANCIAL RISKS

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Abstract. In this paper, we introduce household debt into a general equilibrium model and investigate the sources of changes in household debt through the lens of leverage constraints of the household sector, firms, and banks. Based on this, we analyze the impacts of household debt on economic growth and the financial risks embedded in debt-stimulated economic growth. After fitting our model to the data from China, we find that the increase in household debt in China is conducive to economic growth as it promotes demand growth and reduces financial frictions. In addition, the marginal financial risk induced by the growth of household debt is relatively small, implying that the increase in household debt can somewhat promote economic growth without accumulating much endogenous vulnerability in the economy. This contrasts with the reduction of firms' debt, which leads to drastic negative economic fluctuations in the short term, although it is beneficial to economic growth in the long run given that firms have already been caught in a vicious debt-deflation cycle. Therefore, to ensure the stability of the economy in China, it is plausible to squeeze out firms' debt through increasing debt in the household sector.

Keywords: household debt, leverage, economic growth, financial risk.

JEL Classification: E21, E44, E66.

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1. Introduction

In recent years, in response to the complex domestic and international economic environment and the impact of the COVID-19 epidemic, the overall leverage ratio of the Chinese economy continues to increase, and this is predicted to remain at a high level for some time in the future. As room for increasing the overall leverage ratio becomes increasingly limited, it is of great significance for the continuity and stability of China's economy to explore the potential of economic growth by optimizing debt structure.

The latest round of debt growth in China has witnessed a more rapid increase in the leverage ratio of the household sector than ever before. This rapid growth has changed the overall macroeconomic environment, via enhancing the ties between the household sector and the financial sector and expanding the scope and magnitude of the impacts of household debt. In this process, the influence of household debt growth on the economy changes as the leverage ratio increases, showing non-linear characteristics (Ma & Chen, 2017). Meanwhile,

the financial risks associated with the growth of debt began to emerge due to the high leverage in the economy and the slowdown of economic growth. Therefore, in the adjustment of debt structure, it is necessary to make a trade-off between the economic growth driven by financial easing policies and the financial risks.

Existing research on household debt has paid limited attention to the relationship between household debt and financial risks. The main reason is that, for a long time in China, household debt, compared with firm debt accounts for a low proportion of total debt, resulting in subtle financial risks and negligible direct impact on outputs. Most relevant studies focus on the relationship between household debt and variables such as consumption and real estate, indirectly examining the influence of household debt changes on economic growth (e.g., Li et al., 2014; Peng et al., 2018; Pan & Liu, 2018). Overall, the analysis of financial risks has not attracted sufficient attention in these studies. The limited number of related studies on household debt and financial risks have conducted their analysis mainly through qualitative methods (such as vertical and horizontal comparisons) and drawn some cliched conclusions. For instance, they indicate that the finance is at risk if the ratio of household debt exceeds a specific threshold.

In contrast to the lack of research attention on household debt, the relationship between household debt and other economic sectors becomes much more complicated with the increase in household debt. In some cases, small changes in household debt, after being spread and amplified, may cause drastic fluctuations (Gertler & Gilchrist, 2018). In the presence of these fluctuations likely to dramatically shock the macro economy, existing research methods become powerless in capturing overall changes, predicting future output, dealing with endogeneity, and revealing financial risks. Therefore, a unified framework that considers key macroeconomic variables, financial risks, and the debt of economic sectors (including the household sector) is of great significance.

In China, economic sector debts primarily originate from bank credits, relying heavily on commercial banks' "deposit-taking, loan-granting" operations. In these operations, all banks, households, and firms can act as borrowers, all constrained by the asset-liability ratio. Specifically, in deposit-taking activities, banks that gather funds from households are borrowers. They are required to maintain a strict capital adequacy ratio to ensure the safety of households' deposits. A prolonged fall below the minimum capital adequacy ratio triggers a bank run (Gertler et al., 2017). Likewise, in loan-granting activities, households or firms who "borrow" from banks are borrowers. They need to provide banks with assets more valuable than the outstanding loan as collateral, maintaining the borrowers' asset-liability ratio below a certain level. The collateral ratio, reflecting the bank's risk appetite, is a key tool for risk control. These borrowers constraints imply that financing for economic sectors is determined by bank capital and collateral ratios. Bank capital is primarily influenced by loan defaults in the short to medium term, given the high entry barriers and lengthy capital increase lead time for commercial banks. Banks' collateral ratios, which limit the financing ability of real economic sectors, are chiefly affected by banks' risk appetite. Given the abovementioned insights, we introduce loan default shocks which affect financing through deteriorating bank capital and bank risk appetite shocks which affect financing by altering collateral ratio. By introducing these two shocks, we aim to understand how the economy responds to financing changes and examine associated risks through the lens of final output volatility.

When leverage is at a high level, the economy may be susceptible to minor fluctuations through the channel of bank capital and collateral ratio. In the presence of these minor fluctuations, if banks confront capital losses, they must decrease their asset scale and curtail loan business to meet capital adequacy requirements. In such a situation, some households and firms relying on bank loans might default, in turn causing banks to incur further capital losses. As banks' loan business contracts further, more households and firms default, resulting in a self-reinforcing cycle. Similarly, if minor economic fluctuations exert negative impacts on banks' risk appetite, banks will reduce their collateral ratio, subsequently reducing their lending business. In this case, some households and firms relying on bank loans are prone to default. This default will further enhance banks' risk aversion, leading to reduced lending business by the banks and more default from households and firms. Consequently, these vicious spirals, induced by small default shocks and bank risk appetite shocks, are spread and amplified, resulting in much stronger effects on the economy. The "small shocks, large fluctuations" phenomenon discussed above indicates that the increase in leverage could change the volatility of the economy. Considering that volatility is closely related to risks in financial risk theory, this paper, inspired by the research of Adrian et al. (2019), employes economic volatility caused by negative bank risk appetite shocks and default shocks as a measure of financial risk, integrating debt changes and financial risks within a unified research framework.

This paper incorporates household debt into a stochastic dynamic general equilibrium (DSGE) model that includes households, firms and banks, referring to (Gertler & Kiyotaki, 2010). Unlike conventional DSGE settings, our model allows households to participate in economic activities as borrowers, establishing a new connection with other economic sectors through the balance sheet. It is worth noting that the increasing leverage ratio alters the asset-liability ratio constraint, impacting the running of the economy. Therefore, compared with the commonly used interest rate factor in macroeconomic analysis, the leverage ratio factor is more important (Geanakoplos, 2010). In addition to incorporating household debt, this paper describes the leverage ratio constraints for households, firms, and banks, introducing bank risk appetite shocks and loan default shocks. Within this research framework, we explore the factors driving changes in household debts, discuss the influence of household debts on the economy, unravel the financial risks associated with debt-stimulated economic growth, and provide policy implications for leverage restructuring.

This paper contributes to the current literature in the following ways. First, we develop a DSGE model tailored to China's financial landscape, wherein the leverage ratio, rather than the interest rate, serves as the primary determinant of financial friction influencing macroeconomics. This integrated model enables a comprehensive analysis of the impact of debt changes on economic growth by incorporating the debts of major economic sectors, including households, into a unified framework. Second, we incorporate risk measurement from financial theory into our research framework, recognizing its significance given the highlighted overall leverage ratio in China's economy. Third, employing simulation experiments based on the theoretical model, we predict the relationship between debt changes and economic development. This method is valuable for policy implications, as it significantly reduces the reliance on historical data and thus avoids inaccurate conclusions stemming from the nonlinear relationship between leverage and economic growth.

The rest of this paper is organized as follows. Section 2 presents related literature showing the undetermined impact of household debt growth on the economy. Section 3 describes the model. Section 4 presents the data and estimation results. Section 5 discusses the main findings of the model. Section 6 ends with a brief conclusion.

2. Literature review

The financial deepening theory indicates that the development of the financial sector contributes to economic growth, as the growth of debt can generate income effects and investment effects (Levine et al., 2000). However, the debt-deflation theory suggests that the accumulation of debt is detrimental to economic growth. This is particularly the case when the leverage ratio rises to a relatively high level, as major economic sectors may reduce production expenditures and investment, or even sell assets to repay debt principal and interest. This can lead to a collapse in asset price and, sequentially, a higher leverage ratio, creating a vicious cycle of debt-deflation (Fisher, 1933). Moreover, in the context of debt-deflation, income and aggregate demand also decline, further worsening the vicious circle of the economy (Tobin, 1993). From the consumption perspective, households with high debt experience a more significant decrease in consumption during dramatic negative shocks (Nakamura, 2023; Teulings et al., 2023).

Another strand of studies integrates the opposing views and argues that debt growth initially promotes economic development before imposing inhibiting effects (Cecchetti et al., 2011; Ma & Chen, 2017; Long & Wu, 2022). For instance, by estimating the impact of sectoral leverage on economic growth, Cecchetti et al. (2011) concluded that debt growth has a negative impact on the economy when the asset-liability ratio exceeds 85%. Ma and Chen (2017) also demonstrated a significant "inverted U-shaped" relationship between financial leverage and economic growth. They indicated that, with the increase of financial leverage level, economic growth first rises and then declines, representing an "inflection point".

