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Structural Monetary Policy and Heterogeneous Enterprise Leverage Ratio—Based on the Perspective of Soft Budget Constraints

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Abstract:

By constructing a dynamic stochastic general equilibrium model that includes soft budget constraints and financial accelerators, it explores the impact of "hardened" soft budget constraints on the economy and the differences in the response effects of different monetary policies. The study found that: First, weakening the soft budget constraint can alleviate the structural high leverage problem and reduce the distortion of the economy, but at the cost of a decline in total output. When the economy encounters a risk shock, the existence of soft budget constraints can calm economic fluctuations, but hinder the normal clearing of the market, causing a series of problems such as overcapacity and rising inventories. Second, the “one size fits all” tight monetary policy will not only fail to reduce the leverage ratio, but will also further increase the leverage ratio and exacerbate the degree of distortion of the economic structure. In contrast, structural monetary policies such as targeted adjustment of the reserve ratio are a better choice to deal with structurally high leverage in an economy. Third, monetary policy responds to the leverage ratio of non-financial enterprises (especially the leverage ratio of state-owned enterprises) to help reduce welfare losses.

Keywords*: Soft budget constraints, Monetary policy, Structural deleveraging, DSGE*

I. INTRODUCTION

Since the financial crisis in 2008, the Chinese government has adopted an unprecedented fiscal stimulus plan to offset the credit crunch and maintain economic activity, which has effectively stabilized the Chinese economy in a short period of time, but has also led to a rapid increase in the leverage ratio of non-financial enterprises and a continuous accumulation of financial risks. According to the statistics of the Research Center for National Balance Sheet, the leverage ratio of non-financial enterprises in China was 146.9% in the first quarter of 2015, far exceeding the risk threshold of leverage ratio of non-financial enterprises in emerging market countries by 90% [1]. Too much corporate debt has become an important obstacle to China's economic transformation. Although China's macro leverage ratio has gradually stabilized with the implementation of the deleveraging policy, there is still a structural leverage problem. State-owned enterprises are still areas with high leverage, while private enterprises are still facing

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problems such as high financing cost and difficulty in financing [2]. Structural high leverage also makes the decision-makers realize the importance of structural deleveraging. In April, 2018, the Central Financial and Economic Committee put forward the basic idea of structural deleveraging for the first time, requiring that departments and types of debts should be distinguished and different measures should be taken to de-leverage. Since then, the policy of de-leveraging has shifted from an aggregate policy to a more precise structural policy.

The differentiation and difference of leverage ratio between state-owned and private enterprises may be related to China's dual economic structure and soft budget constraints of state-owned enterprises. Different from the western deficit financing stimulus plan, China's large-scale stimulus plan mainly comes from bank credit. Banks tend to provide loans to state-owned enterprises because of their policy priorities and explicit or implicit government guarantees. Zhang et al. (2015) made a counterfactual study based on enterprise financial model, and found that if there is no government guarantee, its borrowing would be much smaller [3]. Unbalanced leverage is the result of inefficient allocation of credit resources, which will inhibit economic vitality and become an obstacle to China's economic transformation. Therefore, it is inevitable to study the leverage ratio of Chinese enterprises and make classified policies.

The existing research mainly focuses on the formation mechanism and influence of soft budget constraint [4, 5], also embedded the soft budget constraint into the dynamic stochastic general equilibrium model to analyze the market, interest rate, leverage ratio, total factor productivity or policy [6-9], but seldom on the quantitative analysis of the economic changes after weakening the soft budget constraint. At the same time, most domestic literatures pay attention to the typical facts of China's structural high leverage, and the policy analysis is only limited to the traditional aggregate monetary policy or fiscal policy. In order to further clarify the economic distortion caused by soft budget constraints and identify the impact of various policies on structural high leverage, the possible marginal contributions in this paper are as follows: 1. In this paper, a dynamic stochastic general equilibrium (DSGE) model with heterogeneous enterprises is constructed, which numerically simulates the influence of major economic and financial variables such as output, enterprise leverage ratio and interest rate when the proportion of government guarantee decreases, and analyzes whether weakening the soft budget constraint can alleviate the structural leverage problem in the economy. On this basis, the influence of major financial and economic variables in the economy is analyzed by adjusting parameters when the scope of government guarantee expands and the economy encounters risk impact. 2. From the perspective of enterprise leverage ratio and economic structure, the effects of aggregate monetary policy and structural monetary policy are analyzed, as well as the changes of monetary policy effects under different economic structures. 3. The leverage ratio of non-financial enterprises is introduced into Taylor rule, and whether the central bank's monetary rules need to respond to the leverage ratio of non-financial enterprises is analyzed from the perspective of welfare loss, which provides some reference for the formulation of central bank's monetary rules.

The remaining structure of this paper is arranged as follows: In the second part, the existing relevant literature is sorted out and summarized; In the third part, empirical facts are analyzed; In the fourth part, the dynamic stochastic general equilibrium model is constructed; In the fifth part, the existing research is

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used to calibrate the parameters in the model; In the sixth part, based on DSGE model, numerical simulation and counterfactual analysis are carried out by means of parameter adjustment, etc.; In the seventh part, conclusions and specific policy recommendations are given.

II. LITERATURE REVIEW

2.1 The Impact of High Leverage

Experiences have proved that an appropriate leverage ratio in an economy can promote investment and economic growth. However, the rapid increase in leverage ratio will bring a series of negative effects. There is a nonlinear relationship between leverage ratio and economic growth [10]. Schularlick et al. (2012) believed that the credit boom and the rapid growth of leverage ratio will create hidden dangers for the occurrence of systemic financial risks [10]. Reinhart et al. (2010) also believed that leverage ratio is closely related to systemic financial risk, and further proposed the leverage threshold criteria applicable to developed countries and emerging market countries, and held that once the leverage ratio of economies exceeds this threshold, the probability of systemic financial risk in economies will be significantly increased [11]. Maliewskiw et al. (2016) found that 38 economies experienced financial crisis, economic downturn, or both by analyzing 43 economies whose macro leverage ratio increased by more than 30 percentage points in 5 years [12]. Meanwhile, Maliszewskiw et al. (2016) warned that if the credit boom lasted more than six years and started at a higher financial depth, the probability of a crisis would increase, and China met this criterion [12].

2.2 The Impact of Macro Policy and Leverage Ratio

In view of the great harm of high leverage to the financial system, scholars have made detailed studies on deleveraging. Wang Yong et al. (2018) found that tightening interest rates by the central bank will reduce the leverage ratio of state-owned enterprises and increase the leverage ratio of private enterprises, which can alleviate the structural leverage problem in China by establishing a dynamic stochastic general equilibrium model with embedded balance sheet recession mechanism and enterprise heterogeneity mechanism from the perspective of vertical industries [13]. Some scholars also believed that because of financial friction and the existence of implicit government guarantee, the tight monetary policy will have a greater negative impact on private enterprises than the state-owned enterprises with high leverage. Therefore, the tight monetary policy will not only fail to solve the problem of high leverage of state-owned enterprises, but also significantly increase the financing cost of private enterprises, making the real manufacturing industry "worse" and aggravating the distortion of economic institutions [14]. Liu Xiaoguang and Zhang Jieping (2016) found that the tight monetary policy can not effectively reduce the leverage ratio, but will worsen the economic environment and further increase the leverage ratio by amending the BGG financial accelerator model [15].

Besides, some scholars have analyzed the mechanism of fiscal policy's influence on leverage ratio. Eggertsson et al. (2012) believed that deleveraging shock will tighten the debtor's debt constraints,

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resulting in the termination of Ricardian equivalence, which would significantly improve the effectiveness of fiscal policy at this time [16]. Although the government's deleveraging policy can reduce the risk of financial shocks to the economy, it may increase the downward pressure on the economy, so the government has a trade-off between "deleveraging" and "steady growth". In addition, it is difficult for the traditional monetary policy to achieve the precise adjustment of "steady growth" and "deleveraging" [17]. Lyu Wei et al. (2016) found that the two goals of "steady growth" and "deleveraging" can be achieved by controlling the leverage ratio of state-owned enterprises, optimizing the structure of fiscal expenditure, and implementing a proactive fiscal policy focusing on indemnificatory expenditure [18]. Zhou Fei et al. (2019) believed through analysis that fiscal policy can more effectively regulate the structural high-leverage problem in the economy compared with monetary policy [19].

2.3 The Mechanism of Budget Soft Constraint

Enterprises with soft budget constraints are often able to obtain a large amount of credit resources at a lower financing cost due to the loose credit constraints (Lin Yifu and Li Zhiyun, 2004) [4]. At the same time, due to a certain degree of government backing, that is, the government will provide assistance even if the enterprise is not well managed, which easily breeds the negative management psychology of the management (Research Group of the Business Management Department of the People's Bank of China, 2017) [20], and finally causes inefficient enterprises to occupy a large number of production resources [5]. Historical experience has proved that the continuous injection of credit resources into inefficient enterprises will lead to an increase in the proportion of bad debts and uncollectibles of banks, which will bring heavy pressure on the banking system [21]. At the same time, the excessive concentration of resources in inefficient state-owned enterprises will inhibit economic vitality and the economic transformation will be sluggish [14].

