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Effectiveness of Structural Monetary Policy: A Study Based on NK-DSGE Model

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Abstract

By constructing a dynamic stochastic general equilibrium (DSGE) model incorporating heterogeneous enterprises and financial sectors, along with the introduction of structural monetary policy instruments, this study theoretically demonstrates that structural monetary policy exhibits stronger targeted regulatory capacity in facilitating credit financing for small and medium-sized enterprises (SMEs) than it does in maintaining economic stability. Specifically, targeted relending, targeted reserve requirement ratio cuts, and lending facilities can effectively promote SME financing and output growth. However, careful coordination is required when implementing these policies alongside traditional aggregate monetary policy tools. Among these instruments, targeted reserve requirement ratio cuts demonstrate relative advantages in balancing targeted regulation and economic stabilization objectives.

Keywords

Structural Monetary Policy, Small and Medium-Sized Enterprises (SMEs), Targeted Regulation, DSGE, Economic Stability

1. Introduction

The primary objective of structural monetary policy is to provide financial support to enterprises in specific sectors, thereby achieving national strategic development goals and facilitating industrial structural transformation. In terms of policy targeting, this innovative monetary policy shares similarities with fiscal and industrial policies, as all three establish structural objectives based on national policy intentions. However, unlike the latter two, structural monetary policy employs financial institutions as intermediary entities to influence liquidity and fund-

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ing costs through its implementation channels and mechanisms. Consequently, this approach incorporates market-oriented attributes during execution, which reduces arbitrage opportunities but also means it cannot guarantee funds flow as intended. Furthermore, the impact of this new monetary policy instrument on traditional macroeconomic stabilization objectives and its contribution to maintaining economic stability remain underexplored. In summary, the effectiveness of structural monetary policy warrants in-depth investigation.

This paper constructs a multi-sector heterogeneous New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) model to examine the targeted regulatory capacity of various structural monetary policies on credit provision to small and medium-sized enterprises (SMEs). Simultaneously, it investigates the impact of structural monetary policies on conventional monetary policy objectives and compares the performance of different policy instruments across two dimensions: targeted regulation and economic stability.

Regarding the selection of structural monetary policies, this study focuses on three representative and relatively mature instruments: targeted relending, targeted reserve requirement ratio (RRR) cuts, and lending facilities. Among these, targeted (agriculture-supporting) relending constitutes China's earliest implemented structural monetary policy. The People's Bank of China (PBoC) introduced SME-targeted relending in 2014, achieving an outstanding balance of RMB 217.2 billion by the end of 2018, which exceeded RMB 1 trillion by the end of 2022. Targeted RRR cuts were introduced in 2014 and entered an intensive implementation phase during 2018-2020. Specifically, in 2018, liquidity totaling RMB 1.55 trillion was released in three phases to qualifying institutions under the inclusive finance framework. In 2019, two rounds of targeted RRR cuts of 3 percentage points were implemented for inclusive finance-qualified institutions and county-level rural commercial banks, releasing RMB 780 billion in long-term funds. In 2020, RMB 550 billion was released to counter the pandemic shock. Lending facilities have generated even larger scale of liquidity, with the outstanding balance reaching RMB 7.075 trillion by the end of 2023, effectively ensuring medium- to long-term liquidity supply. Collectively, these three policies represent long-standing, large-scale structural regulatory instruments employed by the PBoC, which this paper examines systematically.

Compared to existing literature [1]-[3], this paper's primary contributions and distinguishing features include: 1) Constructing heterogeneous enterprise sectors based on the BGG financial accelerator mechanism and heterogeneous financial sectors based on the GK financial friction mechanism, capturing the differential responses of SMEs and large enterprises to monetary policy; 2) Modeling three structural monetary policy instruments—targeted relending, targeted RRR cuts, and lending facilities—within a unified framework and examining their comprehensive performance; 3) Investigating the coordinated effects of structural and traditional monetary policies using impulse response analysis; 4) Analyzing the impacts of structural monetary policies on social welfare and economic stability through welfare analysis; 5) Employing policy frontier curve analysis to horizontally compare the effectiveness of different structural monetary policies across the dual dimensions of targeted regulation and economic stability maintenance.

2. Research Design of Structural Monetary Policy Supporting SME Development

This section constructs an NK-DSGE model incorporating heterogeneous enterprises and financial sectors. The basic framework is shown in Figure 1. To examine SME issues, this study follows [3] by assuming two types of productive enterprises in the economy—large enterprises and SMEs—along with two types of financial institutions: large banks and small banks. Large enterprises typically benefit from implicit government guarantees, resulting in higher survival rates and greater risk resilience. In contrast, SMEs face greater difficulties and restrictions in obtaining loans due to their smaller scale and higher operational risks. Commercial banks provide funding to both types of enterprises, with large banks capable of lending to both categories, while small banks can only lend to SMEs. When large banks lend to SMEs, they incur additional adjustment costs due to insufficient "soft information" (e.g., non-quantifiable information about operational status, creditworthiness, and management capabilities). Small banks, however, typically serve local SMEs and are more familiar with them; thus, this study assumes no additional costs for their loans. These heterogeneous characteristics make the model more realistic and facilitate exploration of financing differences and challenges among different enterprise types.

Based on this framework, the model incorporates three types of structural monetary policies—targeted relending, targeted reserve requirement ratio (RRR) cuts, and lending facilities—all aimed at promoting SME credit financing. The first two primarily target small banks: targeted relending subsidizes a certain proportion of small banks' SME loans, while targeted RRR cuts specifically lower small banks' deposit reserve ratios. Lending facilities mainly target large banks holding substantial collateral assets, providing them with low-interest loans proportional to their collateral. These three policies have different designs and transmission channels, leading to differentiated policy performances [1] [4] [5].

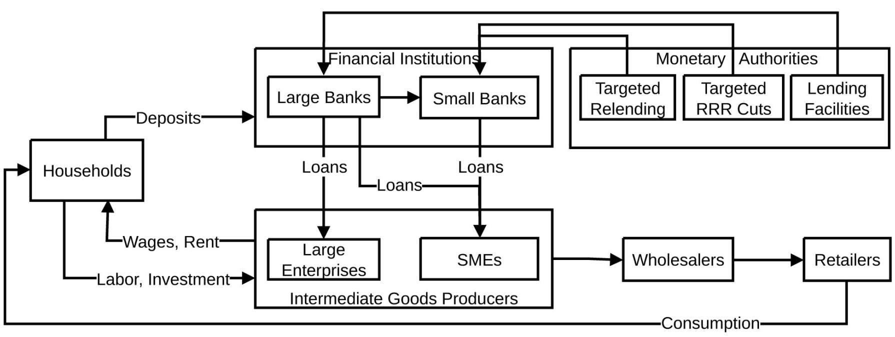

Figure 1. Basic framework of the NK-DSGE model.

It should be noted that this paper introduces two financial friction mechanisms—G-K and BGG [6] [7]. The G-K financial friction mechanism establishes a heterogeneous financial sector capable of optimal decision-making, laying the foundation for subsequent structural monetary policy settings. The introduction of the BGG financial friction mechanism considers two aspects: on the one hand, heterogeneous productivity shocks create information asymmetry between manufacturers and financial departments; on the other hand, such shocks also generate interest spreads between manufacturers and households, justifying the risk premium included in manufacturers' borrowing costs. Building on this framework, this paper analyzes the impact of structural monetary policies such as targeted relending, targeted RRR cuts, and lending facilities on SME credit, output, and economic stability.

2.1. Household Sector

Based on the basic framework of the NK-DSGE model, this section establishes a classic representative household sector with the following optimization problem:

$$\max U = E_0 \sum\nolimits_{t=0}^{\infty} \beta^t \left[\ln\left(c_t\right) - \chi_L \frac{l_t^{1+\theta_L}}{1+\theta_L} \right] \tag{1}$$

Where β is the household's subjective discount factor, c_t denotes real consumption, and l_t denotes labor supply. Key parameters are: χ_L, the relative weight of labor disutility, and θ_L, the inverse of the Frisch elasticity of labor supply.

The household faces the budget constraint:

$$i_t + c_t + d_{t+1} \le w_t l_t + \left(1 + r_t^D\right) d_t + r_t^K k_{t-1} + tax_t + \Pi_t \tag{2}$$

where k_t, d_t, w_t and i_t are real variables representing actual capital, actual deposits, actual wages, and actual new investment, respectively. tax_t denotes government lump-sum taxes, and Π_t represents net profits from the enterprise and financial sectors (after asset transfers). r_t^D and r_t^K denote the savings interest rate and capital return rate, respectively.

The capital accumulation equation is:

$$k_t = \left(1-\delta\right) k_{t-1} + i_t - \frac{\kappa_K}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 i_t \tag{3}$$

where δ is the capital depreciation rate, κ_K is the investment adjustment cost parameter, and $\kappa_K \left(i_t/i_{t-1} - 1\right)^2 i_t/2$ represents investment adjustment costs.

Solving the optimization problem yields first-order conditions:

$$\gamma_t = c_t^{-1} \tag{4}$$

$$\gamma_t w_t = \chi_L l_t^{\theta_L} \tag{5}$$

$$\beta E_t \left[\Lambda_{t,t+1} \left(1 + r_{t+1}^D\right) \right] = 1 \tag{6}$$

$$\gamma_t = q_t \left[1 - \frac{\kappa_K}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 - \kappa_K \left(\frac{i_t}{i_{t-1}} - 1\right)\frac{i_t}{i_{t-1}} \right] + \beta E_t \left[q_{t+1} \kappa_K \left(\frac{i_{t+1}}{i_t} - 1\right)\left(\frac{i_{t+1}}{i_t}\right)^2 \right] \tag{7}$$

$$q_t = \beta E_t\left[\gamma_{t+1} r_{t+1}^{K} + q_{t+1}(1-\delta)\right] \tag{8}$$

Here, γ_t is the Lagrange multiplier for the budget constraint, q_t is the Lagrange multiplier for capital accumulation, and $\Lambda_{t,t+1} = \gamma_{t+1}/\gamma_t$ represents the household's stochastic discount factor.

2.2. Retail Sector

Retailers use homogeneous wholesale goods $y_{w,t}$ as inputs, transforming them into differentiated retail products. These retailers form a continuum, with each retailer z producing retail goods as $y_t(z) = y_{w,t}(z)$, $z \in [0,1]$. Retail goods are aggregated into final products via a CES (Constant Elasticity of Substitution) Dixit-Stiglitz aggregator:

$$y_t = \left(\int_0^1 y_t(z)^{\frac{\psi-1}{\psi}} \mathrm{d}z\right)^{\frac{\psi}{\psi-1}} \tag{9}$$

where ψ represents the elasticity of substitution among different retail products and can depict the competitive dynamics of the retail market and consumer choice behavior.

Assuming retailers operate under perfect competition, their optimization problem is:

$$\max P_t\left(\int_0^1 y_t(z)^{\frac{\psi-1}{\psi}} \mathrm{d}z\right)^{\frac{\psi}{\psi-1}} - \int_0^1 P_t(z) y_t(z) \mathrm{d}z \tag{10}$$

where P_t is the final product price, and $P_t(z)$ is the price of retail product z.

This yields the demand function for $y_t(z)$ and the final product pricing equation:

$$y_t(z) = \left(\frac{P_t(z)}{P_t}\right)^{-\psi} y_t \tag{11}$$

$$P_t = \left(\int_0^1 P_t(z)^{1-\psi} \mathrm{d}z\right)^{\frac{1}{1-\psi}} \tag{12}$$

Retailers then maximize profits:

$$\max E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i}\left[\left(\frac{P_{t+i}(z)}{P_{t+i}} - p_{w,t+i}\right) y_{t+i}(z) - \frac{\kappa_P}{2}\left(\frac{P_{t+i}(z)/P_{t+i}}{\pi_{t-1}^{a_p}\pi^{1-\alpha_p}} - 1\right)^2 c_{t+i}\right] \tag{13}$$

Here, $p_{w,t}$ is the relative price of wholesale goods, $\pi_t = P_t/P_{t-1}$ represents inflation, and π is its steady-state value. $P_t(z) = P_t$ holds in the symmetric equilibrium. The quadratic term $\frac{\kappa_P}{2}\left(\frac{P_{t+i}(z)/P_{t+i}}{\pi_{t-1}^{a_p}\pi^{1-\alpha_p}} - 1\right)^2 c_{t+i}$ denotes Rotemberg-style quadratic price adjustment costs, where κ_P is the price adjustment cost parameter and α_p is the inflation stickiness parameter.

This gives the New Keynesian Phillips Curve (NKPC):

$$p_{w,t} = \frac{\psi - 1}{\psi} + \frac{\kappa_P}{\psi} \frac{1}{y_t} \left\{ \left(\frac{\pi_t}{\pi_{t-1}^{\alpha_p} \pi^{1-\alpha_p}} - 1 \right) \frac{\pi_t}{\pi_{t-1}^{\alpha_p} \pi^{1-\alpha_p}} c_t - \beta E_t \left[\Lambda_{t,t+1} \left(\frac{\pi_{t+1}}{\pi_t^{\alpha_p} \pi^{1-\alpha_p}} - 1 \right) \frac{\pi_{t+1}}{\pi_t^{\alpha_p} \pi^{1-\alpha_p}} c_{t+1} \right] \right\} \tag{14}$$

Since $\alpha_p > 0$, this Phillips curve incorporates both forward-looking and backward-looking elements. When $\kappa_P = 0$, the equation reduces to the classical Phillips curve.

2.3. Wholesale Sector

This section assumes wholesalers use intermediate goods from two types of manufacturers (large enterprises and SMEs) as inputs to produce homogeneous wholesale goods sold to retailers. The production function also adopts CES form:

$$y_{w,t} = \left[\phi y_{l,t}^{\frac{\zeta-1}{\zeta}} + (1-\phi) y_{ms,t}^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta}{\zeta-1}} \tag{15}$$

where $y_{l,t}$ and $y_{ms,t}$ represent intermediate goods output from large enterprises and SMEs, respectively. ζ denotes the substitution elasticity between these two intermediate goods, and ϕ represents the share of large enterprise products in production.

Cost minimization yields demand functions:

$$y_{l,t} = \phi^{\zeta} \left(\frac{p_{l,t}}{p_{w,t}} \right)^{-\zeta} y_{w,t} \tag{16}$$

$$y_{ms,t} = (1-\phi)^{\zeta} \left(\frac{p_{ms,t}}{p_{w,t}} \right)^{-\zeta} y_{w,t} \tag{17}$$

where $p_{l,t}$ and $y_{ms,t}$ represent the relative prices of intermediate goods for large enterprises and SMEs, respectively.

