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Asset Bubble, Bank Risk and " Two-Pillar " Regulation

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Abstract

By constructing a DSGE model that includes both credit supply and demand side financial frictions, this paper depicts the risk transmission channels between the macro-economy and the financial system, and on this basis, discusses the regulatory effects of extended monetary policy and different " two-pillar " policy combinations. The research shows that monetary policy combined with counter-cyclical capital buffer policy or dynamic statutory deposit reserve ratio policy can effectively reduce bank risk volatility to achieve economic and financial stability, and the regulation effect is better than that of expansionary monetary policy. Different " two-pillar " policy combinations have different effects on the regulation of economic variables and financial variables. Furthermore, the " two-pillar " policy combination can significantly improve the level of social welfare. Therefore, the " two-pillar " regulatory framework can better achieve the dynamic balance between " stable economy " and " risk prevention ".

Keywords

Asset Bubble; Bank Risk; " Two-Pillar " Regulation.

1. Introduction

The 2023 Central Financial Work Conference emphasized that " finance should provide high-quality services for economic and social development and dredge the channels for funds to enter the real economy ". Since 2010, the degree of financialization of China 's economy has been deepening. According to the data of the National Bureau of Statistics, the proportion of the added value of China's financial industry in GDP has generally shown an upward trend, reaching a historical high of 8.25 % in 2020. However, in the process of the expansion of the financial industry, funds gradually flow into the financial market and the real estate market, resulting in the stock market, bond market and other financial markets and real estate markets have asset bubble phenomenon. Undeniably, moderate bubbles help to relax borrowing constraints, stimulate consumption and investment, and thus promote economic growth[1], but this is at the expense of bubble burst risk. If asset prices deviate too much from their fundamental values, it will induce market imbalances and lead to bubble burst. At the same time, financial intermediaries such as banks will further amplify and diffuse the impact of bubble burst through the ' financial accelerator ' mechanism, increasing bank risk exposure, which can easily lead to systemic financial risks[4]. At present, asset bubbles have become a major potential factor triggering systemic financial risks. Therefore, in order to keep the bottom line of no systemic financial risk, the central bank first proposed a " two-pillar " regulatory framework for the coordination of monetary policy and macro-prudential policy in 2016.This framework aims to solve the multi-objective dilemma of a single policy, curb financial risks, and achieve economic and financial stability. Based on this background, this paper discusses the regulatory effect of the " two-pillar " policy mix on bank asset bubbles and bank risks from the perspective of policy regulation. The specific research questions include : First, the endogenous transmission mechanism of bank asset bubbles between finance and economy. Second, does the " two-pillar " regulatory framework help prevent bank asset bubble fluctuations and bank

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risk fluctuations ? Under what kind of policy combination, the two-pillar regulation effect is the most obvious ? This paper will discuss the above problems one by one by constructing a DSGE model.

On the relationship between asset bubbles and bank risk, the literature has shown that the collapse of asset bubbles is an important cause of bank risk[6]. Acharya and Naqvi (2019) pointed out by studying the risk-taking channels of banks that when the liquidity of banks (the total investment funds available to banks) is abundant, banks often overestimate the value of risk assets, resulting in a decrease in banks ' risk perception and over-investment in risk assets, boosting the formation of risk asset market bubbles[7]. Aoki and Nikolov (2015) constructed a DSGE model including the banking sector and found that during the boom, the " credit supply effect " of the bubble will expand the bank 's credit supply and reduce the loan spread. When the bubble collapses, banks will face huge losses, net assets will be greatly reduced, and credit will be tightened, which will have a more serious impact on the real economy[8]. Wang et al. (2019) studied the relationship between asset bubbles and banking stability and found that supervision, leverage and credit spreads provide conditions for banks to hold bubble assets through their impact on risk premiums. Once the bubble assets held by banks burst, their stability will be deteriorated by four effects : internal leverage, cash withdrawal, credit friction and network effect[9]. Brunnermeier et al. (2020) used bank-level data to analyze the relationship between asset price bubbles and systemic risks. The study found that higher loan growth, stronger maturity mismatch, especially larger bank size, tend to make financial institutions more vulnerable to asset price bubbles, which highlights the potential of large banks to spread and amplify the impact of asset price bubble bursts when they are in trouble[10].