At the same time, the lack of sensitivity of enterprises to investment, interest rates and other factors under the implicit government guarantee will hinder the transmission mechanism of monetary policy. Soft budget constraints lead to different credit constraints for state-owned enterprises and private enterprises, that state-owned enterprises often get bank external financing at a much lower loan interest rate than private enterprises. Such an asymmetry in the development of the financial system leads to low efficiency in the allocation of credit resources and poor transmission of monetary policy [22]. Given that some state-owned enterprises have easier access to formal financing such as bank credit and bond issuance and may also participate in credit intermediation activities, this has led to the rise of credit intermediation chains, making monetary policy formulation more difficult [3].

Some researchers hold a positive attitude towards the soft budget constraint, believed that government guarantees can improve social welfare and the risk profile of banks and sovereign debt [23, 24], but more called for the elimination of soft budget constraints to ease distortions, such as promoting interest rate liberalization, reducing the difference in financing costs between state-owned and private enterprises to improve the allocation of credit resources [9], deepening the reform of state-owned enterprises and implementing a deposit insurance system [25].

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2.4 Structural Characteristics of Soft Budget Constraint and Leverage Ratio

China's non-financial enterprise leverage ratio presents the dual characteristics of quantity and structure, specifically manifested as the rising trend of the leverage ratio of state-owned enterprises, the decline of the leverage ratio of private enterprises, and the significant leverage imbalance [26]. The problem of structural high leverage may be related to the implicit guarantee of the government to the state-owned enterprises. Constrained by the underdeveloped direct financing market in China, enterprises generally use bank loans to achieve external financing, while the flow of credit resources in the credit market is often subject to government intervention, that is, the state-owned enterprises in implicit government guarantee can access bank loans at a price lower than that of private enterprises [3]. State-owned enterprises have natural political connections. For example, local governments may disclose internal information to them out of their own interests, reducing the economic uncertainty they face, which will enable state-owned enterprises to obtain bank loans when the economic uncertainty is strong [26]. At the same time, in the case of economic downturn, the rise in risk aversion will also cause a large flow of financial resources to state-owned enterprises, and ultimately increase the leverage ratio of state-owned enterprises [27], resulting in and exacerbating the structural high leverage problem.

III. EMPIRICAL FACT ANALYSIS

Under the impact of the global sub-prime crisis in 2008, Chinese government adopted a large-scale fiscal stimulus plan to avoid a "hard landing" of the economy. As shown in Fig. 1, the year-on-year growth rate of M2 currency in China has increased rapidly since 2008, reaching the highest point in history in the third quarter of 2009. The leverage ratio of non-financial enterprises has risen rapidly under the large-scale fiscal stimulus plan. According to the statistics of the National Balance Sheet Research Center, the leverage ratio of China's non-financial enterprises reached 162.3% in December 2020, which was 64.6 percentage points higher than the 97.7% in the first quarter of 2008 in the past 13 years, far exceeding the risk threshold of leverage ratio (90%) in emerging market economies and posing a huge hidden danger to China's financial system.

Recognizing the harmfulness of high leverage to the economic system, the Central Economic Work Conference in December 2015 put forward a request for deleveraging. Its M2 growth rate began to decrease year by year, but the leverage rate of non-financial enterprises showed an upward trend, which is called the leverage rate paradox [15]. Simultaneously, the structural characteristics of leverage ratio of non-financial enterprises in China were obvious. As shown in Fig. 2: From 2008 to 2013, the leverage ratio of private enterprises continued to decline, while that of state-owned enterprises showed a significant upward trend. After 2014, the leverage ratio of state-owned enterprises decreased, but the absolute level of their leverage ratio was still higher than that of private enterprises.

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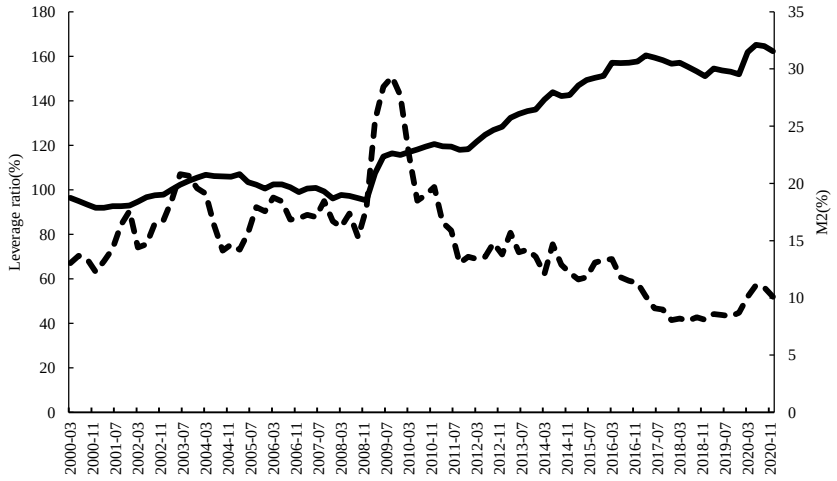

Fig. 1 Leverage ratio and money supply of non-financial enterprises

Fig. 2 Leverage ratio of state-owned and private enterprises

To demonstrate empirically the impact of monetary policy on corporate leverage ratio and the property rights characteristics of leverage ratio, the following measurement model is set up in this paper:

$$Leverage_{it} = \alpha + \beta_1 Police_t + \beta_2 Soe_{\text{it}} + \beta_i Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

Where, i = the enterprise; t =the year; $Leverage_{it}$ = the leverage ratio of enterprise i in t period, expressed by the ratio of total liabilities to total assets of the enterprise; $Police_t$ =the proxy variable of aggregate monetary policy, expressed by M2 year-on-year growth rate; β_1 = the estimated coefficient of $Police_t$, and significantly negative β_1 means that reducing the growth rate of money supply will increase

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the leverage ratio instead. Soe_{it} =the nature of enterprise property rights (1 for state-owned enterprises and 0 for others). $Control_{it}$ =the control variables, including grow (increase rate of sales revenue), Roa (return on total assets), TobinQ (Tobin Q), ind (corporate independence, measured by the proportion of independent directors), Flow (corporate liquidity, expressed by the proportion of cash flows generated from operating activities to total assets) and PFA (proportion of fixed assets), which are selected as with reference to the existing literature; β_i = the fitting parameters of each control variable. μ_i =the individual fixed effect of the enterprise; δ_t =the time fixed effect of the enterprise.

In view of the continuity and availability of data, the data of A-share listed companies from 2008 to 2019 were selected as the research samples. In order to ensure the reliability of the data, the samples of ST, *ST, real estate and financial listed companies were excluded. At the same time, in order to avoid the influence of extreme values, all continuous variables were winsorized by 1% on both sides. Data were collected from CSMAR, Wind and China Statistical Yearbook which were all annually.

TABLE I. Descriptive statistics

Name	N	mean	sd	min	max
Leverage	25,389	0.428	0.207	0.0525	0.946
police	25,390	12.92	4.528	8.275	26.50
grow	25,378	0.190	0.452	-0.549	3.051
Roa	25,378	0.0428	0.0624	-0.224	0.229
TobinQ	25,313	2.116	1.883	0.185	10.81
ind	25,310	0.374	0.0533	0.333	0.571
PFA	25,389	0.235	0.167	0.00366	0.728
Soe	25,390	0.386	0.487	0	1
Flow	25,389	0.0484	0.0693	-0.157	0.245

Column 1 of TABLE II shows the regression results of the benchmark model. The year-on-year growth rate of money supply was significantly negative at 1%, indicating that the central bank's tight monetary policy will not only fail to achieve the goal of deleveraging, but also further increase the leverage ratio. The property rights of enterprises are significantly positive at 1%, and the leverage ratio shows obvious property rights characteristics. Banks prefer to lend to state-owned enterprises, which may have relatively low loan default rate due to the implicit government guarantee.

To test the reliability of the empirical results, the following robustness tests were made: (1) Due to the economic particularity of the municipalities directly under the central government in China, the samples of enterprises in Beijing, Tianjin, Shanghai and Chongqing were deleted, and the remaining enterprises were re-estimated. (2) To avoid the estimation bias caused by the financial crisis, the sample interval of 2008-2010 was deleted and the remaining sample interval of 2011-2019 was re-estimated. The robustness

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results are shown in columns 2 and 3 of TABLE II. The regression results are basically consistent with the benchmark regression results, and the conclusion is robust.