Assuming perfect competition in the wholesale sector, the relative price of wholesale goods is:

$$p_{w,t} = \left[\phi^{\zeta} p_{l,t}^{1-\zeta} + (1-\phi)^{\zeta} p_{ms,t}^{1-\zeta} \right]^{\frac{1}{1-\zeta}} \tag{18}$$

2.4. Intermediate Goods Manufacturers

To examine the targeted regulatory effects of structural monetary policies on SMEs, this section establishes two types of intermediate goods manufacturers: large enterprises (subscript l) and SMEs (subscript ms). To highlight SMEs' "small but sophisticated" characteristics—stronger innovation capabilities and higher technological levels compared to large enterprises—this paper assumes SMEs have relatively higher total factor productivity (TFP). Unless otherwise specified, subscript $J \in \{l, ms\}$ identifies large enterprises and SMEs.

Both types of enterprises use capital and labor (including household labor and entrepreneurial labor) to produce differentiated intermediate goods [6]:

$$y_{J,t} = A_{J,t}\omega_{J,t}k_{J,t}^{1-\alpha}\left[l_{J,t}^{\varphi_J}\left(l_{J,t}^{e}\right)^{1-\varphi_J}\right]^{\alpha} \tag{19}$$

where α measures the share of labor and capital, $l_{J,t}$ and $l_{J,t}^{e}$ represent household labor and entrepreneurial labor, respectively, and φ_J reflects the share of household labor in production. $A_{J,t}$ is TFP, expressed as $A_{J,t} = g^{A}A_{J,t}^{s}$, where g^{A} is a fixed growth trend and $A_{J,t}^{s}$ is a static fluctuation factor assumed to follow a log-normal AR(1) process with persistence coefficient ρ_J.

Both types of intermediate goods manufacturers face heterogeneous productivity shocks $\omega_{J,t}$ [6]. This paper assumes $\omega_{J,t}$ follows a log-normal distribution, *i.e.*, $\ln\omega_{J,t} \sim N\left(\mu_{\omega,t},\sigma_{\omega,t}^{2}\right)$, and that both types of manufacturers face identically distributed productivity shocks. Assuming $E\left(\omega_{J,t}\right) = \int_0^{\infty}\omega \mathrm{d}F(\omega) = 1$, we have $\mu_{\omega,t} = -\sigma_{\omega,t}^{2}/2$ and $\mathrm{Var}\left(\omega_{J,t}\right) = \mathrm{e}^{\sigma_{\omega,t}^{2}} - 1$, where $F(\omega)$ is the cumulative distribution function of ω.

Intermediate goods manufacturers' main costs are wages and capital rents, leading to the optimization problem:

$$\min w_t l_{J,t} + w_{J,t}^{e}l_{J,t}^{e} + r_t^{K}k_{J,t} \tag{20}$$

$$\text{s.t. } y_{J,t} = A_{J,t}\omega_{J,t}k_{J,t}^{1-\alpha}\left[l_{J,t}^{\varphi_J}\left(l_{J,t}^{e}\right)^{1-\varphi_J}\right]^{\alpha} \tag{21}$$

where w_t and $w_{J,t}^{e}$ respectively represent the actual wages of the household sector and the entrepreneur's labor (since the wage level of the household labor is consistent between the two types of enterprises, w_t does not include the subscript J), and $r_t^{K}k_{J,t}$ is the capital funds that intermediate goods manufacturers need to pay.

Solving this yields first-order conditions:

$$\frac{k_{J,t}}{l_{J,t}^{\varphi_J}\left(l_{J,t}^{e}\right)^{1-\varphi_J}} = \frac{1-\alpha}{\alpha}\frac{1}{r_t^{K}}\left(\frac{w_{J,t}^{e}}{1-\varphi_J}\right)^{1-\varphi_J}\left(\frac{w_t}{\varphi_J}\right)^{\varphi_J} \tag{22}$$

$$\frac{l_{J,t}^{e}}{l_{J,t}} = \frac{1-\varphi_J}{\varphi_J}\frac{w_t}{w_{J,t}^{e}} \tag{23}$$

The actual return rate $R_{J,t}$ for intermediate goods manufacturers is:

$$R_{J,t} = p_{J,t}A_{J,t}\left(\frac{1-\alpha}{r_t^{K}}\right)^{1-\alpha}\left\{\left[\frac{\alpha\left(1-\varphi_J\right)}{w_{J,t}^{e}}\right]^{1-\varphi_J}\left(\frac{\alpha\varphi_J}{w_t}\right)^{\varphi_J}\right\}^{\alpha} \tag{24}$$

This section defines the bankruptcy threshold $\bar{\omega}_{J,t}$ to quantify the minimal level of idiosyncratic risk at which the total value of current assets and asset returns is exactly sufficient to cover the repayment of principal and interest on loans. A firm survives if and only if the realized positive idiosyncratic shock is no less than this critical value.

$$\bar{\omega}_{J,t} = \frac{\left(1+r_{J,t}^{B}\right)B_{J,t}}{R_{J,t}\left(N_{J,t-1}+B_{J,t}\right)} \tag{25}$$

where $B_{J,t}$ is nominal bank loans and $N_{J,t-1}$ is nominal net assets. The actual leverage ratio is:

$$lev_{J,t} = \frac{N_{J,t-1}+B_{J,t}}{N_{J,t-1}} = \frac{n_{J,t-1}+b_{J,t}\pi_t}{n_{J,t-1}} \tag{26}$$

where $b_{J,t}$ and $n_{J,t-1}$ are real values of bank loans and net assets, respectively.

The optimization problem is:

$$\max U = \frac{\int_{\bar{\omega}_{J,t}}^{\infty}\left[\omega_{J,t}R_{J,t}\left(N_{J,t-1}+B_{J,t}\right)-\left(1+r_{J,t}^{B}\right)B_{J,t}\right]\mathrm{d}F\left(\omega_{J,t}\right)}{N_{J,t-1}\left(1+r_t^{D}\right)} \tag{27}$$

where the numerator represents the net proceeds to intermediate goods producers conditional on survival (*i.e.*, absence of bankruptcy). The denominator reflects the opportunity costs when engaging in production activities utilizing net assets. To simplify notation, define $\Gamma_t\left(\bar{\omega}_{J,t}\right)=\left[1-F_t\left(\bar{\omega}_{J,t}\right)\right]\bar{\omega}_{J,t}+G_t\left(\bar{\omega}_{J,t}\right)$, where $G_t\left(\bar{\omega}_{J,t}\right)=\int_0^{\bar{\omega}_{J,t}}\omega_{J,t}\mathrm{d}F\left(\omega_{J,t}\right)$.

Therefore, the optimization problem of intermediate goods producers can be rewritten as:

$$\max U = \left[1-\Gamma_t\left(\bar{\omega}_{J,t}\right)\right]\frac{R_{J,t}}{1+r_t^{D}}lev_{J,t} \tag{28}$$

Under the BGG financial friction mechanism, information asymmetry exists between intermediate goods manufacturers and financial institutions. When $\omega_{J,t} \geq \bar{\omega}_{J,t}$, financial institutions collect interest; otherwise, manufacturers enter bankruptcy liquidation. In the latter case, financial institutions partially recover remaining assets: $\left(1-\mu_J\right)\int_0^{\bar{\omega}_{J,t}}\omega_{J,t}R_{J,t}\left(N_{J,t-1}+B_{J,t}\right)\mathrm{d}F\left(\omega_{J,t}\right)$, with μ_J representing bankruptcy costs.

The presence of financial frictions within the BGG mechanism imposes additional costs on financial institutions. Concurrently, the heterogeneity inherent in the banking sector induces imperfect competition. Consequently, the rate of return for financial institutions deviates from the risk-free rate. The average loan return rate $r_{q,t}^{JB}$ for large banks (*LB*) and small banks (*SB*) is determined by the following expression (where $JB \in \{LB, SB\}$ denotes bank size classification):

$$\begin{aligned}\left(1+r_{q,t}^{JB}\right)B_{J,t} &= \left[1-F_t\left(\bar{\omega}_{J,t}\right)\right]\left(1+r_{J,t}^{B}\right)B_{J,t} \\ &\quad +\left(1-\mu_J\right)\int_0^{\bar{\omega}_{J,t}}\omega_{J,t}R_{J,t}\left(N_{J,t-1}+B_{J,t}\right)\mathrm{d}F\left(\omega_{J,t}\right)\end{aligned} \tag{29}$$

This can be rewritten as:

$$\Gamma_t\left(\bar{\omega}_{J,t}\right)-\mu_J G_t\left(\bar{\omega}_{J,t}\right) = \frac{lev_{J,t}-1}{lev_{J,t}}\frac{1+r_{q,t}^{JB}}{R_{J,t}} \tag{30}$$

The first-order condition for manufacturers' optimization is:

$$\left[1-\Gamma_t\left(\bar{\omega}_{J,t}\right)\right]\frac{R_{J,t}}{1+r_t^D} = \frac{1-F_t\left(\bar{\omega}_{J,t}\right)}{1-F_t\left(\bar{\omega}_{J,t}\right)-\mu_J\bar{\omega}_{J,t}F_t'\left(\bar{\omega}_{J,t}\right)}\left\{1-\left[\Gamma_t\left(\bar{\omega}_{J,t}\right)-\mu_J G_t\left(\bar{\omega}_{J,t}\right)\right]\frac{R_{J,t}}{1+r_{q,t}^{JB}}\right\} \tag{31}$$

This equation constitutes the first-order condition for the optimization problem of intermediate goods producers, simultaneously representing the standard debt contract equation for firms within the classic Bernanke-Gertler-Gilchrist (BGG) financial accelerator framework.

Subsequently, to comprehensively characterize the capital accumulation process of intermediate goods producers, this section introduces the following postulate: At each period, a proportion $(1-\xi_J)$ of intermediate goods producers opt to liquidate their assets and exit to the household sector. Concurrently, a commensurate measure of entrepreneurs enters the intermediate goods sector, bringing their real wage income $w_t^e l_{J,t}^e$, thereby preserving dynamic equilibrium within the sector.

The capital accumulation equation incorporates entrepreneurial entry/exit dynamics:

$$n_{J,t} = \xi_J\left[1-\Gamma_t\left(\bar{\omega}_{J,t}\right)\right]R_{J,t}\left(n_{J,t-1}+b_{J,t}\pi_t\right)+w_{J,t}^e l_{J,t}^e \tag{32}$$

Following the established methodologies in the literature, the entrepreneurial labor input for intermediate goods producers is normalized to unity across sectors, such that $l_{J,t}^e = 1$, $J\in\{l,ms\}$. Consequently, the real wage rate $w_{J,t}^e$ becomes time-invariant [8] [9].

Large banks lend to both large enterprises and SMEs, while small banks lend only to SMEs. Thus, SME loans come from both sources: $b_{ms,t} = b_{ms,t}^{LB} + b_{ms,t}^{SB}$. SME average loan rates and commercial bank average loan return rates are:

$$1+r_{ms,t}^B = \left(1+r_{ms,t}^{LB}\right)\frac{b_{ms,t}^{LB}}{b_{ms,t}}+\left(1+r_{ms,t}^{SB}\right)\frac{b_{ms,t}^{SB}}{b_{ms,t}} \tag{33}$$

$$1+r_{q,t}^B = \left(1+r_{q,t}^{LB}\right)\frac{b_{ms,t}^{LB}}{b_{ms,t}}+\left(1+r_{q,t}^{SB}\right)\frac{b_{ms,t}^{SB}}{b_{ms,t}} \tag{34}$$

The SME loan share is:

$$\tau_{ms,t} = \frac{b_{ms,t}}{b_{l,t}+b_{ms,t}} \tag{35}$$

2.5. Financial Sector

This model uses commercial banks as representative financial institutions, assuming two types: large banks (superscript LB) and small banks (superscript SB). Their main differences are: 1) Different lending targets—large banks can lend to both large enterprises and SMEs, while small banks can only lend to SMEs due to capital constraints; 2) Different balance sheet structures—large banks are net lenders in the interbank market, while small banks are net borrowers.

This setting is justified by: 1) It is common practice to set up different financial intermediaries for heterogeneous intermediate sectors. For instance, [1] institute distinct banking entities for green versus non-green industries. When addressing firms of divergent scales, methodological refinement becomes necessary. This section adopts the framework of [3], postulating two heterogeneous banking classes while incorporating an interbank market; 2) Large banks are the main force in supporting SMEs. The 2021 Government Work Report required that "large commercial banks increase inclusive SME loans by over 30%"; by the end of 2023, large banks (state-owned and joint-stock commercial banks) had 34% more inclusive small and micro loans than small banks (city and rural commercial banks). This setting reflects SMEs' "credit discrimination" in reality by incorporating information friction costs when large banks lend to SMEs.

2.5.1. Large Banks

The balance sheet of large banks is as follows:

$$b_{l,t}^{LB} + b_{ms,t}^{LB}\left(1+\Delta_t\right) + re_t^{LB} + d_t^{ILB} = d_t^{LB} + d_t^{LF} + n_t^{LB} \tag{36}$$

where $b_{l,t}^{LB}$ and $b_{ms,t}^{LB}$ represent loans to large enterprises and SMEs respectively. Δ_t specifically captures exogenous information acquisition costs incurred when lending to small-medium enterprises (SMEs), formulated as $\Delta_t = \frac{\kappa_B}{2}\left(\frac{b_{ms,t}}{b_{ms,t-1}} - 1\right)^2 b_{ms,t}$, where κ_B parametrizes adjustment cost intensity. Reserve requirements are $re_t^{LB} = \tau_t^{LB} d_t^{LB}$, where τ_t^{LB} denotes the reserve ratio and $\left(1+r_t^{DRL}\right)$ represents its interest rate. For central bank lending facilities, d_t^{LF} signifies funds obtained by large banks, with r_t^{LF} denoting the facility interest rate. The pledge ratio τ_t^{LF} governs the proportion of eligible loans accepted as collateral against lending facilities' borrowing. Within this framework, large banks act as lenders in the interbank market, where d_t^{ILB} denotes interbank lending and r_t^{ILB} is the corresponding interest rate. Bank liabilities comprise deposits (d_t^{LB}), while n_t^{LB} represents core bank equity capital.