In China, the increasing leverage ratio in the household sector has sparked debates over the growth of household debt and its impact on economic development. Some studies find that household debt stimulates investment and production in related industries, as households typically use their debts for consumption or real estate acquisition (Liu & Wang, 2018). These activities promote employment and household income growth, and the resulted wealth effect further facilitates investment and consumption, creating a virtuous circle. Given the relatively low leverage ratio in China's household sector, concerns about threats to financial stability or systemic financial safety are deemed unnecessary (Zhang et al., 2019; Chen & Huang, 2022). Besides, by squeezing out firm debt, the growth of household debt is conducive to changing the high debt ratio in the firm sector and offsets the downward pressure on the economy caused by firm deleveraging (Li, 2016). Therefore, the growth of debt in the household sector is beneficial to the economy on the whole (Liu & Wang, 2018; Zhang et al., 2019; Chen & Huang, 2022).

Nevertheless, some other studies argue that household debt has a weak impact on stimulating the economy. For instance, Li et al. (2014) pointed out that, with a significant portion of household debt allocated to real estate in China, the increase in household sector's leverage ratio could lead to asset bubbles, and that the pressure of mortgage loan repayment for

households might squeeze consumption. Zhou and Wang (2009) and Peng et al. (2018) also showed that too many financial resources have been distributed to real estate, and the excessive growth of residential housing loans implies that investment and R&D expenditures in the real economy are being squeezed out, reducing financial efficiency. Conducting empirical analysis based on a tracking survey over Chinese households, Pan and Liu (2018) indicated that the increase in household leverage inhibits individual spending, negatively impacting the optimization of the consumption structure.

In summary, there is no consensus on the relationship between leverage and economic growth. On one hand, debt growth impacts economic growth through fund flow and fund utilization efficiency. If sufficient households use their debts for consumption or investment, it can boost firms' production productivity, thus promoting economic development. However, it is possible that many households already carry high debts burdens. If they primarily use new loans to service existing debts rather than consumption and investment, economic inefficiencies may arise. Moreover, if these households prioritize real estate investment or speculation, new loans could inflate real estate bubbles and accumulate potential financial risks. On the other hand, as the leverage ratio increases, it is likely to alter the financial environment and consequently affect the original relationship between leverage and economic growth (Wagner, 2010). Therefore, it is challenging to identify a specific threshold or inflection point for leverage ratio (Liu et al., 2018), and the relationship between leverage ratio and economic growth cannot be definitely determined under varying economic conditions.

Therefore, the existing widely used research approach, which relies excessively on historical data to examine the impact of household debt without considering the overall economic environment, will no longer be plausible. Without capturing the complexity of the economy and the general equilibrium effects, it is not possible to obtain comprehensive and predictive results (Zabai, 2017; Nakamura, 2023). In light of this, we study household debt from the macroeconomic perspective, by incorporating the debts of main economic sectors and financial risks into a unified framework. This framework serves as an experimental site to analyze the influence of household debt changes on the economy.

3. The model

3.1. Households

With economic growth and income increase, the financial demand of households diversifies. For this reason, Debortoli and Gali (2017) introduced financial services into the household sector and classified households into either the Ricardian type (have full access to financial markets) or the Keynesian type (hand to mouth) based on their access to financial services. Considering that almost all households can easily obtain financial services in the current financial system, this paper reclassifies households into indebted-type and non-indebted type according to whether they are net indebted or not – this differs from the approach applied by Debortoli and Gali (2017). In our general equilibrium model, the net saving households are denoted as *saver*, and the net indebted households are denoted as *spender*, with $i \in \{saver, spender\}$ representing the type of households. The share of *saver* among households is set to 1 – σ, while the share of *spender* is set to σ.

The household debts in China are mainly bank loans, and the collateral rate of commercial banks that constrains household debt is the main factor affecting the leverage ratio in the household sector. Given this background, we assume that households' debts are all obtained through bank loans and that the banks require households to provide assets as collateral. Banks set the collateral ratios of the household sector, m_{HH}, according to their own risk-taking willingness. The change in banks' risk-taking willingness brings bank risk appetite shock in the household sector[1]. Let $\exp(SH_{MH,t})$ denote bank risk appetite shock in the household sector, and this shock follows the *AR* (*1*) process, where $SH_{MH,t} = \rho_{MH} SH_{MH,t-1} - \sigma_{MH,t}, \sigma_{MH,t} \sim IIDNormal(0, \sigma^2_{MH})$. Here, ρ_{MH} denotes the coefficient of bank risk appetite shock (household), and σ_{MH} is the standard deviation of bank risk appetite shock (household). Therefore, the lending to households is constrained as follows:

$$L^i_t \le \exp(SH_{MH,t}) m_{HH} \frac{E_0(q_{t+1})}{1+i^i_t} H^i_t - \vartheta^H_t L^i_t, \tag{1}$$

where L^i_t represents the balance of bank loans to households; q_{t+1} represents the price of households' real estate; H^i_t represents the households' real estate; i^i_t represents the interest rate on loans; $\vartheta^H_t L^i_t$ represents the funds redistributed from the banking sector to the household sector, and, for the banks, ϑ^H_t is the bank bad debt ratio of households, so that $\vartheta^H_t L^i_t$ also represents the capital loss of banks. The change of ϑ^H_t brings in default shock in household sectors, and this shock follows the *AR* (*1*) process, where $\vartheta^H_t = \rho_{\vartheta H} \vartheta^H_{t-1} + \sigma_{\vartheta H,t}, \sigma_{\vartheta H,t} \sim IIDNormal(0, \sigma^2_{\vartheta H})$. Here, ρ_{MH} denotes coefficient of default shock (household), and σ_{MH} is the standard deviation of default shock (household)[2]. The reduction of bank capital shrinks the balance sheet of banks and reduces the issuing of loans to households, which reduces household leverage ratio.

Following the New Keynesianism model, this paper normalizes the households to unit, and assumes that they are composed of continuous individuals, and thus the consumption of households, C^i_t, is:

$$C^i_t = \left(\int_0^1 C^i_t(j)^{1-\varepsilon_p} dj \right)^{1/(1-\varepsilon_p)}, \tag{2}$$

where *j* represents classes of goods, and $1/\varepsilon_p$ represents goods substitution elasticity.

Let P_t represents nominal price, then we have:

$$P_t = (\int_0^1 P_t(j)^{(\varepsilon_p - 1)/\varepsilon_p} dj)^{\varepsilon_p/(\varepsilon_p - 1)}; \tag{3}$$

$$C^i_t(j) = (\frac{P_t}{P_t(j)})^{1/\varepsilon_p} C^i_t. \tag{4}$$

In period *t*, the income of households includes: wage income, $W^i_t N^i_t$ (with W^i_t being wage rate and N^i_t being working time); returns on investing firms, $R^M_t z^{KH}_t K^i_{t-1}$; bank loans, L^i_t; principal and interest income from savings in period $t-1$, $\left(1+i^i_{t-1}\right) D^i_{t-1}$. Here, K^i_t represents the investment of households to firms, R^M_t denotes the return on investment of firms, and

[1] In this paper, the term "bank risk appetite shock (household)" refers to "bank risk appetite shock in the household sector".

[2] In this paper, the term "default shock (household)" refers to "default shock in the household sector".

z_t^{KH} represents the firms' utilization rate of the household investment. The expenditure of households includes: consumption expenditures, C_t^i; savings, D_t^i; real estate purchase expenditures, $q_t\left(H_t^i - H_{t-1}^i\right)$; investment expenditures, I_t^i; repayment of loan principal L_{t-1}^i and interest $i_{t-1}^i L_{t-1}^i$.

In addition, as it is impossible for economic sectors to instantly adjust consumption, real estate, investment and loans to a consensual state, this paper introduces adjustment cost, following Christiano et al. (2010). Therefore, household expenditure will also include the adjustment costs of real estate, investments and loans, denoted by $ac_t^{HH,i} = 0.5\psi_{HH}(H_t^i - H_{t-1}^i)^2 / H_{t-1}^i$, $ac_t^{HK} = 0.5\psi_{HK}(K_t^i - K_{t-1}^i)^2 / K_{t-1}^i$, and $ac_t^{HL} = 0.5\psi_{HL}(L_t^i - L_{t-1}^i)^2 / L_{t-1}^i$, respectively, where ψ_{HH}, ψ_{HK} and ψ_{HL} are the adjustment cost coefficients.