TABLE II. Regression results of econometric model

Name	leverage	leverage	leverage
police1	-0.002***	-0.002***	-0.004***
	(-4.61)	(-4.64)	(-7.87)
soe	0.033***	0.029***	0.040***
	(8.28)	(6.36)	(9.30)
Control	YES	YES	YES
R-squared	0.143	0.1478	0.145
Company FE	YES	YES	YES
Year FE	YES	YES	YES

IV. CONSTRUCTION OF THEORETICAL MODEL

In the previous section, empirical data were used to analyze the impact of aggregate monetary policy on leverage ratio and the property rights characteristics of leverage ratio. However, empirical analysis fails to show the impact of monetary policy on the leverage ratio and transmission mechanism of different enterprises. In order to clarify the problem of leverage differentiation caused by soft budget constraints and comprehensively analyze the mechanism and response effect of monetary policy on corporate leverage and economic structure changes, in this section, by referring to Bernanke et al. (1999), Ma Jiajin (2018), Yin Xingshan et al. (2020), a dynamic stochastic general equilibrium (DSGE) model involving households, enterprises, commercial banks, the central bank and the government was constructed [28-30]. The households hold bank deposits from which they earn interest, provide labor to entrepreneurs and earn wage income, as well as dividend payments from the manufacturer sector. The banks are fully competitive, requiring a deposit reserve to be paid to the central bank after accepting a deposit from the households, with the remainder being lent to the corporate sector in need of funds. Due to the information asymmetry between banks and enterprises, there is a risk of default in corporate loans. The corporate sector is divided into state-owned enterprises (soft budget-constrained enterprises) and private enterprises (budget-constrained enterprises), which obtain loans from banks for financing, employ non-differentiated labor from households, purchase capital goods from capital producers for product production. Capital goods producers use the remaining capital of the previous period after depreciation and the current investment for capital goods production. The final goods manufacturers and intermediate goods manufacturers are set to introduce price stickiness, and government departments and central bank departments formulate relevant policies based on the current operating conditions of the economy to maintain the stable development of the economy.

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4.1 Households

$$max\, E_0 \sum_{t=0}^{\infty} \beta^t \left\{ log\, C_t - \theta \frac{N_t^{1+\chi}}{1+\chi} \right\} \tag{2}$$

C_t, N_t and D_t represent consumption, labor and saving respectively, the households maximize their utility function under budget constraint (3):

$$P_t C_t + D_t = W_t N_t + R_{t-1}^d D_{t-1} + \Pi_t - P_t T_t \tag{3}$$

Where, P_t, W_t, R_t^d,and T_t respectively represent the price of consumer goods, the nominal wage of labor, the principal and interest rate of savings, and the transfer payment of corporate dividends, and the taxable to the government in one lump sum. The households select C_t , N_t , and D_t to maximize their own utilities. If $w_t = \frac{W_t}{P_t}, \pi_t = \frac{P_t}{P_{t-1}}$, the first-order conditions are

$$\theta N_t^{\chi} = \frac{1}{C_t} w_t \tag{4}$$

$$\frac{1}{C_t} = \beta E_t \frac{1}{C_{t+1}} \frac{R_t^D}{\pi_{t+1}} \tag{5}$$

4.2 Capital Goods Producer

To internalize the price of capital goods, capital goods producers were introduced into the model. At the end of t period, capital goods producers buy a certain amount of products from final goods producers as investment I_t and combine them with the depreciated capital $(1-\delta)K_t$ of state-owned enterprises and private enterprises to produce capital goods K_{t+1} which can be used in the next period and sold to state-owned enterprises and private enterprises in the capital market. The movement equation of its capital is:

$$K_{t+1} = (1-\delta)K_t + \left[1 - \frac{\phi}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2\right] I_t \tag{6}$$

Thus, the profit function of capital goods producers is:

$$\Pi_t^k = Q_t K_{t+1} - Q_t(1-\delta)K_t - P_t I_t \tag{7}$$

The capital producers choose to invest the quantity of ty to maximize their profit function:

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$$max\, E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left\{ Q_t \left[1 - \frac{\phi}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right] I_t - P_t I_t \right\} \tag{8}$$

By calculating the partial derivative of investment I_t in the formula and making $q_t = Q_t / P_t$, get the first-order condition:

$$1 = q_t \left[1 - \frac{\phi}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 - \phi \left(\frac{I_t}{I_{t-1}} - 1 \right) \frac{I_t}{I_{t-1}} \right] + \beta E_t \frac{C_t}{C_{t+1}} q_{t+1} \phi \left(\frac{I_{t+1}}{I_t} - 1 \right) \left(\frac{I_{t+1}}{I_t} \right)^2 \tag{9}$$

4.3 State-owned Enterprises

State-owned enterprises are divided into consumer goods manufacturers L and entrepreneurs L. The production department L is responsible for hiring labor and purchasing production materials from capital goods manufacturers to produce consumer goods, and the entrepreneurs L are responsible for applying for loans from banks. The production function of department L of state-owned consumer goods manufacturers is: $Y_{L.t} = A_{L,t} K_{L,t}^{\alpha} L_{L,t}^{1-\alpha}$, and the production objective function of state-owned consumer goods manufacturers is:

$$max\, \Pi_{L,t}^{y} = P_t A_{L,t} K_{L,t}^{\alpha} L_{L,t}^{1-\alpha} - W_{L,t} N_{L,t} - R_{L,t}^{K} K_{L,t} \tag{10}$$

By calculating the partial derivative of capital $K_{L,t}$ and labor $N_{L,t}$ in the objective function and making $r_{L,t}^{K} = R_{L,t}^{K} / P_t, w_t = W_{L,t} / P_t$, get the first-order conditions: $r_{L,t}^{K} = \alpha A_{L,t} K_{L,t}^{\alpha-1} N_{L,t}^{1-\alpha}$, $w_{L,t} = (1-\alpha) A_{L,t} K_{L,t}^{\alpha} N_{L,t}^{-\alpha}$. Entrepreneur L is responsible for applying for a loan from the bank for financing. At the end of t, entrepreneur L borrows a loan L_t from the bank, and the consumer goods manufacturer department uses its own capital V_t and the loan to purchase the means of production K_{t+1} from the capital goods manufacturer at the price of Q_t. Thus, $Q_t K_{L,t+1} = L_{L,t} + V_{L,t}$, and the leverage ratio of entrepreneurs L is defined as $l_{L,t} = Q_t K_{L,t+1} / V_{L,t}$. If $q_t = Q_t / P_t, v_{L,t} = V_{L,t} / P_t$, and $l_{l,t} = q_t K_{L,t+1} / v_{L,t}$, the entrepreneurs will suffer an exogenous risk impact ω_{t+1} in $t+1$period, which will increase or decrease their capital goods $K_{L,t+1} \cdot \omega_{t+1}$ obeys lognormal distribution with the mean value of 1, and its cumulative distribution function is $F_t(\omega_{t+1})$. At the beginning of $t+1$period, the entrepreneurs lease the capital goods $\omega_{t+1} K_{L,t+1}$ to the state-owned enterprise consumer goods producer L at the price of $R_{L,t+1}^{K}$, and sell the depreciated capital goods $\omega_{t+1}(1-\delta) K_{L,t+1}$ back to the capital goods producer at the price of Q_{t+1} at the end of the period, so the total income of entrepreneurs L can be expressed as:

$$\omega_{t+1} \left[R_{L,t+1}^{K} K_{L,t+1} + Q_{t+1}(1-\delta) K_{L,t+1} \right] = \omega_{t+1} R_{L,t+1}^{e} Q_t K_{L,t+1} \tag{11}$$

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$$R_{L,t+1}^{e}=\frac{R_{L,t+1}^{K}+Q_{t+1}(1-\delta)}{Q_t}=\frac{r_{L,t+1}^{K}+q_t(1-\delta)}{q_t} \tag{12}$$

Because the state-owned enterprises bear more social responsibilities, they are entitled to implicit government guarantee. During the $t+1$ period, the government guarantee fund is $t+1$ with a guarantee proportion of $b_{t+1}=B_{t+1}/(R_{L,t+1}^{e}Q_tK_{t+1})$, and the critical value of exogenous risk impact is defined as $\overline{\omega}_{L.t+1}$ to make it meet the following critical condition:

$$B_{t+1}+\overline{\omega}_{L,t+1}R_{L,t+1}^{e}Q_tK_{t+1}=R_{L,t}^{l}L_{L,t} \tag{13}$$

If the heterogeneous impact $\omega_{t+1}<\overline{\omega}_{L,t+1}$, the state-owned enterprises will go bankrupt if they are insolvent; When $\omega_{t+1}>\overline{\omega}_{L,t+1}$, the enterprise will be able to repay the loan principal and interest upon successful operation. If both sides of the above formula are divided by $V_{L,t}$ simultaneously, the following can be obtained:

$$\left(b_{t+1}+\overline{\omega}_{L,t+1}\right)R_{L,t+1}^{e}l_{L,t}=R_{L,t}^{l}\left(l_{L,t}-1\right) \tag{14}$$

Bank L is required to pay the required reserve after accepting a portion of household deposits. Therefore, the behavior equation of bank L is:

$$\begin{aligned}\int_{\overline{\omega}_{L,t+1}}^{\infty}R_{L,t}^{l}L_{L,t}dF_{L,t}(\omega)+\int_{0}^{\overline{\omega}_{L,t+1}}\left[B_{t+1}+(1-\mu)\omega R_{L,t+1}^{e}Q_tK_{L,t+1}\right]dF_{L,t}(\omega)\\=(1-\tau_{L,t})^{-1}R_t^{D}L_{L,t}-(1-\tau_{L,t})^{-1}\tau_{L,t}L_{L,t}R_{L,t}^{\tau}\end{aligned} \tag{15}$$