The 2008 financial crisis exposed the shortcomings of monetary policy in solving the problem of financial " pro-cyclicality " and maintaining financial stability. In contrast, macro-prudential policies restrain the pro-cyclical accumulation or contagion of systemic financial risks by exerting influence on financial institutions and financial infrastructure, so as to achieve financial stability. Therefore, in order to take into account the dual stability objectives, China has carried out active practice and exploration on the " double pillar " framework including monetary policy and macro-prudential policy. Some scholars have studied the effect of the two-pillar policy on asset bubbles. Chen Yanbin et al. (2018) found that the formation mechanism of recessionary asset bubbles is significantly different from that of traditional asset bubbles by constructing a dynamic general equilibrium model with asset bubbles and high debt characteristics. For recessionary asset bubbles, adopting a " robust and loose monetary policy + tight macro-prudential policy " is a more effective policy mix[11]. Zhang Wei and Wang Dongyi (2022) studied the spillover effect of monetary policy on China 's financial market, and found that due to the uncertainty of market expectations and income costs, the monetary policy of " headwind strategy " alone cannot effectively control asset bubbles. Macroprudential policies are needed to reduce the arbitrage space between short-term liabilities and long-term assets of large banks and control the rapid expansion of domestic asset bubbles[12]. Chen Weize et al. (2023) based on the impact of long-term TFP growth changes on the two-pillar framework, pointed out that the two-pillar framework can better cope with the asset bubble burst risk and high debt risk caused by the long-term TFP growth decline[13]. Dong Feng et al. (2023) introduced endogenous asset bubbles into the indefinite dynamic new Keynesian model including the banking sector. The study found that monetary policy combined with macro-prudential policies can stabilize the size of asset bubbles and reduce the negative impact of bubble burst on the economy[14]. Some literatures analyze the regulatory effect of the two-pillar policy based on the perspective of bank risk. Ma Yong and Fu Li (2020) found that the addition of macro-prudential policies can play a role through the financial stability channel by studying the macroeconomic and financial stability effects of the two-pillar policy. The sharp

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fluctuations in the rate of return on capital and the rate of non-performing loans of banks have effectively complemented the stability effect of monetary policy focusing on the real economy[15]. He Dexu et al. (2023) included asset digitization factors and regulatory factors in the DSGE model. The research shows that the " two-pillar " regulatory framework helps to prevent bank risks, and digital development is conducive to improving the constraint of " two-pillar " regulation on bank risks[16]. According to the research of Zhao Xiangqin et al. (2022), the introduction of macro-prudential supervision policies with the core goal of capital adequacy ratio of commercial banks on the basis of monetary policy can effectively alleviate the fluctuation of bank leverage ratio and stabilize the financial system[17]. Wu Di et al. (2022) focused on the transmission mechanism and policy effect of monetary policy and macro-prudential policy that respond to expected housing prices, and found that for housing price fluctuations caused by housing transaction cost shocks, monetary policy combined with counter-cyclical LTV policy effectively inhibits the excessive rise of housing demand and bank credit scale[18]. Based on the theoretical model of bank risk-taking behavior under the limited liability system, Ma and Yao (2021) pointed out that macro-prudential policies represented by capital adequacy ratio requirements and leverage ratio supervision can partially offset the impact of monetary policy on bank risk-taking channels by affecting the overall capital distribution of banks and restricting the scale of bank risk assets, thus reducing the overall risk level of the banking sector[19]. Meng Xianchun and Zhang Yishan (2021) studied the transmission mechanism and dual-pillar regulation of debt default risk in the real sector, and found that household debt default will directly lead to an increase in the bad debt rate of commercial banks, and pass it to the corporate sector by impacting the bank 's balance sheet, resulting in credit contraction and real economic recession. At this time, the implementation of dual-pillar regulation policies by government departments can significantly alleviate the decline in corporate loans, capital losses of commercial banks and the degree of credit crunch[20]. Although the above literature focuses on the effects of macro-prudential policies and monetary policies on regulating bank risks or asset bubbles, it lacks a portrayal of the friction between financial supply and demand, and there is little literature discussing the economic and financial stability effects of ' double-pillar ' regulatory policies in the presence of bank asset bubbles.

The marginal contribution of this paper is mainly reflected in the following three aspects : (1) Under the framework of endogenous interaction between finance and real economy, a dynamic stochastic general equilibrium model with both corporate default risk and bank moral hazard is constructed to analyze the operation dynamics of real economy and finance under various sources of exogenous shocks. (2) Introducing the " asset bubble " into the model to describe the endogenous transmission mechanism of bank asset bubbles in more detail, which helps to maintain bank security and stability. (3) This paper examines the effects and differences of macro-prudential policies represented by " dynamic statutory deposit reserve ratio " and " counter-cyclical capital buffer " in response to bank asset bubbles and bank risks.

2. Basic Model Framework

This paper constructs a DSGE model with double financial frictions and introduces asset bubbles. The model includes households, intermediate goods manufacturers, capital goods manufacturers, commercial banks, macro policies and central banks, which provides a basic analytical framework for analyzing the coordination and matching of monetary policy and macro-prudential policy under dual financial frictions.

2.1. Household Sector

It is assumed that there is no heterogeneous family in the economic system, and all families are evenly distributed in the interval [0, 1]. Referring to the practice of Dong Feng et al. (2023),

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households and commercial banks hold asset bubbles in the whole economic system[14]. The total number of asset bubbles is 1, and a proportion of asset bubbles will exit the market in each period, while the same proportion of asset bubbles will be formed in each period to maintain the total amount unchanged. Asset bubbles held by households $Q_t^H = \sum_{j=0}^{\infty} P_{t|t-j}^Q H_{t|t-j}^H$. The family utility function is :

$$\max E_0 \sum_{i=0}^{\infty} (\beta)^t \left(\frac{C_t^{1-\sigma_c}}{1-\sigma_c} - \frac{N_t^{1+\eta}}{1+\eta} \right) \tag{1}$$