There is a nonlinear relationship between the depreciation rate of houses and the age of the house and any increase in the house age will slow down the depreciation rate. According to Hao and Chen (2012), the depreciation of houses older than 10 years is not significant. Given these facts, we assume that the real estate is not depreciated, to simplify the model setting. The budget constraint for the household sector is:

$$\begin{aligned}&\frac{1}{P_t}\int_0^1 P_t(j)C_t^i(j)dj + D_t^i + q_t\left(H_t^i - H_{t-1}^i\right) + I_t^i + L_{t-1}^i\left(1+i_{t-1}^i\right) + ac_t^{HH,i} + ac_t^{HK} + ac_t^{HL} = \\ &L_t^i + D_{t-1}^i\left(1+i_{t-1}\right) + W_t^i N_t^i + R_t^M z_t^{KH} K_{t-1}^i + \vartheta_t^H L_t^i.\end{aligned} \tag{5}$$

Spender has no savings or investment, but they still need to purchase real estate to meet their housing needs. Since their expenditures depend on current income and new bank loans, the budget constraint of *spender* can be simplified from Equation (5) as follows:

$$\begin{aligned}&C_t^{spender} + q_t\left(H_t^{spender} - H_{t-1}^{spender}\right) + L_{t-1}^{spender}\left(1+i_{t-1}^i\right) + ac_t^{HH,spender} + ac_t^{HL} = \\ &L_t^{spender} + W_t^{spender} N_t^{spender} + \vartheta_t^H L_t^{spender}.\end{aligned} \tag{6}$$

Saver spends a portion of their income on savings and direct investment to firms, and their investment expenditure in period *t* is:

$$I_t^i = \frac{K_t^i - \left(1-\delta_t^{KH}\right)K_{t-1}^i}{\exp(SH_{KI,t})}, \tag{7}$$

where the $\exp(SH_{KI,t})$ at the right-hand side of Equation (7) is the investment technology shock, and this shock follows the $AR(1)$ process, where $SH_{KI,t} = \rho_{KI} SH_{KI,t-1} + \sigma_{KI,t}, \sigma_{KI,t} \sim IIDNormal(0.\sigma_{KI}^2)$. Here, ρ_{KI} denotes coefficient of investment technology shock, and σ_{KI} is standard deviation of investment technology shock. The depreciation rate, δ_t^{KH}, is given in the following expression:

$$\delta_t^{KH} = \delta^{KH} + \left(\frac{1}{\beta^i} - 1 + \delta^{KH}\right)\left[0.5\frac{\zeta_H}{1-\zeta_H}(z_t^{KH})^2 + \left(1 - \frac{\zeta_H}{1-\zeta_H}\right)z_t^{KH} + \left(0.5\frac{\zeta_H}{1-\zeta_H} - 1\right)\right]. \tag{8}$$

Here, $\zeta_H / (1-\zeta_H)$ denotes the curvature of z_t^{KH}; $1/\beta^i - 1 + \delta^K$ denotes the return rate of K_t^i at steady state, and the budget constraint of *saver* is simplified as:

$$C_t^{saver} + D_t^{saver} + q_t\left(H_t^{saver} - H_{t-1}^{saver}\right) + I_t^{saver} + ac_t^{HH,saver} + ac_t^{HK} = D_{t-1}^{saver}\left(1+i_{t-1}\right) + W_t^{saver} N_t^{saver}. \tag{9}$$

Let β_t^i represent the discount factor of household i, where $i \in \{saver, spender\}$; η denotes the household's consumption habits coefficient; J delegates the household's real estate preference coefficient; $\exp(SH_{c,t})$ represents the consumption shock, with this shock following the $AR(1)$ process, where $SH_{C,t} = \rho_C SH_{C,t-1} + \sigma_{C,t}, \sigma_{C,t} \sim IIDNormal(0, \sigma_C^2)$, with ρ_C denoting coefficient of consumption shock and σ_C being standard deviation of consumption shock; $SH_{H,t}$ represents the real estate demand shock, with this shock following the $AR(1)$ process, where $SH_{H,t} = \rho_H SH_{H,t-1} + \sigma_{H,t}, \sigma_{H,t} \sim IIDNormal(0, \sigma_H^2)$, with σ_H denoting standard deviation of real estate demand shock, and ρ_H denoting coefficient of real estate demand shock; and finally, τ represents the weight of leisure in household's utility. The utility function of the household can be given as:

$$U(C_t^i, H_t^i, N_t^i) = E_0 \sum_{t=0}^{\infty} \beta_t^i (\exp(SH_{C,t})(1-\eta)\log(C_t^i - \eta C_{t-1}^i)) + E_0 \sum_{t=0}^{\infty} \beta_t^i (J \exp(SH_{c,t} + SH_{H,t})\log(H_t^i) + \tau \log(1 - N_t^i)). \quad (10)$$

3.2. Firms

The investment of firm's originates from household investment, firm capital and bank loans. Since the firm capital and household investment cannot satisfy the capital demands of firms, firms have to obtain funds from banks. In this paper, the assets of firms are divided into two classes – real estate H_t^E and movable assets K_t^E – and it is assumed that firms can obtain bank loans by pledging these two classes of assets. The advantages of this setting are reflected in three aspects. First, it explains the difference in asset-liability ratio between households and firms. Second, it eliminates the problem of the depreciation rate parameter setting caused by the difference in depreciation rate between real estate and movable property. Third, it is more consistent with the financing business rules. With this setting, firms have greater capacity of financing and larger debt scale than households which can only offer real estate as collateral. When obtaining loans in period t, firms face the following constraint:

$$L_t^E \le \exp(SH_{ME,t}) m_{EH} \frac{E_0(q_{t+1})}{1 + i_t^E} H_t^E + \exp(SH_{ME,t}) m_{EK} K_t^E - m_N W_t^i N_t^i - \vartheta_t^E L_t^E. \quad (11)$$

In Equation (11), we introduce firm debt into the model, as well as default shock and bank risk appetite shock to the firm sector[3]. Here, m_{EH} and m_{EK} represent the collateral rate of H_t^E and K_t^E, respectively; $\exp(SH_{ME,t})$ represents the impact of the bank risk appetite shock (firm), and this shock follows the $AR(1)$ process, where $SH_{ME,t} = \rho_{ME} SH_{ME,t-1} - \sigma_{ME,t}, \sigma_{ME,t} \sim IIDNormal(0, \sigma_{ME}^2)$. Here, σ_{ME} denotes standard deviation of bank risk appetite shock (firm), and ρ_{ME} denotes coefficient of bank risk appetite shock (firm); m_N represents the time point of payroll, where $m_N \in \{1, 0\}$, and 1 is the wage bill that must be pre-paid, while 0 is the wage bill that must be post-paid; $\vartheta_t^E L_t^E$ represents the redistribution of capital from banks to the firms, and ϑ_t^E denotes default shock (firm), which follows the $AR(1)$ process, where $\vartheta_t^E = \rho_{\vartheta E} \vartheta_{t-1}^E + \sigma_{\vartheta E,t}, \sigma_{\vartheta E,t} \sim IIDNormal(0, \sigma_{\vartheta E}^2)$. Here, $\rho_{\vartheta E}$ denotes the coefficient of default shock (firm), and $\sigma_{\vartheta E}$ is the standard deviation of default shock (firm).

[3] In this paper, the term "bank risk appetite shock (firm)" refers to "bank risk appetite shock in the firm sector", and the term "default shock (firm)" refers to "default shock in the firm sector".

The budget constraint of firms is:

$$C_t^E + q_t\left(H_t^E - H_{t-1}^E\right) + W_t^i N_t^i + R_t^M z_t^{KH} K_{t-1}^i + \left(1+i_t^E\right)L_{t-1}^E + I_t^E + ac_t^{EK} + ac_t^{EL} = Y_t + L_t^E + \vartheta_t^E L_t^E. \quad (12)$$

The left-hand side in Equation (12) is the firm's expenditure in period t, including: firm's consumption, C_t^E; purchase of real estate, $q_t\left(H_t^E - H_{t-1}^E\right)$; wages, $W_t^i N_t^i$; investment dividends to households, $R_t^M z_t^{KH} K_{t-1}^i$; principal and interest of debts, $\left(1+i_t^E\right)L_{t-1}^E$; newly increased investment, I_t^E; adjusted cost of firm investment, $ac_t^{EK} = 0.5\psi_{EK}\left(K_t^E - K_{t-1}^E\right)^2 / K_{t-1}^E$, where ψ_{EK} denotes the adjusted cost coefficient of firm investment; adjusted cost of firm loan, $ac_t^{EL} = 0.5\psi_{EL}\left(L_t^E - L_{t-1}^E\right)^2 / L_{t-1}^E$, where ψ_{EL} denotes adjusted cost coefficient of firm loan.

The final output, Y_t, is set in C-D function form:

$$Y_t = \exp(SH_{TFP,t})(z_t^{KH}K_{t-1}^i)^{\alpha\mu}(z_t^{KE}K_{t-1}^E)^{\alpha(1-\mu)}(H_{t-1}^E)^{\nu}(N_t^{saver})^{(1-\alpha-\nu)(1-\sigma)}(N_t^{spender})^{(1-\alpha-\nu)\sigma}, \quad (13)$$

where, $\exp(SH_{TFP,t})$ denotes total factor productivity shock, and this shock follows the *AR*(*1*) process, where $SH_{TFP,t} = \rho_{TFP}SH_{TFP,t-1} + \sigma_{TFP,t}, \sigma_{TFP,t} \sim IIDNormal(0, \sigma_{TFP}^2)$, with ρ_{TFP} denoting the coefficient of total factor productivity shock and σ_{TFP} being the standard deviation of total factor productivity shock; and z_t^{KE} denotes the utilization rate of investment in the firm sector.