Given the preceding framework, the cost function for deposit absorption by large banks can be derived. Specifically, this cost equals the difference between the expected future accrued value of deposits and the expected future accrued value of required reserves, expressed as $E_t\left[\left(1+r_{t+1}^{D}\right)d_t^{LB} - \left(1+r_{t+1}^{DRL}\right)\tau_t^{LB} d_t^{LB}\right]$. This simplifies to $E_t\left(1+r_{d,t+1}^{LB}\right)\left(1-\tau_t^{LB}\right)d_t^{LB}$, where $E_t\left(1+r_{d,t+1}^{LB}\right)$ denotes the expected effective deposit rate, which is identical with $E_t\left(1+r_{t+1}^{D} + \frac{r_{t+1}^{D} - r_{t+1}^{DRL}}{1-\tau_t^{LB}}\tau_t^{LB}\right)$. Furthermore, the loan-to-deposit ratio for large banks is defined as the ratio of total loans to total deposits: $ldr_t^{LB} = \frac{b_{l,t}^{LB} + b_{ms,t}^{LB}\left(1+\Delta_t\right)}{d_t^{LB}}$.

The expected net worth evolves as:

$$
\begin{aligned}
E_t n_{t+1}^{LB} &= E_t\Big[\left(1+r_{l,t+1}^{LB}\right)b_{l,t}^{LB}+\left(1+r_{ms,t+1}^{LB}\right)b_{ms,t}^{LB}+\left(1+r_{t+1}^{ILB}\right)d_t^{ILB} \\
&\quad -\left(1+r_{d,t+1}^{LB}\right)\left(1-\tau_t^{LB}\right)d_t^{LB}-\left(1+r_{t+1}^{LF}\right)d_t^{LF}\Big] \\
&= E_t\Big\{\left(r_{l,t+1}^{LB}-r_{d,t+1}^{LB}\right)b_{l,t}^{LB}+\left(r_{t+1}^{ILB}-r_{d,t+1}^{LB}\right)d_t^{ILB}+\left(1+r_{d,t+1}^{LB}\right)n_t^{LB} \\
&\quad +\left[\left(1+r_{ms,t+1}^{LB}\right)-\left(1+r_{d,t+1}^{LB}\right)\left(1+\Delta_t-\tau_t^{LF}\right)\left(1+r_{t+1}^{LF}\right)\tau_t^{LF}\right]b_{ms,t}^{LB}\Big\}
\end{aligned}
\tag{37}
$$

Subsequently, assuming large banks face a constant survival probability θ^{LB} per period, their optimization objective is formulated as maximizing the expected present discounted value of future real assets, as expressed in Equation (38). This objective encapsulates commercial banks' pursuit of long-term asset appreciation under going-concern conditions, while incorporating trade-offs between risk exposure and return generation.

$$
V_t^{LB} = \max E_t \sum_{i=0}^{\infty}\left(1-\theta^{LB}\right)\left(\theta^{LB}\right)^i \beta^{i+1}\Lambda_{t+i,t+1+i} n_{t+1+i}^{LB} \tag{38}
$$

To simplify notation, denote the real effective assets of large banks as $s_t^{LB} = b_{l,t}^{LB} + b_{ms,t}^{LB}\left(1+\Delta_t-\tau_t^{LF}\right) + d_t^{ILB}$, with the leverage ratio defined as $\phi_t^{LB} = s_t^{LB}/n_t^{LB}$. For analytical purposes, the real effective assets can be decomposed into three components: the SME loan proportion $\zeta_{1,t} = b_{ms,t}^{LB}\left(1+\Delta_t-\tau_t^{LF}\right)/s_t^{LB}$, the large enterprise loan proportion $\varsigma_{2,t} = b_{l,t}^{LB}/s_t^{LB}$, and the interbank lending proportion $\varsigma_{3,t} = d_t^{ILB}/s_t^{LB}$. These components satisfy the additivity constraint $\sum_{i=1}^{3}\zeta_{i,t} = 1$.

Consequently, the expected average asset return rate of large banks can be expressed as:

$$
E_t\left(1+r_{q,t+1}^{LB}\right) = E_t\left[\frac{1+r_{ms,t+1}^{LB}}{1+\Delta_t-\tau_t^{LF}}\varsigma_{1,t}+\left(1+r_{l,t+1}^{LB}\right)\varsigma_{2,t}+\left(1+r_{t+1}^{ILB}\right)\varsigma_{3,t}\right] \tag{39}
$$

Drawing on classical literature, it is assumed that large banks face moral hazard risks when transferring assets to the household sector, which to some extent increases the probability of bank bankruptcy [7]. Therefore, the proportion of asset transfers by commercial banks, denoted as λ^{LB}, must be strictly controlled within a certain threshold, satisfying the condition $V_t^{LB} \ge \lambda^{LB} s_t^{LB}$ (where equality holds under equilibrium conditions).

Subsequently, to solve the optimization problem for large banks, the method of undetermined coefficients is employed. Let the solution take the form:

$$
V_t^{LB} = v_t^{LB} s_t^{LB} + \eta_t^{LB} n_t^{LB} \tag{40}
$$

where v_t^{LB} and η_t^{LB} represent the unit return rates of large banks' real effective assets s_t^{LB} and their own capital n_t^{LB}, respectively.

Solving the Bellman equation yields Equations (41) and (42), where $E_t x_{t+1}^{LB} = E_t s_{t+1}^{LB}/s_t^{LB}$ and $E_t z_{t+1}^{LB} = E_t n_{t+1}^{LB}/n_t^{LB}$.

$$
v_t^{LB} = \left(1-\theta^{LB}\right)\beta E_t\left[\Lambda_{t,t+1}\left(r_{q,t+1}^{LB}-r_{d,t+1}^{LB}\right)\right]+\theta^{LB}\beta E_t\left(\Lambda_{t,t+1}x_{t+1}^{LB}v_{t+1}^{LB}\right) \tag{41}
$$

$$
\eta_t^{LB} = \left(1-\theta^{LB}\right)\beta E_t\left[\Lambda_{t,t+1}\left(1+r_{d,t+1}^{LB}\right)\right]+\theta^{LB}\beta E_t\left(\Lambda_{t,t+1}z_{t+1}^{LB}\eta_{t+1}^{LB}\right) \tag{42}
$$

Substituting the equilibrium condition $V_t^{LB} = \lambda^{LB} s_t^{LB}$ into Equation 40 yields the optimized leverage ratio for large banks: $\phi_t^{LB} = \frac{\eta_t^{LB}}{\lambda^{LB} - \nu_t^{LB}}$. The optimal solution for their next-period expected net worth is:

$$E_t n_{t+1}^{LB} = E_t\left[\left(r_{q,t+1}^{LB} - r_{d,t+1}^{LB}\right)\phi_t^{LB} + 1 + r_{d,t+1}^{LB}\right] n_t^{LB} \quad (43)$$

We can observe that three factors—the expected average asset return rate of large banks $r_{q,t+1}^{LB}$, the effective deposit interest rate $r_{d,t+1}^{LB}$, and the leverage ratio ϕ_t^{LB}—jointly influence the expected asset position in the next period. These variables play crucial roles in banks' asset management and risk control, and their interactions determine the value and dynamics of banks' future assets. Furthermore, $E_t z_{t+1}^{LB}$ can be expressed as $E_t\left[\left(r_{q,t+1}^{LB} - r_{d,t+1}^{LB}\right)\phi_t^{LB} + r_{d,t+1}^{LB}\right]$, while $E_t x_{t+1}^{LB}$ can be represented as $E_t z_{t+1}^{LB} \phi_{t+1}^{LB} / \phi_t^{LB}$.

Given that the survival rate of commercial banks is θ^{LB}, each period a proportion $\left(1-\theta^{LB}\right)$ of commercial bank assets will be transferred to the household sector. Simultaneously, new assets equivalent to χ^{LB} proportion of the previous period's assets will be transferred from the household sector to the banking sector. Therefore, the current-period assets of commercial banks can be expressed as the sum of surviving assets $n_{o,t}^{LB}$ and newly added assets $n_{n,t}^{LB}$, that is: $n_t^B = n_{o,t}^B + n_{n,t}^B$.

These two components are respectively:

$$n_{o,t}^{LB} = \theta^{LB} n_t^{LB} = \left[\left(r_{q,t}^{LB} - r_{d,t}^{LB}\right)\phi_{t-1}^{LB} + 1 + r_{d,t}^{LB}\right] n_{t-1}^{LB} \quad (44)$$

$$n_{n,t}^{LB} = \chi^{LB} n_{t-1}^{LB} \quad (45)$$

2.5.2. Small Banks

Similarly, the balance sheet of small banks is as follows:

$$b_{ms,t}^{SB} + re_t^{SB} = d_t^{SB} + d_t^{ISB} + d_t^{RF} + n_t^{SB} \quad (46)$$

where $b_{ms,t}^{SB}$ represents loans obtained by SMEs from small banks, re_t^{SB} denotes the reserve requirements of small banks, d_t^{SB} stands for deposits absorbed, d_t^{ISB} indicates interbank borrowing funds, d_t^{RF} refers to relending obtained from the central bank, and n_t^{SB} represents the net worth of small banks. Regarding small banks' reserve requirements, τ_t^{SB} denotes the reserve requirement ratio, and r_t^{DRS} denotes its interest rate. For relending, τ_t^{RF} denotes the proportion of relending to total loans, while r_t^{RF} represents the relending interest rate. For interbank borrowing, the ratio τ_t^{ISB} (*i.e.*, the ratio of d_t^{ISB} to d_t^{SB}) and the interbank offered rate r_t^{ISB} are defined.

It should be noted that considering the targeted (SME-supporting) relending policy discussed later—primarily implemented for city commercial banks, rural commercial banks, rural cooperative banks, village banks, and private banks—which aligns more closely with small banks in this model, it is relatively reasonable to include the relending item exclusively in small banks' balance sheets.

Consequently, we can simplify the balance sheet of small banks as:

$\left(1-\tau_t^{RF}\right)b_{ms,t}^{SB}=\left(1-\tau_t^{SB}+\tau_t^{ISB}\right)d_t^{SB}+n_t^{SB}$. Simultaneously, the loan-to-deposit ratio is defined as: $ldr_t^{SB}=b_{ms,t}^{SB}/d_t^{SB}$.

Similarly, when calculating small banks' expected real assets, the same method employed for large banks is adopted:

$$\begin{aligned}E_t n_{t+1}^{SB}&=E_t\left(r_{q,t+1}^{SB}-r_{d,t+1}^{SB}\right)\left(1-\tau_t^{RF}\right)b_{ms,t}^{SB}+E_t\left(1+r_{d,t+1}^{SB}\right)n_t^{SB}\\&=E_t\left[\left(r_{q,t+1}^{SB}-r_{d,t+1}^{SB}\right)s_t^{SB}+\left(1+r_{d,t+1}^{SB}\right)n_t^{SB}\right]\end{aligned} \tag{47}$$

The variables in Equation 47 remain consistent with those of large banks, where s_t^{SB} represents the real effective assets of small banks, while $E_t r_{q,t+1}^{SB}$ and $E_t r_{d,t+1}^{SB}$ denote the expected effective loan return rate and expected effective deposit interest rate of small banks, respectively. These two rates are determined by the following equations:

$$E_t\left(1+r_{q,t+1}^{SB}\right)=\frac{E_t\left[\left(1+r_{ms,t+1}^{SB}\right)-\left(1+r_{t+1}^{RF}\right)\tau_t^{RF}\right]}{1-\tau_t^{RF}} \tag{48}$$

$$E_t\left(1+r_{d,t+1}^{SB}\right)=\frac{E_t\left[\left(1+r_{t+1}^{D}\right)-\left(1+r_{t+1}^{DRS}\right)\tau_t^{SB}+\left(1+r_{t+1}^{ISB}\right)\tau_t^{ISB}\right]}{1-\tau_t^{SB}+\tau_t^{ISB}} \tag{49}$$

Similarly, the optimization problem for small banks also aims to maximize their expected future real assets across all periods:

$$V_t^{SB}=\max E_t\sum_{i=0}^{\infty}\left(1-\theta^{SB}\right)\left(\theta^{SB}\right)^i\beta^{i+1}\Lambda_{t,t+1}n_{t+1+i}^{SB} \tag{50}$$

where θ^{SB} represents the fixed survival rate of small banks. The method of undetermined coefficients is then employed to solve the optimization problem. As the steps are consistent with those described earlier, the process is omitted here.

Similarly, under the moral hazard constraint $V_t^{SB}\geq\lambda^{SB}s_t^{SB}$, the leverage ratio of small banks in equilibrium is derived as $\phi_t^{SB}=\eta_t^{SB}/\left(\lambda^{SB}-\nu_t^{SB}\right)$, where η_t^{SB} and ν_t^{SB} denote the unit return rates of their own capital n_t^{SB} and real effective assets s_t^{SB}, respectively, and λ^{SB} represents the proportion of small bank assets transferred to the household sector.

Under optimal decision-making, the expected next-period real assets are given by $E_t n_{t+1}^{SB}=E_t\left[\left(r_{q,t+1}^{SB}-r_{d,t+1}^{SB}\right)\phi_t^{SB}+1+r_{d,t+1}^{SB}\right]n_t^{SB}$. The current-period real assets can similarly be decomposed into two parts: the carried-over portion from the previous period $n_{o,t}^{SB}$ and the newly transferred portion in the current period $n_{n,t}^{SB}$, such that: $n_{o,t}^{SB}=\theta^{SB}\left[\left(r_{q,t}^{SB}-r_{d,t}^{SB}\right)\phi_t^{SB}+1+r_{d,t}^{SB}\right]n_{t-1}^{SB}$, and $n_{n,t}^{SB}=\chi^{SB}n_{t-1}^{SB}$, where χ^{SB} represents the proportion of new assets transferred from the household sector relative to the previous period's real assets.

2.6. Interbank Market

Given the presence of heterogeneous commercial banks and imperfect competition in this model, and to facilitate the analysis of structural monetary policies, this section establishes a frictionless interbank market. It is assumed that large banks act as net lenders in the interbank market, while small banks serve as net borrowers. The market clearing condition requires $d_t^{ILB} = d_t^{ISB}$, with the market interest rate satisfying $r_t^{ISB} = r_t^{ILB}$.