Where, μ represents the proportion of supervision cost that the bank will have to pay when the entrepreneur goes bankrupt. $\tau_{s,t}$ and $R_{L,t}^{\tau}$ represent the proportion of deposit reserve that the bank L pays to the central bank and the sum of its principal and interest respectively. If both sides of the above formula are divided by $V_{L,t}$ at the same time, the following can be obtained:

$$\left[b_{t+1}+\Gamma_{L,t}(\overline{\omega}_{L,t+1})-\mu G_{L,t}(\overline{\omega}_{L,t+1})\right]R_{L,t+1}^{e}l_{L,t}=R_{L,t}^{mix}\left(l_{L,t}-1\right) \tag{16}$$

Where, $\Gamma_{L,t}(\overline{\omega}_{L,t+1})=\overline{\omega}_{L,t+1}\left[1-F_{L,t}(\overline{\omega}_{L,t+1})\right]+G_{L,t}(\overline{\omega}_{L,t+1})$, $G_{L,t}(\overline{\omega}_{L,t+1})=\int_{0}^{\overline{\omega}_{L,t+1}}\omega dF_{L,t}(\omega)$, $R_{L,t}^{mix}=(1-\tau_{L,t})^{-1}R_t^{D}-(1-\tau_{L,t})^{-1}\tau_{L,t}R_{L,t}^{\tau}$, .Because state-owned enterprises have implicit guarantees from the government, the expected profit function of state-owned enterprises is:

$$E_t\Pi_{t+1}^{e}=E_t\left\{\int_{\overline{\omega}_{L,t+1}}^{\infty}[\omega R_{L,t+1}^{e}Q_tK_{L,t+1}-R_{L,t}^{l}L_{L,t}]dF_{L,t}(\omega)-F_{L,t}(\overline{\omega}_{L,t+1})B_{t+1}\right\} \tag{17}$$

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$$s.t.\ l_{L,t} = \frac{1}{1 - \frac{R^e_{L,t+1}}{R^{mix}_{L,t}}[b_{t+1} + \Gamma_{L,t}(\overline{\omega}_{L,t+1}) - \mu G_{L,t}(\overline{\omega}_{L,t+1})]} \tag{18}$$

After calculating the partial derivative of $\overline{\omega}_{L,t+1}$, the first-order condition is

$$\frac{1 - F_{L,t}(\overline{\omega}_{L,t+1})}{1 - \Gamma_{L,t}(\overline{\omega}_{L,t+1})} = \frac{\frac{R^e_{L,t+1}}{R^{mix}_{L,t}}[1 - F_{L,t}(\overline{\omega}_{L,t+1}) - \mu\overline{\omega}_{L,t+1}F'_{L,t}(\overline{\omega}_{L,t+1})]}{1 - \frac{R^e_{L,t+1}}{R^{mix}_{L,t}}[b_{t+1} + \Gamma_{L,t}(\overline{\omega}_{L,t+1}) - \mu G_{L,t}(\overline{\omega}_{L,t+1})]} \tag{19}$$

In order to make debt financing meaningful and avoid unlimited expansion of entrepreneurs' net worth, it is assumed that the survival probability of entrepreneurs in each period is γ, so the death probability of entrepreneurs is $1-\gamma$, and the dead entrepreneurs transfer their assets to their families. At the same time, new entrepreneurs will enter the market in each period and receive transfer payments W_L^e from their families, so the dynamic equation of entrepreneurs L' own funds is:

$$V_{L,t+1} = \gamma\left[1 - \Gamma_{L,t}\left(\overline{\omega}_{L,t+1}\right) - b_{t+1}\right]R^e_{L,t+1}Q_tK_{L,t+1} + W^e_L \tag{20}$$

After removing the price factor from the above formula and dividing both sides of the equation by P_{t+1} at the same time, we can get:

$$v_{L,t+1} = \gamma\left[1 - \Gamma_{L,t}\left(\overline{\omega}_{L,t+1}\right) - b_{t+1}\right]R^e_{L,t+1}q_t\pi^{-1}_{t+1}K_{L,t+1} + W^e_L \tag{21}$$

4.4 Private Enterprises

Private enterprises, similar to state-owned enterprises, are also divided into consumer goods manufacturers H and entrepreneurs H internally. Production department H is responsible for hiring labor and purchasing production materials from capital goods manufacturers to produce consumer goods, while entrepreneurs H are responsible for applying for loans from banks. Different from state-owned enterprises, private enterprises have no implicit guarantee from the government and therefore have relatively high financing costs. The optimization problem faced by consumer goods manufacturer H is:

$$max\ \Pi^y_{H,t} = P_tA_{H,t}K^{\alpha}_{H,t}N^{1-\alpha}_{H,t} - W_{H,t}N_{H,t} - R^K_{H,t}K_{H,t} \tag{22}$$

By calculating the partial derivative of capital $K_{H,t}$ and labor $N_{H,t}$ in the above formula and making $r^K_{H,t} = R^K_{H,t} / P_t, w_{H,t} = W_{H,t} / P_t$, get the first-order conditions: $r^K_{H,t} = \alpha A_{H,t}K^{\alpha-1}_{H,t}N^{1-\alpha}_{H,t}$, $w_{H,t} = (1-\alpha)A_{H,t}K^{\alpha}_{H,t}N^{-\alpha}_{H,t}$. Entrepreneurs H are responsible for the loan financing of private enterprises.

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Similar to state-owned enterprises, the leverage ratio of entrepreneurs H can be expressed as:

$l_{H,t} = \frac{q_t K_{H,t+1}}{v_{H,t}}$, total return on total assets is $R^e_{H,t+1} = \frac{r^K_{H,t+1} + q_{t+1}(1-\delta)}{q_t}\pi_{t+1}$. Since the private enterprises have no implicit guarantee from the government, their critical value is expressed as $\overline{\omega}_{H,t+1} R^e_{H,t+1} l_{H,t} = R^l_{H,t}(l_{H,t} - 1)$. The behavior equation of bank H's lending to private enterprises is:

$$\left[\Gamma_{H,t}\left(\overline{\omega}_{H,t+1}\right) - \mu G_{H,t}\left(\overline{\omega}_{H,t+1}\right)\right] R^e_{H,t+1} l_{H,t} = R^{mix}_{H,t}\left(l_{H,t} - 1\right) \tag{23}$$

$R^{mix}_{H,t} = (1-\tau_{H,t})^{-1} R^D_t - (1-\tau_{H,t})^{-1}\tau_{H,t} R^r_{H,t}$,. The first-order condition of entrepreneurs H, and the net asset accumulation equations are expressed as:

$$\frac{1 - F_{H,t}(\overline{\omega}_{H,t+1})}{1 - \Gamma_{H,t}(\overline{\omega}_{H,t+1})} = \frac{\frac{R^e_{H,t+1}}{R^{mix}_{H,t}}\left[1 - F_{H,t}(\overline{\omega}_{H,t+1}) - \mu\overline{\omega}_{H,t+1} F'_{H,t}(\overline{\omega}_{H,t+1})\right]}{1 - \frac{R^e_{H,t+1}}{R^{mix}_{H,t}}\left[\Gamma_{H,t}(\overline{\omega}_{H,t+1}) - \mu G_{H,t}(\overline{\omega}_{H,t+1})\right]} \tag{24}$$

$$v_{H,t+1} = \gamma\left[1 - \Gamma_{H,t}\left(\overline{\omega}_{H,t+1}\right)\right] R^e_{H,t+1} q_t \pi^{-1}_{t+1} K_{H,t+1} + W^e_H \tag{25}$$

4.5 Final Goods Manufacturer and Intermediate Goods Manufacturer

In order to introduce the setting of price stickiness into the model, intermediate goods manufacturers and final goods manufacturers are introduced, with the former facing monopoly competition and the latter facing perfect competition. The final goods manufacturers Y_t use production technology (Dixit-Stiglitz Aggregator) to produce the final goods as follows:

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{26}$$

Where, $Y_t(j)$ =the intermediate produced by the j-th intermediate manufacturer; and $\mathcal{E}$ =the elasticity of substitution between different intermediate goods.