The depreciation rate of the firm sector is:

$$\delta_t^{KE} = \delta^{KE} + (\frac{1}{\beta^E} - 1 + \delta^{KE})[0.5\frac{\zeta_E}{1-\zeta_E}(z_t^{KE})^2 + (1 - \frac{\zeta_E}{1-\zeta_E})z_t^{KE} + (0.5\frac{\zeta_E}{1-\zeta_E} - 1)], \quad (14)$$

where $\zeta_E / 1-\zeta_E$ denotes the curvature of z_t^{KE}, $1/\beta^E - 1 + \delta^{KE}$ denotes the return rate of K_t^E at steady state, and the newly increased investment in period *t*, I_t^E, is:

$$I_t^E = \frac{K_t^E - \left(1-\delta_t^{KE}\right)K_{t-1}^E}{\exp(SH_{KI,t})}. \quad (15)$$

Assuming that the utility of the firm only depends on consumption, then the utility function of the firm sector is given as:

$$U\left(C_t^E\right) = E_0\sum_{t=0}^{\infty}\beta_t^E \log(C_t^E), \quad (16)$$

where β_t^E is the discount factor of firms.

3.3. Banks

In bank's consolidated balance, the asset side consists of bank loans L_t, and the liability side consists of household savings D_t^i and bank capital n_t. Bank's capital loss in period *t* is $\vartheta_t L_t$, where $\vartheta_t = (\vartheta_t^H L_t^i + \vartheta_t^E L_t^E) / L_t$, $L_t = L_t^i + L_t^E$, and so $n_t = L_t - D_t^i - \vartheta_t L_t$. Banks are constrained by the capital adequacy ratio in their business activities:

$$n_t \geq \left(1-\gamma\right)\left(L_t - \vartheta_t L_t\right). \quad (17)$$

Through banks, households and firms are connected via balance sheets. Due to the high barriers of entry of China's banking industry, this paper assumes that the capital accumulation

of banks can only be carried out by converting profits into capital, and investors of banks make optimal choices between consumption and capital conversion. The bank's capital investment in period t, I_t^B, is:

$$I_t^B = n_t - \left(n_{t-1} - \vartheta_t L_t\right). \tag{18}$$

Let C_t^B represent the banker's consumption, and ac_t^{BL}, ac_t^{BD} represent the adjustment cost of bank loans and savings, respectively. Here, $ac_t^{BLE} = 0.5\psi_{BLE}(L_t^E - L_{t-1}^E)^2 / L_{t-1}^E$, where ψ_{BLE} denotes the firm loan adjustment cost in banks, $ac_t^{BLSP} = 0.5\psi_{BLSP}(L_t^i - L_{t-1}^i)^2 / L_{t-1}^i$, where ψ_{BLSP} denotes the firm loan adjustment cost in banks, and $ac_t^{BD} = 0.5\psi_{BD}(D_t^i - D_{t-1}^i)^2 / D_{t-1}^i$, where ψ_{BD} denotes the saving adjustment cost in banks. The budget constraint and adjustment cost of banks are:

$$C_t^B + \left(1+i_{t-1}\right)D_{t-1}^i + L_t + I_t^B + ac_t^{BLE} + ac_t^{BLSP} + ac_t^{BD} = D_t^i + \left(1+i_t^i\right)L_{t-1}^i + \left(1+i_t^E\right)L_{t-1}^E. \tag{19}$$

Similar with the firm sector, the utility function of banks is:

$$U\left(C_t^B\right) = E_0\sum_{t=0}^{\infty}\beta_t^B \log(C_t^B). \tag{20}$$

with β_t^B being the discount factor of banks.

3.4. General equilibrium

This paper normalizes gross real estate to unit, where $H_t^i + H_t^E = 1$. The right-hand side of the general equilibrium equation includes consumption expenditure, investment expenditure, real estate purchase expenditure, and adjustment cost. The general equilibrium is:[4]

$$\begin{aligned} Y_t = {} & C_t^i + C_t^E + C_t^B + I_t^B + n_t + I_t^i + q_t\left(H_t^i - H_{t-1}^i + H_t^E - H_{t-1}^E\right) + \\ & ac_t^{HH,i} + ac_t^{HK} + ac_t^{HL} + ac_t^{BLE} + ac_t^{BLSP} + ac_t^{BD} + ac_t^{EK} + ac_t^{EL}. \end{aligned} \tag{21}$$

4. Estimation

4.1. Data

In this paper, household debt is the main concern in selecting the data used for the Bayesian estimation. Accordingly, we use China quarterly data from 2005Q1 to 2020Q4 to estimate the model. The following eight quarterly time series are adopted: consumption, investment, household savings, household loans, corporate loans, real estate prices, deposit interest rates, and loan interest rates.[5] For the time series of consumption, investment, household savings, household loans, firm loans, and real estate prices, this paper converts the nominal value to the real value using the GDP deflator. Furthermore, we remove the seasonal factor before taking the logarithmic values and using one-side HP filtering to detrend. As for deposit interest rates and loan interest rates, we take the logarithmic values.

[4] As previously suggested, the general equilibrium in the budget constraints, as denoted by equation (21), is an established condition.

[5] The data for consumption, investment, household savings, household loans, and firm loans are from *China's Macroeconomy*: *Time Series Data*, which is collected and calculated by Chang et al. (2016) based on the method proposed by Higgins and Zha (2015). The data for real estate prices, deposit rates, and loan rates are from Wind Database.

4.2. Calibration

For weakly identified parameters, this paper uses a calibration method to determine the parameter values, as shown in Table 1. As *spender* is more impatient than *saver*, and the firm is more impatient than *spender*, we derive the relationship of discounter factors as $\beta^{saver} > \beta^{spender} > \beta^{E}$. Banks, which connect firms with households, show a level of patience between firms and households, where $\beta^{saver} > \beta^{spender} > \beta^{B} > \beta^{E}$. Thus, based on the research of Iacoviello (2005, 2015), Christiano et al. (2010, 2014) and Wang and Hou (2017), the discount factors are: $\beta^{saver} = 0.9925$, $\beta^{spender} = 0.99$, $\beta^{B} = 0.945$, $\beta^{E} = 0.94$. As widely used in related studies (Iacoviello, 2015), the real estate preference coefficient is 0.075 in this paper. The ratio of household working time to leisure time is usually 0.5, so the weight of leisure in household's utility, τ, is set to 2. We assume that workers are paid in advance, thus $m_N = 1$. The collateral rate of commercial banks for residential mortgage loans is 70% as usual. It is worth noting that, although the percentage of down payment on mortgage loans varies from city to city in China due to different real estate policies in each city, 30% down payment for the first house is commonly applied. For firms, the collateral rate of real estate is usually 70%, and the pledge rate which takes machinery equipment as collateral is mainly 60% in China. We set the collateral rate at 0.7, and set the pledge rate of movable assets at 0.6, so that $m_{HH} = 0.7$, $m_{EH} = 0.7$, $m_{EK} = 0.6$. According to the requirements of China's bank capital adequacy ratio and the public information of the banking industry, the bank capital adequacy ratio is set at 10%, where $\gamma = 0.9$.

Table 1. Calibrated parameters

Parameter		Value
β^{saver}	Discount factor of *saver*	0.9925
$\beta^{spender}$	Discount factor of *spender*	0.99
β^{E}	Discount factor of firms	0.94
β^{B}	Discount factor of banks	0.945
τ	Weight of leisure in household's utility	2
J	Real estate preference coefficient	0.075
m_{HH}	Collateral rate of household's real estates	0.7
m_{EH}	Collateral rate of firm's real estates	0.7
m_{EK}	Pledge rate of firm's movable assets	0.6
m_N	Time point of paying wage bills	1
$1 - \gamma$	Bank capital adequacy ratio	0.1

4.3. Estimation results

For parameters other than weak identification, we use the Bayesian method to estimate them. The posterior coefficient values of bank risk appetite shock (household), bank risk appetite shock (firm), housing demand shock, and default shock (firm) are higher than their prior values, indicating that the impact of the above shocks is relatively long-lasting. The household credit participation rate value is estimated at 39.15%. According to China inclusive finance index analysis report (Financial Consumer Rights Protection Bureau of People's Bank of China,

2022), as of 2021, the participation rate of Chinese respondents in borrowing from financial institutions is 39%. Meanwhile, the survey on assets and liabilities of urban households in China in 2019 (Urban Household Assets, 2020) reported that the credit participation rate of urban residents in China is 56.5%. These two reports, both conducted by the Central Bank of China, show that the household credit participation rate estimated by the model closely aligns with actual survey results. Detailed results are shown in Table 2.