2.7. Equilibrium Conditions

Under general equilibrium conditions, when all markets clear, the aggregate resource constraint can be expressed as Equation (51). In this expression, g_t represents government purchases in period *t*.

$$\begin{aligned} y_t &= c_t + i_t + g_t + \frac{\kappa_P}{2}\left(\frac{\pi_t}{\pi_{t-1}^{\alpha_p}\pi^{1-\alpha_p}} - 1\right)^2 c_t \\ &+ \mu_{ms} G_t\left(\bar{\omega}_{ms,t}\right) R_{ms,t}\left(\frac{n_{ms,t-1}}{\pi_t} + b_{ms,t}\right) \\ &+ \mu_l G_t\left(\bar{\omega}_{l,t}\right) R_{l,t}\left(\frac{n_{l,t-1}}{\pi_t} + b_{l,t}^{LB}\right) + \Delta_t b_{ms,t}^{LB} \end{aligned} \tag{51}$$

Considering that both types of intermediate goods manufacturers rely on capital and labor as fundamental input factors, and given the production functions and demand functions of these two types of manufacturers, the market clearing conditions for capital and labor require that the sum of factor demands from all manufacturers equals the total supply in the market. Therefore, $k_{t-1} = k_{ms,t} + k_{l,t}$, and $l_t = l_{ms,t} + l_{l,t}$. Simultaneously, bank loans to intermediate goods manufacturers are $b_{l,t} = b_{l,t}^{LB}$ and $b_{ms,t} = b_{ms,t}^{LB} + b_{ms,t}^{SB}$. Additionally, household deposits are $d_t = d_t^{SB} + d_t^{LB}$.

Finally, consumption, investment, and government purchases together constitute real GDP:

$$gdp_t = c_t + i_t + g_t \tag{52}$$

2.8. Fiscal Sector

Within this model, we construct a simplified fiscal sector framework in which lump-sum taxes levied on the household sector are assumed to equal government purchase expenditures. This setting facilitates a clearer analysis of the balancing relationship between taxation and government spending, as well as how this relationship influences the operation of the entire economic system.

$$tax_t = g_t \tag{53}$$

Fiscal policy adopts a Taylor rule form, simplified based on existing literature. The government expenditure rule targets the relative deviation of real GDP [10] [11].

$$\frac{g_t}{g} = \left(\frac{g_t}{g}\right)^{\rho^G}\left[\left(\frac{gdp_t}{gdp}\right)^{\alpha_{gy}}\right]^{1-\rho^G} e^{\varepsilon_{G,t}} \tag{54}$$

2.9. Central Bank

2.9.1. Traditional Monetary Policy Rule

Traditional monetary policy refers to the central bank's aggregate monetary policy. This section follows methods from the classical literature, assuming traditional monetary policy follows a Taylor rule [12]-[14]. Adopting the specification in Equation 55, it is assumed that the policy rate equals the risk-free deposit rate, *i.e.*, $r_t = r_t^D$ [3]. Here, $\varepsilon_{r,t}$ represents the aggregate monetary policy shock.

$$\frac{1+r_t}{1+r} = \left(\frac{1+r_{t-1}}{1+r}\right)^{\rho_r} \left[\left(\frac{\pi_t}{\pi}\right)^{\alpha_\pi} \left(\frac{gdp_t}{gdp}\right)^{\alpha_y}\right]^{1-\rho_r} e^{\varepsilon_{r,t}} \quad (55)$$

2.9.2. Structural Monetary Policy Rules

The central bank can utilize both aggregate regulation tools based on the Taylor rule and structural policy tools for targeted regulation [15]. Within a unified framework, this section introduces three types of structural monetary policy tools: targeted relending, targeted reserve requirement ratio (RRR) cuts, and lending facilities.

a) Targeted Relending Tool

Targeted relending primarily refers to the central bank providing preferential subsidies to commercial banks for loans directed to specific sectors, including agriculture-supporting relending, SME-supporting relending, and other novel relending instruments directly serving the real economy. Since this model focuses on structural monetary policy's targeted support for SMEs, SME-supporting relending is used as an example. According to the PBOC's "Specific Tool Introduction (as of end-June 2024)" document on structural monetary policies released on October 25, 2023, SME-supporting relending recipients include city commercial banks, rural commercial banks, rural cooperative banks, village banks, and private banks, which align with the small banks defined in this model.

With reference to relevant literature, this model sets the following rule for the SME-supporting relending tool [1]:

$$\frac{\tau_t^{RF}}{\tau^{RF}} = \theta^{RF} \left(\frac{b_{ms,t}^{SB}}{b_{ms}^{SB}}\right)^{\alpha_{RF}} e^{\varepsilon_{RF}} \quad (56)$$

In this equation, τ_t^{RF} represents the proportion of relending to small banks' total loans, $b_{ms,t}^{SB}$ denotes small banks' credit scale to SMEs, and b_{ms}^{SB} stands for its steady-state value. α_{RF} reflects the policy's sensitivity to loan changes, indicating policy intensity. θ^{RF} is the policy coefficient. When the central bank observes that small banks' SME loan scale exceeds its steady-state value, it increases the relending proportion to incentivize greater support for SME development.

This policy rule has the following characteristics: 1) The operational target of SME-supporting relending is τ_t^{RF}, which effectively subsidizes the portion $\tau_t^{RF} b_{ms,t}^{SB}$ of small banks' loans, aligning with the "credit-pledged relending" model; 2) Both the operational and targeting objects are ratios of current scale to steady-state value. This design stems from the central bank's "Three No Less Than" requirements for financial institutions' SME loans under the SME-supporting relending program: SME loan growth should maintain parity with overall loan growth, the base number of SME loan accounts should not be lower than the previous year's level, and SME loan approval rates should remain at previous-year levels (CBRC, 2015). However, growth rate forms like $b_{ms,t}^{SB} / b_{ms,t-1}^{SB}$ may exacerbate volatility and cause policy discontinuity. Therefore, after comprehensive consideration, this model adopts the form of Equation (56).

b) Targeted RRR Cuts

Targeted RRR cuts reduce the RMB deposit reserve requirement ratio for commercial banks that meet prudent operation requirements and extending qualified loans to "agriculture, rural areas, and farmers" and SMEs, thereby achieving targeted regulatory effects. This policy primarily targets rural financial institutions such as rural credit cooperatives, rural commercial banks, rural cooperative banks, and village banks, as well as city commercial banks operating within provincial administrative regions. Therefore, this model uses small banks' deposit reserve requirement ratio as the operational target, setting the following targeted RRR cut rule:

$$\frac{\tau_t^{SB}}{\tau^{SB}} = -\theta^{RR} \left(\frac{b_{ms,t}^{SB}}{b_{ms}^{SB}} \right)^{\alpha_{RR}} \mathrm{e}^{\varepsilon_{RR}} \tag{57}$$

Here, τ_t^{SB} represents small banks' deposit reserve requirement ratio, τ^{SB} denotes its steady-state value, and its targeting objective aligns with the aforementioned targeted relending tool—both focus on small banks' loan scale to SMEs. Following relevant literature, this rule adopts the form of deviation from steady-state value [1]. The implementation process is as follows: When the central bank observes small banks' SME loans positively deviating from their steady-state value, it lowers their reserve requirement ratio to incentivize greater support for SME development.

c) Lending Facilities

The People's Bank of China established Standing Lending Facility (SLF) in 2013 and Medium-term Lending Facility (MLF) in 2014, followed by Targeted Medium-term Lending Facility (TMLF) at the end of 2018. These three lending facilities operate through collateralized transactions, requiring financial institutions to provide eligible collateral (pledged assets) to obtain funds. For MLF, eligible collateral primarily includes government bonds, central bank bills, policy financial bonds, local government bonds, and AAA-rated corporate credit bonds. The collateral expansion policy implemented in June 2018 incorporated additional assets: financial bonds of at least AA rating for SMEs, green sectors, and agriculture-related sectors, as well as high-quality SME loans and green loans. Commercial banks can pledge these collateral assets to obtain low-interest loans from the central bank.

Compared to targeted relending and targeted RRR cuts, lending facilities exhibit more market-oriented characteristics. Except for TMLF, other lending facilities impose no explicit requirements on the direction of fund usage. Therefore, based on their strategic, profitability, and risk control needs, commercial banks can use the funds for general profitable investments and lending activities or direct them toward policy-oriented sectors (e.g., SMEs, green industries), thereby obtaining more collateral assets to exchange for additional lending facilities from the central bank.

Since high-credit-quality assets (e.g., government bonds, central bank bills, AAA corporate bonds) that dominate eligible collateral are not explicitly modeled, this section introduces a collateral framework into the financial sector using an endowment approach. Commercial banks with high collateral endowments can pledge eligible collateral assets to obtain lending facilities, while those with low endowments cannot. Meanwhile, SME credit assets among commercial banks' modeled assets qualify as eligible collateral and can be pledged by high-endowment banks to obtain lending facilities.

Based on this, this section designates large banks as high-collateral-endowment entities and small banks as low-endowment entities. This setting is justified by the following: 1) SLF primarily serves large financial institutions. Initially, only policy banks and national commercial banks meeting macroprudential requirements could apply, corresponding to large banks in this model. Although eligible small and medium-sized financial institutions were gradually included starting January 2014, SLF mainly serves large commercial banks; 2) SME credit—a key focus of this research—constitutes an important component of MLF collateral. For example, under the inclusive finance framework, large state-owned and joint-stock commercial banks outperform city and rural commercial banks in both the scale and growth of inclusive small and micro loans. For instance, the four large state-owned banks (Industrial and Commercial Bank of China, China Construction Bank, Agricultural Bank of China and Bank of China) each maintained year-end balances exceeding RMB 1.2 trillion with growth rates generally above 25%. Among joint-stock banks, Industrial Bank Co., Ltd. held over RMB 120 billion in inclusive small and micro loans with 20% annual growth. In contrast, city and rural commercial banks mainly serve local enterprises and face limitations due to local economic conditions, the number of SMEs, and business types (e.g., some banks primarily serve local farming enterprises), making it difficult to compete with large banks; 3) While lending facilities share formal similarities with targeted relending, they feature stronger market orientation. Under targeted relending rules, small banks receive support to increase SME lending. Under lending facilities, large banks obtain funds that can be allocated to both large enterprises and SMEs, which serves as an incentive rather than a compulsory directive—consistent with the nature of lending facilities.

Accordingly, this section establishes the following lending facility rule:

$$\frac{\tau_t^{LF}}{\tau^{LF}} = \theta^{LF} \left(\frac{b_{ms,t}}{b_{ms}} \right)^{\alpha_{LF}} e^{\varepsilon_{LF}} \tag{58}$$

Here, τ_t^{LF} represents the collateral pledge rate, *i.e.*, the proportion of lending facilities obtained by commercial banks to their pledged collateral assets. In this model's characterization of commercial bank assets, only SME credit qualifies as eligible collateral, thus $d_t^{LF} = \tau_t^{LF} b_{ms,t}^{LB}$. τ^{LF} denotes the steady-state value of

τ_t^{LF}. The lending facility targets the deviation of SME credit scale from its steady-state level, with the rule form also referencing [1]. When the central bank observes SME loan scale positively deviating from its steady state, it releases liquidity to large banks to incentivize increased support for SME development.

3. Parameter Calibration and Bayesian Estimation

Next, this section employs calibration and Bayesian estimation methods for parameter estimation. The specific procedures are as follows: 1) For deep structural parameters, reference values from representative DSGE literature depicting China's economy; 2) Adopt real economic data as steady-state values for some endogenous variables; 3) For dynamic parameters related to shock specifications, confirm based on calibration values from representative literature using Bayesian estimation methods [16] [17].

This section sets one period in the model to correspond to one quarter in the real economy. The household sector's subjective discount factor β is set to 0.995, corresponding to an annualized risk-free interest rate of 2.0%. The Frisch labor supply elasticity is calibrated to 0.5, with the corresponding θ_L value being 2 [9]. For consumption habits, the parameter χ_c is set to 0.907. The capital depreciation rate δ is set to 0.025, representing quarterly capital depreciation and corresponding to approximately 10% annual depreciation [4] [18]. Regarding price markup settings, this section fixes it at 1.16, implying a substitution elasticity ψ of 7.25 for retail goods. This setting aligns with the price markup range [1.1, 1.2] commonly used in literature [19].

Regarding the relationship between the two types of intermediate goods, this section sets the substitution elasticity ζ between intermediate goods to 3.2, from which the market share ϕ of large enterprise intermediate goods is calculated to be approximately 0.3859. According to reports, by the end of 2018, China had over 30 million SMEs contributing approximately 60% of GDP, thus the market share of SMEs in this model generally aligns with reality [20]. In the production function of intermediate goods manufacturers, the fixed growth trend of total factor productivity (TFP) is set to 1.0125, corresponding to an average annual technological growth rate of about 5%. For TFP levels of both types of enterprises (large enterprises and SMEs), this section standardizes the former to 1 and sets the latter to 1.42 [9]. The capital share α for both types of enterprises is uniformly set to 0.55, while their monitoring costs μ_l and μ_{ms} are both set to 0.15.

Regarding enterprise survival rates, large enterprises and SMEs have survival rates ξ_l and ξ_{ms} set to 0.97 and 0.70 respectively, corresponding to average operating cycles of approximately 33 quarters (about 8 years) and 3.33 quarters (about 9 months) [9]. Finally, in the financial institution settings, commercial banks' survival rates θ^{LB} and θ^{SB} are assigned values of 0.980 and 0.931 respectively, implying average operating cycles of approximately 50 quarters and 15 quarters for commercial banks [3].

When constructing this model, this section uses real economic data as references to ensure that interest rates and ratios in the model align with the real economic environment. Specifically, through moment matching or direct assignment methods, based on average one-year Medium-term Lending Facility (MLF) rate of 3.19% and one-year Loan Prime Rate (LPR) of 4.64%, the steady-state values of r^{LF} and r_q^{LB} are calibrated to 0.0079 and 0.0114 respectively. Similarly, with the weighted average one-year interbank offered rate at 2.70% and relending rate at 3.80%, the steady-state values of r^{ISB} and r^{RF} are set to 0.0067 and 0.0094 respectively.

Considering LPR's function as the benchmark lending rate that reasonably reflects commercial banks' average returns, it is used to calibrate large banks' average effective asset return rate r_q^{LB}. Through Equation 31 of the standard BGG debt contract, the lending rate for large enterprises can be determined. As SME financing costs are relatively harder to determine, this section calibrates the steady-state value of r_q^{B} by adding 1% to r_q^{LB} [21]. The reserve requirement ratios for large and small banks τ^{LB} and τ^{SB} are set to 17.56% and 14.98% respectively, while reserve requirement interest rates r^{DRL} and r^{DRS} are uniformly calibrated to 0.0044 based on the one-year reserve requirement interest rate of 1.76% [1].