The intertemporal budget constraint of the household sector is expressed as :

$$\begin{aligned} &C_t + D_t + T_t + Q_t^H + Q_t^K K_{t+1}^H = W_t N_t + R_{t-1} D_{t-1} + R_t^K K_t^H \\ &+(1-\sigma) Q_t^K K_t^H + Z_t + \varphi(Q_t^H) + R_t^H (1-\sigma_q) Q_{t-1}^H + \Pi_t \end{aligned} \tag{2}$$

Among them, β $(0\langle\beta\langle 1)$, σ_c and η are the reciprocal of family subjective discount factor, family risk aversion coefficient and labor supply elasticity, respectively. σ and σ_q are capital depreciation rate and asset bubble loss rate. D_t represents the deposits held by households, T_t represents the total one-time tax of the government, Q_t^K represents the price of capital or asset bubbles, K_t^H represents the supply of household capital, W_t represents the real wage, Z_t represents the new asset bubble, R_t represents the real interest rate of deposits, R_t^K represents the real rental rate of household capital, R_t^H represents the real return rate of asset bubbles, which is regarded as the impact of liquidity premium and obeys the AR (1) process. Π_t represents the excess profits obtained by the family. $\varphi(Q_t^H)$ is the cost of household holding asset bubbles, Q_t is the total amount of social asset bubbles, which satisfies $Q_t = Q_t^H + Q_t^B = B_t + Z_t = \sum_{j=0}^{\infty} \sigma_q (1-\sigma_q)^j P_{t|t-j}^Q$. Q_t^B represents the asset bubble held by the bank, B_t represents the existing asset bubble before t period, φ_q is the cost coefficient of the asset bubble, and $\varphi(Q_t^H)$ is expressed as :

$$\varphi(Q_t^H) = \frac{\varphi_q}{2} \left(\frac{Q_t^H}{Q_t} \right)^2 Q_t \tag{3}$$

2.2. Intermediates Manufacturers Sector

The intermediate product manufacturer produces intermediate products by using capital $K_t(i)$ and labor $N_t(i)$, and its production function is :

$$Y_t(i) = A_t \varepsilon_{i,t}^F \left(K_{t-1}(i) \right)^{\alpha} \left(N_t(i) \right)^{1-\alpha} \tag{4}$$

Among them, A_t represents the exogenous technology shock, obeys the AR (1) process, Y_t , K_t and N_t represent the manufacturer 's output, total capital and labor respectively, and $\varepsilon_{i,t}^F$ represents the measurement of heterogeneous productivity. Referring to the practice of Fan and Gao (2018), it is set that the intermediate manufacturer pays wages and capital rents by obtaining loans from the bank, and the enterprise financing equation satisfies $L_t = W_t N_t + R_t^k K_{t-1}$

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[21]. Referring to the setting of enterprise default by Zhao Xiangqin et al. (2022), this paper assumes that heterogeneous productivity $\varepsilon_{i,t}^{F}$ obeys the uniform distribution on the $[a,b]$ interval[17], and the manufacturer 's default condition is :

$$\chi_t Y_t < R_t^L L_t \tag{5}$$

Among them, χ_t represents the overall return rate of the collateral, that is, the realization ability of the collateral. When the realization value of the collateral of the manufacturer is lower than the principal and interest of the bank, the manufacturer defaults, and the overall return rate obeys the AR (1) process, which can be regarded as a liquidity risk shock. R_t^L represents the actual loan interest rate of the intermediate goods manufacturer.

According to the practice of Ma Yong and Fu Li (2020), it is set that banks absorb loan losses with bank capital[15], and the bank non-performing loan rate ζ_t^N function is in the form of :

$$\zeta_t^N = \frac{(1-\chi_t)\int_a^{\varepsilon_{i,t}^{F,M}} \chi_t Y_t f\left(\varepsilon_{i,t}^F\right) d\varepsilon_{i,t}^F}{(1-\gamma_t) N_t^B} \tag{6}$$

Suppose that each period of the manufacturer can adjust the price to sell the product to the final product manufacturer to maximize the profit, but there is a second-order adjustment cost, MC_t represents the actual marginal production cost, φ_p is the price adjustment cost parameter, ψ is the substitution elasticity, $\Lambda_{0,t}$ represents the random discount factor, so the manufacturer 's profit maximization function and the demand function of the intermediate product are :

$$E_0 \sum_{t=0}^{n} \Lambda_{0.t} \left[\left(\frac{P_t(i)}{P_t} - MC_t \right) Y_t(i) - \frac{\varphi_p}{2} \left(\frac{P_t(i)}{P_{t-1}(i)} - 1 \right)^2 Y_t \right] \tag{7}$$

2.3. Capital Goods Manufacturers

Capital goods manufacturers sell new capital goods at the price Q_t^K by recycling capital goods and purchasing final products from final goods manufacturers. ε_t^k is the impact of investment efficiency, φ_k is the parameter of investment adjustment cost, and the equation of capital accumulation is :

$$K_t = (1-\delta) K_{t-1} + \left[1 - \frac{\varphi_k}{2} \left(\frac{I_t \varepsilon_t^k}{I_{t-1}} - 1 \right)^2 \right] I_t \tag{8}$$

Capital goods manufacturers choose the optimal investment I_t to maximize their profits :

$$\max E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left(Q_t^K \left[1 - \frac{\varphi_k}{2} \left(\frac{I_t \varepsilon_t^k}{I_{t-1}} - 1 \right)^2 \right] I_t - I_t \right) \tag{9}$$