Table 2. Estimation parameters

Parameters		Prior means	Posterior means	90% HPD Interval	Prior density
ρ_{KI}	Investment technology shock coefficient	0.7	0.4396	0.3091, 0.5700	Beta
ρ_{MH}	Bank risk appetite shock (household) coefficient	0.7	0.9511	0.9315, 0.9719	Beta
ρ_{H}	Real estate demand shock coefficient	0.7	0.9579	0.9393, 0.9778	Beta
ρ_{C}	Consumption shock coefficient	0.7	0.7096	0.6184, 0.7940	Beta
ρ_{TFP}	Total factor productivity shock coefficient	0.7	0.6132	0.4930, 0.7358	Beta
ρ_{ME}	Bank risk appetite shock (firm) coefficient	0.7	0.7991	0.6986, 0.9005	Beta
$\rho_{\vartheta H}$	Default shock (household) coefficient	0.8	0.7808	0.7202, 0.8465	Beta
$\rho_{\vartheta E}$	Default shock (firm) coefficient	0.8	0.7059	0.5936, 0.8236	Beta
ψ_{HK}	Investment adjustment cost coefficient in the household sector	0.25	0.3177	0.2312, 0.4052	Gamma
ψ_{HL}	Loan adjustment cost coefficient in the household sector	0.25	0.2166	0.1433, 0.2875	Gamma
ψ_{BLE}	Firm loan adjustment cost coefficient in banks	0.25	0.2635	0.1721, 0.3425	Gamma
ψ_{BD}	Savings adjustment cost coefficient in banks	0.25	0.2577	0.1733, 0.3456	Gamma
ψ_{BLSP}	Household loan adjustment cost coefficient in banks	1	1.027	0.9419, 1.1111	Gamma
ψ_{EK}	Investment adjustment cost coefficient in the firm sector	0.25	0.252	0.1671, 0.3377	Gamma
ψ_{EL}	Loan adjustment cost coefficient in the firm sector	0.25	0.3009	0.2016, 0.3959	Gamma
α	Share of investment in production	0.35	0.6879	0.6177, 0.7528	Beta
μ	Share of household investment in production	0.4	0.0408	0.015, 0.0639	Beta
ν	Share of firm real estate in production	0.04	0.0093	0.0063, 0.0122	Beta
σ	Household credit participation rate (share of *spender*'s labor in production)	0.3	0.3915	0.2894, 0.4879	Beta
ζ_{H}	Utilization rate curvature of household investment	0.1	0.0636	0.0078, 0.1276	Beta
ζ_{E}	Utilization rate curvature of firm investment	0.4	0.2038	0.1902, 0.2136	Beta
η	Households consumption habits coefficient	0.4	0.1645	0.0532, 0.2756	Beta
σ_{KI}	Std. Investment technology shock	0.05	0.0405	0.0351, 0.0453	Inv-gamma
σ_{MH}	Std. Bank risk appetite shock (household)	0.05	0.0527	0.0454, 0.0586	Inv-gamma
σ_{H}	Std. Real estate demand shock	0.05	0.051	0.0441, 0.0581	Inv-gamma
σ_{C}	Std. Consumption shock	0.05	0.0522	0.0446, 0.0594	Inv-gamma
σ_{TFP}	Std. Total factor productivity shock	0.05	0.0435	0.0374, 0.0491	Inv-gamma
σ_{ME}	Std. Bank risk appetite shock (firm)	0.25	0.2107	0.1821, 0.238	Inv-gamma
$\sigma_{\vartheta H}$	Std. Default shock (household)	0.05	0.0396	0.0346, 0.0446	Inv-gamma
$\sigma_{\vartheta E}$	Std. Default shock (firm)	0.05	0.0426	0.0362, 0.0479	Inv-gamma

Specifically, the share of household investment in total investment drops dramatically, and the consumer habit coefficient undergoes tremendous changes after the COVID-19 epidemic outbreak. We use the data before the COVID-19 epidemic outbreak (i.e., 2005Q4–2018Q4) to fit our model to get control group parameters. We find that, after the COVID-19 pandemic, the share of household investment largely decreases, while the share of firm investment increases, and the consumer structure changes greatly. In addition, we find that the household credit participation rate drops from 49% to 39% after the pandemic. These changes indicate that the COVID-19 pandemic significantly affects the household sector. Overall, the parameters estimation is in line with our expectation and practical experience.

5. How does household debt affect the economy

5.1. Household debt changes and economic growth

5.1.1. Impulse response

As shown in Figures 1, 2, under the bank risk appetite shock and default shock, the household debt decreases, and aggregate output, consumption, household savings, and household labor income are all negatively affected. We adopt credit spread to represent financial friction, with larger credit spreads indicating larger financial frictions. The results of the impulse response indicate that the financial frictions under both negative shocks rise to varying degrees. However, in this process, aggregate output and consumption appear to rise in the early stage. This is because, under these negative shocks, household debt, being the first to be affected, falls rapidly while the fall of household savings relatively lags. In consequence, the credit resources released by the household sector flow into firms in the short term, resulting in periodic positive fluctuations in output and consumption. After that, the positive volatility quickly disappears with the decline of household savings. The results of the impulse response suggest that the reduction of household debt has a negative impact on major economic variables and is detrimental to China's economic growth.

5.1.2. Simulation experiment

However, it is not clear enough whether the reduction of household debt has negative impacts on the economy, because some points in Figure 1 and Figure 2 seemingly suggest that reducing household debt benefits the economy at some time. To further study the impact of changes in household debts, this paper simulates the changes in aggregate output, household income, and financial friction when the leverage ratio in the household sector continuously declines.

Our experiment introduces a 12-period-lasting bank risk appetite shock. During this period, the collateral rate of the household sector continues to decrease. At the end of the 12th period, the collateral rate decreases by 15%; that is, the collateral rate decreases from 0.7 to 0.6. As shown in Figure 3, the reduction in household debt induces the total output to drop by 0.024% at most, and the credit spread increases by as high as 0.145%.

We then introduce a default shock that lasts for 12 periods, during which the default rate of household debt continuously rises until the default rate reaches 6%. In Figure 4, the simulation experiment shows the results when the household sector passively deleverages

through loan defaults. As the loan default rate reaches 6%, the total output drops by as high as 0.11%, and the loan spread increases by 0.58%.

These results illustrate that both the persistent reduction of collateral rates and continuous loan defaults in the household sector negatively affect output and financial frictions. The results of the simulation experiment further suggest that the reduction of household debt has an adverse effect on the economy.

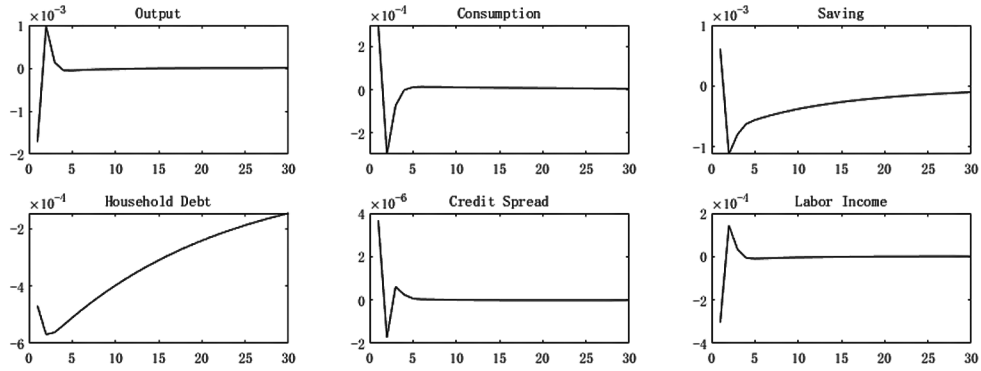

Figure 1. Impulse response-default shock (household)

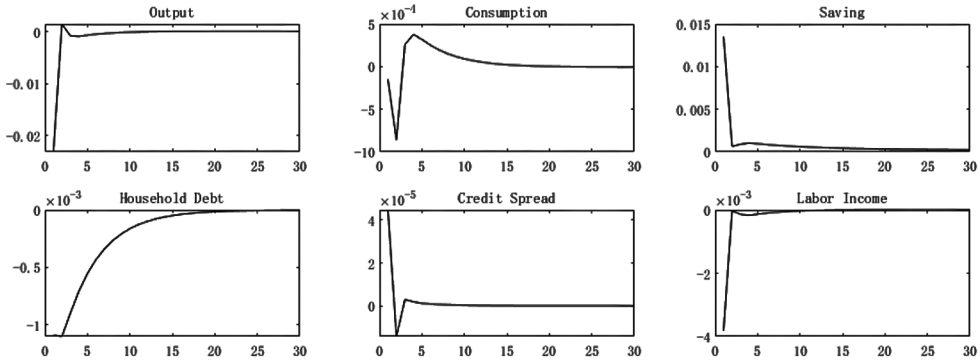

Figure 2. Impulse response-bank risk appetite shock (household)