For some steady-state ratios, this section continues to use moment matching methods for calibration. Based on data from large state-owned and joint-stock commercial banks' loans to small and micro enterprises, the steady-state proportion of large banks' loans to SMEs b_{ms}^{LB}/b_{ms} is calibrated to 0.55. This section considers state-owned commercial banks and joint-stock banks as large banks, and city commercial banks and rural commercial banks as small banks. Based on micro-level bank data, the steady-state loan-to-deposit ratios for large and small banks ldr^{LB} and ldr^{SB} are 0.61 and 0.78 respectively. Using relending scale data from the CSMAR Rural Finance Database, the relending proportion τ^{RF} is calibrated to 0.056. Regarding the pledge rate for lending facilities, although the central bank has not disclosed pledge rates for various collateral assets, this section estimates that qualified collateral pledge rates for commercial banks range between 55% and 80% based on the central bank's operational guidelines, policy documents, and market practices. Considering that SME credit is relatively lower-quality among collateral assets, its pledge rate τ^{LF} is calibrated to 0.60. Then, using the employment ratio from the CSMAR Population Aging Database, the steady-state labor supply l is calibrated to 0.56 [12] [22]. Based on national GDP, consumption, and investment data, this paper calibrates the steady-state consumption and investment shares to 0.393 and 0.410 respectively. Additionally, the steady-state leverage ratios for large and small banks are calibrated to 1.5 and 2.5 respectively [3].

Based on the above steady-state values or proportions, the remaining parameters will be derived from these results. Since key steady-state data are calculated from real data, the model's fit with actual economic data is reasonably ensured. The sample period spans from Q1 2010 to Q4 2022, matching the frequency and time span of the observable variables used in the subsequent Bayesian estimation. All data are sourced from the CSMAR Database and Wind Database.

Table 1. Parameters, steady-state calibration, and selection of prior values.

Variable	Definition	Calibrated Value	Reference Source	Target Value
	Structural Parameters			
β	Subjective discount factor	0.995	[9]	Annual risk-free rate ≈ 2.0%
χ_c	Consumption habit parameter	0.907	[4]	0.907
θ_L	Inverse of Frisch labor elasticity	0.5	[9]	Corresponding $\theta_L = 2$
ψ	Substitution elasticity of retail goods	7.25	[19]	Price markup = 1.16
δ	Capital depreciation rate	0.025	[1]	Annual depreciation rate ≈ 10%
α	Capital share in production	0.55	[1]	0.55
ζ	Substitution elasticity of intermediate goods	3.2	[9]	$1-\phi \geq 60\%$
g^A	TFP growth trend	1.0125	[9]	Annual technological growth rate = 5%
A_l^s	TFP level coefficient for large enterprises	1	[9]	1
A_{ms}^s	TFP level coefficient for SMEs	1.42	[9]	1.42
μ_l	Monitoring cost for large enterprises	0.15	[9]	0.15
μ_{ms}	Monitoring cost for SMEs	0.15	[9]	0.15
ξ_l	Survival rate for large enterprises	0.97	[9]	$1/(1-\xi_l) = 33.3$
ξ_{ms}	Survival rate for SMEs	0.70	[9]	$1/(1-\xi_{ms}) = 3.33$
θ^{LB}	Survival rate for large banks	0.980	[3]	$1/\left(1-\theta^{LB}\right) = 50$
θ^{SB}	Survival rate for small banks	0.931	[3]	$1/\left(1-\theta^{SB}\right) = 15$
	Steady-State Values			
r^{LF}	Lending facility rate	0.0079	Economic data	1-year MLF rate = 3.19%
r^{RF}	Relending rate	0.0094	Economic data	1-year relending rate = 3.80%
r^{ISB}	Interbank offered rate	0.0067	Economic data	1-year interbank rate = 2.70%
r_q^{LB}	Financing cost for large enterprises	0.0114	Economic data	1-year LPR = 4.64%
r_q^{B}	Financing cost for SMEs	0.0214	Economic data	$r_q^{LB} + 1\%$
r^{RE}	Reserve requirement interest rate	0.0044	[1]	1-year rate = 1.76%
τ^{LB}	Reserve requirement ratio for large banks	0.1756	Economic data	0.1756
τ^{SB}	Reserve requirement ratio for small banks	0.1498	Economic data	0.1498
τ^{RF}	Relending proportion to loans	0.056	Economic data	0.056
τ^{LF}	Collateral pledge rate for lending facilities	0.60	Economic data	0.60
b_{ms}^{LB}/b_{ms}	Proportion of SME loans from large banks	0.55	Economic data	0.55

Continued

ldr^{LB}	Loan-to-deposit ratio of large banks	0.61	Economic data	0.65
ldr^{SB}	Loan-to-deposit ratio of small banks	0.78	Economic data	0.78
l	Labor supply	0.56	Economic data	0.56
c/gdp	Consumption share in GDP	0.393	Economic data	0.393
i/gdp	Investment share in GDP	0.410	Economic data	0.410
ϕ^{LB}	Leverage ratio for large banks	1.5	[3]	1.5
ϕ^{SB}	Leverage ratio for small banks	2.5	[3]	2.5
	Prior Parameter Selection			
α_p	Price stickiness parameter	0.5	[23]	0.5
κ_K	Investment adjustment cost parameter	1	[9]	1
κ_P	Price adjustment cost parameter	22	[9]	22
κ_B	Credit friction for large banks lending to SMEs	1		1

Additionally, this section employs Bayesian methods to estimate the remaining dynamic parameters. Prior values are selected based on classical literature to minimize subjectivity issues. Specifically, the prior values for the price stickiness parameter α_p and several quadratic adjustment cost parameters are determined by referencing relevant literature [9] [23]. The prior value for the standard deviation of heterogeneous risk shocks σ_ω is set to 0.26, derived from the posterior mean in existing literature [8]. The main parameters, steady-state values, and prior value selections for this model are detailed in **Table 1**.

Building on this, this section adopts Bayesian estimation methods to estimate some structural parameters and other dynamic parameters. For prior distribution selection: Beta distributions are used for parameters with ranges in (0, 1), Gamma distributions for positive-valued parameters, Inverse-Gamma distributions for shock standard deviations, and Normal distributions are primarily employed for other cases.

Table 2. Prior value selection and bayesian estimation results.

Variable	Definition	Prior Selection	Posterior Mean	95% Confidence Interval
α_p	Price stickiness parameter	B [0.5, 0.1]	0.4146	[0.3834, 0.4523]
κ_K	Investment adjustment cost parameter	G [1, 0.5]	0.0894	[0.0793, 0.1208]
κ_P	Price adjustment cost parameter	G [20, 3.5]	3.6809	[3.5218, 4.6341]
κ_B	Credit friction of large banks lending to SMEs	G [1, 0.5]	0.1985	[0.1913, 0.3821]
ρ_l	Persistence coefficient of large enterprise TFP shock	B [0.5, 0.1]	0.1512	[0.0887, 0.1924]
ρ_{ms}	Persistence coefficient of SME TFP shock	B [0.5, 0.1]	0.6532	[0.6165, 0.6998]
ρ_r	Persistence coefficient of monetary policy interest rate adjustment	B [0.75, 0.1]	0.6919	[0.6577, 0.6981]

Continued

α_π	Monetary policy interest rate response coefficient to inflation	G [1.5, 0.1]	1.7210	[1.6733, 1.7275]
α_y	Monetary policy interest rate response coefficient to output	G [0.5, 0.1]	0.5501	[0.5156, 0.5595]
ρ^G	Persistence coefficient of government expenditure shock	B [0.5, 0.1]	0.7996	[0.7912, 0.8201]
α_{gy}	Government expenditure response coefficient to output	N [0, 0.05]	−0.0937	[−0.1020, −0.0928]
σ_l^A	Standard deviation of large enterprise TFP shock	IG [0.005, Inf]	0.6575	[0.4899, 0.7678]
σ_{ms}^A	Standard deviation of SME TFP shock	IG [0.005, Inf]	0.0980	[0.0672, 0.1078]
σ_ω	Standard deviation of idiosyncratic risk shock	IG [0.005, Inf]	0.0798	[0.0654, 0.0995]
σ_r	Standard deviation of monetary policy interest rate adjustment	IG [0.005, Inf]	0.0336	[0.0259, 0.0368]
σ_G	Standard deviation of government expenditure shock	IG [0.005, Inf]	0.2690	[0.2054, 0.2983]
σ_{LF}	Standard deviation of lending facility quantity shock	IG [0.005, Inf]	0.1099	[0.0957, 0.1423]

Note: The distributions B, G, N, and IG in the table represent the Beta, Gamma, Normal, and Inverse-Gamma distributions, respectively.

For the setting of prior values, we generally set the exogenous shock coefficients to 0.5 and shock standard deviations to 0.005. It should be noted that a few prior values require separate settings based on classical literature [21] [24] [25]. Specifically, the prior for the persistence coefficient of aggregate monetary policy interest rate adjustment is set to 0.75, and the prior for the inflation response coefficient is set to 1.5. The setting for government expenditure shocks is relatively unique: following literature practices, the prior for its output response coefficient is set to 0 with a normal distribution assumed, while whether government expenditure is procyclical or countercyclical can be determined by subsequent posterior estimates. The results are presented in **Table 2**.

This model encompasses seven exogenous shocks. To avoid the problem of stochastic singularity, this study selects six variables—gross domestic product (GDP), consumer price index (CPI), fixed-asset investment, large-bank loans, small-bank loans, and the reserve requirement rate—as the observable variables for Bayesian estimation. The sample period of all variables spans from the first quarter of 2010 to the fourth quarter of 2022 with a quarterly frequency, and the data are sourced from the China Stock Market & Accounting Research (CSMAR) Database, the Wind Financial Terminal, and the official releases of the People's Bank of China. Nominal variables are all converted into real variables using the corresponding price indices; real non-interest variables are successively processed with X12 multiplicative seasonal adjustment and a one-sided HP filter (smoothing parameter $\lambda = 1600$, a classic setting for quarterly data) to eliminate seasonal and trend interference. As exogenous policy variables with no seasonal characteristics, interest variables are only subjected to simple quarterly averaging followed by a one-sided HP filter [26]. The source series, data transformation steps, and one-to-one mapping relationships between each observable variable and model variables are detailed in Table 3.

Table 3. Construction details of observable variables.

Observable Variables	Data Source and Source Series	Data Transformation Steps	Mapping to Model Variables
Real Gross Domestic Product (GDP)	Wind China Macroeconomic Database: Quarterly nominal GDP; National Bureau of Statistics: GDP deflator with 2010 as the base period	1) Real GDP = Nominal GDP/GDP deflator × 100; 2) X12 multiplicative seasonal adjustment to eliminate seasonality; 3) One-sided HP filter for detrending.	gdp_t (Model real GDP)
Inflation Rate (CPI)	CSMAR Macroeconomic Database: Quarterly consumer price index (MoM); National Bureau of Statistics: Fixed-base CPI with 2010 = 100	1) Convert CPI data to quarterly fixed-base CPI; 2) X12 multiplicative seasonal adjustment; 3) One-sided HP filter for detrending; 4) Calculate inflation rate as $\pi_t = P_t / P_{t-1} - 1$.	π_t (Model inflation rate)
Real Fixed-Asset Investment	Wind Fixed-Asset Investment Database: Quarterly nominal completed investment in fixed assets for the whole society; Fixed-asset investment price index with 2010 as the base period	1) Real investment = Nominal investment / Fixed-asset investment price index × 100; 2) X12 multiplicative seasonal adjustment; 3) One-sided HP filter for detrending.	i_t (Model real new investment)
Large-Bank Loans	CSMAR Banking Database: Monthly total loans outstanding of state-owned large commercial banks + joint-stock commercial banks	1) Convert monthly total loans outstanding to quarterly ending balance; 2) X12 multiplicative seasonal adjustment; 3) One-sided HP filter for detrending.	b_t^{LB} (Total large-bank loans)
Small-Bank Loans	CSMAR Banking Database: Monthly total loans outstanding of urban commercial banks + rural commercial banks + village and township banks	1) Convert monthly total loans outstanding to quarterly ending balance; 2) X12 multiplicative seasonal adjustment; 3) One-sided HP filter for detrending.	b_t^{SB} (Small-bank loans)
Reserve Requirement Rate	Official website of the People's Bank of China: Monthly one-year RMB reserve requirement rate of financial institutions	1) Calculate the simple quarterly average of monthly interest rates; 2) One-sided HP filter for detrending.	r^{RE} (Reserve requirement rate for banks)

During analysis, 70,000 Markov Chain Monte Carlo (MCMC) samplings are executed, with the first 35% of sampling results discarded to avoid initial value effects. Detailed Bayesian estimation results are shown in Table 2.

By examining the posterior results presented in Table 2, the following observations emerge: 1) SMEs exhibit greater stability than large enterprises in terms of technology and productivity shocks, with higher persistence coefficients but significantly smaller shock standard deviations; 2) The response coefficient of government expenditure shocks to output is significantly negative, indicating that domestic fiscal policy features countercyclical adjustment; 3) The posterior mean of the monetary policy interest rate adjustment persistence coefficient is 0.6919, suggesting that the continuity of China's monetary policy is slightly weaker than the Western level of 0.9; 4) Estimated values for some adjustment cost parameters are significantly lower than their priors, possibly due to heterogeneity and financial frictions introduced in this model altering price stickiness and financial frictions in classical DSGE models. Overall, these findings validate the robustness and effectiveness of the Bayesian estimation results to some extent, laying the foundation for subsequent empirical testing.

The preprocessing methods for observable variables in this study are set based on variable type characteristics, the laws of Chinese macroeconomic data, and classic econometric norms, and the processing logic for different types of variables has clear rationality:

Firstly, the interest variable (reserve requirement rate) selected in this study is the official policy benchmark interest rate announced by the People's Bank of China, which is an exogenous monetary policy regulatory variable with no obvious quarterly seasonal fluctuation characteristics, and thus no seasonal adjustment is conducted. The monthly interest rate is only converted into a simple quarterly average to match the quarterly analysis frequency of the model, followed by a one-sided HP filter for detrending, which is consistent with the classic processing method of interest variables in macroeconomic models.