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2.4. Capital Goods Manufacturers

Referring to the setting method of commercial banks by Gertler and Karadi (2011), the moral hazard problem is introduced, that is, the bank can choose to withdraw from the operation or continue to operate at the end of the period. Banks obtain deposits from households while holding loans and asset bubbles at the same rate of return. Unlike households, there is no cost for banks to hold bubbles[22]. Assuming that the bank has $1-\theta$ probability of bankruptcy and exits the banking market in each period, the discounted value of the bank 's net assets and the incentive compatibility constraint are expressed as :

$$V_t = E_t\left[\sum_{j=1}^{\infty}\Lambda_{t,t+j}\theta^{j-1}(1-\theta)N_{t+j}^{B}\right] \tag{10}$$

$$V_t \geqslant \lambda_l\left(L_t + Q_t^B\right) \tag{11}$$

Among them, λ_l indicates the proportion of assets misappropriated by bankers, which is used to characterize the degree of financial friction at the credit supply side, and (11) indicates that the bank 's incentive constraints are established for loans and asset bubbles. $Q_t^B = \sum_{j=0}^{\infty} P_{t|t-j}^{Q} H_{i,t|t-j}^{B}$ is the asset bubble held by the bank, and N_t^B is the net asset owned by the bank.

This paper introduces two macro-prudential policies of counter-cyclical capital buffer and dynamic deposit reserve. With reference to the setting of Mei Dongzhou et al. (2021), the central bank extracts Γ_t -proportion reserve from deposits absorbed by commercial banks[23]. At the same time, with reference to the setting of Hua Qiuling et al. (2023), the comprehensive cost function of deposit reserve ratio is introduced. θ_1 and θ_2 represent cost coefficients. Γ_t^M is the statutory deposit reserve ratio stipulated by macro-prudential policy[24], which is expressed as :

$$f_{\mathrm{t}}^{\Gamma} = \theta_1\left(\Gamma_t - \Gamma_t^M\right) + \theta_2/2\left(\Gamma_t - \Gamma_t^M\right)^2 \tag{12}$$

Referring to the setting of Dai Huajuan et al. (2021), the interest rate penalty function is introduced[25]. The specific form is :

$$R_t^D = R_t + \tau^a \exp\left[\tau^b\left(\frac{\gamma_t^M - \gamma_t}{\gamma}\right)\right] \tag{13}$$

Among them, R_t^D is the actual financing interest rate of the bank, τ^a and τ^b are the scale parameters and scale parameters of the interest rate penalty function, γ_t^M is the counter-cyclical capital buffer rate stipulated by the macro-prudential policy, γ_t is the actual counter-cyclical capital buffer rate of the bank, and γ is the steady-state value of the counter-cyclical capital buffer rate of the bank. After considering the two macro-prudential policies, referring to the practice of Ma Yong and Lu Lin (2022), the bank 's balance sheet and the bank 's own capital accumulation are expressed as[26] :

$$L_t + Q_t^B = \left(1-\gamma_t\right)N_t^B + \left(1-\Gamma_t\right)D_t \tag{14}$$

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$$N_{t+1}^{B}=\left[R_{t}^{L}\left(L_{t}+Q_{t}^{B}\right)-R_{t}^{D}D_{t}-f_{t}^{\Gamma}D_{t}+\Gamma_{t}rD_{t}\right] \tag{15}$$

Among them, r is the statutory deposit reserve rate paid by the central bank to banks. The yield of asset bubbles and loans held by banks is R_{t}^{L}. Φ_{t} represents the leverage ratio of banks, expressed in the form of $\Phi_{t}=\left(L_{t}+Q_{t}^{B}\right)/\left[\left(1-\gamma_{t}\right)N_{t}^{B}\right]$.

2.5. Macro Policy and the Central Bank

2.5.1. Central Bank

Based on the setting of Xiong Chen and Jin Hao (2018), the ratio of government consumption to output is stable at g [27]. The government collects penalties from banks, imposes statutory deposit reserves on banks and taxes on households for government expenditure, pays interest on statutory deposit reserves and repays statutory deposit reserves. The government budget constraint expression is :

$$G_{t}=gY_{t} \tag{16}$$

$$G_{t}+r\Gamma_{t-1}D_{t-1}=\Gamma_{t}D_{t}+T_{t}+\left(R_{t}^{D}-R_{t}\right)D_{t} \tag{17}$$

2.5.2. Monetary Policy and Expanded Monetary Policy

In this paper, the monetary policy is the standard Taylor rule, and the risk-free interest rate is adjusted.

$$R_{t}=(1-\rho_{r})\bar{R}+\rho_{r}R_{t-1}+(1-\rho_{r})\left[\rho_{\pi}^{R}(\pi_{t}-\bar{\pi})+\rho_{\mathrm{y}}^{R}\left(Y_{t}-\bar{Y}\right)\right]+\zeta_{R,t} \tag{18}$$

Among them, $\bar{R}$ is the steady-state value of nominal risk-free interest rate, ρ_{r} is the smoothing coefficient of nominal risk-free interest rate, $\bar{Y}$ is the steady-state value of output, ρ_{π}^{R} and ρ_{y}^{R} are the response coefficients of nominal risk-free interest rate to inflation gap and output gap respectively, $\zeta_{R,t}$ is the impact of monetary policy.