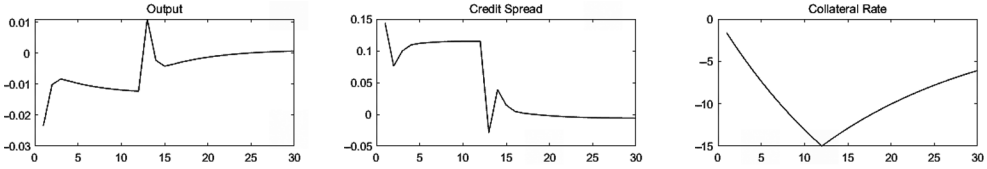

Figure 3. Simulation-bank risk appetite shock (Household)

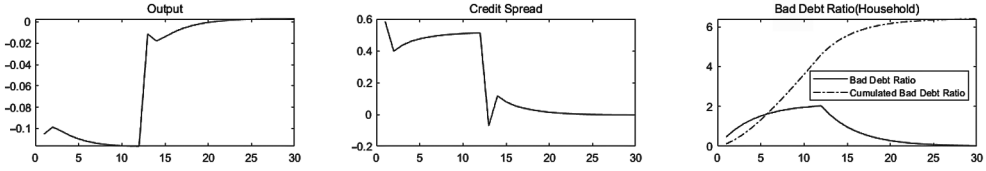

Figure 4. Simulation-default shock (Household)

Using contrafactual analysis, the experimental results in this section suggest that the increase in household debts can promote demand growth, thereby increasing output. At the same time, the growth of household debts also reduces financial frictions and increases bank revenue. This will motivate banks to turn more profit into capital, thus improving the bank's capacity and reducing the cost in loan issuance. This benefits production through reducing financial costs and generating investment. Therefore, although the rapid growth of household debt should of some concern, this does not mean China's household sector should be deleveraged. On the contrary, the growth of China's household debt is still conducive to the economic growth.

5.2. Validation and robustness

5.2.1. Current leverage state of the household sector

By changing the constraints and recalibrating the corresponding parameters, we simulate two extreme states: an extremely low leverage state and an extremely high leverage state. In the state of absolutely low leverage, the proportion of indebted households is minimal. At the same time, because household asset-liability ratios are extremely low, households are not constrained by collateral ratio, which means that the bank risk appetite shocks no longer influence the economy. Conversely, in the situation with absolute high leverage, the household credit participation rate and the household sector's asset-liability ratio are extremely high. In addition, we assume that banks adjust all classes of collateral rates synchronously as in real economic practices. The specific settings are shown in Table 3.

The simulation in Figure 5 introduces a default shock (household) lasting 12 periods, during which the default rate of household loans reaches 6%, same with the setup of shocks as in Figure 4.

In the high leverage state, the impact of household loan default shock on output is between 0.003% and –0.02%, and the credit spread increases by about 0.66%. In the low leverage state, the impact of household loan default shock on output is between 0.004% and –0.15%, and the credit spread increases by about 0.48%. Comparing the two states above, we find that: 1) default shock (household) in the high leverage state greatly enhances financial friction, but output is much less negatively affected; 2) default shock (household) in the low leverage state has relatively less impact on financial frictions, but has a stronger negative impact on output. Using counterfactual analysis, the above results suggest that when the asset-liability ratio of households exceeds a certain level, the increase in output brought about by the growth of household debts becomes not significant anymore. Meanwhile, when the asset-liability ratio of households is below a certain level, the increase in household debt exerts a significant positive influence on output. The performance of China's economy, which is marked by the normal state line in Figure 5, is similar to that of the low leverage state.

The simulation in Figure 6 introduces bank risk appetite shock (household) lasting 12 periods, during which the collateral rate drops from 0.7 to 0.6, and has the same setup of shocks as in Figure 4. It can be seen that the household debts will not be affected by bank risk appetite in the low leverage state, so the simulation experiment in Figure 6 does not include the low leverage state graph.

Table 3. Parameters settings under extreme state

Parameters	Absolutely low leverage state	Absolutely high leverage state	Normal State
Household credit participation rate	0.1	0.99	0.492
Bank capital adequacy ratio	0.1	0.01	0.1
Collateral rate	/	0.99	0.7
Pledge rate	/	0.99	0.6
Default shock (household)	Y	Y	Y
Bank risk appetite shock (household)	N	Y	Y

Note: As the leverage ratio has been greatly changed here, part of the estimated parameters in Table 2 become not able to fit to data to some extent; therefore we put these parameters as calibrated parameters which have the same values as Table 2.

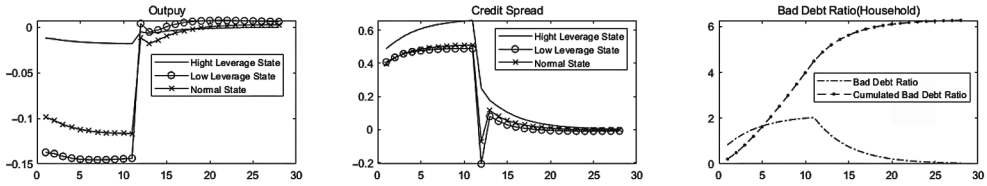

Figure 5. Simulation-household debt changes and economic growth with different leverage ratio

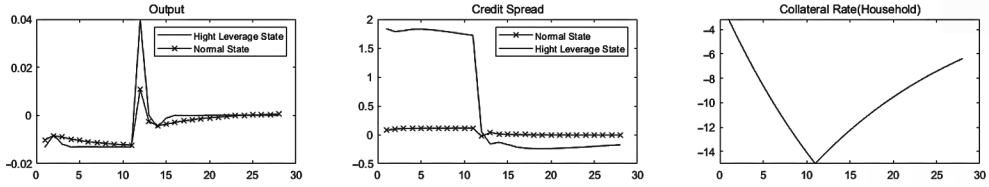

Figure 6. Simulation-household debt changes and economic growth with different leverage ratio

In the high leverage state, the impact of bank risk appetite shock on output is between 0.04% and –0.013%, and the credit spread increases by about 1.8%. In contrast, in the normal state, the impact of bank risk appetite shock on output is between 0.01% and –0.012%, and the credit spread increases by about 0.11%. As shown in Figure 6, in the state of high leverage, although the financial friction caused by bank risk appetite shock is enhanced, it has a relatively positive impact on output. However, under the normal state, the bank risk appetite shock shows a negative impact on output.

In summary, under the bank risk appetite shock and default shock, the performance of China's economy in the normal state is similar to that in the low leverage state, and is far from the performance in the high leverage state. On the one hand, this result indicates that our model is appropriate for analyzing the nonlinear impact of changes in households leverage ratio on economic growth by using a simulation experiment. On the other hand, this result illustrates that household debt in China is still at a low level and that an increase in household debt is beneficial to economic growth.

5.2.2. Different economic impacts: Firm debt growth vs. household debt growth

As shown in Figure 7, the simulation experiment introduces default shock (firm) and bank risk appetite shock (firm) that lasts 12 periods. During this period, the firm loan default rate reaches 15%, and the collateral rate decreases from 0.7 to 0.6. Under the default shock (firm), output decreases by 0.028%. After the 14th period, the output returns to positive, and gradually increases to 0.003%. Under the bank risk appetite shock (firm), the output decreases by 0.41%. After the 15th period, output returns to positive and gradually increases to 0.054%.

This result suggests that the reduction of firm debt may lead to negative volatility in the short term, but in the long run, it benefits economic growth. For a long time, China's household sector exhibited high savings and low debts. Consequently, firms heavily rely on bank loans for operational and investment funds, resulting in substantial firm debt. In the period with rapid economic growth, firms typically generate profits after serving debt obligations for investment and R&D. However, as economic growth slows down, the high leverage ratio constraints firms' expenditure on investment and R&D, trapping them in debt-deflation cycle. To break this vicious circle, firms need to reduce their debt levels. The contraction of firm loans reduces demand and increases financial frictions, resulting in a certain degree of short-term negative fluctuation. This contraction in firm loans leads to a decrease in total output initially, but it sustains higher-than-initial output growth in the long term. As shown in Figure 7, output initially declines but subsequently rises, maintaining output levels above the initial baseline in the later periods.

However, given China's relatively high leverage ratio and the complicated international political and economic landscape, proactive deleveraging of the firm sector is likely to cause dramatic economic fluctuations. Therefore, while keeping the overall leverage stability, promoting the growth of household debt can not only reduce firm debt but also offset short-term adverse effects such as decreased demand and increased financing costs resulting from reduced firm debt. Thus, promoting household debt growth can aid in changing the high leverage ratio scenario in the firm sector, thereby facilitating the goal of adjusting the leverage structure and promoting long-term stable economic growth.