Secondly, the real non-interest economic variables, such as GDP, CPI, investment and bank loans, exhibit significant quarterly seasonal characteristics (e.g., fluctuations in economic activities during the Spring Festival and at the end of quarters), and thus are processed with X12 multiplicative seasonal adjustment. Compared with additive adjustment, multiplicative adjustment is more suitable for macroeconomic time series with trend fluctuations and is more in line with the characteristics of Chinese economic data. A one-sided HP filter ($\lambda = 1600$) is adopted for detrending instead of a two-sided HP filter because the two-sided HP filter decomposes trends using future data, leading to a "look-ahead bias", while the one-sided HP filter only uses current and historical data for trend decomposition, which is more consistent with the decision-making logic of monetary policy makers in reality (formulating policies based on historical and current data). The smoothing parameter $\lambda = 1600$ is a classic setting for detrending quarterly macroeconomic time series, which has been verified by a large number of literature characterizing the Chinese economy.

Finally, the conversion of nominal variables to real variables is reasonable: Nominal variables such as GDP, fixed-asset investment, and bank loans are all converted into real variables using the corresponding price indices, eliminating the interference of price level fluctuations on the analysis of real economic activities and ensuring the consistency between model variables and the connotation of real economic variables.

In this study, the policy experiments of structural monetary policy are independent of the Bayesian estimated shock processes, and all policy experiments are carried out based on the estimated benchmark model. The cross-instrument comparison of different structural monetary policy tools has strict validity for three reasons. First, unified policy intensity: the initial values of the core response coefficients and shock standard deviations of targeted relending, targeted RRR cuts, and lending facilities are all set to the same level, with no difference in the regulatory intensity of policy tools. Second, unified model foundation: the analysis of all policy tools is based on the same set of Bayesian estimated dynamic parameters and shock processes, eliminating the interference of parameter estimation results on policy effects. Third, unified logic for policy intensity changes: all tools investigate the impact of policy intensity on regulatory effects by adjusting the absolute values of policy response coefficients (0.5/0.6/0.7), and the trends and magnitudes of parameter changes are comparable. In this study, the aggregate monetary policy shock and structural monetary policy shocks are separately introduced into the model without superposition, aiming to clearly identify the independent transmission effects of various policy tools.

4. Targeted Regulation Analysis of Structural Monetary Policies

This section examines the targeted regulatory effects of tools including targeted relending, targeted reserve requirement ratio (RRR) cuts, and lending facilities. To facilitate in-depth analysis and comparison, the impulse responses to expansionary aggregate monetary policy shocks are used as benchmark results. Simultaneously, to explore the impact of intensity changes in structural monetary policy shocks on their targeted regulatory effects, this section adjusts the response coefficients of policy rules to compare the differential impacts of policy shocks at different levels.

It should be noted that aggregate monetary policy shocks and structural monetary policy shocks are added separately, not simultaneously. Considering that parameters such as response coefficients and shock standard deviations set in this model are not obtained through Bayesian estimation, merely comparing the amplitude differences in impulse responses between different policy tools is insufficient to judge policy effectiveness (subsequent sections will examine policy effectiveness using relatively rigorous methods). This section analyzes the direction, trend, and speed of changes in variables under structural and aggregate monetary policy shocks to obtain intuitive and credible conclusions.

4.1. Targeted Regulation Analysis of Targeted Relending Tool

Figure 2 presents impulse response results of key model variables under expansionary aggregate monetary policy and targeted relending tool shocks. Since these two shocks are added separately, their empirical results are displayed separately to avoid excessive differences in impulse response amplitudes that might reduce presentation effectiveness. For comparison, both results are juxtaposed. The first and third rows in the figure show impulse responses to expansionary aggregate monetary policy shocks (solid lines), while the second and fourth rows display responses to targeted relending shocks.

Based on the design of the targeted relending tool in Section 2.9, this section sets a positive relending shock with initial absolute response coefficient $\alpha_{RF} = 0.5$ and shock standard deviation $\sigma_{RF} = 0.005$. This shock is marked with a solid line as "RF1". Subsequently, the absolute values of α_{RF} are increased to 0.6 and 0.7 respectively to compare differential impacts under different shock intensities. These are marked with dashed lines ("-") and dotted lines ("·") as "RF2" and "RF3". Results are shown in Figure 2.

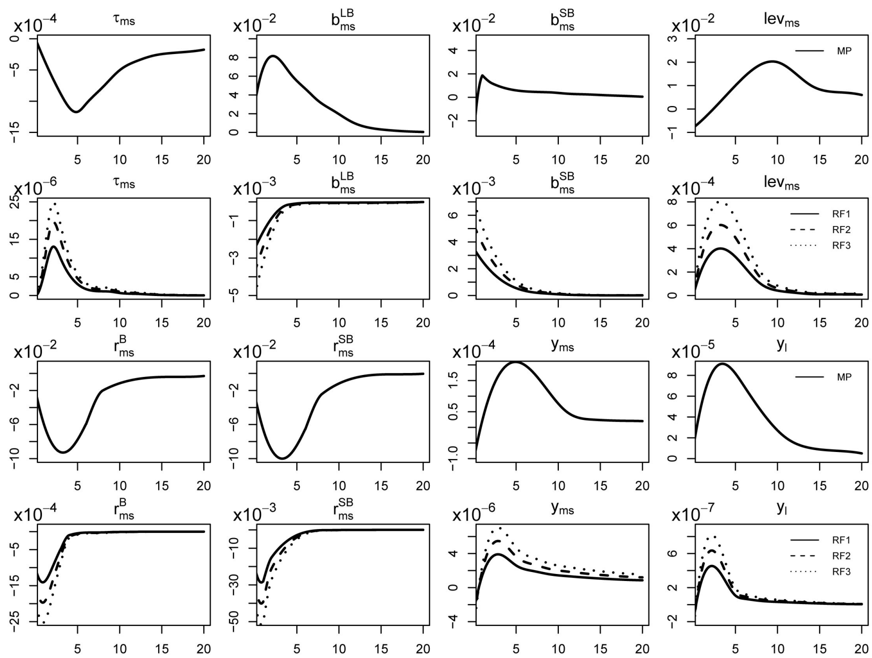

Figure 2. Targeted regulatory effects of targeted relending tool.

1) Impact on SME Loan Proportion

Figure 2 shows that SME loan proportion τ_{ms} significantly increases under targeted relending policy shocks, while expansionary aggregate monetary policy shocks cause τ_{ms} to decrease markedly. This indicates that targeted relending tools can indeed directionally improve SME credit financing and increase their share in total loans, whereas expansionary aggregate monetary policy disadvantages SME loans. Specifically, interest rate reductions help expand operations of both large and small banks, but large banks benefit more due to advantages in business scale and diversity, leading to increased loans to both large enterprises and SMEs. Simultaneously, large banks' expansion crowds out small banks' market space in the short term, reducing SME loans from small banks. Long-term, although small banks also increase lending under aggregate monetary policy, Figure 2 shows SME loan proportion still declines overall.

2) Impact on SME Loan Scale

As mentioned, SME loans consist of two parts: those from large banks (b_{ms}^{LB}) and small banks (b_{ms}^{SB}). Aggregate monetary policy shocks significantly increase SME loans from large banks while initially decreasing then increasing SME loans from small banks, consistent with the τ_{ms} analysis. Targeted relending tools substantially increase SME loans from small banks while reducing SME loans from large banks. The former verifies the targeted regulatory function, while the latter occurs because small banks' loan expansion crowds out large banks' SME loan market space, prompting large banks to reduce SME lending. The increase in b_{ms}^{SB} exceeds the decrease in b_{ms}^{LB} , indicating this policy still improves SME financing constraints. Similarly, both expansionary monetary policy and targeted relending tools increase SME leverage ratios for reasons consistent with the above analysis.

3) Impact on SME Loan Rates

Under either traditional expansionary monetary policy shocks or targeted relending shocks, average SME loan rates r_{ms}^{B} and small bank loan rates r_{ms}^{SB} decrease significantly, indicating both policies effectively reduce SME financing costs [27] [28]. Notably: 1) r_{ms}^{SB} decreases more substantially than r_{ms}^{B} , showing greater sensitivity of small bank rates; 2) Traditional policy effects slightly lag behind targeted relending effects, indicating more direct transmission mechanisms for structural monetary policies.

4) Impact on Output

Regarding output, aggregate monetary policy shocks significantly increase the output of large enterprises, while exerting a short-term negative followed by a positive effect on the output of SMEs. The former occurs by enhancing liquidity in the economy, increasing credit scale, and reducing financing costs, thereby boosting large enterprise output. The latter results from interest rate declines causing SMEs to experience crowding-out effects, leading to a short-term reduction in their output. Subsequently, increased loan volumes and decreased financing costs elevate SME output levels.

Simultaneously, targeted relending policy shocks exert a short-term negative followed by a positive effect on both SME and large enterprise output, with the distinction that the magnitude of output increase is greater for SMEs than for large enterprises. In the short term, targeted relending directs funds to small banks, whose SME loan business expands, thereby impacting large banks' credit operations and causing a simultaneous slowdown in large banks' credit allocation to both large enterprises and SMEs. This is the reason for the temporary negative impact on output of both large enterprises and SMEs. In the long term, small banks increase credit allocation to SMEs, crowding out market demand and leading to a contraction in large banks' SME loan business. Due to the substitutability between these two types of loan businesses at large banks, they shift to increasing loan scale to large enterprises. Thanks to the optimization of the credit structure, the short-term decline in output is quickly compensated, maintaining stable growth in the long term. Therefore, the output of both large enterprises and SMEs is positively affected by targeted relending policies in the long run.

It is noteworthy that the response of output, whether for large enterprises or SMEs, to the two types of policy shocks is significantly weaker than the response of loan volume and loan interest rates to policy shocks. This indicates, to some extent, that the transmission effect of structural monetary policies on enterprise output is limited.

Overall, compared to expansionary aggregate monetary policy, the targeted relending tool has a more significant effect and shorter time lag on the structural targets focused on in this model.

4.2. Targeted Regulation Analysis of Targeted RRR Cuts

Next, this section examines the impulse response results of targeted RRR cut policy shocks [27]. Similarly, the initial absolute value of the response coefficient α_{RR} is set to 0.5, and the shock standard deviation σ_{RR} is set to 0.005. Solid lines, dashed lines ("-"), and dotted lines ("·") represent cases where the response coefficient is set to 0.5, 0.6, and 0.7, respectively, with labeling methods similar to the previous subsections. The results are shown in Figure 3. Since the impulse response results of expansionary aggregate monetary policy shocks have been provided in Figure 2, they are not shown here.

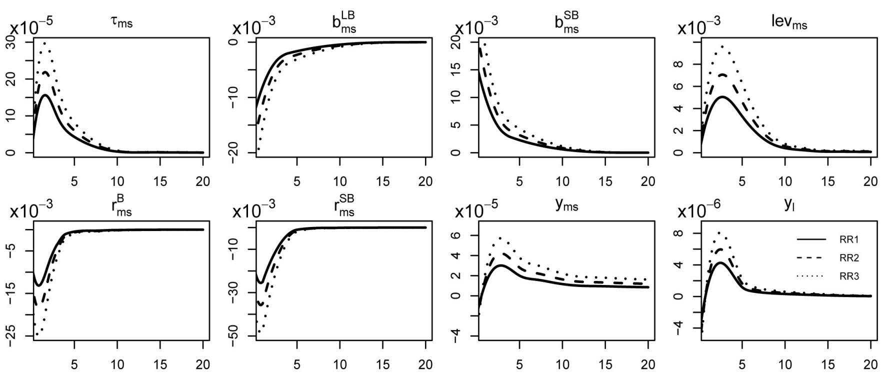

Figure 3. Targeted regulatory effects of targeted RRR cuts.

Figure 3 shows the targeted regulatory effects of targeted RRR cut policies, including three impulse response results under different response coefficients, similar in structure to Figure 2. It can be observed that targeted RRR cuts also significantly promote SME credit and output. According to the setup, targeted RRR cuts are a structural monetary policy that targets changes in the loan scale of small banks to SMEs, using the reserve requirement ratio of small banks as the operational tool. When a decline in the loan scale of small banks is observed, the central bank will lower their reserve requirement ratio, increase the liquidity of small banks, and stimulate their business expansion, thereby achieving support for SME credit financing.

It can be observed that the operational entities of the aforementioned two types of structural monetary policies are both small banks, which, by design, can only lend to SMEs. Therefore, these policy tools can improve the financing constraints of SMEs. Different types of policies may vary in effectiveness, but due to the limitations of the evaluation method used in this section, no comparison can be made. Additionally, these two policies perform significantly weaker in enhancing SME output than in their impact on credit financing, reflecting that the transmission of structural monetary policies to enterprise output requires more channels compared to transmission to financing, and their actual effect is limited. Therefore, the support of structural monetary policies for target enterprise output still needs further advancement.

4.3. Targeted Regulation Analysis of Lending Facilities

Finally, this section examines the impulse response results of lending facility policy shocks [29]. The initial absolute value of the response coefficient α_{LF} for the lending facility tool is set to 0.5, and the shock standard deviation σ_{LF} is set to 0.005. The results are shown as the "LF1" line in **Figure 4**. This section sets the shock ε_{LF} as positive to simulate the effect of an active lending facility tool. On this basis, the absolute value of α_{LF} is increased to 0.6 and 0.7, respectively, to compare the differential impacts of policy shocks at different intensities. The results are shown as "LF2" and "LF3" in **Figure 4**.

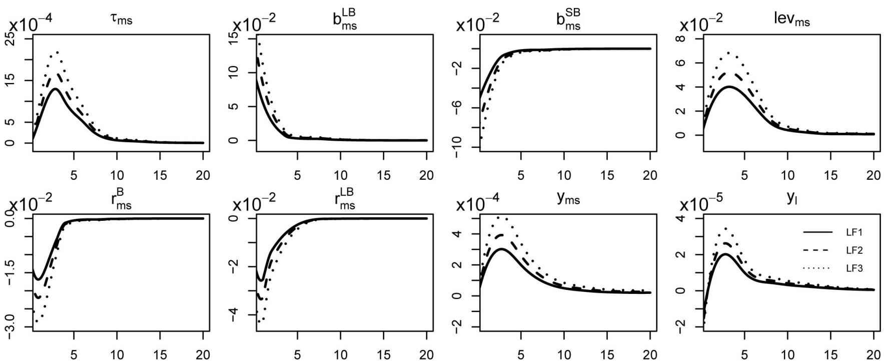

Figure 4. Targeted regulatory effects of lending facilities.

As can be seen from **Figure 4**, similar to the two aforementioned structural monetary policy tools, lending facilities can also increase the credit scale of SMEs and promote their output growth, thereby achieving targeted regulatory effects [30].