In order to explore the effect of expansionary monetary policy on financial variables, this paper refers to the general setting form of the literature on expansionary monetary policy, and adjusts it on the basis of the standard Taylor rule (18). Bank asset bubbles and loans are added to the policy objectives. The specific expression of expansionary monetary policy is as follows :

$$R_{t}=(1-\rho_{r})\bar{R}+\rho_{r}R_{t-1}+(1-\rho_{r})\left[\rho_{\pi}^{R}(\pi_{t}-\bar{\pi})+\rho_{\mathrm{y}}^{R}\left(Y_{t}-\bar{Y}\right)+\rho_{qb}^{R}\left(Q_{t}^{B}-\bar{Q}^{B}\right)+\rho_{l}^{R}\left(L_{t}-\bar{L}\right)\right]+\zeta_{R,t} \tag{19}$$

Among them, ρ_{qb}^{R} and ρ_{l}^{R} are the reaction coefficients of nominal interest rate to bank asset bubble and loan respectively. Referring to the research of Galí (2014), the rise of interest rate will cause the expansion of asset bubble scale[28]. Therefore, this paper sets that when other conditions remain unchanged, when the bank asset bubble increases or the loan decreases, the expansionary monetary policy requires the nominal interest rate to decrease to reduce the asset bubble level or increase the loan level.

2.5.3. Macro-Prudential Policy

In this paper, macro-prudential policy is represented by dynamic statutory deposit reserve ratio and counter-cyclical capital buffer. Through its counter-cyclical regulation mechanism,

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macro-prudential policies affect banks ' financing costs and risk appetite, inhibit banks ' pro-cyclical behavior, and prevent credit expansion and bubble expansion. Combined with the characteristics of financial institutions and the effect of macro-prudential policy regulation, the macro-prudential policy is set to focus on output and leverage ratio.

$$S_t = (1-\rho_s)\overline{S} + \rho_s S_{t-1} + (1-\rho_s)\left[\rho_s^y\left(Y_t - \overline{Y}\right) + \rho_s^{mp}\left(\Phi_t - \overline{\Phi}\right)\right] \tag{20}$$

Among them, S_t represents the two macro-prudential policies of dynamic statutory deposit reserve ratio and counter-cyclical capital buffer, $\overline{S}$ represents the steady-state of macro-prudential policy tools, ρ_s represents the continuous coefficient of dynamic change of macro-prudential policy, ρ_s^y and ρ_s^{mp} represent the response coefficient of macro-prudential policy to output gap and leverage gap respectively.

3. Parameter Calibration

In this paper, the assignment and calibration methods are used to set the values of standard parameters and structural parameters. According to the three-month basic deposit interest rate data published by the People 's Bank of China from the first quarter of 2010 to the fourth quarter of 2023, the average value is 1.64 %. In this paper, the household subjective discount factor is calibrated to 0.996. Referring to the practice of Dai Huajuan et al. (2021), the reciprocal of labor supply elasticity is calibrated to 1, and the capital depreciation rate is calibrated to 0.025[25]. The share of capital in output follows the value of Wu Di et al. (2022), which is set to 0.5[18]. Based on the research of He et al. (2023), the family risk aversion coefficient is calibrated to 1, and the manufacturer 's elasticity of substitution is set to 6[16]. Referring to the practice of Dong Feng et al. (2023), the cost coefficient of asset bubble and the real interest rate of household asset bubble are set to 0.105 and 1.0375 respectively, and the bank survival rate is calibrated to 0.93[14]. Based on the research of Ma Yong and Fu Li (2020), the upper and lower bounds of heterogeneous productivity are calibrated to 1.36 and 1, respectively[15]. According to the practice of Fan and Gao (2018), the manufacturer 's default probability is calibrated to 0.035[21]. Based on the research of Ma Yong and Lu Lin (2022), the value of investment adjustment cost parameter is 2, the value of price adjustment cost parameter is 30, and the steady-state value of bank countercyclical capital buffer rate is calibrated to 0.026[26]. According to the practice of Hua Qiuling et al. (2023), the cost coefficient and are calibrated to − 0.01 and 0.2 respectively[24]. According to the average RMB deposit reserve ratio of China 's large deposit-taking financial institutions announced in the first quarter of 2010-the fourth quarter of 2023, the statutory deposit reserve ratio of commercial banks is calibrated to 0.16. Referring to the research of Zhao Xiangqin et al. (2022), the scale parameters and scale parameters of the actual interest rate of the statutory deposit reserve and the interest rate penalty function are set to 1.004,0.0015 and 25 respectively[17]. Based on the practice of Ma Yong et al. (2023), the smoothing coefficient of nominal interest rate is calibrated to 0.75, the response coefficient of nominal interest rate to inflation gap is calibrated to 1.5, and the response coefficient of nominal interest rate to output gap is calibrated to 0.5[29]. Referring to the practice of Meng Xianchun and Zhang Yishan (2021), the dynamic change persistence coefficient of the dynamic statutory deposit reserve ratio policy and the counter-cyclical capital buffer policy is set to 0.75[20]. Based on the research of Ma Yong and Fu Li (2020), the sum of the response coefficients of the two macro-prudential policies to the output gap and the leverage gap is set to 0.5[15]. Referring to the practice of Chen Weize et al. (2023), the autoregressive coefficient of each shock is calibrated to 0.8[13]. According to the GDP expenditure method data released from the first quarter of 2010 to the fourth quarter of 2023,

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the proportion of consumption to output is calibrated to 0.53. According to the commercial bank data published by the State Administration of Financial Supervision and Administration from the first quarter of 2011 to the fourth quarter of 2023, the capital adequacy ratio is calibrated to 13.63 %, and the bank non-performing loan ratio is calibrated to 1.51 %.