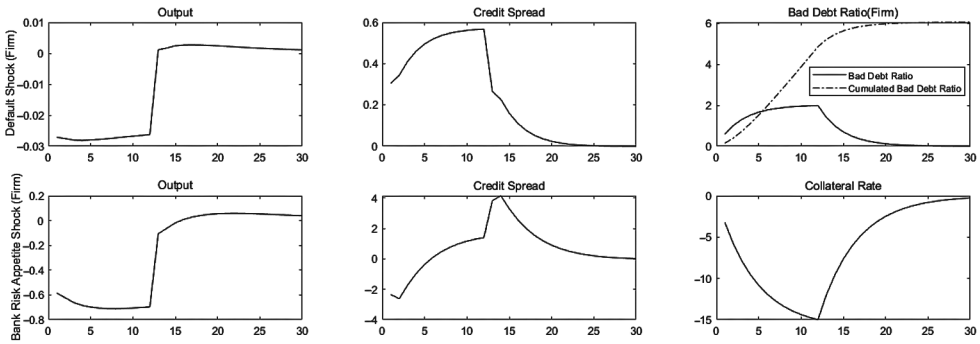

Figure 7. Simulation-firm debt changes and economic growth

5.3. Financial risks behind stimulating the economy with household debt

As household leverage increases, the relationship between household debt and financial stability intensifies. Previous results suggest that the expansion of household debt is beneficial to economic growth, yet the increase in household leverage also alters financial risks. When advocating for increased household debt, it is crucial to avoid trading higher financial risk for lower economic growth.

Considering volatility is closely related to risk in financial theory, this paper, following Adrian et al. (2019), measures financial risk using output volatility in 30 periods under a negative financial shock. We measure the level of household debt based on the asset-liability ratio of indebted households and household credit participation rate, as the leverage ratio change in the household sector closely relates to these two factors. Accordingly, we can ascertain the relationship between financial risk and household debt, by analyzing the economy's volatility under negative bank risk appetite shock (household) and default shock (household).

First, this paper analyzes the impact of changes in the asset-liability ratio of indebted households on financial risks. We derive these changes by setting different levels of collateral rates which constrain the leverage ratio of indebted households (as shown in Table 4). The result of the impulse response shows that, compared with the normal state: 1) under the impact of bank risk appetite shock, the financial risk in the low asset-liability ratio state is greatly reduced, while the financial risk in the high asset-liability ratio state is greatly increased; 2) under the impact of default shock, the financial risk in the low asset-liability ratio state is greatly increased, whereas the financial risk in a high asset-liability ratio state is significantly decreased.

In actual financial activities, since it is difficult for banks to distinguish the source of collaterals, the collateral ratios of the household sector and firm sector change synchronously. An increase in the collateral ratio means that the liabilities of households and firms will increase at the same time, which causes an increasing accumulation of vulnerability in the economy and thus increases the volatility of the economy under financial shocks. The negative bank risk appetite shock (household) curtails households' loan accessibility. The higher the asset-liability ratio of households, the more significant the impact on their loan balances, escalating financial risks. The default shock (household) triggers banks' capital losses, causing simultaneous reductions in the loan balance of households and firms. While the shrinkage of household loan balance hampers economic development, the decline in firm loan balance contributes to the economy's long-term stable growth, given the overleveraged high debt in the firm sector. Therefore, in the high asset-liability ratio state, the household sector can absorb more credit resources due to the higher collateral ratio in the household sector, thereby squeezing out more firm loans in the event of default shocks, consequently mitigating financial risk.

Second, this paper analyzes the impact of changes in household credit participation rate on financial risks, with the parameter settings outlined in Table 5. The impulse response indicates that an increase in household credit participation rate does not necessarily lead to an increase in financial risk. Compared with the normal state: 1) in response to a bank risk appetite shock, the financial risk slightly decreases in states with low credit participation rate, while it shows a slight increase in states with high credit participation rate; 2) under a default shock, the financial risk significantly increases in states with low credit participation rate, whereas it markedly decreases in states with high credit participation rate (as shown in Table 5).

Table 4. Parameter settings under different household asset-liability ratio

Parameters		Low asset-liability ratio state	High asset-liability ratio state	Normal state
Household credit participation rate		0.3915	0.3915	0.3915
Collateral ratio		0.65	0.75	0.7
Pledge ratio		0.56	0.64	0.6
Shock 1	Volatility of output (financial risk)	1.25912E-08	2.01435E-08	1.60446E-08
	Changes of volatility	–21.52%	+25.55%	0
Shock 2	Volatility of output (financial risk)	5.09683E-07	2.87432E-07	3.87134E-07
	Changes of volatility	+31.66%	–25.75%	0

Note: Shock 1 = bank risk appetite shock (household); Shock 2 = default shock (household).

Table 5. Parameter settings under different household credit participation rate

Parameters		Low credit participation rate state	High credit participation rate state	Normal state
Household credit participation rate		0.35	0.45	0.3915
Collateral ratio		0.7	0.7	0.7
Pledge ratio		0.6	0.6	0.6
Shock 1	Volatility of output(financial risk)	1.4791E-08	1.74579E-08	1.60446E-08
	Changes of volatility	–7.81%	+8.81%	0
Shock 2	Volatility of output(financial risk)	4.95582E-07	2.66193E-07	3.87134E-07
	Changes of volatility	+28.01%	–31.24%	0

Note: Shock 1 = bank risk appetite shock (household); Shock 2 = default shock (household).

The increase in household credit participation rate increases household debt and the vulnerability of the economy. However, unlike the rise in asset-liability ratio of indebted households, the rise in the household credit participation rates not only fails to boost the asset-liability ratio of the firm sector, but also effectively reduces debts in the firm sector when overall leverage remains stable. Therefore, the increase in household credit participation rate diminishes the vulnerability of the firm sector, thereby slowing down or even reversing the growth of financial risk in economy. Under a bank risk appetite shock (household), the household's capacity of obtaining loans weakens, affecting more households as the household credit participation rate rises, thus posing higher financial risk. Meanwhile, under a default shock (household), banks incur capital losses, causing simultaneous reductions in loan balances for both the household and firm sectors. Given the high debt levels in the firm sector, firm loans are initially squeezed out. Therefore, increasing the household credit participation rate can even reduce the financial risk under the default shock (as shown in Table 5).

The overall change in financial risk resulting from changes in household debt comprises "changes of financial risk in the household sector + changes of financial risk in the firm sector." In terms of the relationship between the growth of household debts and financial risks, as shown in Table 6, the financial risks stemming from increases in household asset-

liability ratio and the increase of household credit participation rate are different, although in both cases, household debts increase. This disparity can be attributed to two factors. First, the increase in asset-liability ratio renders both households and the firms more vulnerable to negative shocks, facilitating the spread and amplification of these shocks. Conversely, the increase in the household credit participation rate broadens the scope of shock impact without magnifying the shocks themselves. As shown in Table 4 and Table 5, under a bank risk appetite shock (household), changes in household asset-liability ratios exert a greater influence on financial risk, while changes in household credit participation rate have less influence on financial risk. Second, because the banks are constrained by capital, which is hard to replenish in the short term, the growth of household loans squeezes out firm loans, thereby reducing the financial risk in the firm sector. In China, as the firm sector is highly indebted, the decrease in firm debt significantly mitigates financial risk within this sector. This reduction has the potential to offset or even surpass the increase of financial risk stemming from the growth of household debt. This result is consistent with the findings of Li (2016), Liu et al. (2017), Wang et al. (2019), and Dong and Xu (2020).

Table 6. Financial risk in economic sectors

Economic state	Behavior	Financial risk in the household sector	Financial risk in the firm sector	Overall financial risk
Increase of asset-liability rate	shock 1	increase	increase	largely increase
	shock 2	increase	decrease	largely decrease
Increase of household credit participation rate	shock 1	increase	decrease	slightly increase
	shock 2	increase	decrease	largely decrease

Note: Shock 1 = bank risk appetite shock (household); Shock 2 = default shock (household).

In summary, the expansion of household debt promotes economic growth, while the associated accumulation of financial risks remains moderate. Our estimation results suggest that the asset-liability ratio of the indebted households is relatively high, and further increases in the debt ratio of indebted households could entail considerable financial risks. Conversely, augmenting household credit participation rate can spur economic development with significantly less financial risk. Therefore, prioritizing the increase in household credit participation rate should be emphasized for stimulating the growth of household debt.

6. Conclusions

In recent years, household sector debt in China has experienced rapid growth, leading to an increase in leverage ratio and a corresponding shift in the macroeconomic landscape. In this context, the growth of household debt exhibits evident nonlinear impacts on the economy and financial risk becomes increasingly significant in economic development. This paper constructs a DSGE model that integrates the debts of the major economic sectors and considers financial risk and debts within a unified framework, which enables simulating experiments to analyze the influence of leverage on economic development. By incorporating the leverage ratio constraints for households, firms, and banks, this paper explores the drivers for house-

hold debt changes and discusses how household debt growth affects economic growth and the financial risks associated with financial easing. We calibrate our model using Chine's data and present the following findings.