However, unlike the two aforementioned policy tools, lending facilities incentivize large banks to increase credit allocation to SMEs, resulting in significant differences in impulse response results. First, the scale of credit allocation by large banks to SMEs increases significantly. This is because large banks, after obtaining lending facilities, can achieve higher returns by allocating funds to SMEs and can increase their lending facility quotas, thus having sufficient motivation to increase credit allocation to SMEs. Simultaneously, this leads to a short-term decline in credit and output of large enterprises, but in the long term, the decrease in commercial banks' financing costs will promote the growth of financing and output of large enterprises. Second, credit allocation by small banks to SMEs decreases, but the magnitude of change is smaller than the increase in credit allocation by large banks to SMEs. As the SME credit business of large banks grows rapidly, the business space of small banks is squeezed, leading to a decline in their SME credit scale. Third, the loan interest rates of large banks to SMEs decrease. The low interest rates of lending facilities reduce the financing costs of commercial banks, thus creating room for a decrease in commercial banks' credit interest rates. Finally, SME output increases. Unlike the impulse response results of targeted relending and targeted RRR cuts, the negative effect of lending facilities on the loan business of small banks is offset to some extent by the effect of increased SME loans from large banks, so SME output does not show a trend of first declining and then rising.

The crowding-out effect leading to the reverse response of large and small banks in SME lending induced by structural monetary policy in this study is the combined result of hard bank balance sheet constraints, inherent informational frictions in large-bank lending to SMEs, and equilibrium in interbank market fund allocation. In the model, large banks face an additional information adjustment cost Δ_t when lending to SMEs; both large and small banks are subject to hard balance sheet constraints of leverage ratio and loan-to-deposit ratio, and the interbank market satisfies the frictionless clearing condition (large banks are net fund lenders, small banks are net fund borrowers, $d_t^{ILB} = d_t^{ISB}$). Under the targeted relending policy, the central bank provides credit subsidies to small banks, which leads to an increase in small banks' liquidity and a substantial expansion of their SME lending, accompanied by a contraction in their fund demand in the interbank market. Combined with the informational frictions of large banks, both the profit and liquidity incentives for large banks to lend to SMEs decline, resulting in the credit crowding-out of large banks by small banks. Under the lending facility policy, the central bank releases low-interest pledged funds to large banks, and the reduction in large banks' financing costs offsets the informational friction costs, prompting large banks to greatly expand their SME lending. Funds in the interbank market concentrate on large banks, leaving small banks with limited access to interbank borrowing and squeezed market space, thus leading to the credit crowding-out of small banks by large banks. The targeted RRR cut policy functions by directly easing the liquidity constraints of small banks and has a milder impact on fund allocation in the interbank market; therefore, the crowding-out effect it induces is significantly weaker than that of the other two policies, which is the core reason for the more stable impulse response results of this policy.

5. Impact of Structural Monetary Policies on Traditional Monetary Policy Objectives

The previous section examined the targeted regulatory function of structural monetary policies, with results indicating that all three types—targeted relending, targeted RRR cuts, and lending facilities—significantly promote SME credit and output. Considering that structural monetary policies are "star" members newly added to the monetary policy toolkit in recent years, it is crucial to investigate whether they impact the aggregate objectives traditionally focused on by monetary policy and whether they interfere with the implementation effectiveness of traditional monetary policies. Therefore, this section focuses on the following issues: first, what impact the joint implementation of structural and expansionary aggregate monetary policies will have on the economy; second, whether the combination of structural and aggregate tools exacerbates or suppresses economic fluctuations when facing risk shocks.

5.1. Impact of Structural Monetary Policies on the Effectiveness of Aggregate Monetary Policy

The previous section employed a strategy of separately implementing expansionary aggregate monetary policy shocks and structural monetary policy shocks to compare and examine the targeted regulatory capacity of the latter. This section combines expansionary aggregate monetary policy with three types of structural monetary policies for implementation, with results shown in the first row of **Figure 5**. The three subfigures respectively display impulse response results for total output, consumption, and inflation. Each subfigure shows four lines: expansionary aggregate monetary policy shock alone (denoted as "MP", solid line), aggregate monetary policy combined with targeted relending shock (denoted as "MP + RF", dotted line "·"), aggregate monetary policy combined with targeted RRR cut shock (denoted as "MP + RR", dash-dot line "·-"), and aggregate monetary policy combined with lending facility shock (denoted as "MP + LF", dashed line "-").

It should be noted that the traditional monetary policies discussed in this paper refer exclusively to expansionary aggregate monetary policies. When examining the "traditional + structural" policy overlay states, only the overlay of expansionary traditional monetary policies and structural monetary policies is included. This is based on two considerations: On the one hand, from a regulatory perspective, the structural monetary policies discussed in this paper adopt a targeted approach that partially releases liquidity and promotes credit to specific sector enterprises, rather than inhibiting the development of other sectors (e.g., [1] set targeted relending and targeted RRR cuts to suppress negative externality industries). Correspondingly, expansionary aggregate monetary policy aligns with their regulatory direction (although the focuses and effects of expansionary aggregate monetary policy differ from those of targeted monetary policies), thus requiring examination of policy coordination. Contractionary monetary policy conflicts with their regulatory direction and should avoid overlay implementation to prevent affecting regulatory objectives. On the other hand, from the perspective of the actual policy environment, the sample period coincides with the vigorous development of structural monetary policies. During this period, monetary policy included both expansionary and contractionary measures, but most years were predominantly expansionary. For example, the central bank implemented multiple RRR cuts and interest rate cuts in 2014-2015 against the backdrop of weak global economic recovery; adopted appropriately expansionary policies in 2016 to support supply-side reforms; implemented RRR cuts and interest rate cuts in 2018-2019 to support real economic development under dual pressures of internal deleveraging and external trade friction; and employed interest rate cut measures in 2020-2021 to increase liquidity supply under the impact of COVID-19. This also adds practical motivation for this paper to focus on coordination between expansionary aggregate monetary policies and structural monetary policies.

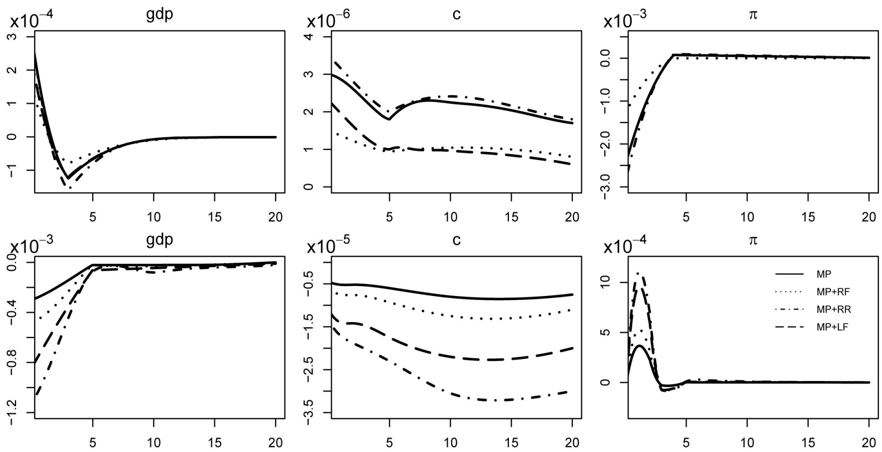

Figure 5. Impulse responses of macro variables under combined expansionary aggregate monetary policy and structural monetary policies.

From the first row results of Figure 5, expansionary aggregate monetary policy stimulates total output and consumption while reducing inflation. Specifically, real GDP shows an initial increase followed by a decrease, while consumption improves significantly. This indicates that interest rate reductions lower financing costs for enterprises, stimulating output and consumption, but simultaneously create some negative effects, such as reduced loan business for small banks and decreased credit availability for SMEs. Inflation shows an initial decrease followed by an increase, indicating that interest rate reductions increase aggregate demand, but price stickiness means the impact on price levels doesn't immediately appear, resulting in lagged inflation increases.

Based on this, all three structural monetary policies affect the effectiveness of traditional monetary policy on aggregate targets. Specifically, the combination of aggregate policy and targeted relending policy shows the smallest amplitude change in impulse responses (dotted line "·" in the figure), while the combination of aggregate policy and targeted RRR cuts shows the largest change amplitude (dash-dot line "·-" in the figure). This indicates that among these three structural monetary policies, targeted relending policy relatively hinders or interferes more with aggregate monetary policy, while targeted RRR cuts relatively hinder or interfere less, even producing synergistic effects that amplify the positive stimulus of aggregate monetary policy on the economy to some extent.

Generally, the impact of structural monetary policy shocks on expansionary aggregate monetary policy shock effects has two sides: On the one hand, structural monetary policies have strong targeted support capabilities for loan business of large (small) banks and SME credit, while simultaneously releasing some liquidity, thus producing synergistic effects with expansionary aggregate monetary policy implementation. But on the other hand, the implementation of structural monetary policies may also negatively affect financing and output of large enterprises, thus hindering the implementation effectiveness of expansionary aggregate monetary policy to some extent.

Regarding the different performances of these three structural monetary policies, this section analyzes the reasons from the following perspective: As mentioned, targeted relending policy directly affects the asset side of small banks, directly influencing their loan volume to SMEs; lending facility policy affects the liability side of large banks, guiding their asset side to some extent; while targeted RRR cut policy indirectly influences small banks' lending decisions by affecting their liquidity. In other words, targeted RRR cut policy and aggregate monetary policy share similarities in operation methods, differing mainly in "targeted" versus "aggregate" aspects. Policy tools like targeted relending that directly affect credit may create greater distortions, thus weakening the role of aggregate monetary policy. Comparatively, lending facilities are more "market-based" than targeted relending, but their relationship with aggregate monetary policy is not as "close" as targeted RRR cuts, thus their actual impact on aggregate monetary policy objectives falls between the two.

5.2. Risk Response Capacity of Structural Monetary Policies

Maintaining stable economic operation while promoting high-quality development is an important task of monetary policy. As a new member of the monetary policy system, structural monetary policies should also emphasize their risk response capacity. From the perspective of coordination between structural and aggregate monetary policies, this section continues to examine the positive or negative impacts of the former on the latter under risk shocks.

According to previous settings, intermediate goods enterprises face identically distributed heterogeneous risk shocks (*i.e.*, the heterogeneous productivity shock $\omega_{J,t}$ in section 2.4, called risk shock here to avoid confusion with TFP shock). Although shock distributions are identical, large enterprises and SMEs differ in assets/liabilities, loan costs, and risk thresholds, leading to heterogeneous responses when facing risk shocks.

This section examines how various monetary policy combinations affect macroeconomic variables under positive risk shocks, with results shown in the second row of **Figure 5**. It can be observed that under risk shocks, output and consumption levels in the economy decrease significantly while inflation remains high, and the implementation of structural monetary policies exacerbates these economic fluctuations. In other words, implementing structural monetary policies on top of aggregate monetary policy regulation not only fails to help maintain economic stability but amplifies risk fluctuations. Specifically, the combination of aggregate monetary policy and targeted RRR cuts most significantly amplifies fluctuations caused by risk shocks, while targeted relending policy has relatively the smallest negative effect.

As mentioned, although large enterprises and SMEs have different sensitivities to risk shocks, both face certain bankruptcy risks under such shocks, resulting in decreased output and consumption. At the commercial bank level, large banks show lower sensitivity to risk shocks due to relatively diversified asset allocation, while small banks significantly reduce credit allocation to SMEs due to excessive risks. In this context, the implementation of structural monetary policies fails to alleviate excessively high risk premiums, thus unable to effectively promote small banks to increase credit allocation. Some measures might even increase the bankruptcy risk of small banks. Therefore, structural monetary policies show negative effects in empirical results.

Overall, the emergence of structural monetary policies has enhanced the targeted regulatory capacity of monetary policy tools. However, if specific targeted regulatory objectives are pursued while ignoring synergistic effects between policies, the ability of aggregate monetary policy to regulate economic cycles may be weakened, causing significant economic fluctuations. Therefore, the coordination between these two types of monetary policies is an issue that cannot be ignored in the future implementation process of structural monetary policies.

6. Analysis of the Impact of Structural Monetary Policies on Economic Stability

The previous section discussed the risk response capacity of structural monetary policies, which falls within the scope of economic stability analysis to some extent. This section will employ welfare analysis methods to deeply examine the impact of structural monetary policies on economic stability. It should be noted that traditional welfare analysis methods focusing primarily on second moments emphasize economic fluctuations, which would be relatively one-sided for analyzing social welfare in transitional economies like China. Therefore, this section follows the approach of [1] by using "economic stability analysis" instead of "welfare analysis" as the research theme.

This section performs a second-order Taylor expansion of the household utility function to obtain the economic fluctuation function (*i.e.*, welfare loss function) [24] [31]:

$$Loss_t = \sum_{t=0}^{\infty} \beta^t \left\{ \left[\frac{1}{2\bar{c}} E_0 \hat{c}_t^2 \right] + \left[\frac{\chi_L \theta_L \bar{l}^{\theta_L - 1}}{2} E_0 \hat{l}_t^2 \right] \right\} \tag{58}$$

where $\bar{c}$ and $\bar{l}$ represent the steady-state values of real consumption and labor, respectively, while $\hat{c}_t$ and $\hat{l}_t$ represent the deviations of consumption and labor from their steady states. Further simplifying the above equation yields:

$$Loss_t = \frac{1}{2}\left[\frac{1}{\bar{c}}V\left(\hat{c}_t\right) + \chi_L \theta_L \bar{l}^{\theta_L - 1} V\left(\hat{l}_t\right)\right] \tag{59}$$

where $V(\cdot)$ denotes the second moment of endogenous variables.

Based on this, this section uses welfare loss as a measure of economic fluctuations to examine the impact of three structural monetary policies—targeted relending, targeted RRR cuts, and lending facilities—on economic stability under different shocks. Specifically, it first examines the difference in economic fluctuations with and without structural monetary policies under expansionary aggregate monetary policy shocks. Second, it investigates the difference in economic fluctuations between combined implementation of structural and aggregate policies versus aggregate policies alone under heterogeneous risk shocks. Finally, it tests changes in economic fluctuations when TFP shocks occur in large enterprises and SMEs separately. Table 4 reports the empirical results.

Table 4. Economic stability analysis.