4. Analysis of the Effect of ' Two-Pillar ' Policy Regulation

4.1. Analysis of the Effect of ' Two-Pillar ' Policy Combination Regulation

Based on the previous DSGE model, this part first simulates the benchmark model, the introduction of the dynamic deposit reserve ratio policy, the introduction of the counter-cyclical capital buffer policy and the expansionary monetary policy, respectively. In the face of 1 % unit positive exogenous shocks, the regulatory effects of each policy. Further, this paper will use the social welfare function to conduct a comparative analysis of policy portfolio welfare.

According to Figure 1, it can be found that in the case of given factor input, positive technology shocks stimulate manufacturers to increase investment and promote output by increasing productivity. The increase in output leads to an increase in consumption and investment, and inflation is significantly reduced under the effect of a decrease in the marginal cost of goods. The increase of output and the decrease of inflation lead to the decrease of nominal interest rate and the decrease of loan cost of manufacturers. Under the combined effect of cost reduction and productivity improvement, the demand for credit of manufacturers increases, which leads to the increase of loans. Due to the decrease of loan interest rate, the net assets of banks decrease. Referring to the framework of " acceleration-buffering-extrusion " proposed by Dong Feng et al. (2023), the acceleration mechanism refers to the increase of bank net assets caused by the increase of bank asset bubble scale, the expansion of bank balance sheet, which leads to the increase of loans, the rise of economy and the further expansion of asset bubble. The buffer mechanism means that when the bank 's credit creation ability changes, the bank will first adjust the holding scale of the asset bubble, and then adjust the loan scale. The crowding-out mechanism refers to the limited loanable funds of banks. The expansion of asset bubbles will reduce the scale of loans, form a crowding-out effect, and cause the economy to decline[14]. At this time, in the case of the benchmark model, the buffer mechanism in the bank 's asset bubble transmission mechanism is dominant, and the bank reduces the size of the asset bubble held. According to the definition of commercial bank leverage, under the combined effect of bank loans, asset bubbles and bank net assets, the bank leverage ratio increases. At the same time, the positive technological shock increases the probability of corporate default, which leads to an increase in the non-performing loan ratio of banks and an increase in the risk level of banks.

After adding the financial stability target to the monetary policy to form the expansionary monetary policy, the impulse response fluctuation degree of the benchmark model and the expansionary monetary policy model shows a significant difference. Specifically, in the expansionary monetary policy, the impulse response amplitude of output, consumption, investment, loan, bank leverage ratio, bank net assets and bank non-performing loan ratio is smaller. The bank asset bubble has a higher response amplitude in the initial stage, and the response amplitude is smaller than that of the benchmark model after the 20 th period. At this time, the bank asset bubble buffer mechanism is still dominant ; compared with the benchmark model, the expansionary monetary policy amplifies the impact of technological shocks on inflation. From the perspective of the effect of expansionary monetary policy on each variable, its effect on output, consumption, investment and loan is the most significant. After the introduction of counter-cyclical capital buffer policy and dynamic statutory deposit reserve ratio policy, the abnormal fluctuations of output and bank leverage ratio are transmitted to two macro-prudential policies, which control bank asset bubbles and bank non-performing loan ratio fluctuations by reducing bank financing costs. Therefore, compared with the benchmark

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model, when the two macro-prudential policies regulate the non-performing loan ratio, although the response amplitude of the non-performing loan ratio is higher in the initial stage, the impulse response is smaller than that of the benchmark model after about the sixth period. On the whole, the two macro-prudential policies combined with monetary policy to form a " two-pillar " policy portfolio is better than the expansionary monetary policy, which can effectively suppress macroeconomic fluctuations, alleviate the volatility of bank asset bubbles and bank non-performing loan ratios, and reduce the impact of technology shocks on bank risks. Comparing the two different two-pillar policy combinations, it can also be found that the dynamic statutory deposit reserve ratio policy combined with monetary policy has a better regulatory effect on output, consumption, investment, inflation and loans. The counter-cyclical capital buffer policy combined with monetary policy has a better regulatory effect on bank leverage ratio, bank net assets and non-performing loan ratio.