First, the increase in household debt stimulates demand and aggregate output while reducing financial friction. The reduction in financial friction enhances banks' lending capability and lowers loan costs, facilitating the productive sector to reduce financial burdens and boost investment, thereby promoting economic growth. Robustness analysis suggests that the performance of household debt in the current economic state resembles that of the low-leverage state model, differing significantly from the high-leverage state model. Overall, the rise in household debt currently support economic growth.

Second, heavy indebtedness among firms lead to funds being used for investment, research and development due to debt servicing. Consequently, reducing firm debt positively impacts output in the medium and long term. Given limited room to increase the overall leverage ratio, promoting household debt growth can alleviate short-term negative fluctuations resulting from reduced firm sector's debt, thereby sustaining stable economic growth.

Third, household debt growth heightens financial risk in the household sector but diminishes the it in the firm sector by displacing firm debt. Therefore, the net increase in household debt brings small marginal financial risk. Compared with raising the asset-liability ratio of indebted households, expanding household credit participation entails less financial risks to the economy, promoting relatively rapid economic growth with minimal economic vulnerability.

The expansion of household debt benefits economic development, provided the approach is appropriately selected. Based on our findings, we propose a feasible strategy for debt structure adjustment. Encouraging short-term consumption loans in China can increase the household credit participation rate, fueling economic growth while minimizing financial stability and reducing firm debt. Policies should promote consumption through subsidies and tax incentives, while guiding the financial sector to reduce the interest rates and thresholds of household consumption loans. In addition, robust financial supervision is essential to prevent new loans from inflating inefficient fields, such as real estate bubbles.

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Author contributions

Ziwei Liu conceived the study and is responsible for the design and development of the data analysis. Ziwei Liu and Xuemei Zheng are responsible for data collection and analysis. Ziwei Liu and Xuemei Zheng are responsible for data interpretation. Ziwei Liu wrote the first draft of the article. Xuemei Zheng and Fenju Zou revised the manuscript.

Disclosure statement

No potential competing interest was reported by the authors.

References

Adrian, T., Boyarchenko, N., & Giannone, D. (2019). Vulnerable growth. *American Economic Review*, *109*(4), 1263–1298. https://doi.org/10.1257/aer.20161923

Cecchetti, S. G., Mohanty, M. S., & Zampolli, F. (2011). *The real effects of debt* (BIS Working Paper No. 352). Bank for International Settlements.

Chang, C., Chen, K., Waggoner, D. F., & Zha, T. (2016). Trends and cycles in China's macroeconomy. *NBER Macroeconomics Annual*, *30*, 1–84. https://doi.org/10.1086/685949

Chen, X., & Huang, B. (2022). Household consumption quality and debt leverage: Theory and evidence. *Shanghai Journal of Economics*, (8), 34–45.

Christiano, L. J., Motto, R., & Rostagno, M. (2010). *Financial factors in economic fluctuations* (ECB Working Paper No. 1192). European Central Bank. https://doi.org/10.2139/ssrn.1600166

Christiano, L. J., Motto, R., & Rostagno, M. (2014). Risk shocks. *American Economic Review*, *104*(1), 27–65. https://doi.org/10.1257/aer.104.1.27

Debortoli, D., & Gali, J. (2017). *Monetary policy with heterogeneous agents*: *Insight from TANK models* (Economics Working Paper). Universitat Pompeu Fabra. https://EconPapers.repec.org/RePEc:upf:upfgen:1686

Dong, F., & Xu, Z. (2020). Cycles of credit expansion and misallocation: The good, the bad and the ugly. *Journal of Economic Theory*, *186*, Article 104994. https://doi.org/10.1016/j.jet.2020.104994

Fisher, I. (1933). The debt-deflation theory of great depressions. *Econometrica*, *1*(4), 337–357. https://doi.org/10.2307/1907327

Financial Consumer Rights Protection Bureau of People's Bank of China. (2022). *China inclusive finance index analysis report* (*2021*). http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/4671788/index.html

Geanakoplos, J. (2010). *The leverage cycle* (Clowles Foundation Discussion Paper No. 1715R). https://doi.org/10.2139/ssrn.1539483

Gertler, M., & Gilchrist, S. (2018). What happened: Financial factors in the great recession. *Journal of Economic Perspectives*, *32*(3), 3–30. https://doi.org/10.1257/jep.32.3.3

Gertler, M., & Kiyotaki, N. (2010). Financial intermediation and credit policy in business cycle analysis. *Handbook of Monetary Economics*, *3*, 547–599. https://doi.org/10.1016/B978-0-444-53238-1.00011-9

Gertler, M., & Kiyotaki, N., & Prestipino, A. (2017). *A macroeconomic model with financial panics* (International Finance Discussion Paper No. 1219). https://doi.org/10.17016/IFDP.2017.1219

Hao, Q., & Chen, J. (2012). Housing age, depreciation rate and housing price: An empirical study based on Shanghai data. *World Economic Papers*, (6), 64–77.

Higgins, P., & Zhan, T. (2015). *China's macroeconomic time series*: *Methods and implications* (Working Paper). Federal Reserve Bank of Atlanta. https://www.atlantafed.org/-/media/documents/cqer/researchcq/china-macroeconomy/ChinaTimeSeries_WorkingPaper.pdf

Iacoviello, M. (2015). Financial business cycles. *Review of Economic Dynamics*, *18*(1), 140–163. https://doi.org/10.1016/j.red.2014.09.003

Iacoviello, M. (2005). *Private debt and idiosyncratic volatility*: *A business cycle analysis* (Society for Economic Dynamics Meeting Paper No. 186).

Levine, R., Loayza, N., & Beck, T. (2000). Financial intermediation and growth: Causality and cause. *Journal of Monetary Economics*, *46*(1), 31–77. https://doi.org/10.1016/S0304-3932(00)00017-9

Li, C. F., Liu, J. J., & Chen, Y. X. (2014). The crowding out effect of housing price rise on residents' consumption in China. *Statistical Research*, *31*(12), 32–40.

Li, R. Y. (2016). International comparison and enlightenment of the leverage ratio of the residential sector. *Journal of Finance and Economics*, *6*(1), 23–27.

Liu, L., & Wang, Y. (2018). Household leverage and financial stability. *China Opening Journal*, *196*(1), 20–25.

Liu, X. G., Liu, Y. C., & Wang, J. (2018). Leverage, economic growth and recession. *Social Sciences in China*, (6), 50–70+205.

Liu, X. H., Zhou, Y., & Mu, Y. (2017). Study on the path of re-balancing of balance sheet by enterprise de-leveraging and household leveraging: From the view of stock market. *Nankai Economic Studied*, (3), 111–126.

Long, H. M., & Wu, D. (2022). The effect of real leverage on economic growth: Based on the moderating effects of financial stability. *Journal of Financial Research*, *506*(8), 38–54.

Ma, Y., & Chen, Y. L. (2017). Financial leverage, leverage volatility and economic growth. *Economic Research Journal*, *52*(6), 31–45.

Nakamura, F. (2023). Household debt and borrower-based measures in Finland: Insights from a heterogeneous agent model. *IMF Working Papers*, *2023*(262), 1–19. https://doi.org/10.5089/9798400263132.001

Pan, M., & Liu, Z. Q. (2018). Does "adding leverage" stimulate household consumption? Evidence from Chinese household survey. *Journal of Financial Research*, *454*(4), 71–87.

Peng, Y., Huang, X., & Shen, J. (2018). Real estate investment and financial efficiency: Regional variation in shifting financial resources from real to fictitious sector. *Journal of Financial Research*, *458*(8), 51–68.

Teulings, R., Wouterse, B., & Ji, K. (2023). Disentangling the effect of household debt on consumption. *Empirical Economics*, *65*, 2213–2239. https://doi.org/10.1007/s00181-023-02428-4

Tobin, J. (1993). Price flexibility and output stability: An old Keynesian view. *The Journal of Economic Perspectives*, *7*(1), 45–65. https://doi.org/10.1257/jep.7.1.45

Urban Household Assets. (2020). *Survey on assets and liabilities of urban households in China in 2019*. https://mp.weixin.qq.com/s/LfLwbHgjxGMwE2PHnqQO4Q

Wagner, W. (2010). Diversification at financial institutions and systemic crises. *Journal of Financial Intermediation*, *19*(3), 373–386. https://doi.org/10.1016/j.jfi.2009.07.002

Wang, P., & Hou, C. Q. (2017). Expectation shocks, house price movements, and economic fluctuation. *Economic Research Journal*, *52*(4), 48–63.

Wang, Y. Z., Luo, N. S., & Liu, W. B. (2019). What leverage is beneficial to firm innovation. *China Industrial Economics*, (3), 138–155.

Zabai, A. (2017). Household debt: Recent developments and challenges. *BIS Quarterly Review*.

Zhang, X. J, Chang, X., & Liu, L. (2019). Structural deleveraging: Process, logic and prospects – China's deleveraging 2017 annual report. *Economic Perspectives*, (05), 16–29.

Zhou, H., & Wang, Q. (2009). Monetary policy and asset price volatility: Theoretical model and empirical study in China. *Economic Research Journal*, *44*(10), 61–74.