Shock Scenario		Targeted Relending	Targeted RRR Cuts	Lending Facilities
Baseline test	Economic fluctuation reduction (%)	1.203	0.141	0.255
	Coordination ranking	3	1	2
Positive risk shock	Economic fluctuation reduction (%)	−0.102	−0.725	−0.238
	Coordination ranking	1	3	2
Large enterprise positive TFP shock	Economic fluctuation reduction (%)	−0.010	−0.325	−0.073
	Coordination ranking	1	3	2
SME positive TFP shock	Economic fluctuation reduction (%)	−0.009	−0.194	−0.059
	Coordination ranking	1	3	2

Note: The "economic fluctuation reduction percentage" measures the welfare difference between the simultaneous implementation of traditional monetary policy and structural monetary policy versus implementing traditional monetary policy alone. The "/" in the first row represents the baseline test without other external shocks.

It should be noted that the even-numbered rows in Table 4 are ordered according to the coordination between the aforementioned three structural monetary policies and traditional monetary policies. Coordination refers to the synergistic effect of structural monetary policies on traditional monetary policies. If the goal of traditional monetary policy is to positively stimulate the economy (as in the baseline test in the first row of Table 4), structural policy tools that amplify this effect have strong coordination, while those that hinder it have weak coordination. Similarly, if the goal of traditional monetary policy is to mitigate economic fluctuations caused by other shocks (as in the three exogenous shock scenarios presented in Table 4), structural monetary policies that help reduce fluctuations have strong coordination, while those that increase fluctuations have weak coordination. Additionally, since the economic stability analysis method in this section examines the second-moment fluctuation level of macroeconomic variables, the positivity or negativity of exogenous shocks does not alter the impact of structural monetary policies on economic stability.

From Table 4, it can be observed that in the absence of shocks other than aggregate monetary policy, expansionary aggregate monetary policy positively stimulates the economy, which increases economic fluctuations to some extent. Meanwhile, all three structural monetary policy tools hinder the effectiveness of traditional monetary policy, with targeted RRR cuts having the weakest hindering effect, lending facilities having a moderate effect, and targeted relending having the strongest hindering effect. Therefore, even though the implementation of targeted relending suppresses economic fluctuations to the greatest extent, its coordination ranking remains the lowest. Under positive risk shocks, economic fluctuations cause welfare losses, while traditional aggregate monetary policy helps mitigate fluctuations and maintain economic stability. The three structural monetary policies examined in this section hinder the effectiveness of traditional monetary policy to varying degrees, exacerbating economic fluctuations. Among them, targeted RRR cuts contribute the most to amplifying fluctuations, thus having the poorest coordination, while targeted relending contributes the least to amplifying fluctuations, ranking first in coordination. Similarly, under TFP shocks in large enterprises and SMEs, targeted RRR cuts still contribute the most to amplifying fluctuations, followed by lending facilities, with targeted relending having the smallest amplification effect.

Overall, on the one hand, structural monetary policies such as targeted relending, targeted RRR cuts, and lending facilities, when implemented alongside traditional monetary policies, are detrimental to maintaining economic stability. Therefore, the timing of implementing structural monetary policies should be carefully chosen, and policy tools and transmission channels should be improved to minimize the "collision" between aggregate and structural policies. On the other hand, the selection of structural monetary policies should balance the effectiveness of targeted regulation and the controllability of aggregate impact. For example, when using expansionary monetary policy to stimulate the economy, it should be complemented with relatively market-based structural monetary policies like targeted RRR cuts, while policy tools such as relending that directly affect credit markets should be chosen when facing external risk shocks.

7. Comparison of Structural Monetary Policy Tools

This section introduces policy frontier curve analysis to compare the trade-offs between different policy objectives for three structural monetary policy tools: targeted relending, targeted RRR cuts, and lending facilities [1] [17]. Traditional policy frontier curves primarily depict the relationship between policies and objectives such as output and inflation. However, in transitional economies like China, besides traditional monetary policy objectives like economic growth and price stability, structural objectives such as SME credit financing should also be emphasized. Therefore, this section explores how structural monetary policies trade off between these two types of objectives.

Specifically, this section uses the economic fluctuation function to represent traditional policy objectives, while the proportion of SME loans serves as a measure for targeted regulatory objectives. Based on this, the shock sequences during the sample period are obtained through Bayesian estimation. By jointly implementing traditional monetary policy and structural monetary policy, all possible policy parameters are traversed to obtain the optimal set achievable under different conditions, *i.e.*, the policy frontier curve shown in **Figure 6**.

In **Figure 6**, the horizontal axis represents the improvement in credit structure, measured here by the increment in the proportion of SME loans (the difference between implementing structural monetary policy and not implementing it, on the basis of expansionary aggregate monetary policy). The vertical axis represents the enhancement of economic stability, measured by the increment in the economic fluctuation function constructed in the previous section (the welfare difference between implementing structural monetary policy and not implementing it, on the basis of expansionary aggregate monetary policy). Considering that the structural monetary policies examined in this paper all exacerbate fluctuations and reduce economic stability, the vertical axis in **Figure 6** is below the zero mark, and values closer to zero indicate that the policy is more "conducive" to maintaining economic stability (*i.e.*, causing less "damage" to economic stability). Among the three curves, the solid line represents targeted relending policy, the dotted line ("·") represents targeted RRR cut policy, and the dashed line ("-") represents lending facility policy. These three structural tools are implemented jointly with aggregate monetary policy, with shock sequences set, and the minimal "damage" to economic stability achievable by each structural policy tool under different credit structures is plotted.

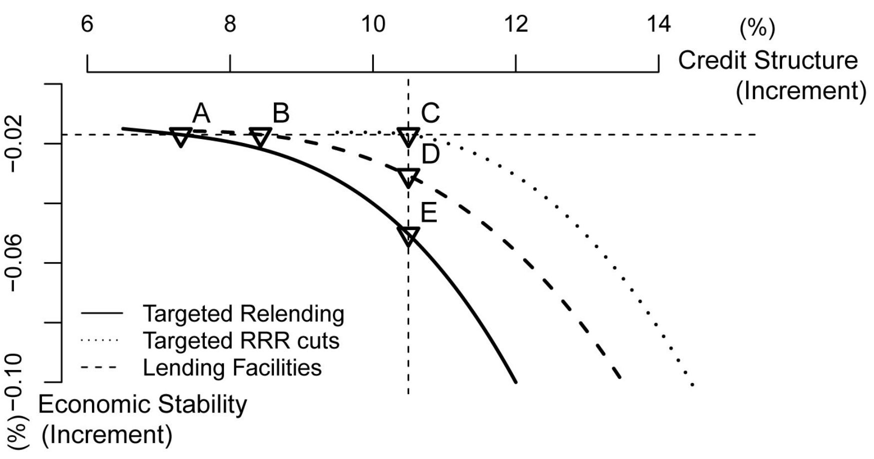

Figure 6. Policy frontier curves of structural monetary policies.

From **Figure 6**, it can be observed that the policy frontier curves of all three structural monetary policies slope downward to the right, indicating that if these policy tools choose to improve credit structure, they will inevitably reduce economic stability, and vice versa. Simultaneously, from left to right, each curve becomes steeper, indicating that the negative slope gradually decreases. Specifically, when the central bank prefers to improve credit structure, *i.e.*, sets higher targets for the latter (observe the right side of the figure), even sacrificing more economic stability can only slightly increase the SME proportion. Conversely, when the central bank prefers to maintain economic stability and reduce the negative impact of structural monetary policies (observe the left side of the figure), even making significant concessions in promoting SME financing cannot markedly enhance economic stability.

If we horizontally compare the effectiveness of these three structural monetary policies, it can be evaluated from two dimensions: On the one hand, from a geometric perspective, the ABC line shows that when achieving the same level of economic stability, targeted RRR cut policy can achieve the highest proportion of SME loans, followed by lending facilities, and targeted relending has the lowest. The CDE line indicates that when achieving the same level of credit structure, targeted RRR cut policy has the smallest negative impact on economic stability, followed by lending facilities, and targeted relending still ranks last, *i.e.*, has the largest negative impact. Therefore, targeted RRR cut policy is the most effective. On the other hand, from the perspective of marginal rate of substitution, the absolute value of the slope at point A on the ABC line is the largest, followed by points B and C (with little difference between them), indicating that when the central bank primarily focuses on economic stability objectives, targeted relending policy requires the smallest "sacrifice" in terms of SME credit structure, thus being most beneficial for the central bank's macro-control. On the CDE line, the absolute value of the slope at point E is the largest, followed by point D, and point C has the smallest, indicating that when the central bank focuses on SME credit objectives, targeted RRR cut policy is most conducive to central bank operations, requiring the least "sacrifice" in economic stability.

In summary, when implementing structural monetary policies, the central bank must make certain trade-offs between structural objectives and economic stability objectives. When higher demands are placed on one objective, greater concessions must be made on the other objective. Comparing the differences in effectiveness among targeted relending, targeted RRR cuts, and lending facilities, it can be found that targeted RRR cut policy is currently the relatively optimal choice, performing best in achieving both structural objectives and economic stability objectives. Targeted relending policy has certain comparative advantages and is more beneficial for the central bank's macro-control when the central bank primarily focuses on economic stability objectives.

To verify that the core policy ranking conclusion of this study is not dependent on the preprocessing methods of observable variables, this paper designs three alternative preprocessing schemes. Keeping other model settings and parameter estimation results unchanged, Bayesian estimation and policy frontier curve analysis are re-conducted to test whether the validity ranking of policy tools changes. The three alternative preprocessing schemes are: 1) only conducting X12 multiplicative seasonal adjustment on non-interest variables without HP filter detrending; 2) replacing the one-sided HP filter with a two-sided HP filter ($\lambda = 1600$) while retaining X12 multiplicative seasonal adjustment; 3) conducting X12 multiplicative seasonal adjustment plus one-sided HP filter on all variables (including the reserve requirement rate).

The results of the robustness test show that under the three alternative preprocessing schemes, although there are minor numerical fluctuations in the Bayesian estimated parameters of the model, the validity ranking of the three types of structural monetary policy tools remains unchanged, with targeted RRR cuts performing the best, followed by lending facilities and then targeted relending, and the relative positions of the policy frontier curves also show no significant changes. This indicates that the core conclusions of this study are not driven by the specific preprocessing methods of observable variables and are robust under different time series processing norms.

8. Conclusions

This paper constructs an NK-DSGE model incorporating heterogeneous enterprises and banking sectors to examine the performance of credit financing and output for large enterprises and SMEs under various structural monetary policies. To ensure the model aligns with China's economic reality, parameter calibration and estimation strictly reference relevant economic data, enhancing the model's practicality. Based on this, the paper compares and examines the similarities and differences in the implementation effects of three structural monetary policies—targeted relending, targeted RRR cuts, and lending facilities—versus traditional aggregate monetary policies, drawing the following conclusions: On the one hand, structural monetary policy tools can effectively channel more funds to SMEs, thereby reducing their financing costs; on the other hand, compared to aggregate monetary policies, structural monetary policies demonstrate higher targeted regulation capacity and lower latency.

Secondly, this paper investigates the impact of implementing structural monetary policies on traditional aggregate monetary policy objectives. Here, the implementation effect of aggregate monetary policy shocks serves as the benchmark result, comparing the effects of combining aggregate policies with different types of structural policies. It can be observed that the positive stimulative effect of aggregate monetary policies on the economy is weakened by structural monetary policies. Among the three structural monetary policies examined, targeted relending has the most significant weakening effect, followed by lending facilities, while targeted RRR cuts have the smallest effect. Simultaneously, this paper tests the effects of combining different structural policies with aggregate policies under heterogeneous risk shocks. The results show that all three structural monetary policies amplify the impact on key macro-regulation objectives such as output, consumption, and inflation to varying degrees, with targeted RRR cuts having the strongest amplification effect and targeted relending the weakest. Overall, maintaining economic stability is one of the primary objectives of aggregate monetary policies, while structural monetary policies excel in targeted regulation and promoting industrial structure upgrading. Although the latter is not yet "perfect", as the central bank gradually improves policy practice and flexibly coordinates the timing and intensity of both types of monetary policies, the conflict between "stabilizing the economy" and "adjusting structure" objectives will be effectively alleviated.

Thirdly, this paper constructs a welfare loss function to examine the impact of structural monetary policies on economic stability. By setting different exogenous shocks and comparing the contribution of three structural monetary policies to reducing economic fluctuations, their coordination with traditional aggregate monetary policies is ranked. The results indicate that targeted RRR cuts have the strongest amplification effect on exogenous shocks and the poorest coordination with aggregate monetary policies. Therefore, conflicts in implementation timing with aggregate policies should be avoided to reduce economic instability.

Finally, this paper investigates the relationship between structural monetary policies' targeted regulation objectives and economic stability objectives, while horizontally comparing the effectiveness of targeted relending, targeted RRR cuts, and lending facilities. The results show that when implementing structural monetary policies, the central bank must make certain trade-offs between targeted regulation (e.g., the SME loan proportion indicator focused on in this paper) and maintaining economic stability. Among these, targeted RRR cuts perform optimally in achieving both structural objectives and aggregate economic stability objectives, making them the most effective structural monetary policy currently. Targeted relending, however, has certain comparative advantages and performs better when the central bank primarily focuses on economic stability objectives.

This paper examines the effectiveness of structural monetary policies in both theory and practice, providing important reference significance. As a targeted regulation tool, structural monetary policies have a targeted improving effect on SME credit financing, offering policymakers an effective means to achieve their structural regulation objectives. By increasing SME credit scale and reducing their credit financing costs, structural monetary policies can effectively promote the development of SMEs, providing a solid foundation for economic growth and job creation.

Based on the aforementioned conclusions, this paper proposes the following policy recommendations:

First, the central bank should continuously enhance the precision and flexibility of structural monetary policies. On the one hand, through advanced technological means and mature mechanism design, ensure funds are accurately directed to target groups (e.g., SMEs), thereby reducing arbitrage and rent-seeking opportunities. On the other hand, adjust the scale and direction of structural monetary policies according to market demand, particularly increasing support for SMEs during economic downturns.

Second, when implementing structural monetary policies, close attention should be paid to their impact on aggregate monetary policy objectives (e.g., inflation, economic growth rate), avoiding policy conflicts and ensuring macroeconomic stability. As a "precision tool" for regulation like structural monetary policies, only through careful coordination with other policies can economic and financial stability be maintained while achieving specific economic objectives.

Finally, efforts should be made to actively promote financial infrastructure construction to improve the effectiveness of structural monetary policies. On the one hand, improve the credit system for SMEs to enhance information transparency, thereby reducing information acquisition costs for financial institutions. On the other hand, leverage fintech means to enhance monetary policy transmission efficiency and launch financial service products that meet the development needs of SMEs.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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