Under the given production technology, the final goods manufacturer regards the final goods price P_t and the intermediate goods price $P_t(j)$ as given, and the final goods manufacturer selects the intermediate goods input $Y_t(j)$ quantity to produce the final goods to maximize its profit function:

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$$max\ P_t Y_t - \int_0^1 P_t(j)Y_t(j)dj = P_t\left(\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}}dj\right)^{\frac{\varepsilon}{\varepsilon-1}} - \int_0^1 P_t(j)Y_t(j)dj \tag{27}$$

For an intermediate goods $Y_t(j)$, its first-order condition is $Y_t(j)=\left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon} Y_t$. Solving the two-stage problem of intermediate goods manufacturers is also the key setting part of introducing price stickiness into the model. First, intermediate goods manufacturers solve the cost minimization problem to determine their marginal cost MC_t, and then refer to Calvo (1983) pricing method to solve the profit maximization problem, so as to introduce the setting of sticky price [31]. Its objective function is $\max E_t\sum_{i=0}^{\infty}\xi_p\beta^i\frac{\lambda_{t+i}}{\lambda_t}[P_t(j)Y_{t+i}(j)-MC_{t+i}Y_{t+i}(j)]$, in which $Y_t(j)=\left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon} Y_t$, $\beta^i\frac{\lambda_{t+i}}{\lambda_t}$ represents the random discount factor of the intermediate goods manufacturer, and the optimal pricing of the intermediate goods manufacturer meets the first-order condition:

$$(1-\varepsilon)P_t(j)^{-\varepsilon}E_t\sum_{i=0}^{\infty}\xi_p^i\beta^i\lambda_{t+i}P_{t+i}^{\varepsilon}Y_{t+i} + \varepsilon P_t(j)^{-1-\varepsilon}E_t\sum_{i=0}^{\infty}\xi_p^i\beta^i\lambda_{t+i}MC_{t+i}P_{t+i}^{\varepsilon}Y_{t+i} = 0 \tag{28}$$

After simple algebraic operation on the above formula, the optimal pricing expression of intermediate goods manufacturers is further arranged as:

$$P_t^* = \frac{\varepsilon}{\varepsilon-1}\frac{X_{1,t}}{X_{2,t}} \tag{29}$$

$$X_{1,t} = \lambda_t MC_t P_t^{\varepsilon}Y_t + \xi_p\beta E_t X_{1,t+1} \tag{30}$$

$$X_{2,t} = \lambda_t P_t^{\varepsilon}Y_t + \xi_p\beta E_t X_{2,t+1} \tag{31}$$

According to Calvo's (1983) pricing rule [31], the overall price level of intermediate goods meets the relational expression:

$$P_t^{1-\varepsilon} = (1-\zeta_p)(P_t^*)^{1-\varepsilon} + \zeta_p P_{t-1}^{1-\varepsilon} \tag{32}$$

4.6 Governments and the Central Bank

The government collects a tax P_tT_t from households to pay for the government's purchase of P_tG_t, so as to achieve fiscal balance, i.e., $P_tG_t = P_tT_t$, in which $G_t = g_tY_t$, g_t is an exogenous fiscal policy shock. In this model, the central bank has two types of policy instruments: structural monetary policy and aggregate monetary policy. The former includes the directional adjustment of reserve ratio and reserve

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interest rate, while the latter refers to the central bank's policy adjustment by adjusting the deposit interest rate R_t^D for both inflation and economic growth targets, subject to the following Taylor rule:

$$log\, R_t^D = \rho_R\, log\, R_{t-1}^D + (1-\rho_R)[log\, R^D + \Psi_\pi\, log\, \pi_{t-1} + \Psi_y\, log(Y_{t-1}/Y_{t-2})] + \varepsilon_{R,t} \quad (33)$$

4.7 Market Clearing

Assuming that the proportion of state-owned enterprises in the economy is Ψ b and that of private enterprises is $(1-\psi)$, so the total capital and total output in the economy are expressed as:

$$K_t = \psi K_{L,t} + (1-\psi)K_{H,t} \quad (34)$$

$$Y_t = \psi Y_{L,t} + (1-\psi)Y_{H,t} \quad (35)$$

In addition, state-owned enterprises and private enterprises employ undifferentiated labor, which has nothing to do with ownership, that is $N_{L,t} = N_{H,t} = N_t$, the constraint condition of the total resources of the economy is: $Y_t = C_t + I_t + G_t$. According to the above setting, there are 10 exogenous shocks in the model, all of which obey a simple $AR(1)$ process.

4.8 Calibration of Parameters

In this paper, the parameters in the model were calibrated by referring to the existing literature. Referring to Yin Yanhui et al. (2020)' s research, the household subjective discount factor was calibrated to 0.9973[32], and the capital depreciation rate δ was calibrated to 0.025 [28, 30]. According to the research by Ma Jiajin (2018) and Zhou Lei et al. (2021), and in combination with the actual situation in China, the share of capital in the production function α was set to 0.5[29, 33]. It was assumed that labor supply had unit elasticity, i.e. the reciprocal of labor supply elasticity χ was calibrated to 1, and the labor negative effect weight θ was calibrated to 7.5. The parameter ξ_p that affects price stickiness was set to 0.75[34] in this paper based on the research of He Guohua and Wu Jinxin (2016). Referring to the research results of Meng Xianchun et al. (2020), the product substitution elasticity ε was calibrated to 6, and the capital goods production adjustment coefficient ϕ was calibrated to 2[6]. With reference to the research by Peng Yuchao and Fang Yi (2016), the statutory deposit reserve ratio $\tau_{L,t}$ and steady-state value $\tau_{H,t}$ were calibrated to 13.93%, and the reserve deposit interest rate $R_{L,t}^{\tau}$ and steady-state value $R_{H,t}^{\tau}$ were calibrated to 1.0044[35]. Since the probability of bankruptcy of state-owned enterprises is lower than that of private enterprises due to the implicit government guarantee, Ma Jiajin (2018) set the steady-state value F_L of the bankruptcy probability of state-owned enterprises to 0.007 and that F_L of private enterprises to 0.01, which was also adopted in this paper [29]. Referring to the research of Wu Panwen et al. (2017), the reaction coefficient ψ_Y of interest rate to output and that ψ_π of interest rate to inflation were set to 0.5 and 1.5

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respectively [36]. Using (Chris-tensen& Dib, 2008; Bernanke et al., 1999) for reference, the bank supervision cost ratio μ was calibrated to 0.21, and the entrepreneur profit retention ratio γ was calibrated to 0.97[37, 28]. According to the research by the (Research Group of Business Management Department of People's Bank of China, 2017; Ma Jiajin, 2018; Yin Xingshan et al., 2020), the steady-state value of government guarantee ratio b was calibrated to 0.0006, the steady-state value of deposit interest rate R^D to 1.0063, the steady-state value of risk impact σ_ω to 0.28, the proportion of state-owned enterprises in the economy Ψ to 0.5, the household-to-state enterprise transfer payment W_L^e to 0.2953 and the household-to-private enterprise transfer payment W_H^e to 0.0855 [20,29,30]. According to Ma Jiajin's (2018) research, the autoregressive coefficient of all exogenous shocks was calibrated to 0.9 and the standard deviation was calibrated to 0.01[29]. See TABLE III for the calibration values of the above parameters.

TABLE III. Main parameter calibration

Parameters	Economic connotation	Value	Parameters	Economic connotation	Value
α	Share of production function capital	0.5	Ψ	The proportion of state-owned enterprises in the economy	0.5
β	Resident discount rate	0.9937	W_L^e	Household-to-entrepreneur L transfer payments	0.2953
δ	Capital depreciation rate	0.025	W_H^e	Household-to-entrepreneur H transfer payments	0.0855
χ	Reciprocal of labor supply elasticity	1	ψ_Y	The response coefficient of interest rates to output	0.5
θ	Negative effect of labor weight	7.5	ψ_π	The response coefficient of interest rates to inflation	1.5
ϕ	Production adjustment coefficient of capital goods	2	g	Steady-state value of the proportion of fiscal expenditure	0.2
F_H	Probability of bankruptcy of entrepreneur H	0.01	R^D	Steady state value of deposit interest rate	1.0063
F_L	Probability of bankruptcy of entrepreneur L	0.007	ξ_p	Proportion of unchanged price	0.75
b	Steady state value of government guarantee ratio	0.0006	ε	Elasticity of substitution of product	6
σ_ω	Steady state value of risk impact	0.28	γ	Entrepreneur profit retention ratio	0.97
μ	Proportion of bank supervision costs	0.21			

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IV. NUMERICAL SIMULATION

Based on the set dynamic stochastic general equilibrium model, the impulse response was used to analyze the changes of economic and financial variables such as economic output, inflation, interest rate, leverage and so on in case of exogenous shocks.

4.1 The Shock on Soft Budget Constraint Mechanism and Government Guarantee

According to the model set in the previous section, the expression of expected return of investment of state-owned and private entrepreneurs can be obtained after simple algebra operation of financing decisions of state-owned enterprises and private enterprises:

$$E_t R^e_{L,t+1} = \frac{1}{1 + b_{t+1} - \mu[G_{L,t}(\overline{\omega}_{L,t+1}) + \overline{\omega}_{L,t+1} F'_{L,t}(\overline{\omega}_{L,t+1}) \frac{1 - \Gamma_{L,t}(\overline{\omega}_{L,t+1})}{1 - F_{L,t}(\overline{\omega}_{L,t+1})}]} R^{mix}_{L,t} \tag{36}$$

$$E_t R^e_{H,t+1} = \frac{1}{1 - \mu[G_{H,t}(\overline{\omega}_{H,t+1}) + \overline{\omega}_{H,t+1} F'_{H,t}(\overline{\omega}_{H,t+1}) \frac{1 - \Gamma_{H,t}(\overline{\omega}_{H,t+1})}{1 - F_{H,t}(\overline{\omega}_{H,t+1})}]} R^{mix}_{H,t} \tag{37}$$

Comparing the expression of expected return between state-owned enterprises and private enterprises, the state-owned enterprises have an additional proportion b_{t+1} of government guarantee in the denominator, which is inversely proportional to the expected return of investment, thus, $R^e_{H,t} > R^e_{L,t}$. When the economy is in a steady state and its vicinity, the capital stock of state-owned enterprises is higher than that of private enterprises, resulting in the low efficiency of the allocation of production capital.