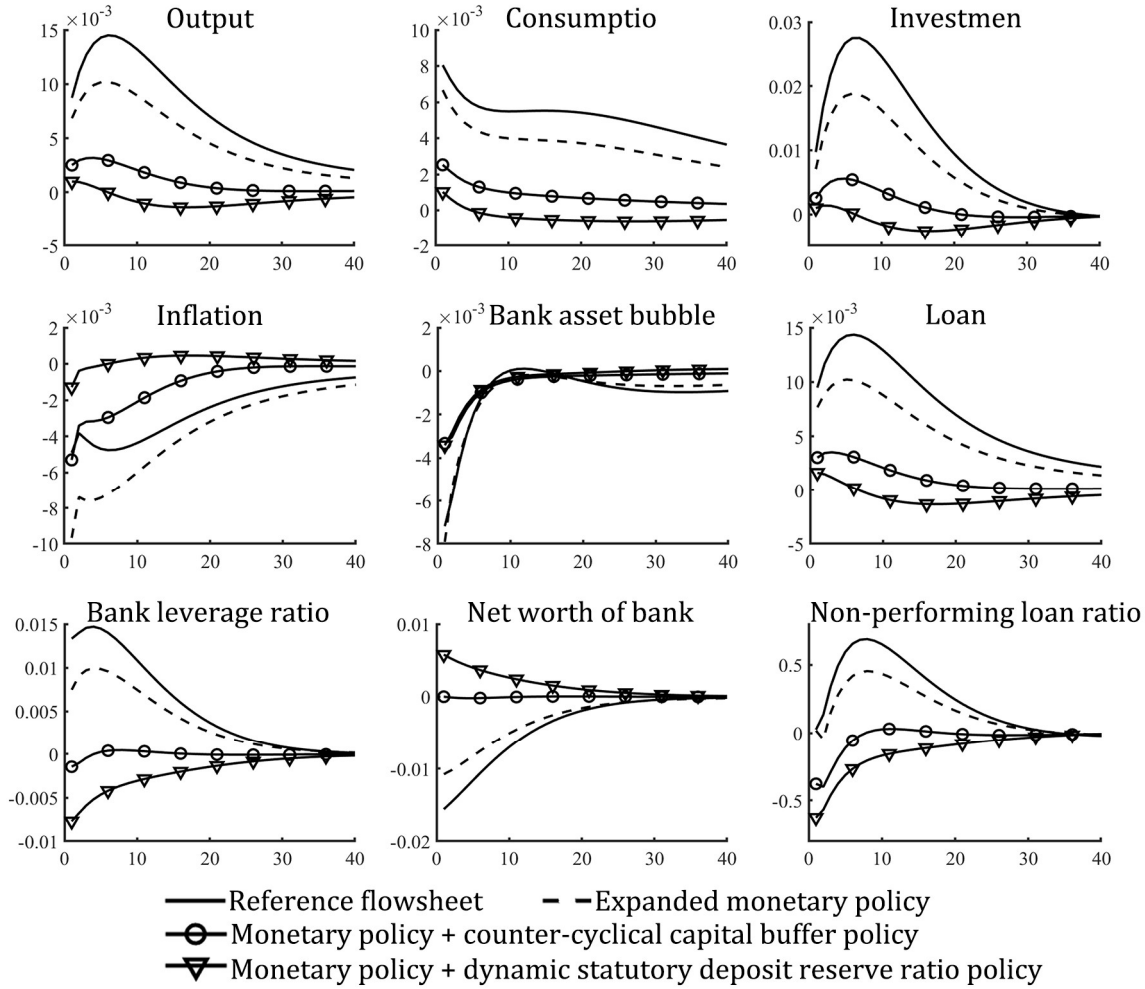


Figure 1. Impulse response of each model under technical shock

4.2. Welfare Analysis

In the above, the stability effects of different ' two-pillar ' policy combinations are intuitively compared through the impulse response diagram. This part will further use the social welfare function as the evaluation standard of the policy combination to conduct a comparative analysis of welfare. In order to comprehensively measure the effect of each policy combination on maintaining financial and economic stability, this paper refers to the practices of Woodford (2012)[30]and Ma Yong et al. (2023)[29], and adopts the social welfare loss function considering both economic and financial fluctuations :

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$$WL = \lambda_1 \operatorname{var}(\pi_t) + \lambda_2 \operatorname{var}(Y_t) + \lambda_3 \operatorname{var}(Q_t^B) + \lambda_4 \operatorname{var}(L_t) + \lambda_5 \operatorname{var}(\zeta_t^N) \quad (21)$$