As the soft budget constraint is a distortion of normal market mechanism, how will reducing or eliminating the soft budget constraint affect the economy? Figure 3 shows the impact of the negative impact of the government guarantee ratio on the main economic and financial variables by one unit, that is, the degree of soft budget constraint decreases by one standard deviation will lead to an increase in financing costs of state-owned enterprises, a decrease in loan demand, a decrease in expenditure on capital and labor, and a decrease in the output Y_l of state-owned enterprises. As the degree of soft budget constraint decreased, more credit resources in the economy flowed to private enterprises, the financing cost of private enterprises decreased, the financing demand increased, the expenditure on capital and labor increased, and the output Y_h of private enterprises increased, but the increase in output of private enterprises was smaller than the decrease in output of state-owned enterprises, and the total output Y of the economy decreased. At this time, there was downward pressure on the economy. At the same time, under the impact of the negative guarantee from the government, the leverage ratio lev_l of state-owned enterprises began to decrease, while that lev_h of private enterprises increased, and the structural high leverage in the economy

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was solved. Referring to the research results of Liu Yinan and Song Xiaoling (2018) [14], the parameter "Output of State-owned Enterprises/Output of Private Enterprises (DDES)" was selected to measure the degree of distortion of economic structure, because the excessive prosperity of state-owned enterprises represented by real estate and local financing platforms will squeeze out the resources of private enterprises and aggravate the imbalance of economic structure. As shown in Fig. 3, the reduction of government guarantee has prompted banks to gradually incline their credit resources to private enterprises, and the output of private enterprises has increased in proportion to the total output of the economy. At this time, the distortions caused by soft budget constraints in the economy have been alleviated.

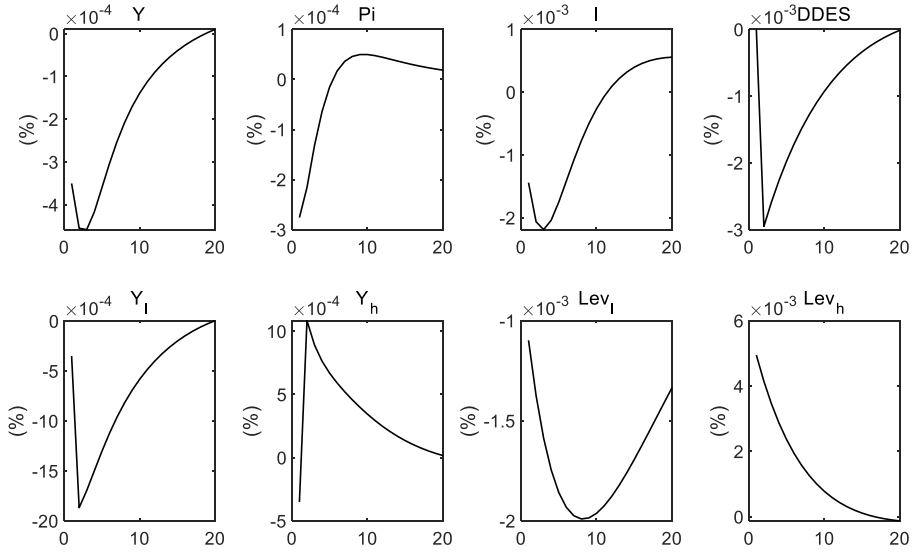

Fig. 3 Impact of government guarantee shock on main economic and financial variables

4.2 Risk Shock

When the economy is impacted by exogenous risks, the operating efficiency of enterprises will be reduced and the financial cost will deteriorate, which will directly promote the rise of corporate loan default rate. As a result, banks will increase their loan interest rates and corporate financing costs will rise with the increase of loan interest rates. Eventually, enterprises will reduce their expenditure on capital and labor, and the scale of production will be reduced, thus reducing the level of investment and output in the economy.

In comparisons with $\psi = 0.2$, $\psi = 0.5$, and $\psi = 0.8$, that is, when the scope of government guarantee is expanded, the fluctuation range of economic and financial variables such as total output Y, investment I, capital stock K, and enterprise leverage ratio $(Lev_l、Lev_h)$ will decrease, the downward pressure on the current economy will decrease, and the financial stability will be enhanced, because the existence of implicit government guarantee plays an important role in the economy. However, implicit government guarantee will also lead to some adverse effects. For example, enterprises with soft budget

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constraints that should have gone bankrupt and liquidated can continue to survive with the help of the government, and the market cannot be cleared effectively, resulting in a series of serious problems such as zombie enterprises, high structural leverage and overcapacity. In addition, although the expansion of the scope of government guarantees can reduce the negative impact on the economy in the current period, it will also lead to the rapid growth of government debt, and the risk of local debt is likely to be converted into systemic financial risk, laying a hidden danger for the long-term development of the economy.

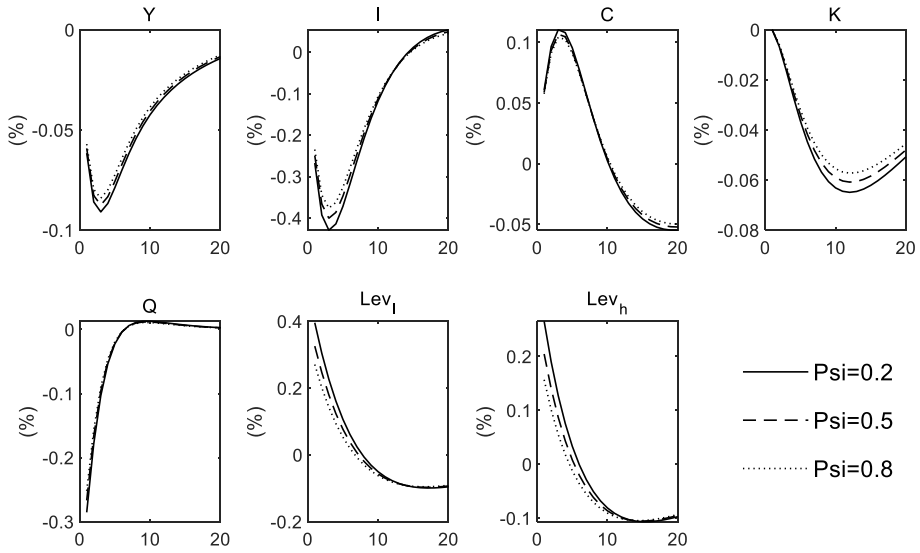

Fig. 4 Impact of risk shock on major economic and financial variables

4.3 Tight Monetary Policy

Figures 5 and 6 show the impact of the central bank's tight interest rate on major economic and financial variables. The central bank's tightening of interest rates will lead to a decrease in total output Y, asset prices Q, investment I, consumption C and capital stock K of the economy, a decrease in inflation Pi, and an increase in the leverage ratio Lev_l Lev_h of state-owned enterprises and private enterprises. At this time, downward pressure on the economy will increase. The economic mechanism set according to the model and sorted out in Figs. 5 and 6 is as follows: when the central bank raises the policy interest rate, the bank financing cost rises R_d. In order to maintain normal operation, commercial banks are bound to raise the loan interest rate $(R_L$、$R_h)$, which will lead to an increase in the financing cost of enterprises, thus weakening the enthusiasm of enterprises for investment, reducing the expenditure on capital and labor and reducing the output. Interest rate shocks have a disincentive to investment I and consumption C, reducing aggregate demand in the economy and thus exerting downward pressure on inflation Pi. Interest rate shocks act on corporate leverage ratio $(Lev_l$、$Lev_h)$ from two aspects. On the one hand, the increase of interest rate makes asset prices decline, and enterprises will reduce the purchase of capital due to the increase of financing costs. The combined effect of these two aspects will inhibit corporate leverage ratio.

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On the other hand, the increase of interest rate will reduce enterprise's own capital $(V_l、V_h)$, thus stimulating the increase of leverage ratio. The latter is more powerful than the former, so the central bank's tight monetary policy will not reduce the leverage ratio of enterprises, but will push up the leverage ratio of enterprises. At the same time, due to the soft budget constraints of state-owned enterprises, there are differences in the impact of monetary policy on state-owned enterprises and private enterprises, which is specifically manifested in the fact that the government's backing when the central bank tightened interest rates prevented the output of state-owned enterprises from falling too fast. However, private enterprises do not have such conditions, so the decline in output will be more severe when monetary policy is tightened, and the degree of economic distortion will be further aggravated $(DDES\uparrow)$. In summary, the aggregate-based tight monetary policy not only cannot effectively solve the structural high-leverage problem faced by the economy, but will further squeeze out the output of private enterprises and intensify the distortion of economic structure.

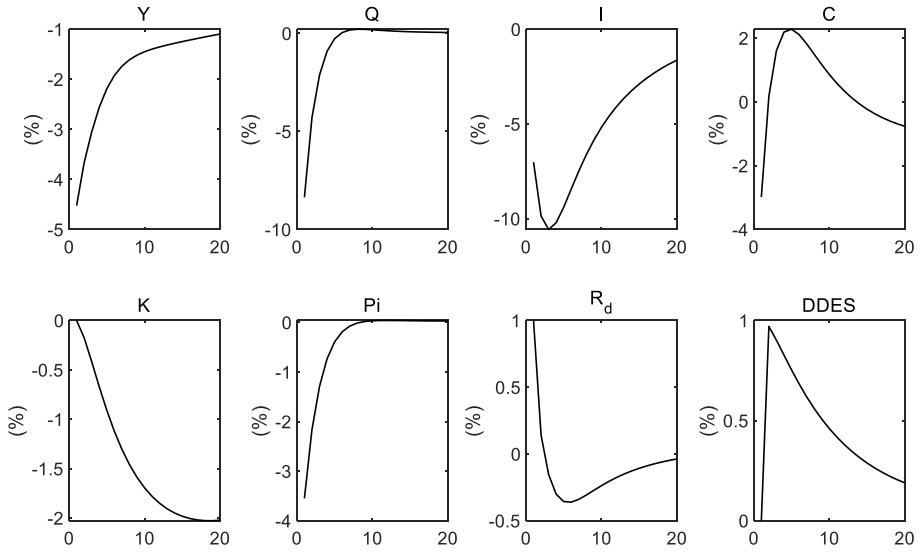

Fig. 5 Impact of interest rate shock on major financial and economic variables

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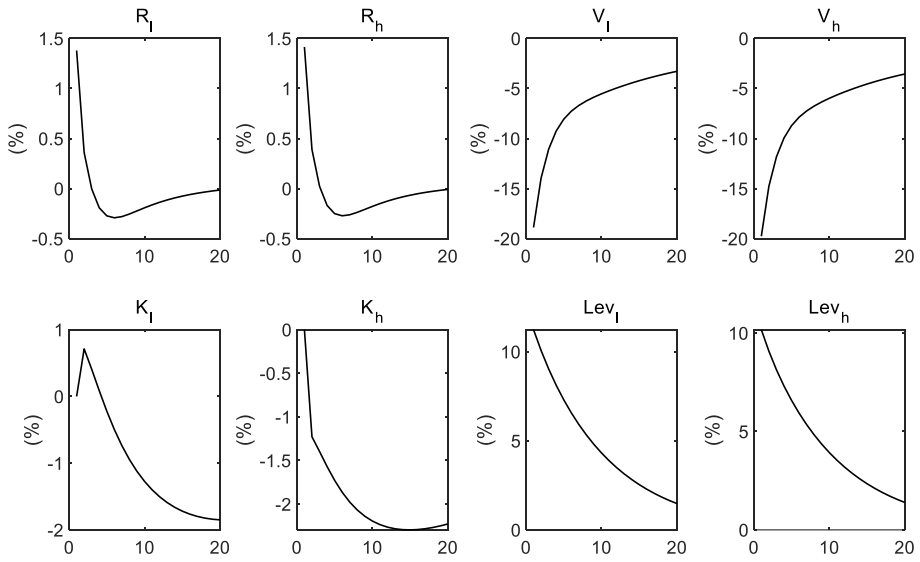

Fig. 6 Impact of interest rate shock on enterprise leverage ratio

4.4 Structural Monetary Policy

Generally speaking, increasing the credit supply to private enterprises is conducive to stimulating the vitality of the market and effectively allocating credit [2]. Figures 7 and 8 show the impact of the central bank's directional adjustment of deposit reserve on the economy. When the central bank directionally reduces the deposit reserve ratio for bank H that lends to private enterprises, the loan cost of private enterprises decreases and the demand for loans increases, thus increasing the expenditure of private enterprises on capital and labor and the output of private enterprises. Private enterprises have increased their demand for capital due to the reduction of financing costs, which has led to an increase in capital prices Q, a decrease in the production enthusiasm of state-owned enterprises $(K_l \downarrow)$, a decrease in the output of state-owned enterprises, a decrease in the degree of distortion in the economy, an increase in the output of private enterprises more than a decrease in the output of state-owned enterprises, and an increase in the total output of the economy. The targeted cuts to required reserve ratios of the central bank will stimulate consumption and investment, and increase the total demand in the economy, resulting in slight inflation, and the economy is in an upward trend. At the same time, under the control of the central bank's structural monetary policy, the leverage ratio of state-owned enterprises has decreased significantly, while the leverage ratio of private enterprises has increased slightly. The structural leverage problem in the economy has been effectively alleviated and financial stability has been enhanced. Figures 7 and 8 also show the results of the tightening monetary policy implemented by the central bank (increasing the deposit quasi-principal ratio of commercial bank L). Under the influence of this policy, the cost of loans to state-owned enterprises increased, which led to a decrease in output due to the decrease in labor and capital expenditures. At the same time, the decrease in capital prices made it a good time for private enterprises to expand their production scale $(K_h \uparrow)$. As a result, the output of private enterprises increased, but the

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increase was smaller than the decrease in the output of state-owned enterprises, the total output of the economy decreased, and the economy was under downward pressure. Similarly, the directional increase of the deposit reserve ratio of commercial bank L can also effectively solve the problem of leverage imbalance in the economy, but the policy effect is slightly worse than that of reducing the deposit reserve ratio of commercial bank H.

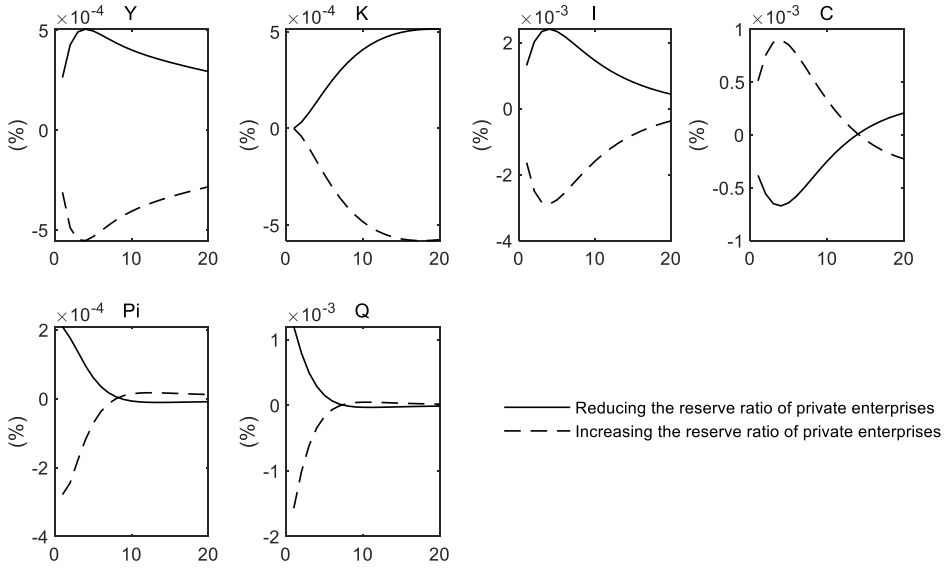

Fig. 7 Impact of central bank's adjustment of reserve interest rate on major financial and economic variables

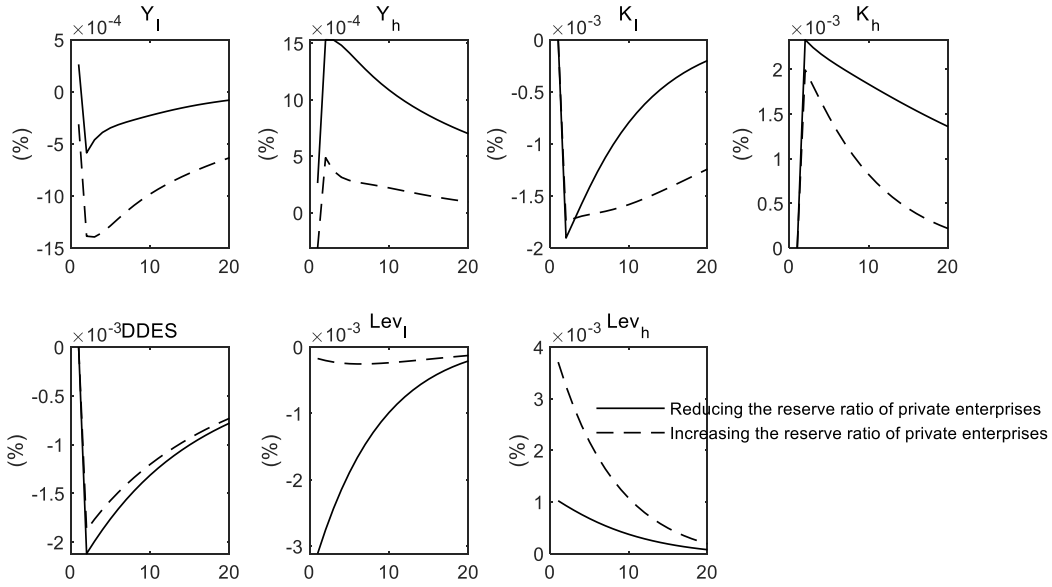

Fig. 8 Impact of central bank's adjustment of reserve ratio on major economic and financial variables

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4.5 Policy Effects under Different Economic Structures

With the expansion of the scope of government guarantees, the central bank increases the benchmark interest rate, and the decline in total social output Y is reduced. Due to the soft budget constraints of state-owned enterprises, the capital decline of state-owned enterprises K_l is significantly smaller than that of private enterprises K_h, and the increase of enterprise leverage ratio decreases with the expansion of government guarantee scope. On the whole, the government guarantee weakens the effect of monetary policy tightening, as is shown in Figures 9.