Among them, $\operatorname{var}(\pi_t)$, $\operatorname{var}(Y_t)$, $\operatorname{var}(Q_t^B)$, $\operatorname{var}(L_t)$ and $\operatorname{var}(\zeta_t^N)$ are inflation, output, bank asset bubble, loan and bank non-performing loan ratio respectively, indicating that the central bank 's policy objectives include economic stability (represented by inflation and output) and financial stability (represented by bank asset bubble, loan and bank non-performing loan ratio). λ_1, λ_2, λ_3, λ_4 and λ_5 are the central bank 's preference parameters for inflation, output, bank asset bubbles, loans and bank non-performing loan ratio, respectively. This paper sets five typical weight ratios $(\Omega_1、\Omega_2、\Omega_3、\Omega_4、\Omega_5)$ to reflect the central bank 's different preferences for economic stability and financial stability. (1) $\Omega_1 = (\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 1)$, which means that economic fluctuations and financial fluctuations have the same impact on social welfare ; (2) $\Omega_2 = (\lambda_1 = \lambda_2 = 2,\ \lambda_3 = \lambda_4 = \lambda_5 = 1)$, indicating that the impact of economic fluctuations on social welfare is greater than the impact of financial fluctuations on social welfare ; (3) $\Omega_3 = (\lambda_1 = \lambda_2 = \lambda_4 = \lambda_5 = 1,\ \lambda_3 = 2)$, indicating that the impact of bank asset bubble volatility on social welfare is greater than the impact of loans, bank non-performing loan ratio and economic fluctuations on social welfare ; (4) $\Omega_4 = (\lambda_1 = \lambda_2 = \lambda_3 = \lambda_5 = 1,\ \lambda_4 = 2)$, indicating that the impact of loan fluctuations on social welfare is greater than the impact of bank asset bubbles, bank non-performing loan ratio and economic fluctuations on social welfare ; (5) $\Omega_5 = (\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 1,\ \lambda_5 = 2)$, indicating that the impact of bank non-performing loan rate fluctuations on social welfare is greater than the impact of bank asset bubbles, loans and economic fluctuations on social welfare.

Based on the above social welfare loss function and related parameter settings, the social welfare losses of different ' two-pillar ' policy combinations are shown in table 1. From the results of Table 1, the following conclusions can be drawn : Compared with a single monetary policy, the use of extended monetary policy or the introduction of counter-cyclical capital buffer policy and dynamic statutory deposit reserve ratio policy in the benchmark model can effectively improve the degree of social welfare loss. And under various weight structures, in the face of technological shocks, monetary policy with counter-cyclical capital buffer policy has the most significant effect on social welfare improvement ;

Table 1. The social welfare loss of various " two-pillar " policy combinations under the impact of technology

sources of oil price shocks	policy mix	welfare loss (%)				
		Ω_1	Ω_2	Ω_3	Ω_4	Ω_5
technology impact	Monetary policy only (reference flowsheet)	5.803	6.148	5.817	6.110	10.937
	Expanded monetary policy	2.554	2.782	2.568	2.700	4.719
	Monetary policy + counter-cyclical capital buffer policy	0.487	0.507	0.490	0.497	0.938
	Monetary policy + dynamic statutory deposit reserve ratio policy	1.606	1.610	1.609	1.610	3.200

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5. Conclusion and Policy Suggestion

5.1. Research Conclusion

Based on the GK model, this paper constructs a new Keynesian DSGE model including bank asset bubbles and bank risks, and uses counter-cyclical capital buffers and dynamic statutory deposit reserve ratio as macro-prudential policies, and further introduces interest rate penalty mechanism and deposit reserve ratio. The comprehensive cost function analyzes the macroeconomic and financial stability effects and social welfare effects of different " two-pillar " policy combinations in the face of technological shocks. The study found that compared with a single monetary policy, the coordination of monetary policy and macro-prudential policy can effectively alleviate asset bubbles and bank risk fluctuations, and maintain macroeconomic and financial stability. The introduction of macro-prudential policy in monetary policy can improve social welfare losses, and the combination of monetary policy and counter-cyclical capital buffer policy has the most significant effect on social welfare improvement.

5.2. Policy Suggestion

Based on the above research conclusions, this paper proposes the following policy recommendations : First, we should increase the rate of return on investment in the real economy, reduce the imbalance between the rate of return on financial assets and the rate of return on the real economy, guide social capital to invest in the real economy from the financial market and then digest the stock of asset bubbles, prevent the risk of asset bubbles, and promote healthy and stable economic growth. On the one hand, establish and improve long-term mechanisms such as credit support and tax reform, and increase government subsidies to reduce the burden on real enterprises, reduce the production costs of the real economy, and increase the rate of return on the real economy. On the other hand, we should deepen the reform of interest rate marketization, improve the market regulation mechanism, improve the efficiency of credit allocation, build a multi-level capital market, provide more abundant financial products and increase the supply scale of safe assets, squeeze out financial asset bubbles, guide the return on financial assets to return to a reasonable range, and constantly promote finance to provide high-quality services for the real economy. Second, when banks hold asset bubbles, the bubble burst will magnify bank risks and have a more serious negative impact on the economy. Therefore, banks should pay attention to their own sound operation, strengthen risk management, improve risk expectation recognition ability, establish and improve crisis contingency plans, and enhance banks ' ability to cope with risk shocks. In terms of financial supervision, the regulatory authorities should implement targeted regulatory measures according to the characteristics of banks, timely monitor important indicators of banks, prevent the sudden rise of bank risks, and improve the overall stability of the banking system. Thirdly, according to the relevant conclusions of this paper, monetary policy combined with macro-prudential policy can significantly improve financial stability, reduce the volatility of the economic system and the financial system, and improve the level of social welfare. However, there are differences in the regulatory effects of different " two-pillar " policy combinations. Therefore, when targeting specific imbalances in specific markets, it is necessary to first clarify the sources and nature of shocks that cause real economic and financial fluctuations. Secondly, it is necessary to deeply study the endogenous relationship between economy and finance, comprehensively consider the object, degree and potential risks of imbalances, and finally build a reasonable " two-pillar " policy combination on this basis. Maximize the efficiency of policy implementation.

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