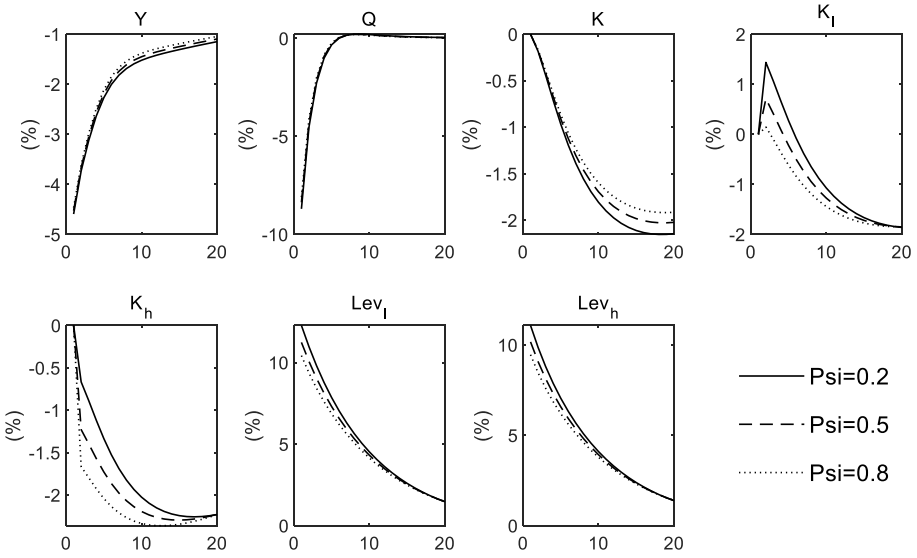

Fig.9 Impact of monetary policy shock under different economic structures

4.6 Welfare Analysis

Since the financial crisis in 2008, scholars have realized that high leverage is an important inducement of systemic financial risks. In the traditional monetary rules, the central bank implements the monetary policy mainly by responding to the two goals of economic growth and inflation, and then adjusting the deposit interest rate R_d, and lacks the response to the leverage ratio of non-financial enterprises. In this paper, referring to the research ideas of Faia &Monacelli(2007) and on the basis of the traditional Taylor rule, it is assumed that the central bank will respond to the leverage ratio of non-financial enterprises[38] , which is specifically expressed as:

$$\log R_t^D = \rho_R \log R_{t-1}^D + (1-\rho_R)[\log R^D + \Psi_\pi \log \pi_{t-1} + \Psi_y \log(Y_{t-1}/Y_{t-2}) - \Psi_{Lev_l} \log(Lev_{l,t-1}/Lev_{l,t-2})] + \varepsilon_{R,t} \quad (38)$$

$$\log R_t^D = \rho_R \log R_{t-1}^D + (1-\rho_R)[\log R^D + \Psi_\pi \log \pi_{t-1} + \Psi_y \log(Y_{t-1}/Y_{t-2})$$

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$$-\Psi_{Lev\_h}\, log(\, Lev_{h,t-1}/Lev_{h,t-2})] + \varepsilon_{R,t} \quad (39)$$

Where, Lev_l =the leverage ratio of state-owned enterprises; Lev_h =the leverage ratio of private enterprises; Ψ_{Lev} = the response of monetary policy to the leverage ratio of non-financial enterprises, and the negative coefficient in front of it reflects the idea of counter-cyclical adjustment. Referring to the research of Ma Yong and Fu Li (2020), the response coefficient of monetary policy to the leverage ratio of state-owned enterprises and private enterprises was set to 0.5[39].

Drawing on the research of Galí(2015), the economic fluctuation range was used to measure the degree of welfare loss in the economy[40], which is specifically expressed as:

$$WelfareLoss_t = \lambda\sigma_{yt}^2 + (1-\lambda)\sigma_{\pi t}^2 \quad (40)$$

Where, λ=the loss weight; σ_{yt}^2 =the variance of output; $\sigma_{\pi t}^2$ =the variance of inflation rate. In this paper, equal weight is assumed, that is $\lambda = 0.5$ .TABLE I shows the size of welfare losses under different monetary rules. Compared with traditional monetary rules, when monetary authorities consider the leverage ratio of non-financial enterprises, they can stabilize economic fluctuations and reduce welfare losses. Compared with the leverage ratio of private enterprises, the monetary policy considering the leverage ratio of state-owned enterprises has lower welfare loss.

TABLE IV Welfare loss

	Variance of output	Variance of inflation rate	Welfare loss
Traditional monetary rules	0.1858	0.0020	0.0939
Pegging to the leverage ratio of private enterprises	0.1296	0.0016	0.0656
Pegging to the leverage ratio of state-owned enterprises	0.1254	0.0016	0.0635

V. CONCLUSION AND SUGGESTION

In this paper, a dynamic stochastic general equilibrium (DSGE) model was constructed, covering micro-subjects, such as households, enterprises, commercial banks, central banks and the government. Through numerical simulation, the impact of government guarantee shocks and risk shocks on economic and financial fluctuations was analyzed. Furthermore, the actual economic effects of deleveraging policy were analyzed by counterfactual facts, and the following main conclusions were drawn:

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Under the negative impact of government guarantee, the structural high leverage problem in the economy has been alleviated but with a downward pressure at this time. Under the risk shock, the expansion of the government's implicit guarantee can stabilize the economic fluctuation to a certain extent and increase the current financial stability. However, it will also lay a hidden danger for the economy, because the enterprises that should have been eliminated under the risk impact can continue to survive with the help of the government, and the market cannot be cleared out effectively, resulting in a series of adverse effects such as rising inventory and overcapacity. At the same time, the expansion of the scope of soft budget constraints will also lead to the rapid accumulation of government debt, which will increase the possibility of systemic financial risks in the future economy. An overall tightening of interest rates by the central bank will not only fail to effectively solve the structural high-leverage problem faced by the economy, but further squeeze out the output of private enterprises and intensify the distortion of economic structure. When the central bank adopts the structural monetary policy to adjust the deposit reserve ratio of state-owned enterprises and private enterprises, the structural problem of high leverage is alleviated and the degree of economic distortion is reduced. The tightening effect of monetary policy has been weakened with the expansion of enterprises with soft budget constraints. The welfare analysis shows that when monetary policy responds to the leverage ratio of non-financial enterprises, it can stabilize the economic fluctuation and reduce the social welfare loss. Compared with pegging to the leverage ratio of private enterprises, the welfare improvement effect of monetary policy considering the leverage ratio of state-owned enterprises is more significant.

Based on the above conclusions and enlightenment, the following suggestions are put forward. Firstly, the reform of state-owned enterprises should be deepened, soft budget constraints should be hardened, and price distortions should be gradually eliminated. The soft budget constraints are likely to lead to the excessive support of the banking sector for state-owned enterprises, which affects the fair competition of enterprises and hinders the normal clearing of the market. Therefore, it is necessary to break the implicit guarantee of local governments for state-owned enterprises through the supply-side structural reform, fundamentally eliminate the soft budget constraints, and highlight the decisive role of the market in credit resources. These are the key to promote the high-quality development of China's economy. In the meantime, enterprises with soft budget constraints have undertaken national policy tasks. In order to avoid the great fluctuation of the economy in the process of eliminating the soft budget constraint, the government authorities should pay close attention to the economic operation in real time during the reform process, and take corresponding measures to avoid the great economic shock caused by the reform of state-owned enterprises. Secondly, as the leverage ratio of non-financial enterprises in our country has the dual attributes of "aggregate" and "structure", relying solely on traditional policy instruments can not only solve the problem of structural high leverage, but also aggravate it. Therefore, it is necessary to avoid the "one-size-fits-all" comprehensive tightening policy, and to effectively solve the structural high leverage problem of the current economy by implementing the structural monetary policy and combining it with fiscal policy and industrial policy.

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